American Journal of Epidemiology

Vol. 143, No. 7
Printed in U.S.A.

A BRIEF ORIGINAL CONTRIBUTION

Heterogeneity of Hip Fracture: Age, Race, Sex, and Geographic Patterns of Femoral Neck and Trochanteric Fractures among the US Elderly

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To explore potential etiologic differences in the two major types of hip fracture, the authors computed the incidence rates of fractures of the femoral neck and trochanteric region of the proximal femur using a 5% sample of the US Medicare population aged 65–99 years. For the period they examined, July 1, 1986, through June 30, 1990, the rates of both hip fracture types increased with age in all race and sex categories. The proportion of hip fractures that occurred in the trochanteric region rose steeply with age among white women, but not among black women, white men, or black men. Within the United States, a north-to-south gradient in rates of both fracture types was observed among women, while no clear pattern was found for men. These findings raise the possibility of etiologic differences in the two fracture types, and the results provide further evidence of sex and racial differences in the risk of osteoporotic fractures. *Am J Epidemiol* 1996;143:677–82.

hip fracture; osteoporosis; race

Fractures of the femoral neck, greater and lesser trochanter, and subtrochanteric parts of the proximal femur collectively comprise hip fractures, and most epidemiologic studies have considered these together as a single entity. However, this grouping may obscure distinctions in etiologic factors and occurrence patterns that result from differences in anatomic structure and bone composition (1). It is known that advanced age is more strongly associated with risk of trochanteric fractures than of neck fractures (2), but the possibility of other differences is largely unexplored. Trochanteric and neck fractures may also differ in other regards. For example, racial differences in overall hip fracture incidence are well known (3, 4), but almost all the epidemiologic data published regarding specific hip fracture types has been collected among whites and may not apply to other races. Incidence rates of hip fracture vary geographically within the United States, with the highest rates reported in the southern United States and the lowest rates in the north (5, 6). The presence of geographic differences by specific hip fracture type has not been investigated previously.

Using a 5 percent sample of US Medicare beneficiaries, we compared the age-, sex-, and race-specific rates of femoral neck fractures with those occurring at other anatomic locations of the proximal femur and examined the geographic distribution of these fractures.

MATERIALS AND METHODS

We identified hip fractures from hospital and physician claims for the period July 1, 1986, through June 30, 1990, for a 5 percent random sample of Medicare recipients by using an approach similar to that in our previous studies (3). Excluded from this sample were those whose Medicare records may have been incomplete because they did not receive both hospital (Part "A") and physician (Part "B") insurance or had health maintenance organization coverage. Those who were eligible through Railroad Board Entitlement or for reasons other than age, i.e., those less than age 65 years, were also removed from the sample, as were those aged 100 years or more.

A hip fracture was defined on the basis of 1) a hospital discharge diagnosis code of hip fracture (*In-*

Received for publication January 20, 1995, and in final form January 19, 1996.

Abbreviations: CI, confidence interval; CPT4, *Current Procedural Terminology*, Version 4; ICD-9-CM, *International Classification of Diseases*, Version 9, Clinical Modification.

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ternational Classification of Diseases, Version 9, Clinical Modification (ICD-9-CM) codes 820–820.9) (7), or 2) a physician claim coded for the treatment of a hip fracture (Current Procedural Terminology, Version 4 (7)) (CPT4 codes 27230–27248), as long as this physician claim was confirmed either by hospital discharge information indicating that an appropriate surgical procedure took place or by the presence of a second physician claim for the treatment of a hip fracture within 2 days of the first. Fractures were then grouped according to the site of occurrence as femoral neck fractures (ICD-9-CM codes 820–820.19, 820.8, and 820.9) or trochanteric fractures, including subtrochanteric fractures (ICD-9-CM 820.2–820.32). If no hip fracture discharge diagnosis ICD-9-CM codes were present, the location of the fracture was taken from the physician claims. CPT4 codes 27230–27236 were classified as femoral neck fractures, and codes 27238–27248 were classified as trochanteric fractures. If both hip and non-hip femur fracture codes were present, we chose the most frequently cited diagnosis. However, individuals whose records contained both femoral neck and trochanteric ICD-9-CM or CPT4 codes were considered unclassifiable and were excluded from the analysis. We further excluded those who had an indication of treatment for complications of an earlier fracture (i.e., prevalent cases) or metastatic or bone cancer at the time of fracture or during the preceding 6 months.

Demographic data, such as birth date, sex, and race (classified as white, black, and other), enrollment status, and estimates of the population at risk were obtained from Medicare enrollment summary files maintained by the Health Care Financing Administration for the years 1986 through 1990.

We computed age-, sex-, and race-specific rates for each of the hip fracture types. For each combination of 5-year age group, sex, and race, we divided the number of fractures in our 4-year study period by the combined number of enrollees in the 5 percent Medicare sample at the end of 1986, 1987, 1988, and 1989. Directly age-standardized rates of each fracture were also calculated for each race and sex category by using the number of enrollees in the total 5 percent sample as the standard. We restricted our analyses to whites and blacks, since there were too few hip fracture events in the "other" race category to provide meaningful data.

We estimated the ratio of the age-specific rates of the two fracture types by using weighed least squares regression. Our model included sex, race, age (in 5-year groups), and all possible interaction terms. Because calculated variances for the rate ratios did not reflect the total variability of the data, empiric weights were chosen using the variance about the regression line for each of the four sex-race groups.

To examine the geographic patterns of incidence, we calculated directly age- and race-standardized rates for men and women, for each of the nine census divisions of the United States (see Appendix 1) for both fracture types. We then estimated the ratio of the rates of trochanteric to neck fractures and computed the 95 percent confidence intervals for these ratios (8).

RESULTS

We identified 39,599 black or white residents of the United States who had a hip fracture diagnosis of interest during the period July 1, 1986, to June 30, 1990, and who were aged 65–99 years. Of these, we excluded 616 (1.6 percent) whose eligibility for Medicare was through Railroad Board Entitlement, 1,197 (3.0 percent) who had concomitant membership in a health maintenance organization, and 899 (2.3 percent) who did not have full Medicare coverage, leaving 36,887 candidate cases. We also removed from the analysis an additional 591 (1.5 percent) whose records showed evidence of an earlier hip fracture and 979 (2.5 percent) with indications of metastatic or bone cancer. Another 1,074 (2.7 percent) cases did not meet our criteria for a hip fracture, i.e., their records had a single physician claim or conflicting diagnosis codes. Thus, our final sample included a total of 34,243 hip fractures among black or white enrollees aged 65–99 years: 16,901 (49.4 percent) at the femoral neck, 16,914 (49.4 percent) below the neck, and 428 (1.2 percent) at an unknown subsite. Of those classified as trochanteric (i.e., below the neck), 14,396 (85.1 percent) were diagnosed as intertrochanteric, 814 (4.8 percent) were diagnosed as subtrochanteric, and 1,271 (7.5 percent) had both diagnoses present or had a diagnosis of trochanteric fractures, not further specified. The remaining 433 (2.6 percent) had a physician claim with a CPT4 code specifying a trochanteric fracture and no additional information about the fracture site.

As expected, the overall annual age-standardized rates of both femoral neck fractures and trochanteric fractures were higher among white women than among black women (4.33 vs. 1.91 and 4.23 vs. 1.54 per 1,000, respectively). As shown in table 1, the rates of both hip fractures steadily increased with age in all sex and race groups, but with distinct patterns. The ratio of trochanteric to neck fractures remained close to one at all ages for black men, white men, and black women, but increased steeply with age among white women (figures 1 and 2). Based on the regression analysis, the ratio of trochanteric to femoral neck

TABLE 1. Age-, sex-, and race-specific incidence rates (per 1,000 person-years) of femoral neck and trochanteric fractures of the proximal femur, among Medicare beneficiaries aged 65–99 years, July 1986–June 1990

Race and age (years)	Women				Men			
	Neck		Trochanteric		Neck		Trochanteric	
	No. of cases	Rate	No. of cases	Rate	No. of cases	Rate	No. of cases	Rate
White								
Age								
65–69	999	1.28	658	0.84	308	0.49	328	0.52
70–74	1,679	2.43	1,291	1.87	505	0.99	522	1.02
75–79	2,665	4.81	2,329	4.20	769	2.20	731	2.09
80–84	3,201	8.28	3,099	8.01	783	3.95	786	3.96
85–89	2,671	12.05	3,202	14.44	616	6.97	668	7.55
90–94	1,357	14.16	1,818	18.98	293	9.95	348	11.81
95–99	339	13.73	498	20.17	87	13.17	96	14.53
Overall*		4.33		4.23		2.18		2.28
Black								
Age								
65–69	30	0.44	31	0.45	17	0.32	23	0.44
70–74	72	1.21	34	0.57	31	0.78	25	0.63
75–79	79	1.74	71	1.56	36	1.29	31	1.11
80–84	92	3.05	77	2.55	29	1.87	35	2.25
85–89	104	5.92	84	4.78	26	3.58	31	4.26
90–94	61	8.28	62	8.42	12	4.76	11	4.36
95–99	35	14.98	23	9.85				
Overall*		1.91		1.54		1.23		1.24

* Overall rate age-adjusted to the total Medicare population using 5-year age groups.

fractures increased 2.78 percent for each year of age (95 percent confidence interval (CI) 2.48 to 3.08). Among white males, black males, and black females, these percentages were 0.40 (95 percent CI −0.11 to 0.91), −1.65 (95 percent CI −3.82 to 0.52), and −0.09 (95 percent CI −1.71 to 1.52), respectively.

Evidence of sex differences in the geographic patterns of the two fracture types was found. As shown in table 2, the geographic distribution of the two types of hip fracture were similar in women; for both fractures, rates were generally highest in the southern census divisions and lowest in the northern regions. The corresponding results in men were less consistent; the ratio of trochanteric to femoral neck fracture rates showed little geographic variation.

DISCUSSION

We found that among white women, trochanteric fractures comprised an increasing proportion of proximal femur fractures with increasing age; this was not observed for black women or for men of either race. The geographic patterns for the two fracture types were similar for women, but were somewhat disparate among men. Our findings suggest a heterogeneity of hip fracture and indicate that complete understanding of the etiology and prevention of these fractures may require separate study of the fracture subtypes.

Our study was based on medical care claim files maintained by the Health Care Financing Administration, and the limitations of these data have been described in several previous reports (3, 5, 9). Of particular relevance to our analyses is the lack of confirmation of femoral neck and trochanteric fractures by external sources (medical records or subject verification). However, we conducted internal comparisons of the diagnoses coded on physician claims with those reported by the inpatient facilities. The level of agreement was high for hip fracture overall (89.1 percent, k = 0.78) (9), and when the specific site was indicated on both hospital and physician claims in our final sample, they agreed 87 percent of the time for femoral neck fractures and 88 percent for trochanteric fractures. We also minimized misclassification of the fracture types by removing from our analysis individuals who had a single physician claim without confirmation and by excluding individuals who had claims with diagnoses or procedure codes for both fracture types.

Our findings generally agree with previous work with respect to the increase in the ratio of trochanteric

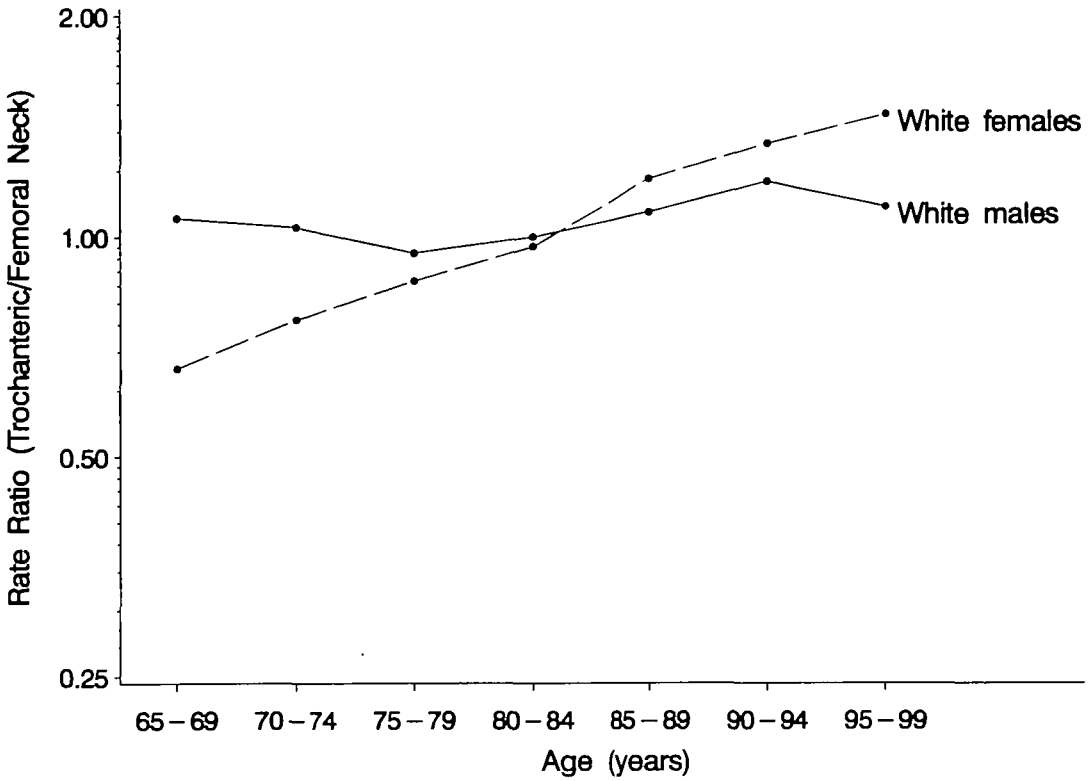

FIGURE 1. Ratio of the rates of trochanteric to femoral neck fractures of the proximal femur among a 5% sample of the white US Medicare population, July 1986-June 1990.

to femoral neck fractures with age among white women (2). However, to our knowledge, the impact of race on the basic epidemiology of the subtypes of hip fracture has been examined only in one previous study, limited to Maryland. Hinton et al. (10) found that the ratio of trochanteric to femoral neck fractures increased with age among white women, as in our analysis. In addition, they found that femoral neck fractures were more common than trochanteric fractures among black women of all ages and that the ratios of trochanteric to femoral neck fractures increased slightly with advancing age. We did not detect a similar trend in the fracture ratios among black women. These patterns will need to be examined more fully in future analyses containing a large number of fractures among blacks.

Our findings of race and sex differences in the rates of femoral neck and trochanteric fractures could, at least in part, be due to localized differences in bone density at specific sites of the proximal femur. Melton et al. (11) found that the incidence rates of femoral neck and trochanteric fracture were similar among individuals whose bone mineral densities in the respective regions of the femur were above 0.60 g/cm^2; however, those who had bone mineral densities at or below 0.60 g/cm^2 had trochanteric fracture rates twice those of femoral neck fractures. Hip fractures occur more often in women than in men and among whites more than among blacks (3, 4), and there is evidence that both sex and racial differences in fracture risk are associated with differences in bone density. Our observation of a greater risk of trochanteric fractures than femoral neck fractures with advancing age among white women but not among black women or men of either race is thus consistent with the findings of lower bone density in white women compared with other groups.

A north-to-south geographic gradient in hip fracture risk has been observed among women (5, 6) and to a some extent among men (6) in the United States. The reasons for this are as yet unknown and, in previous studies, could not be accounted for by geographic differences in any known or hypothesized risk factors for hip fractures (5, 6). We found that among women, rates of both trochanteric and femoral neck fractures were highest in the southern states and lowest in the northern states, suggesting that the factors responsible for this trend are associated with risk of each fracture type. We did not observe any particular pattern in fracture rates for men for either of the two fracture types. However, one limitation of this analysis is the relatively small number of fractures among men; it is

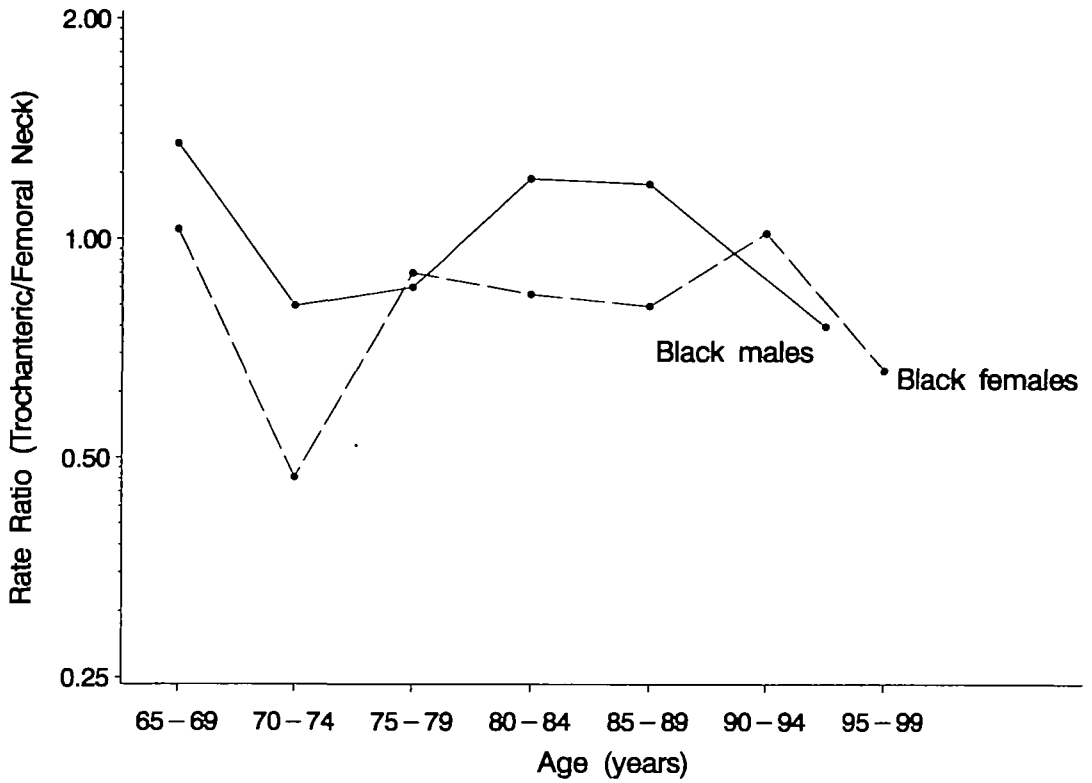

FIGURE 2. Ratio of the rates of trochanteric to femoral neck fractures of the proximal femur among a 5% sample of the black US Medicare population, July 1986–June 1990.

TABLE 2. Incidence rates (per 1,000 person-years) and rate ratio of trochanteric to femoral neck fractures according to US Census division

Census division*	Women				Men			
	Femoral neck rate	Trochanteric rate	Trochanteric/ neck rate ratio	95% CI†	Femoral neck rate	Trochanteric rate	Trochanteric/ neck rate ratio	95% CI
New England	3.65	3.81	1.04	0.94–1.15	2.03	1.73	0.85	0.69–1.06
Middle Atlantic	3.54	3.79	1.07	1.01–1.14	1.92	2.10	1.09	0.97–1.23
East North Central	3.91	3.77	0.97	0.91–1.02	2.05	2.35	1.15	1.03–1.28
West North Central	3.99	3.95	0.99	0.91–1.08	2.32	2.11	0.91	0.78–1.07
Mountain	4.12	4.23	1.03	0.91–1.16	1.94	2.35	1.21	0.95–1.55
Pacific	4.33	3.90	0.90	0.84–0.97	2.35	2.09	0.89	0.77–1.03
Southern Atlantic	4.47	4.26	0.95	0.90–1.01	2.00	2.10	1.05	0.93–1.18
East South Central	5.05	4.35	0.86	0.79–0.94	2.69	2.41	0.89	0.75–1.07
West South Central	4.74	4.49	0.95	0.88–1.02	2.10	2.40	1.14	0.99–1.33

* States included in each census division are listed in the Appendix.
† CI, confidence interval.

possible that with larger numbers more meaningful patterns would emerge. Our data also had a relatively small number fractures among blacks. If blacks have regional variability that is distinct from that of whites, this would argue against combining blacks and whites as we did in our analysis. However, a previous analysis did not find any black-white differences in the geographic distribution of hip fractures overall (6), and when we restricted our analysis to whites alone, our findings were similar (data not shown). In conclusion, while the underlying explanations for our results are not fully understood, our findings emphasize the need to investigate separately the different types of hip fracture.

ACKNOWLEDGMENTS

Support for this study was provided in part by National Institute on Aging grant 5R01 AG07146–04 and Agency for Health Care Policy and Research grant 5R18HS 05745–04.

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APPENDIX 1
Census Divisions and Regions

New England
- Connecticut
- Maine
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont

Middle Atlantic
- New Jersey
- New York
- Pennsylvania

East North Central
- Illinois
- Indiana
- Michigan
- Ohio
- Wisconsin

West North Central
- Iowa
- Kansas
- Missouri
- Minnesota
- Nebraska
- North Dakota
- South Dakota

Mountain
- Arizona
- Colorado
- Idaho
- Montana
- Nevada
- New Mexico
- Utah
- Wyoming

Pacific
- Alaska
- California
- Hawaii
- Oregon
- Washington

South Atlantic
- Delaware
- District of Columbia
- Florida
- Georgia
- Maryland
- North Carolina
- South Carolina
- Virginia
- West Virginia

East South Central
- Alabama
- Kentucky
- Mississippi
- Tennessee

West South Central
- Arkansas
- Louisiana
- Oklahoma
- Texas