

# Trends in Mortality Following Hip Fracture in Older Women

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**A**mong US women 65 years and older, the annual incidence of hip fractures is estimated at 793 per 100,000 women, based on Medicare claims data from 2005.<sup>1</sup> While hip fractures constitute only 14% of all osteoporotic fractures,<sup>2</sup> they result in substantial morbidity and mortality,<sup>1-6</sup> with short-term mortality risk 2- to 8-fold higher than that of age-matched controls.<sup>4,7,8</sup> One-year mortality rates are in the range of 22%,<sup>1</sup> with excess mortality risk highest during the first 3 to 6 months following hip fracture.<sup>4,7</sup> Given the projected increase of the aging US population over the next 2 decades<sup>9</sup>—particularly among those over 65 years old and those of nonwhite race/ethnicity,<sup>9,10</sup> in whom less is known regarding contemporary fracture outcomes—hip fractures remain a significant public health concern.

Numerous risk factors contribute to hip fracture mortality in women, including age, fracture type, functional status, comorbidities, post fracture care, and rehabilitation.<sup>1,7,11-13</sup> Examination of 20-year trends since 1985 demonstrated national declines in 1-year mortality following hip fracture, largely due to mortality reduction prior to 1998.<sup>1</sup> These findings may be potentially attributable in part to advances in surgical and post operative medical care.<sup>1</sup> Survival rates following hip fracture also vary by race/ethnicity, with historical mortality rates slightly higher for blacks compared with whites.<sup>14</sup> Few studies have examined differences in mortality following hip fracture among US women of other race/ethnicities.

After experiencing hip fracture, only a subset of women will regain their pre-fracture quality of life, while many suffer permanent deficits in activities of daily living<sup>6,15</sup>; it is estimated that up to 17% of remaining post fracture life may be spent in a nursing facility.<sup>6</sup> Hospital readmission rates are high following hip fracture and have been mostly attributable to nonorthopedic/nonsurgical conditions.<sup>3,16</sup> In one study, infections (21%), followed by cardiac conditions (12%), were the leading causes of readmission within

## ABSTRACT

**Objectives:** To examine contemporary trends in mortality following hip fracture among older postmenopausal women in an integrated healthcare delivery system.

**Study Design:** Retrospective cohort study of 13,550 women aged  $\geq 65$  years with hip fracture during 2000 to 2010.

**Methods:** Demographic factors, comorbidity index score, fracture history, early rehospitalization, and all-cause mortality within 1 year following hip fracture were examined using health plan databases and records. Temporal trends, risk factors, and the association of race/ethnicity and mortality within 1 year post fracture were examined using multivariable logistic regression.

**Results:** Among 13,550 women with hip fracture, 84.6% were aged  $\geq 75$  years: 83.6% were white, 2.8% black, 5.6% Hispanic, 4.5% Asian, and 3.5% of other/unknown race. Following hip fracture, 2.4% died during the index hospitalization, while 12.3% were rehospitalized within 30 days of discharge. Infection, pneumonia, and cardiovascular conditions were the most common nonorthopedic indications for readmission. Mortality rates at 6 months (17%) and 1 year (22.8%) following hip fracture were high and increased with age. Greater comorbidity and early rehospitalization were associated with increased mortality risk, while Asian and Hispanic race/ethnicity were associated with lower mortality risk (vs white). Temporal trends demonstrated a small but significant reduction in mortality risk during 2004 to 2010.

**Conclusions:** While hip fracture morbidity and mortality remain high, temporal trends suggest recent declines in mortality risk, with risk of death following hip fracture lower for Asian and Hispanic women. Future studies should examine potential benefits of targeted interventions within integrated healthcare settings and factors contributing to observed racial/ethnic differences in post fracture survival.

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the first 6 months, while surgical complications accounted for only 11% of readmissions.<sup>16</sup> Rehospitalization following hip fracture has also been shown to be an independent predictor of adverse morbidity and mortality outcome.<sup>3,5,16</sup>

In the contemporary era, limited data pertaining to hip fracture morbidity and mortality exist in large community-based practice settings serving demographically diverse populations. This study examines early rehospitalization and mortality outcome following hip fracture during 2000 to 2010 within a northern California integrated healthcare delivery system, with a specific focus on racial/ethnic differences and temporal trends in mortality risk.

## METHODS

Kaiser Permanente Northern California (KPNC) is a large, integrated healthcare delivery system providing care to over 3 million members. There are more than 150 medical offices and 20 hospitals providing care, with centralized databases of all network and nonnetwork hospitalization discharge diagnoses, ambulatory visit diagnoses, and pharmacy records. The Kaiser Foundation Research Institute's Institutional Review Board approved the study and a waiver of informed consent was obtained due to the nature of the study.

### Cohort Identification

Using health plan databases, we identified all female health plan members 65 years or older with a principal hospital discharge diagnosis of a proximal femur fracture between January 1, 2000, and December 31, 2010. A proximal femur (hip) fracture was defined by a fracture of the femoral neck (*International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes 820.00-820.03, 820.09, 820.8*) or pertrochanteric region (*ICD-9-CM 820.20, 820.21*), excluding open fractures and those associated with major trauma (*ICD-9-CM E800-E848*). The final cohort was established by ascertaining the first qualifying hip fracture per woman. Women without continuous health plan membership in the year prior to hip fracture were excluded from these analyses in order to define a cohort with ongoing membership and to allow for ascertainment of baseline covariates. Temporal trends and race/ethnic differences in femur fracture among KPNC women have been separately reported.<sup>17</sup>

### Take-Away Points

While hip fracture mortality remains high, significant declines in mortality risk and important racial/ethnic differences were seen following hip fracture in older women receiving care within a large integrated healthcare delivery system.

- Older age, increased comorbidity, and early rehospitalization were associated with an increased risk of death within 1 year following hip fracture.
- Racial/ethnic differences in post fracture survival were also seen; compared with women of white race, Asian and Hispanic women had lower mortality risk during the first year.
- Temporal trends demonstrated small but significant mortality risk reduction, where the potential benefits of targeted healthcare interventions should be further examined.

### Patient Characteristics

Age and self-reported race/ethnicity (classified as non-Hispanic white, black, Hispanic, Asian, or other/unknown) were obtained from administrative databases. A clinical comorbidity index score was calculated based on diagnosis and procedure codes obtained from all hospitalization, emergency, and ambulatory visits in the prior year (including the index fracture admission) using a modification of the Charlson Comorbidity Index established by Deyo and colleagues.<sup>18</sup> Fracture history (fractures occurring after age 40 and prior to hip fracture) was obtained by identifying prior outpatient and hospitalization diagnoses of fractures involving the spine, trunk, upper and lower extremities (*ICD-9-CM 805, 807-815, 817-825, 827-829*), excluding open fractures, fractures associated with spinal cord injury, fractures of the head/fingers/toes, and hospitalized fractures associated with high-energy trauma (*ICD-9-CM E800-E848*).

### Rehospitalization Outcomes

Early rehospitalization was defined as rehospitalization within 1 to 30 days following discharge from the initial hip fracture hospitalization (same- or next-day readmissions or transfers with a principal diagnosis of hip fracture were considered part of the initial hospitalization, affecting only 0.8% of the cohort). The principal diagnosis assigned to the rehospitalization event was categorized as follows: 1) cardiovascular condition: hypertension, ischemic heart disease, cardiomyopathy, heart failure, cardiogenic shock, conduction disorder, dysrhythmia, or tachycardia (*ICD-9-CM 401-405, 410-414, 425-428, 785.0, 785.51*); 2) venous embolism/thrombosis, pulmonary embolism (*ICD-9-CM 415.1, 453*); 3) cerebrovascular disease: hemorrhage, occlusion, ischemia, late effects (*ICD-9-CM 430-438*); 4) pneumonia, pneumonitis, influenza, respiratory insufficiency or failure (*ICD-9-CM 480-488, 507, 518.81-84*); 5) chronic obstructive pulmonary disease/asthma/bronchitis (*ICD-9-CM 466.0, 490-493, 496, 519.11*); 6) urinary tract infection (*ICD-9-CM 599.0*); 7) cog-

nitive impairment or altered mental status (ICD-9-CM 290-298, 331, 348.3, 780.0-1, 780.97); 8) acute or chronic kidney disease/failure (ICD-9-CM 584-586); 9) gastritis, gastrointestinal ulcers/hemorrhage (ICD-9-CM 531-535, 526.12-13, 578.9); 10) glucose-, electrolyte-, or fluid-related disorder (ICD-9-CM 249-251, 275.2-4, 276); 11) *Clostridium difficile* infection (ICD-9-CM 8.45); 12) skin infection, ulcer, gangrene, or wound infection (ICD-9-CM 681-682, 686, 707, 785.4, 998.5); 13) bacteremia/septicemia, sepsis, septic shock (ICD-9-CM 038, 790.7, 785.52, 995.91-92); 14) malignant neoplasm (ICD-9-CM 140-208); 15) nonpelvic, nonhip/femur fracture (ICD-9-CM 800-807, 809-819, 822-829); 16) pelvic- or femur-related fracture/aftercare (ICD-9-CM 733.14-15, 808, 820, 821, V54.13, V54.14, V43.64, V54.13, V54.23, V54.8-9); and 17) surgical implant or hardware-related issue (ICD-9-CM 996.4-996.6, 996.70, 996.77-996.79, V43.64).

### Mortality Ascertainment

For ascertainment of death from any cause, women were followed up to 1 year after fracture, through December 31, 2011. Only 3.1% had membership cessation prior to 1 year without an ascertained death outcome (and were presumed alive); sensitivity analyses were conducted with exclusion of these women. All-cause mortality was assessed at 30, 90, 180 and 365 days following hip fracture, using health plan and administrative databases (updated with information from state death certificates and Social Security Administration files). These included mortality outcomes previously reported for a subset of women who experienced a hip fracture during 2007 and 2008.<sup>19</sup>

### Statistical Analysis

Differences between subgroups (eg, by age and race/ethnicity) were compared using the  $\chi^2$  test. Multivariable logistic regression was used to evaluate the association of race/ethnicity, calendar year, and early rehospitalization with mortality outcome, adjusting for confounders associated with both the predictor and outcome of interest. We did not specifically examine for potential interactions. Calendar year was represented as a categorical variable (using the year 2000 or 2004 as reference) and as a continuous variable when evaluating for a linear trend. A 2-sided *P* value of <.05 was used as the criterion for statistical significance. All analyses were performed using SAS 9.3 (SAS Institute, Cary, North Carolina).

## RESULTS

We initially identified 14,059 female health plan members 65 years and older who suffered a low-trauma hip

fracture in the femoral neck or pertrochanter during 2000 to 2010. After excluding 509 women without continuous health plan membership in the year prior to fracture, the final cohort included 13,550 women, with a mean age of  $82.5 \pm 7.4$  years and 84.6% aged 75 years or over. The cohort was predominantly white (83.6%), with 2.8% black, 5.6% Hispanic, 4.5% Asian, and 3.5% of other/unknown race. During the index hospitalization, 2.4% died, including a slightly higher proportion among women 85 years and older (3.3%) compared with women aged 65 to 74 and 75 to 84 years (both 1.8%; *P* <.001).

Among the 13,221 (of 13,550 women) who suffered a hip fracture and were discharged alive, 1624 (12.3%) were rehospitalized within 30 days following initial discharge. These included 212 (10.3%) among women aged 65 to 74 years, 671 (11.7%) among women aged 75 to 84 years, and 741 (13.6%) among women 85 years and older. The most common indications for rehospitalization (excluding 11.9% for orthopedic conditions) were pneumonia (11.6%), other infection-related conditions (14.9% including sepsis/bacteremia, urinary tract infection, and *Clostridium difficile* infection), and cardiovascular disease (9.7%), as shown in **Table 1**. In addition, 12.6% (204 of 1624) of rehospitalized women experienced more than 1 rehospitalization event during the 30-day readmission window. Increasing age, comorbidity status, and prior fracture were all associated with 30-day readmission following the initial hip fracture discharge, whereas fracture type was not (data not shown). Early rehospitalization rates were similar across racial/ethnic subgroups except for a higher proportion among black compared with white women (**Table 2**).

The overall rate of death from any cause was 6.3%, 12.7%, 17%, and 22.8% at 1, 3, 6, and 12 months, respectively. These included 2.4% who died during the index hospitalization and an additional 1.5% who died during a subsequent rehospitalization occurring within 30 days of initial discharge. Among the 1624 women rehospitalized within 30 days of discharge, the 1-year mortality rate was substantially higher at 43.4%. Women who died during the first year following hip fracture were somewhat more likely to have had a prior fracture (40.5% vs 36.6%; *P* <.001) and to have experienced a pertrochanteric fracture (46.1% vs 43.5%; *P* = .01) compared with women who survived; they were also much more likely to have a comorbidity score  $\geq 3$  (31.0% vs 19.2%; *P* <.001). The strong association of older age and mortality is shown in **Figure 1**, with women 85 years and older nearly twice as likely to die compared with women aged less than 85 years during the ensuing 6 months (23.9% vs 12.1%; *P* <.001) and 1 year (31.4% vs 16.7%; *P* <.001) following hip fracture.

**Table 1.** Principal Diagnosis Category<sup>a</sup> for Women Rehospitalized Within 30 Days After Discharge From the Index Hip Fracture Hospitalization (column percentages presented)

Principal diagnosis category <sup>a</sup> for the first rehospitalization event within 1-30 days after initial discharge <sup>b</sup>	Total (N = 1624) <sup>b</sup>	Aged 65-74 years (N = 212)	Aged 75-84 years N = 671)	Aged ≥85 years (N = 741)
Pneumonia/respiratory distress	189 (11.6%)	15 (7.1%)	87 (13.0%)	87 (11.7%)
COPD/asthma/bronchitis	40 (2.5%)	9 (4.3%)	18 (2.7%)	13 (1.8%)
Cardiovascular condition	157 (9.7%)	19 (9.0%)	60 (8.9%)	78 (10.5%)
Sepsis/bacteremia	95 (5.9%)	10 (4.7%)	33 (4.9%)	52 (7.0%)
Urinary tract infection	84 (5.2%)	9 (4.3%)	38 (5.7%)	37 (5.0%)
Glucose/electrolytes/fluid disorder	59 (3.6%)	6 (2.8%)	21 (3.1%)	32 (4.3%)
GI ulcer/gastritis/bleeding	57 (3.5%)	2 (0.9%)	15 (2.2%)	40 (5.4%)
Venous thromboembolism	52 (3.2%)	8 (3.8%)	29 (4.3%)	15 (2.0%)
Cerebrovascular disease	58 (3.6%)	6 (2.8%)	25 (3.7%)	27 (3.6%)
Altered cognition/mental status	37 (2.3%)	7 (3.3%)	15 (2.2%)	15 (2.0%)
<i>Clostridium difficile</i> infection	62 (3.8%)	11 (5.2%)	24 (3.6%)	27 (3.6%)
Skin infection/ulcer/gangrene	52 (3.2%)	9 (4.3%)	25 (3.7%)	18 (2.4%)
Kidney disease or failure	24 (1.5%)	1 (0.5%)	8 (1.2%)	15 (2.0%)
Cancer (malignant neoplasm)	15 (0.9%)	6 (2.8%)	6 (0.9%)	3 (0.4%)
Fracture (nonfemur/pelvis fracture)	13 (0.8%)	0	8 (1.2%)	5 (0.7%)
Pelvic/femur fracture or aftercare	92 (5.7%)	15 (7.1%)	27 (4.0%)	50 (6.8%)
Surgical/fracture complication	88 (5.4%)	9 (4.3%)	35 (5.2%)	44 (5.9%)
Other conditions not included above	450 (27.7%)	70 (33.0%)	197 (29.4%)	183 (24.7%)

COPD indicates chronic obstructive pulmonary disease; GI, gastrointestinal.  
<sup>a</sup>See Methods section of text for conditions included within each diagnostic category.  
<sup>b</sup>Among 1624 women rehospitalized within 30 days after discharge, 204 (12.6%) had more than 1 rehospitalization within the 30 days (N = 30, aged 65-74 years; N = 91, aged 75-84 years; N = 83, aged ≥85 years).

One-year mortality also varied by race/ethnicity (Table 3), with crude mortality rates significantly higher among whites (23.6%) compared with Hispanics (19%) and Asians (15.6%;  $P < .01$ ), but not significantly different from blacks (22.1%). Among women 85 years and older (41.5% of the fracture cohort), the 1-year mortality was 32.5% in whites, also significantly higher than that of Hispanics (24.1%) and Asians (19%), but similar to that of blacks (31.8%). Table 2 shows the distribution of age, baseline comorbidity, fracture history, and anatomic fracture site by race/ethnicity, where significant differences were seen in age (Hispanic and Asians compared with whites), comorbidity index score (higher comorbidity among all races/ethnicities compared with whites), prior fracture, and fracture type. In multivariable analyses adjusting for these confounders (Table 3), both Asian race and Hispanic ethnicity were associated with significantly lower odds of death at 1 year compared with white race, adjusting for age, comorbidity index score, prior fracture, fracture subtype, and fracture year (odds ratio [OR], 0.64; 95% CI, 0.51-0.80 for Asian; and OR, 0.75; 95% CI, 0.62-0.91 for Hispanic). These findings were unchanged after excluding the 3.1% of women

without death outcome whose health plan membership ended prior to 1 year (data not shown). Having at least 1 rehospitalization within 30 days of discharge was also associated with greater than 3-fold increased odds of death at 1 year (OR, 3.41; 95% CI, 3.04-3.82, adjusting for age, race/ethnicity, and comorbidity index score).

Given evidence of a potential reduction in mortality risk after the year 2004 (Table 3), we next examined temporal trends in the risk of death at 6 months and 1 year post fracture between 2004 and 2010 as shown in Figure 2. Compared with 2004, the adjusted odds of death in 2010 were significantly lower at 6 months (OR, 0.73; 95% CI, 0.59-0.90) and 1 year (OR, 0.70; 95% CI, 0.57-0.85), adjusting for age, race/ethnicity, comorbidity index score, and prior fracture, with a small but significant declining trend in the adjusted odds of death during this interval ( $P < .01$ , test for linear trend).

## DISCUSSION

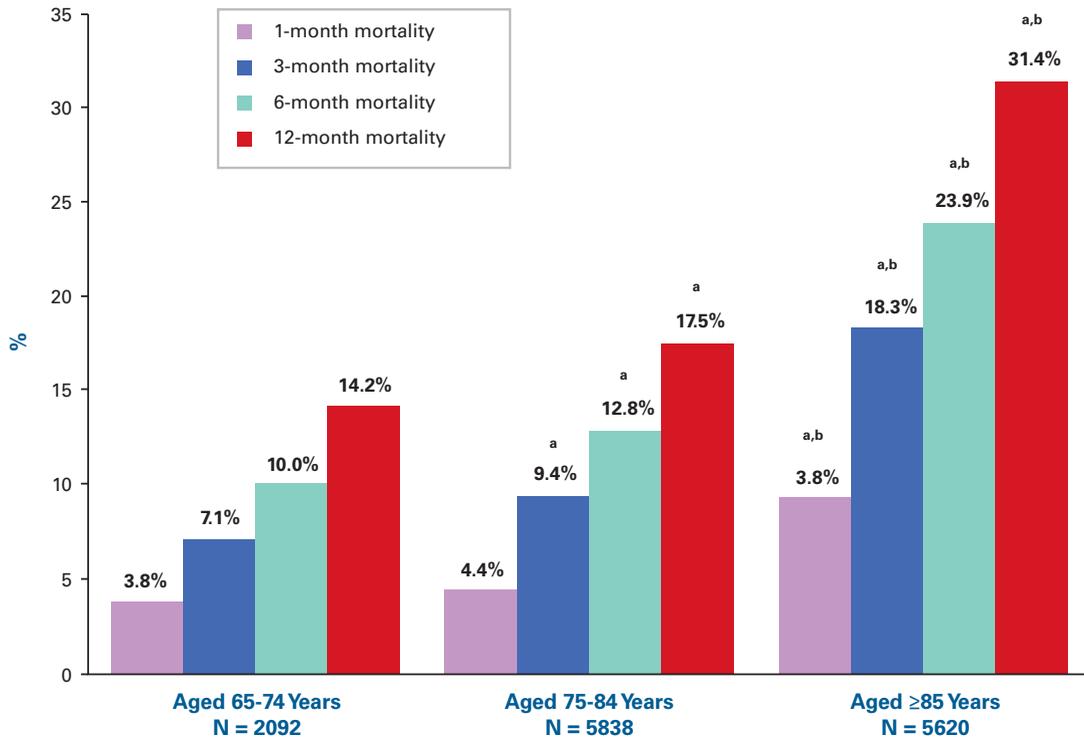
Hip fractures remain a major public health burden due to persistently high mortality and associated disability.<sup>7,20</sup> While several recent reports demonstrate that age-adjust-

**Table 2.** Baseline Characteristics, In-Hospital Mortality, and Early Rehospitalization by Race/Ethnicity Among Older Women Following Hip Fracture (column percentages presented)

	White N = 11,323	Black N = 381	Hispanic N = 758	Asian N = 615	Other/Unknown N = 473
<b>Age group</b>			a	a	a
65-74 years	1660 (14.7%)	68 (17.8%)	144 (19.0%)	131 (21.3%)	89 (18.8%)
75-84 years	4854 (42.9%)	165 (43.3%)	336 (44.3%)	284 (46.2%)	199 (42.1%)
≥85 years	4809 (42.5%)	148 (38.9%)	278 (36.7%)	200 (32.5%)	185 (39.1%)
<b>Comorbidity index</b>		a	a	a	a
Score 0	4891 (43.2%)	141 (37.0%)	283 (37.3%)	241 (39.2%)	163 (34.5%)
Score 1-2	4084 (36.1%)	137 (36.0%)	254 (33.5%)	212 (34.5%)	178 (37.6%)
Score ≥3	2348 (20.7%)	103 (27.0%) <sup>b</sup>	221 (29.2%) <sup>b</sup>	162 (26.3%) <sup>b</sup>	132 (27.9%) <sup>b</sup>
<b>Fracture type, N (%)</b>		c	a	c	c
Femoral neck	6321 (55.8%)	222 (58.3%)	389 (51.3%)	368 (59.8%)	278 (58.8%)
Petrochanteric	5002 (44.2%)	159 (41.7%)	369 (48.7%)	247 (40.2%)	195 (41.2%)
<b>Prior fracture</b>	4340 (38.3%)	97 (25.5%) <sup>a,c</sup>	277 (36.5%)	171 (27.8%) <sup>a,c</sup>	200 (42.3%) <sup>d</sup>
<b>In-hospital death</b>	289 (2.6%) <sup>e</sup>	11 (2.9%) <sup>e</sup>	16 (2.1%)	7 (1.1%)	6 (1.3%)
<b>Rehospitalized in 30 days</b>	1345 (11.9%)	59 (15.5%) <sup>a</sup>	97 (12.8%)	69 (11.2%)	54 (11.4%)

<sup>a</sup>*P* < .05 compared with whites.  
<sup>b</sup>*P* < .01 comorbidity index score (0-2 vs ≥3) compared with whites.  
<sup>c</sup>*P* < .05 compared with Hispanics.  
<sup>d</sup>*P* < .05 compared with blacks, Hispanics, Asians.  
<sup>e</sup>*P* < .05 for the index hip fracture admission, compared with Asians.  
 The letters at the top of the column refer to the overall  $\chi^2$  comparison (multiple category comparison).

**Figure 1.** Age-Specific Mortality at 1, 3, 6, and 12 Months Following Hip Fracture



<sup>a</sup>*P* < .01 compared with women aged 65-74 years.  
<sup>b</sup>*P* < .01 compared with women aged 75-84 years.

■ **Table 3.** Baseline Demographic and Clinical Predictors of Mortality Outcome Following Hip Fracture

	6-Month Mortality			12-Month Mortality		
	Rate per 100	Unadjusted OR	Adjusted OR <sup>a</sup>	Rate per 100	Unadjusted OR	Adjusted OR <sup>a</sup>
<b>Age</b>	—	1.07 (1.07-1.08)	1.08 (1.07-1.09)	—	1.07 (1.06-1.08)	1.08 (1.07-1.09)
<b>Age group</b>						
65-74 years	10.0	—	—	14.2	—	—
75-84 years	12.8	1.32 (1.12-1.55)	1.37 (1.16-1.62)	17.5	1.29 (1.12-1.49)	1.34 (1.17-1.55)
≥85 years	23.9	2.81 (2.41-3.28)	3.15 (2.68-3.69)	31.4	2.78 (2.43-3.19)	3.13 (2.72-3.60)
<b>Race/ethnicity</b>						
White	17.7	—	—	23.6	—	—
Black	17.6	0.99 (0.76-1.30)	0.98 (0.74-1.29)	22.1	0.91 (0.72-1.17)	0.90 (0.70-1.16)
Hispanic	14.5	0.79 (0.64-0.97)	0.79 (0.64-0.98)	19.0	0.76 (0.63-0.91)	0.75 (0.62-0.91)
Asian	9.6	0.49 (0.38-0.65)	0.52 (0.40-0.69)	15.6	0.60 (0.48-0.75)	0.64 (0.51-0.80)
Other/unknown	12.7	0.68 (0.51-0.89)	0.66 (0.50-0.88)	18.4	0.73 (0.58-0.92)	0.71 (0.56-0.91)
<b>Comorbidity index</b>	—	1.17 (1.15-1.20)	1.23 (1.20-1.26)	—	1.18 (1.16-1.20)	1.24 (1.21-1.27)
<b>Comorbidity index</b>						
Score 0	13.2	—	—	18.0	—	—
Score 1-2	16.7	1.32 (1.19-1.47)	1.38 (1.24-1.54)	22.7	1.34 (1.22-1.47)	1.41 (1.27-1.55)
Score ≥3	24.6	2.15 (1.92-2.40)	2.63 (2.33-2.96)	32.2	2.17 (1.96-2.40)	2.67 (2.40-2.98)
<b>Prior fracture</b>	18.2	1.14 (1.04-1.25)	1.04 (0.95-1.15)	24.6	1.18 (1.09-1.28)	1.08 (0.99-1.18)
<b>Fracture subtype</b>						
Femoral neck	16.2	0.89 (0.81-0.97)	0.99 (0.90-1.09)	22.0	0.90 (0.83-0.98)	1.00 (0.92-1.09)
Pertrochanteric	17.9	—	—	23.8	—	—
<b>Year of fracture</b>						
2000	14.9	—	—	21.0	—	—
2001	17.7	1.23 (0.99-1.54)	1.27 (1.01-1.60)	22.5	1.09 (0.90-1.33)	1.12 (0.91-1.38)
2002	15.3	1.03 (0.82-1.30)	1.02 (0.81-1.29)	22.0	1.07 (0.87-1.30)	1.05 (0.85-1.29)
2003	16.8	1.16 (0.93-1.44)	1.15 (0.91-1.44)	22.5	1.10 (0.90-1.33)	1.08 (0.88-1.32)
2004	18.3	1.29 (1.04-1.60)	1.21 (0.97-1.51)	24.6	1.23 (1.01-1.49)	1.15 (0.94-1.41)
2005	17.4	1.21 (0.97-1.51)	1.11 (0.88-1.39)	23.6	1.17 (0.96-1.41)	1.06 (0.87-1.30)
2006	18.2	1.28 (1.03-1.59)	1.13 (0.91-1.42)	23.5	1.16 (0.96-1.41)	1.02 (0.84-1.25)
2007	17.1	1.19 (0.95-1.48)	1.01 (0.80-1.27)	23.2	1.14 (0.93-1.38)	0.97 (0.79-1.19)
2008	17.4	1.21 (0.97-1.51)	0.96 (0.76-1.21)	23.2	1.14 (0.94-1.39)	0.90 (0.73-1.11)
2009	17.0	1.17 (0.94-1.46)	0.92 (0.73-1.16)	22.9	1.12 (0.92-1.36)	0.87 (0.71-1.07)
2010	16.1	1.10 (0.88-1.38)	0.88 (0.69-1.11)	21.2	1.01 (0.83-1.24)	0.80 (0.65-0.99)

OR indicates odds ratio.

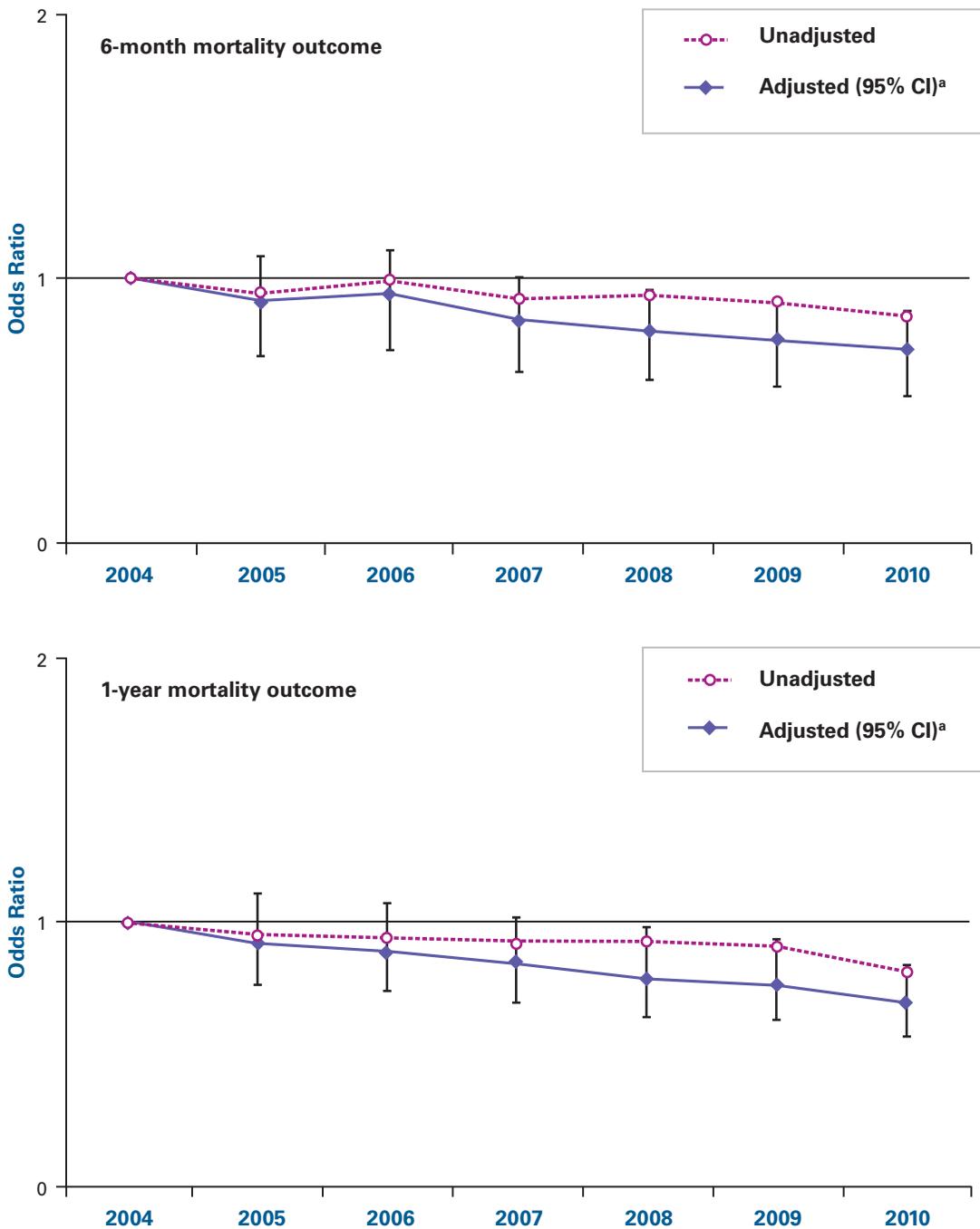
<sup>a</sup>ORs are presented with 95% CI; adjusted for age, race/ethnicity, year of fracture, comorbidity index score, fracture subtype, and prior fracture. Age and comorbidity index score are included in the model as continuous variables except where indicated.

ed hip fracture rates have declined in older women,<sup>1,21,22</sup> the average age of women sustaining hip fracture has increased,<sup>20,22</sup> and the number of fracture events is expected to rise with the aging US population.<sup>1</sup> In this study, we examined data from more than 13,000 women experiencing hip fracture within an integrated healthcare delivery system, and found that 1-year mortality post fracture was 23% and increased significantly with age—approaching 32% for women 85 years and older. These estimates are in the range of, or somewhat lower than, other population cohorts examined in different care settings.<sup>7,23</sup> Following discharge from the initial hip fracture hospitalization, approximately 1 in 8 women experienced early rehospitalization within the ensuing 30 days, associated with a substantially higher 1-year mortality risk. Others have also found that rehospitalization following the initial

hip fracture admission is associated with significantly increased mortality.<sup>3,5,16</sup> Furthermore, consistent with published literature, our study demonstrates that surgical and fracture-specific complications account for only a small proportion of repeat admissions compared with medical comorbidity or complications,<sup>3,16</sup> where infection and pulmonary- and cardiovascular-related conditions were identified as the most common indications for early readmission. These findings have important implications for short-term management of older women experiencing an acute hip fracture, particularly with regard to the importance of aggressive management of medical comorbidities.

Within our fracture cohort of more than 13,000 women, 82% were white, reflecting the predominant racial subgroup within our health plan for this female age group (66% white) and the known higher risk of hip fracture as-

**Figure 2.** Linear Trend in the Adjusted Odds of Death at 6 Months and 1 Year Post Hip Fracture During 2004-2010



<sup>a</sup> $P < .01$  when examining for a linear trend (calendar year as a continuous variable). Odds ratios are represented by calendar year compared with 2004 (categorical variable), unadjusted and adjusted for age, race/ethnicity, comorbidity index score, and prior fracture.

sociated with white race.<sup>24</sup> However, we noted that post fracture mortality varied significantly by race/ethnicity, with mortality risk following hip fracture being lowest for women of Asian race followed by women of Hispanic ethnicity. In contrast to historical studies,<sup>14</sup> no significant

differences were seen in mortality risk when comparing white and black women. While it is possible that these findings may reflect racial/ethnic differences in mortality within the general background population and the fact that older Asians<sup>25,26</sup> and US immigrants<sup>27</sup> have been re-

ported to have higher life expectancy compared with other US subgroups, the extent to which our findings reflect racial/ethnic disparities in hip fracture or health survival rates,<sup>25-28</sup> modifiable risk factors,<sup>29,30</sup> disease management, social relationships,<sup>31</sup> or socioeconomic factors is unclear. These considerations are likely to become increasingly relevant with the anticipated growing subset of nonwhite women in the aging US population.<sup>9,10</sup>

Although a large proportion of deaths following hip fracture relate to the fracture itself,<sup>32</sup> patient comorbidity clearly remains an important contributor toward excess mortality.<sup>12,33,34</sup> Implementing multidisciplinary or medical co-management of hospitalized hip fracture patients has been shown to decrease inpatient postoperative complications, subsequent readmission, and/or mortality rates,<sup>35-39</sup> as has osteoporosis treatment, vitamin D supplementation, and fall-prevention efforts post hip fracture.<sup>40,41</sup> Within our health plan, a number of these factors may have contributed to the small but significant observed reduction in mortality risk. Increased screening and treatment of vitamin D deficiency<sup>42</sup> and implementation of regional programs targeting osteoporosis therapy for primary and secondary fracture prevention during the past 10 years may have also contributed to the overall decline in hip fractures observed within our health plan, in which the age-adjusted incidence of hip fracture fell from 281 to 240 per 100,000 women between 2006 and 2012.<sup>17</sup> Greater interdisciplinary collaboration between orthopedic surgeons and hospitalists surrounding the acute hip-fracture admission has been increasingly evident at both the hospital and facility level, with a joint focus on optimizing inpatient medical care in this high-risk population. Based upon this team approach, region-wide programs are now underway to formalize hip fracture management pathways, and they are anticipated to result in an even greater reduction of mortality risk following hip fracture.

### Limitations

First, we were unable to ascertain functional status, frailty, and quality of life—important factors that require qualitative assessment beyond the scope of this retrospective study. It is assumed that the majority of women were community-dwelling individuals although we were not able to determine how many were in assisted living or institutional care at the time of hip fracture. Second, data pertaining to specific surgical interventions, postoperative medical management, and receipt of subsequent care in nonacute settings were not examined. Third, mortality outcome may have been incomplete for members who left the health plan and relocated out of state, although our

findings were unchanged after excluding the 3.1% with early membership cessation who were presumed alive at 1 year. Finally, we did not examine background mortality trends within our health plan, so we cannot exclude the possibility that the temporal decline in mortality risk reflects temporal trends in mortality across our health plan population, irrespective of hip fracture status. As such, these data represent findings from an aging insured population of older women with access to healthcare and may not necessarily reflect morbidity and mortality rates in other care settings.

Nonetheless, our results provide contemporary estimates that may be generalizable to similar populations, and provide data from one of the largest contemporary hip fracture cohorts within a single healthcare system. Our findings also point to the need for further studies examining contemporary trends and disparities in post fracture morbidity and mortality outcome, including the role of multidisciplinary care, complex comorbidity management, post operative nutrition, and other interventions.

## CONCLUSIONS

While mortality rates remain high among older women post hip fracture, a significant temporal reduction in adjusted mortality risk was observed during the past decade, coincident with multidisciplinary efforts within our health plan to improve clinical outcomes in patients with osteoporosis and post fracture. We also found that race/ethnicity was an important predictor of outcome, with Asian women, and to a lesser extent Hispanic women, demonstrating lower mortality risk over 1 year compared with white women. Future investigations should focus on potential explanations for these differences and the associated cost benefit of targeted interventions, in which strategies to prevent hip fractures and reduce adverse health outcomes are anticipated to have substantial public health implications.

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