Hip Fracture Risk Among Community-Dwelling Elderly People in the United States: A Prospective Study of Physical, Cognitive, and Socioeconomic Indicators

Robin Taylor Wilson, PhD, Gary A. Chase, PhD, Elizabeth A. Chrischilles, PhD, and Robert B. Wallace, MD, MS

Objectives. We determined risks of short-term (2-year) hip fracture in a nationally representative, prospective cohort of community-dwelling elderly people 70 years or older.

Methods. We used self-report data from 2 waves of the Asset and Health Dynamics Survey (n = 5630). Sample-weighted logistic regression analyses were conducted to determine risk of hip fracture in relation to several demographic, cognitive, physical, and socioeconomic indicators.

Results. During the 2-year study period, 102 participants reported a new hip fracture. Several indicators of physical functioning and cognitive status, including incorrect delayed word recall and inability to lift 10 lbs (4.5 kg), were significantly associated with hip fracture risk. In the final model, mobile home residents, individuals without Medicare part B insurance, and those without a high-school diploma were at more than a 2-fold risk of hip fracture. Educational level, physical functioning, and insurance status were the top 3 contributors to hip fracture risk.

Conclusions. In addition to functional status measures, health insurance status, educational level, and type of residence appear to be independent predictors of hip fracture. (*Am J Public Health.* 2006;96:1210–1218. doi:10.2105/AJPH.2005.077479)

Hip fracture is one of the most serious and debilitating injuries among older individuals. The 1-year mortality rate among elderly people after a hip fracture is 20%, and a significant proportion of survivors are admitted to nursing homes, approximately half with permanently limited physical functioning.[1,2] After the age of 65 years, half of White women and one quarter of White men will sustain at least 1 osteoporotic fracture.[3] In addition, expenditures on hip fractures and their related medical care are increasing. Projections suggest that health care expenditures related to hip fracture, which were at a level of $2.9 billion in 1991, are expected to exceed $20 billion per year as of 2006.[4–8]

During the past 3 decades, several countries have seen an increase in the age-adjusted incidence of trochanteric hip fractures, and at least 1 analysis has reported an increase in successive birth cohorts, suggesting that factors other than those generally associated with aging are playing a role.[9–14] Factors commonly associated with hip fracture among the elderly include female gender, White race, advanced age, osteoporosis, previous hip fracture, level of physical functioning, medication use, and hormonal and dietary factors.[15] Other measures of short-term risk among community-dwelling elderly people, particularly those that are relatively simple to administer in the clinic or via telephone, may be important in promoting hip fracture prevention. We assessed short-term (2-year) hip fracture risks among a representative sample of elderly African Americans, Hispanics, and non-Hispanic Whites residing in the United States.

METHODS

We used self-report data from 5630 community-dwelling elderly people 70 years or older who were taking part in the Asset and Health Dynamics Survey (AHEAD). These individuals reported their health status at 2 time points: baseline (wave I; 1993) and follow-up (wave II; 1995). The AHEAD cohort has been described in detail elsewhere.[16] Briefly, the AHEAD target population included noninstitutionalized individuals born in 1923 or earlier. Individuals aged 70 through 79 years were identified via an area probability sampling frame (i.e., the population was divided into groups or clusters from which a random sample of clusters was drawn and subsequently sampled). Half of those 80 years or older were identified (through area probability sampling) by means of a telephone screening, and the other half were identified from a list of enrollees provided by the Centers for Medicare and Medicaid Services. Proxy respondents (husbands or wives) could provide responses in cases in which the target respondent was too ill to do so.

The sampling frame of the Centers for Medicare and Medicaid Services, from which race/ethnicity information is available, was used to oversample Hispanic, African American, and Florida residents so that subgroup analyses could be conducted. Telephone interviews were conducted with individuals aged 70 to 79 years, and in-person interviews were conducted with those 80 years or older. A computer-aided personal and telephone interview system was used in recording participants' responses.

Questionnaire

At wave I, participants answered questions regarding their age, gender, race/ethnicity, place of residence, number of biological children, income and net worth, housing status, health insurance status, medical conditions, and physical functioning. They also completed cognitive and depression indices. Those reporting that they were Hispanic/White or Hispanic/African American were classified as Hispanic. Respondents' reports of the location of their primary residence were used to code metropolitan statistical areas and geographical regions of residence in

relation to the 9 geographical regions of the country defined by the US Census Bureau (Pacific, Mountain, West North Central, West South Central, East North Central, East South Central, South Atlantic, Middle Atlantic, New England).

Household income was computed through a series of questions on gross income derived from employment, retirement benefits, and investments. Net worth was calculated as assets minus debts. Housing data collected included type of housing structure, monetary value of the home (in 1993 dollars), whether or not the home was part of a farm, and an overall self-perceived housing quality rating (excellent, very good, good, fair, or poor). Health insurance status was determined as Medicare part B, Medicaid, Medigap, basic, or other supplemental coverage. Individuals reporting that they did not have Medicare part B, Medigap, basic health, or other supplemental insurance were classified as having no supplemental insurance coverage.

Impairments in activities of daily living (ADLs) and instrumental ADLs (IADLs) were defined as "needing help" or "having difficulty" with these tasks. ADLs included walking across a room, getting dressed, bathing, eating, getting in and out of bed, and using the toilet. IADLs included shopping for groceries, preparing a meal, using the telephone, taking medicine, and managing household finances. Other physical functioning measures included walking several blocks, lifting 10 lbs (4.5 kg), pushing large objects, climbing a flight of stairs, and picking up a dime from a table. In the case of all ADLs, IADLs, and other physical functioning measures, individuals reported whether they "could not" (for medical reasons) or "did not" undertake the activities of interest.

Medical conditions determined through self-reports at wave I included arthritis (within the past 12 months), blindness, cataracts, hypertension or high blood pressure (physician diagnosis), incontinence, hip or other joint replacement (within the past 5 years), myocardial infarction (within the past 5 years), pain (often), stroke (ever), previous hip fracture, and previous fall (within the past 12 months). Respondents were asked to list any other health problems not included in the questionnaire. The conditions reported included osteoporosis, sensorineural problems (headaches, dizziness, sciatica, memory loss), and paralysis (form unspecified).

Cognitive tests included global cognitive measurements, word recall, and serial subtraction. The global cognitive score was derived from the Telephone Interview for Cognition Status (TICS), a validated adaptation of the Folstein Mini-Mental Status Examination.[17] On the TICS, respondents were asked to list the day, month, year, date, current president, and current vice president. Also, they were asked to "name the object that people usually use to cut paper," "name the prickly plant that grows in the desert," and count backward from 20. Each correct answer was assigned a score of 1, with the exception of counting backward, which was assigned a score of 2 on the first attempt and a score of 1 if a correct response was provided on the second attempt; thus, the total possible TICS score was 10.

In the case of word recall, participants were asked to memorize a list of 10 nouns and then immediately asked to recall the list. After a delayed interval during which several other questions were asked, participants were asked again to recall the list of words. The total number of words correctly recalled and the total number of words "recalled" that had never been mentioned were recorded for both the immediate and delayed responses. Incorrect delayed or immediate word recall was defined as mentioning 1 or more words that had not been listed. The number of incorrect words was recorded. Correct word recall was defined as the number of words recalled that matched those in the list.

Depressive symptoms were scored through a nonweighted, 8-item (score range: 0 to 8) truncated version of the Center for Epidemiologic Studies Depression Scale (CES-D-8).[18,19] The CES-D has been validated with multiethnic populations.[20,21] On this instrument, respondents were asked to describe how they had felt "much of the time during the past week" (depressed, everything was an effort, my sleep was restless, happy, lonely, interested in things, enjoyed life, felt sad, could not get going, had a lot of energy). Individuals scoring 2 standard deviations above the control group's (individuals without hip fracture) unweighted mean CES-D-8 score (i.e., a score of 6 or above on the positively adjusted scale) were classified as having depressive symptoms.

Statistical Analysis

As a result of their small numbers, we excluded wave I participants who had used proxy respondents and those identifying themselves as members of racial/ethnic groups other than Hispanic, Black/African American, or White from the analyses. Proxy respondents were excluded because we wanted to minimize response error and because these respondents were not asked to provide information on cognitive status or depressive symptoms. In order to account for the survey's sample design, respondent-level population weights were used in calculating mean population characteristics.

We determined the statistical significance ($P<.05$) of 2-year hip fracture risk (i.e., hip fractures occurring between waves I and II) odds ratios (ORs) in relation to risk factors assessed at baseline (wave I) using univariate and multivariate models and 2-sided χ^2 tests. We used sample-weighted logistic regression analyses (Proc SurveyLogistic, SAS, SAS Institute, Cary, NC) to adjust for multiple risk factors and to account for the oversampling strategy of AHEAD's survey design.

We constructed a multivariate model to determine the variables exhibiting the greatest independent effects. The criterion for entry of a variable into the multivariate model was a P value of at least .25 for the unadjusted association with hip fracture risk. While constructing the final model, we included commonly recognized factors associated with hip fracture, such as age, gender, race/ethnicity, previous hip fracture, osteoporosis, smoking, and alcohol use, whether or not they were shown to be statistically significant. We constructed the multivariate model by initially including biological/clinical factors and then entering, in order, physical functioning, depression, cognition, and socioeconomic indicators (income, education, and housing variables). Among the physical functioning variables that were highly correlated (Pearson $r>0.50$), specific constructs (e.g., using furniture to get around a room) were preferred for inclusion in the final model over less specific constructs (e.g., difficulty walking).

TABLE 1—Baseline Sample Characteristics and Hip Fracture Odds Ratios: Asset and Health Dynamics Survey, 1993–1995

	Sample Weighted %	No. of Respondents	No. of Hip Fractures	Adjusted Odds Ratio[a] (95% Confidence Interval)
Age, y				
70–74	58.9	2276	16	Reference
≥75	41.1	3363	86	3.2 (1.79, 5.84)
Gender				
Female	64.9	3537	79	1.9 (1.10, 3.15)
Male		2093	23	Reference
Race/ethnicity				
African American	9.3	723	5	0.3 (0.12, 0.83)
Hispanic	3.5	282	4	0.8 (0.30, 2.39)
Non-Hispanic White	87.2	4625	93	Reference
Marital status				
Married	50.5	2858	31	Reference
Widowed	41.2	2281	64	1.7 (1.02, 2.86)
Never married	5.2	167	4	1.4 (0.47, 4.46)
Health characteristics				
Body mass index, kg/m^2				
≤23.4	32.1	1750	45	1.3 (0.77, 2.15)
23.5–26.6	33.8	1911	30	Reference
≥26.7	33.3	1921	26	1.1 (0.64, 1.98)
Fall within previous 12 mo	24.2	1362	43	1.8 (1.17, 2.77)
Previous hip fracture	4.2	233	19	3.3 (1.78, 5.97)
Comorbid condition				
Arthritis	25.1	1429	30	1.1 (0.68, 1.72)
Blindness	0.8	42	4	2.6 (0.81, 8.30)
Cataracts	27.3	1527	47	1.5 (0.93, 2.40)
Depressive symptoms	6.0	349	12	1.7 (0.88, 3.29)
Hypertension/high blood pressure	49.6	2754	52	0.9 (0.59, 1.37)
Incontinence	19.1	1034	22	0.9 (0.56, 1.53)
Hip replacement	3.7	187	7	0.5 (0.18, 1.24)
Osteoporosis	1.4	71	4	1.9 (0.64, 5.90)
Pain	31.3	1749	42	1.1 (0.70, 1.69)
Paralysis	0.2	7	2	9.5 (1.45, 62.21)
Stroke	6.5	364	10	1.4 (0.69, 2.88)
Transient ischemic infarction	1.8	96	3	1.8 (0.50, 6.55)
Difficulties with ADLs[b]				
Walking across a room	18.8	1109	47	2.6 (1.62, 4.16)
Getting dressed	8.9	519	22	1.9 (1.10, 3.17)
Bathing	8.0	465	25	2.9 (1.69, 5.03)
Eating	2.7	151	8	2.2 (0.90, 5.26)
Getting in and out of bed	5.9	358	16	2.0 (1.04, 3.71)
Using the toilet	2.4	139	4	1.3 (0.40, 4.03)
Any ADLs	24.2	1405	55	2.6*** (1.67, 4.11)

Continued

Because variables with high correlations violate the assumptions of logistic regression, the Pearson correlation between any 2 variables in the final model was restricted to 0.50 or less. We used survey-weighted logistic regression (Proc Logistic, SAS) to calculate the Hosmer–Lemeshow goodness-of-fit *P* values in order to determine the fits of all preliminary models and the fit of the final regression model. Because we found that housing characteristics remained significant in several of the models, we included net worth, which was of borderline statistical significance, in the final model. We tested the statistical significance of trends (2-sided) in odds ratios by conducting multiple logistic regression analyses of a single categorical variable (with values of 0, 1, 2, 3, and so forth) representing the corresponding ordinal categories of the variable of interest.

We calculated the population-attributable risk percentage for each variable included in the multivariate model using the method outlined by Miettinen and expanded on by Hanley.[22,23] According to the Hanley approach, the attributable risk estimate is weighted by the distribution of cases in the population. The population-attributable risk percentage approximates the percentage of cases in the population that can be attributed to the risk factor of interest.

RESULTS

Of the 6565 wave I African American, Hispanic, and non-Hispanic White respondents 70 years or older, 935 did not respond at wave II. Of these 935 individuals, 578 (61.8%) were lost to follow-up because they had died, resulting in an overall response rate of 85.8% at wave II. Thus, data from 5630 respondents were available for the present analyses. Loss to follow-up for reasons other than death was not associated with gender (*P*=.41) or age (*P*=.71; data not shown).

At baseline, 4.2% and 24.2% of respondents (population-weighted percentages; Table 1) reported histories of hip fractures and falls, respectively. Between baseline and follow-up, 102 respondents reported a hip fracture, corresponding to a sample-weighted percentage of 1.8% (95% confidence interval [CI]=1.46%, 2.13%) for the study interval.

TABLE 1—*Continued*

Difficulty with instrumental ADLs				
Shopping for groceries	12.1	714	31	1.9 (1.12, 3.08)
Preparing a meal	4.64	284	16	2.1 (1.08, 3.99)
Using the telephone	2.1	134	5	1.4 (0.51, 3.97)
Managing household finances	12.0	703	24	1.7 (0.97, 2.89)
Taking medication	1.5	91	3	1.0 (0.25, 3.78)
Any instrumental ADLs	23.0	1341	43	1.8** (1.12, 2.79)
Physical functioning				
Fine motor functioning: picking up a dime from a table				
Can't do	0.4	21	0	. . .
Difficulty doing	6.7	392	16	2.1 (1.15, 3.83)
No difficulty	92.8	5206	86	Reference
Walking several blocks				
Can't do	7.4	412	21	2.9 (1.57, 5.41)
Difficulty doing	23.0	1266	30	1.7 (1.03, 2.96)
Don't do	2.3	130	2	1.1 (0.24, 5.01)
No difficulty	67.4	3620	41	Reference
Lifting 10 lb				
Can't do	8.8	52	26	3.1 (1.75, 5.59)
Difficulty doing	20.1	111	30	1.7 (1.99, 2.88)
Don't do	2.5	145	3	1.3 (0.41, 4.41)
No difficulty	68.6	3837	43	Reference
Pushing large objects (e.g., furniture)				
Can't do	10.8	575	23	2.2 (1.27, 3.97)
Difficulty doing	16.3	877	18	1.3 (0.71, 2.31)
Don't do	5.4	282	10	2.3 (1.04, 4.90)
No difficulty	67.5	3661	43	Reference
Climbing 1 flight of stairs				
Can't do	5.5	311	17	2.6 (1.33, 4.97)
Difficulty doing	15.3	853	19	1.3 (0.60, 3.25)
Don't do	3.1	202	7	1.4 (0.50, 3.25)
No difficulty	76.0	4054	51	Reference
Using form of assistance to get around a room				
Walker	4.8	289	15	1.5 (0.74, 3.06)
Cane	11.0	656	29	2.3 (1.37, 3.94)
Furniture	0.2	15	3	13.3 (3.23, 54.48)
Cognitive functioning				
Incorrect immediate word recall score				
0	86.1	4693	79	Reference
1	12.0	669	14	1.2 (0.68, 2.30)
2	1.4	80	1	0.4 (0.04, 3.24)
3	0.5	32	2	5.5 (1.15, 25.98)
Incorrect delayed word recall score				
0	84.7	4587	76	Reference
1	12.8	696	9	0.8 (0.41, 1.75)
2	2.0	115	6	3.5 (1.44, 8.28)
3	0.5	29	3	10.7** (2.66, 43.19)

Continued

After adjustment for age, gender, race/ethnicity, and previous hip fracture, respondents older than 75 years were at significantly elevated risk of hip fracture compared with those aged 70 to 74 years (OR=3.2; 95% CI=1.79, 5.84), women were at significantly elevated risk compared with men (OR=1.9; 95% CI=1.10, 3.15), and widows were at significantly elevated risk compared with married respondents (OR=1.7; 95% CI=1.02, 2.86). African Americans were less than one third as likely to experience a hip fracture as non-Hispanic Whites. The association between nulliparity and hip fracture risk was not significant among women overall (OR=0.7; 95% CI=0.39, 1.40), and the same was true among non-Hispanic White women in particular (OR=0.7; 95% CI=0.36, 1.42; data not shown).

Histories of falls (OR=1.8; 95% CI=1.17, 2.77) and hip fractures (OR=3.3; 95% CI=1.78, 5.97) were significantly associated with elevated hip fracture odds (Table 1). Also, in terms of the self-reported medical conditions assessed, individuals reporting any type of paralysis (OR=9.5; 95% CI=1.45, 62.21) were at significantly elevated risk. In comparison with no alcohol intake, moderate alcohol intake (2 drinks per day) was associated with a reduced likelihood of hip fracture (OR=0.2; 95% CI=0.05, 0.76), although there was no trend associated with specific number of drinks consumed. There were no statistically significant associations between hip fracture risk and smoking status (current, past, or never) and total number of cigarettes smoked per day (data not shown).

Several ADL and IADL measures were associated with increased hip fracture odds, including receiving assistance with or difficulty in walking across a room, getting dressed, bathing, getting in and out of bed, shopping for groceries, and preparing a meal. Odds ratios for individuals experiencing difficulties in these areas (vs those not experiencing difficulties) ranged from 1.9 to 2.9 after adjustment for age, gender, race/ethnicity, and previous hip fracture (Table 1). Other self-reported gross and fine motor skill functions associated with hip fracture included difficulty picking up a dime from a table and inability to walk several blocks, lift 10 lb, push large objects across a room, or climb a flight

TABLE 1—*Continued*

Telephone interview cognition score				
0–7	12.7	803	25	2.1* (1.14, 3.87)
8	10.6	620	15	1.5 (0.77, 3.00)
9	25.3	1417	27	1.2 (0.69, 2.01)
10	51.4	2755	35	Reference
Socioeconomic characteristics				
Type of residence				
Mobile home	6.5	396	12	2.3 (1.16, 4.59)
Apartment	17.7	1050	28	1.4 (0.88, 2.36)
House, duplex, or town home	75.1	4146	62	Reference
Health insurance coverage				
Medicaid	8.0	520	9	0.9 (0.40, 2.19)
Medicare part B[c]	89.0	4976	79	0.4 (0.26, 0.71)
Basic	15.5	831	10	0.7 (0.33, 1.31)
Other supplemental insurance	31.8	1758	29	0.9 (0.54, 1.40)
Medigap	29.5	1573	30	0.9 (0.59, 1.52)
No supplemental insurance[d]	2.5	169	8	3.4 (1.52, 7.65)
Net worth, $				
<41 500	29.0	1760	45	1.7 (0.93, 3.17)
41 500–144 199	33.3	1880	37	1.5 (0.84, 2.71)
≥144 200	37.6	1990	20	Reference
Annual household income, $				
<12 000	26.9	1599	45	1.6 (0.91, 2.81)
12 000–24 999	36.1	2038	30	1.1 (0.64, 2.01)
≥25 000	37.1	1993	27	Reference
Educational level				
No high-school diploma	38.2	2267	53	2.1 (0.97, 4.34)
High school or equivalent	47.5	2596	38	1.4 (0.65, 2.87)
College	14.4	757	10	Reference

Note. ADLs = activities of daily living. Sample weighted percentages were used so that values would be nationally representative. For variable subcategories without reference groups, odds ratio comparison groups were individuals without evidence of the risk factor of interest.
[a]Adjusted for age, gender, race/ethnicity, and previous hip fracture.
[b]Relative to no difficulty or assistance with these tasks.
[c]Among individuals 70 years or older at baseline.
[d]Includes no Medicare B and no Medicaid.
*P<.05; **P<.01; ***P<.001 for trend.

of stairs. Difficulty walking several blocks and difficulty lifting 10 lb also were associated with hip fracture, and the trend (from inability to difficulty and no difficulty) was statistically significant (P<.001).

Incorrect immediate and incorrect delayed word recall scores were both associated with hip fracture, although the trend was significant only for delayed word recall (OR=10.7; 95% CI=2.66, 43.19), in the case of 3 or more words incorrectly recalled compared with no incorrectly recalled words (trend P<.01). Correct word recall (delayed or immediate) was not significantly associated with hip fracture (data not shown). Odds of hip fracture also increased with decreasing telephone interview cognition scores (trend P<.001). Ability to count backward from 20 was inversely related to hip fracture, although the association was not statistically significant (OR=0.6; 95% CI=0.34, 1.17; data not shown).

Several socioeconomic and residential characteristics were associated with hip fracture risk, including living in a mobile home (vs a house, duplex, or town home; OR=2.3; 95% CI=1.16, 4.59), Medicare part B insurance coverage (vs no part B coverage; OR=0.4; 95% CI=0.26, 0.71), and no supplemental health insurance coverage (vs supplemental coverage; OR=3.4; 95% CI=1.52, 7.65). Net worth and household income were not statistically significant, and educational level was of borderline statistical significance (Table 1).

The results of the final multivariate model are presented in Table 2. Inability to lift 10 lbs, using furniture to get around a room, any difficulties in ADLs, incorrect delayed word recall, mobile home residence, Medicare part B insurance coverage, and low educational level were significantly associated with hip fracture risk after adjustment for age, gender, race/ethnicity, previous hip fracture, osteoporosis, alcohol use, paralysis, hip replacement, and net worth.

Also, lack of supplemental health insurance (OR=2.7; 95% CI=1.17, 6.31) remained statistically significant when it was substituted for Medicare part B coverage in the multivariate model, although the Hosmer–Lemeshow goodness-of-fit value was decreased (P=.25; data not shown) in comparison with that of the final model (P=.32) presented in Table 2. The highest population-attributable risk percentages were observed among those who did not have a high-school diploma (31.2%), who had difficulties in any ADLs (25.5%), and those who reported no Medicare part B insurance coverage (13.2%), followed by previous hip fracture (12.2%), those not able to lift 10 lbs (8.7%), mobile home residents (7.1%), and cognitive functioning (4.5%, 2.7%).

DISCUSSION

Our results revealed several independent predictors of 2-year hip fracture risk among community-dwelling elderly people, including functional and cognitive status, educational attainment, and insurance and housing status. Educational attainment, level of physical functioning, and insurance status were the top 3 contributors to hip fracture risk. Our results suggest that these factors contributed to at least half of the cases observed.

Several studies have shown that having sustained a hip fracture is significantly associated with the risk of a subsequent fracture.[24–28]

TABLE 2—Multivariate Model of 2-Year Hip Fracture Risks: Asset and Health Dynamics Survey, 1993–1995

Risk Factor	Adjusted Odds Ratio (95% Confidence Interval)	Population-Attributable Risk, %
Previous hip fracture	2.9 (1.53, 5.48)	12.2
Lifting 10 lb		
Can't do	2.1 (1.08, 3.98)	8.7
Difficulty doing	1.2 (0.69, 2.26)	3.1
Don't do	1.3 (0.39, 4.50)	1.6
No difficulty	Reference	
Using furniture to get around a room	9.3 (2.35, 36.86)	2.6
Any difficulties in activities of daily living	1.9 (1.10, 3.15)	25.5
Cognitive functioning (incorrect delayed word recall score)		
0	Reference	
1	1.0 (0.47, 2.04)	0.0
2	4.2 (1.62, 8.69)	4.5
3	14.8 (3.01, 73.07)	2.7
Type of residence		
Mobile home	2.5 (1.21, 5.17)	7.1
Apartment	1.5 (0.87, 2.71)	9.2
House	Reference	
Educational level		
No high-school diploma	2.5 (1.03, 6.12)	31.2
High school or equivalent	2.0 (0.84, 5.01)	18.6
College	Reference	
Medicare part B coverage		
Yes	Reference	
No	2.4 (1.53, 4.11)	13.2

Note. Odds ratios were adjusted for age, gender, race/ethnicity, previous hip fracture, osteoporosis, alcohol use, paralysis, hip replacement, and net worth. The Hosmer–Lemeshow goodness-of-fit *P* value (calculated via weighted logistic regression) for the model was .32.

Although more than 80% of hip fractures among individuals 65 years or older are attributed to osteoporosis, recent studies have shown that only 20% of women, and even a lower percentage of men, receive treatment for osteoporosis after suffering a hip fracture.[29,30] In the AHEAD cohort, approximately 19% of those sustaining a hip fracture within the 2-year interval also had a previous fracture, indicating that a substantial proportion of hip fractures could have been prevented.

After adjustment for multiple demographic, functional, and socioeconomic factors, mobile home residents were twice as likely as those living in other types of residences to report hip fractures. Mobile home residence has not been previously identified as a risk factor for hip fracture, although 1 study reported an association between type of housing structure and hip fracture risk.[31] The majority of hip fractures occur indoors and may be related to type of flooring.[32,33] The flooring of mobile homes may be more likely to become uneven than that of other types of housing because mobile homes require releveling and may develop soft spots caused by an accumulation of excess moisture between the subfloor and the "belly-wrap" tarp located beneath the home.[34] This tarp can be punctured by weather conditions or animal infestation.

However, it is possible that the association we found was not because of specific characteristics of mobile homes; rather, it could be that mobile home residence is a proxy for a combination of adverse health and socioeconomic factors. For instance, poor housing and neighborhood characteristics combined with low functional status may synergistically increase the risk of hip fracture.[35,36] Our sample size was not sufficient to estimate these types of interactions. As the proportion of mobile homes in the US housing stock has increased, focused research is necessary to determine whether aspects of home settings themselves may place mobile home residents at excess risk.[37]

In our study, lack of Medicare part B insurance coverage was associated with a significantly increased risk of hip fracture. Medicare part B recipients pay a monthly premium and receive coverage for outpatient services, including physical or occupational therapy and, in some instances, home health care. Although our finding may suggest that reduced access to ambulatory health care services is a risk factor for hip fracture, it is also possible that self-reported enrollment in part B represents something other than access to health care.

In particular, the percentage of self-reported enrollment in Medicare part B in this study (89%) was lower than the enrollment figure reported by the Medicare program (according to which 93% of US adults 65 years or older have Medicare coverage).[38] Self-reported nonenrollment in Medicare part B may be a marker of an individual's awareness of the details of his or her health insurance coverage. The fact that insurance status, including Medicare part B coverage and no supplemental coverage, remained significant in a model with educational, physical functioning, and cognitive risk factors, suggests that either actual or perceived access to care is an independent predictor of hip fracture risk.

We found that, after adjustment for other factors, a low level of educational attainment (i.e., lack of a high-school diploma) was associated with the highest population-attributable risk of any of the factors that were statistically significant. A number of studies have shown an inverse association between education level and osteoporosis or bone mineral density, and this relation appears to be stronger for weight-bearing sites of the hip and spine.[39–42] The reason may be, in part, that women in higher socioeconomic groups are more likely to use hormone replacement therapy.[43,44] In 1 large randomized trial, hormone

replacement therapy was associated with a 33% reduced hip fracture risk.[45]

Several of our other findings were consistent with previous research, including the overall incidence of hip fracture observed,[46,47] the lower hip fracture risks among African Americans[48–51] and moderate drinkers,[52] and the increased risks among women,[15,50] widows,[31] individuals at advanced ages,[54–55] and those with diminished cognitive[56] and physical[57] functioning. Physical functioning capacity, assessed through measurements focusing on ADLs, strength, and reliance on furniture to move around a room, remained in the final model, suggesting that strength and ambulatory capacity contribute independently to hip fracture risk.

In contrast to previous research, we did not find associations between hip fracture risk and osteoporosis, body mass index, height, parity, smoking status, stroke history, or depression.[52,58–63] Osteoporosis is generally underdiagnosed in the United States,[64] and we may have underestimated its true prevalence in our study population, in part because osteoporosis status, rather than being assessed via a direct question, was volunteered by respondents. Smoking has been shown to be associated with low bone mass[15]; however, data on lifetime cigarette use were not collected in the AHEAD study, and here only a small percentage of adults in this age group reported current smoking (9.5%). In addition, fewer than 25% of our participants were men, and the relation between hip fracture risk and body mass index may be stronger among men than women.[58]

A limitation of this study is that we used self-reported information on hip fracture and comorbid conditions. False-positive rates for self-reports of hip fracture are approximately 8% to 15%, and the rate of false-negative reports is approximately 11%.[65,66] Thus, some conditions associated with hip fracture may not have been identified in this study, particularly those that might be underdiagnosed in older individuals (e.g., osteoporosis[64]) or those that might be more prevalent among community-dwelling elderly people who require proxy respondents. In addition, our exclusion of individuals with proxy respondents may have resulted in underestimations of the magnitude of some risk factors.

We also lacked information on several other factors associated with hip fracture, including bone mineral density, bone mass, hip axis length, use of hormone replacement therapy, vitamin D deficiency, physical activity level, and use of psychotropic drugs, corticosteroids, oral contraceptives, and thyroid medications.[45,62,67–72] Moreover, we did not have information on type of hip fracture; trochanteric and cervical fractures may be etiologically distinct.[73–75] Finally, because some of the categories included only a small number of participants, it is possible that the logistic regression models did not fully adjust for the effects of all other factors.

Our study involved several primary strengths. First, because we used a large, nationally representative cohort of community-dwelling elderly people, our results are more likely than the results of hospital-based studies to be generalizable to the overall community-dwelling elderly population of the United States.[76] Second, we assessed risk factors before the occurrence of hip fractures; this eliminated recall bias, which can be problematic in case–control studies. Third, we included a number of socioeconomic factors that have been assessed in only a few previous studies.

In addition, physical functioning items in this study included a "don't do" response category, ensuring that individuals falling into this category were not included in the "no difficulty" category; this design element probably improved the precision of the physical functioning classification. Finally, the cognitive and functional status measures included on the questionnaire were relatively simple to ascertain in the clinic or by telephone, and public health practitioners can consider these measures in targeting interventions toward community-dwelling individuals at the greatest risk of hip fracture.

In conclusion, our results confirm the demographic, cognitive, and physical functioning risks related to hip fracture that have been identified in previous studies. Also, they suggest that educational attainment, type of residence, and health insurance status are independent predictors of hip fracture risk that contribute to a substantial proportion of hip fractures among community-dwelling elderly people. ■

About the Authors

Robin Taylor Wilson and Gary A. Chase are with the Divisions of Epidemiology and Biostatistics, Department of Health Evaluation Sciences, Pennsylvania State College of Medicine, and the Penn State Cancer Institute, Hershey. Elizabeth A. Chrischilles and Robert B. Wallace are with the Department of Epidemiology, University of Iowa College of Public Health, Iowa City.

Requests for reprints should be sent to Robin Taylor Wilson, Division of Epidemiology, Department of Health Evaluation Sciences, Pennsylvania State College of Medicine, 600 Centerview Dr, Suite 2200, Mail Code A210, Hershey, PA 17033-0855 (e-mail: rwilson@psu.edu).

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Contributors

R.T. Wilson and R.B. Wallace originated the sudy and supervised all aspects of the design, analysis, interpretation, and discussion. R.T. Wilson and G.A. Chase performed the statistical analyses and interpreted the results. E.A. Chrischilles contributed to the analyses of health insurance and health status measures and to interpretation of the findings.

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This study involved the use of publicly available data for which a data use agreement was obtained.

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