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## Hip fracture and increased short-term but not long-term mortality in healthy older women

Erin S. LeBlanc, MD, MPH<sup>1</sup>, Teresa A. Hillier, MD, MS<sup>1,2</sup>, Kathryn L. Pedula, MS<sup>1</sup>, Joanne H. Rizzo, MPA<sup>1</sup>, Peggy M. Cawthon<sup>3</sup>, Howard A. Fink, MD, MPH<sup>4</sup>, Jane A. Cauley, DrPH<sup>5</sup>, Douglas C. Bauer, MD<sup>3</sup>, Dennis M. Black, PhD<sup>3</sup>, Steven R. Cummings, MD<sup>3</sup>, and Warren S. Browner, MD<sup>3</sup>

<sup>1</sup>Center for Health Research, Kaiser Permanente Northwest, Portland, OR, USA

<sup>2</sup>Center for Health Research, Kaiser Permanente Hawaii, Honolulu, HI, USA

<sup>3</sup>San Francisco Coordinating Center, California Pacific Medical Center, CA, USA

<sup>4</sup>Geriatric Research Education and Clinical Center, VA Medical Center, Minneapolis, MN, USA

<sup>5</sup>Department of Epidemiology University of Pittsburgh, Pittsburgh, PA, USA

### Abstract

**Background**—Fractures have been associated with subsequent increases in mortality, but it is unknown how long that increase persists.

**Methods**—5580 women from a large community-based multicenter US prospective cohort of 9704 (Study of Osteoporotic Fractures) were followed prospectively for almost 20 years. We age-matched 1116 hip fracture cases with four controls (n=4464). To examine the effect of health status, we examined a healthy older subset (n=960) aged 80+ who attended the 10-year follow-up examination, and reported good/excellent health. Incident hip fractures were adjudicated from radiology reports by study physicians. Death was confirmed by death certificates.

**Results**—Hip fracture cases had two-fold increased mortality in the year after fracture compared to controls [16.9% vs. 8.4%; Odds Ratio (OR)=2.4; 95% Confidence Interval (CI) 1.9, 3.1]. When examined by age and health status, short-term mortality was increased in those aged 65 to 70 (16.3% vs 3.7%; OR=5.0; 2.6, 9.5), aged 70 to 79 (16.5% vs 8.9%; OR=2.4; 1.8, 3.3), and only in aged 80+ with good/excellent health (15.1% vs. 7.2%; OR=2.8; 1.5, 5.2). After the first year, survival of hip fracture cases and controls was similar except in those aged 65 to 70 who continued to have increased mortality.

**Conclusions**—Short-term mortality is increased after hip fracture in women aged 65 to 79 and in exceptionally healthy women 80 or older. Women 70 and older return to previous risk levels after a year. Interventions are needed to decrease mortality in the year after hip fracture, when mortality risk is highest.

### Keywords

Hip fracture; mortality; elderly; female

<sup>1</sup>**Corresponding Author:** Center for Health Research 3800 N. Interstate Ave Portland OR 97227 Phone: (503) 335-2400 Fax: (503) 335-2424 erin.s.leblanc@kpchr.org.

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## Introduction

Hip fractures are a major public health problem, with nearly 300,000 occurring annually in the United States.<sup>1</sup> Hip fractures cause substantial short- and long-term disability<sup>1</sup> as well as increased mortality.<sup>2-19</sup>

In a recent meta-analysis, women had nearly three-fold increased mortality risk in the year after hip fracture.<sup>16</sup> Long-term (10 year) mortality data are mixed.<sup>2, 4, 7, 9, 12, 14, 20, 21</sup> In the meta-analysis, excess mortality risk from hip fracture decreased during the first 2 years after fracture but did not return to the rate of aged matched controls during long-term (10 year) follow-up.<sup>16</sup>

Prior mortality risk estimates have some important limitations. Some studies used hospitalized patients or registries to identify samples while drawing controls from the general community.<sup>3, 6, 9, 10, 12, 14, 21</sup> Such studies are likely biased by differences in health status of hip fracture cases compared to nonfracture controls. Using hospitalized patients or registries also does not allow for examination of health status or other important covariates, such as bone mineral density (BMD), prior to fracture occurrence. Other studies have combined nursing home residents and community-dwelling women, populations which would be expected to have very different health status.<sup>16</sup>

Such methodological limitations have made it difficult to determine whether the noted increase in mortality after hip fracture is due to underlying poor health or the hip fracture itself. Some studies have found that healthy participants without comorbidities have no increased mortality risk after hip fracture<sup>3, 4, 15</sup> and have concluded that comorbidities explain much of the increased mortality risk after hip fracture;<sup>2, 6, 19, 22</sup> others have noted higher mortality in those without comorbidities compared to those with comorbidities.<sup>14</sup>

Prior studies exploring the influence of age on mortality after hip fracture are conflicting, and limitations include insufficient information about health status<sup>13, 23</sup> and use of registries to retrospectively identify cases.<sup>9, 13</sup> Some studies have found mortality after hip fracture increases with age.<sup>6, 12, 24-26</sup> However, in several studies from Europe, the relative risk of death after hip fracture compared to the risk of death in the general population was lower in older, compared to younger, hip fracture patients.<sup>9, 13, 23</sup>

Among 5580 community-dwelling ambulatory women age 65 and older enrolled in our prospective cohort (1116 incident hip cases and 4464 age-matched controls), our aim was to determine the short-(<1 year), intermediate-( 1 to 5 years), and long-term ( 5 to 10 years) mortality associated with hip fracture. Because expected mortality rates increase significantly with advanced age combined with poor health, a secondary aim was to determine if healthy women aged 80 and older would have increased mortality associated with hip fracture, compared to healthy age-matched controls.

## Methods

### Study Sample

In 1986-88, the Study of Osteoporotic Fractures recruited 9704 community-dwelling women, age 65 or older (>99% Non-Hispanic White) in four US regions: Baltimore County, Maryland; Minneapolis, Minnesota; Portland, Oregon; and the Monongahela Valley near Pittsburgh.<sup>27</sup> Women unable to walk without assistance and those with bilateral hip replacements were excluded. All women provided written consent, and SOF was approved by each site's Institutional Review Board.

We prospectively followed 1116 women who had an adjudicated incident hip fracture (cases) during almost 20 years of follow-up until December, 2005 (mean 14.4 years; Figure 1).<sup>27</sup> Each fracture case was matched by exact year of age at baseline with four controls (n=4464) without hip fracture; controls had to similarly survive at least to the time of the case hip fracture. To confirm that the selected controls were representative of the SOF population, we compared frequencies and means of selected baseline characteristics (age, body mass index, hip bone mineral density, pack years smoked, mini mental status exam, health status, standing from a chair, and medical conditions) between nonfracture participants who were selected and not selected for this analysis. The two groups were relatively similar except that those who were not selected for the study were younger (69 vs. 73 years [age was a matching criteria for the fracture cases]). We followed women for up to 19 years after hip fracture (mean 4.8 years).

### Healthy Subset Study Sample

To determine if healthy women age 80 and older have increased mortality associated with hip fracture compared to healthy age-matched controls, we also analyzed a healthy older subset of women, chosen based on their status at the year 10 SOF exam (Figure 1). Inclusion criteria for the healthy subset were: 1) survival to age 80 or more at Year 10; 2) healthy enough to return to the clinic for their year 10 examination (i.e., did not need to have the exam at their home); and 3) reported good or excellent health at year 10. Of this healthy subset, 192 had an adjudicated incident fracture during a mean of 6.7 years follow-up after the year 10 exam (defined as cases for this analysis). These cases were matched by age with four controls (n=768) from the healthy subset who had survived to the time of the case's fracture.

### Baseline characteristics

Weight was measured in light clothing without shoes by a balance-beam scale and height was measured by stadiometer. These measures were then used to compute body mass index (BMI).<sup>27</sup> Cognitive function was assessed using a modified version of the Mini-Mental State Examination (MMSE).<sup>28</sup> Neuromuscular function tests included a subject's ability to stand from a chair, without using her arms.<sup>29</sup> Age, smoking and alcohol consumption, medical history, and self-reported health were determined by questionnaire and interview at baseline and current medications were recorded.

### Bone Mineral Density (BMD)

Dual-energy x-ray absorptiometry (DXA) was first available and measured by Hologic QDR 1000 in 1988-1990 at the two-year exam (Hologic, Bedford, Massachusetts). DXA BMD measurement standards and precision have been previously detailed<sup>30</sup> and quality control procedures were rigorous.<sup>27</sup> Complete data for DXA total hip BMD was available for 86.1% of the cohort at the year 2 exam.

### Ascertainment of incident hip fractures and mortality

Participants were contacted every four months by postcard (with phone follow-up for non-responders) to ascertain incident hip fractures or death; more than 95% of these contacts were completed. Incident hip fractures were obtained from radiology reports. Cause of death was determined from death certificates and, if available, other supporting documentation (medical records, hospital discharge data) at each SOF clinic site. For consistency in coding across SOF sites, all final outcomes (hip fracture and cause of death) were centrally adjudicated by a physician at the SOF Coordinating Center. Final adjudicated cause of death was done using ICD-9 codes and cause of death was categorized at the coordinating center.<sup>31</sup>

## Statistical Analyses

We identified death within the first year following the fracture for each woman within a matched case and control quintuplet (1 case plus 4 controls), based on the date of fracture for the case. When no death occurred for any woman within the quintuplet, we also evaluated mortality from one to five years; quintuplets without a death within 5 years post-case fracture were further evaluated for mortality from five to 10 years of the case fracture date. Thus, in the 5- to 10-year period, all five women in the quintuplet had to survive at least 5 years.

We used conditional logistic regression to evaluate the associations between hip fracture and mortality during several post-fracture time periods. Based on prior studies of the association between fracture and mortality,<sup>2, 32</sup> models were adjusted for age, BMD, smoking status, self-reported health status, SOF clinical site, history of diabetes, hypertension, stroke or Parkinson's disease, MMSE score, and ability to stand from a chair at the baseline exam. Total hip BMD was then added to the model to evaluate its effect. We tested for the presence of interaction by stratifying for age groups (<70, 70-79, 80+ years). We also examined the associations between intertrochanteric and femoral neck fractures on mortality. We repeated the analyses in the healthy subset of older women, as defined at the year 10 exam. We used SAS 8.2. We considered  $p < 0.05$  to be significant.

## Results

### Baseline characteristics

Hip fracture cases had lower BMI, lower total hip BMD, and more cigarette exposure than age matched non-fracture controls (Table 1). A slightly greater proportion of cases had Parkinson's disease and needed their arms to stand from a chair compared with controls, but mean MMSE score was similar in the two groups. In those under the age of 70 (but not in the older age groups), more cases than controls had diabetes ( $p = .002$ ). Self-reported health status was worse in those over the age of 80 who fractured compared to non-fracture controls ( $p = .04$ ), but health status was not different between younger cases and controls (data not shown).

### Association between hip fracture and subsequent mortality

Overall, 48.2% ( $n = 2690$ ) of the sample died during a mean 14.4 ( $\pm 4.1$  SD) years of follow-up. Mortality risk was highest in the first year after hip fracture (Table 2). During the first year after an index hip fracture, 16.9% ( $n = 189$ ) of the cases died compared with 8.4% ( $n = 374$ ) of the non-fracture controls [OR 2.2 (1.8, 2.7)]. This increase in mortality persisted when the analysis was adjusted for other risk factors for hip fracture, including total hip BMD [OR 2.4 (1.9, 3.1)]. While deaths in the control group were evenly spread over the first year of observation (~25% every 3 months), 72% of year 1 deaths in the cases occurred within 6 months of a hip fracture. Moreover, over half (52%) of deaths in the first year following hip fracture occurred within the first 3 months for the cases.

Mortality risks for fracture and non-fracture participants were generally similar after the first year (Table 2). In the 3340 participants who remained in the analysis after the first year (because no one in their quintuplet had died), 24.6% ( $n = 164$ ) of hip fracture cases and 21.9% ( $n = 585$ ) of controls died by year 5 [OR 1.2 (1.0, 1.5)]; the association was no longer significant after adjusting for potential confounders [1.2 (0.9, 1.5)]. Among the 1265 remaining in the analysis between five and 10 years, 14.2% ( $n = 36$ ) of hip fracture cases compared with 10.0% ( $n = 101$ ) of non-fracture controls had died by the end of follow-up [OR 1.6 (1.0, 2.6)]; however, this increased risk was no longer present in multivariable

models [OR 1.4 (0.8, 2.6)]. The associations were similar when stratified by type of fracture (femoral neck and intertrochanteric fracture data available in online tables).

We noted a significant interaction between age and risk of death after hip fracture ( $p=0.002$ ). When stratified into 3 age categories (<70, 70 to 79, and 80+ years at baseline exam), the risk of death from hip fracture decreased as age increased (Table 3). Those aged 65 to 69 who suffered a hip fracture had a 5-fold increased risk of death in the first year [OR 5.0 (2.6, 9.5)]. In contrast, there was no increased risk of death in the first year after a hip fracture in those over the age of 80 years [OR 1.1 (0.6, 2.1)]. Those aged 70 to 79 had a risk of death in the first year that was intermediate between the youngest and oldest SOF participants [OR 2.4 (1.8, 3.3)]. Examining longer term follow-up, those aged 65 to 70 had an increased risk of mortality after hip fracture during the 1 to 5 [OR 1.9 (1.1, 3.2)] and 5 to 10 year follow-up [OR 3.2 (1.0, 10.2)] periods, although risks were attenuated compared to the first year. The older age groups did not have an increased risk of death in longer term follow-up.

### Association between hip fracture and subsequent mortality in the healthy subset

Healthy women over the age of 80 years did not have overall increased mortality after fracture (Table 4). However, short-term mortality was increased among these women: hip fracture cases had a nearly three-fold increased risk of death in the first year after a fracture, even after adjustment for other risk factors including BMD [OR 2.8 (1.5, 5.2)]. In the 600 women who remained in the analysis after the first year (because no one in quintuplet had died), the risk of death was not increased. Indeed, there may even have been a decreased risk of death in hip fracture cases from 1 to 5 years after hip fracture, although the results were statistically significant only in the multivariable models adjusted for total hip BMD [OR 0.4 (0.2, 0.8)].

### Causes of death

In the overall sample, the leading causes of death were coronary heart disease, cancer, and stroke in both the hip fracture cases and controls. There were no differences in death rate from coronary heart disease between fracture cases and controls (24.9% vs 26.0%), stroke (9.8% vs 11.7%), or sepsis (1.8% vs 2.1%). However, a greater proportion of hip fracture cases than controls died from pneumonia (10.5% vs 5.6%;  $p<.0001$ ), cognitive disorders (9.2% vs 6.7%;  $p=0.03$ ), and osteoporotic fracture (2% vs 0%;  $p<.0001$ ); in contrast, more controls died of cancer (11.0% cases vs 18.2% controls;  $p<.0001$ ).

### Discussion

We found women over the age of 65 who suffer a hip fracture have a two-fold increased risk of death in the first year after the fracture compared with similarly aged women who do not suffer a hip fracture. After the first year, mortality rates are similar when we examined the entire cohort of SOF women. Our overall findings of increased short-term mortality are consistent with a recent meta-analysis<sup>16</sup> that found an almost three-fold increased risk of death in the first year after a hip fracture. Previous data on long-term mortality are mixed<sup>2, 4, 7, 9, 12, 14, 16, 21, 33</sup> with some,<sup>16</sup> but not all,<sup>7, 12</sup> showing increased mortality risk for up to 10 years after hip fracture, although excess mortality risk was lower during later years of follow-up compared to the first year or two after hip fracture.<sup>16</sup>

Limitations in previous study designs have made it difficult to determine whether excess mortality was driven by the hip fracture itself or differences in pre-fracture health status and/or age. Because of the large size and prospective, extended follow-up of the SOF cohort, we were able to examine the effects of both health status and age on the association between hip fracture and mortality and found they may influence mortality risk after fracture. Those aged

65 to 70 years had the greatest risk of short-term death (5-fold) after a hip fracture. In contrast, the oldest participants (80+ years) overall had no increased short-term mortality risk after a hip fracture. However, when we separately examined women over the age of 80 who reported good to excellent health status, we did find a two-fold increased risk of death in the first year after a fracture. Similarly, when we examined long-term mortality by age and health status, we found that those age 65 to 70 had a persistent increase in intermediate and long-term (5 to 10 year) mortality, although the risks were attenuated compared to short-term risk. In contrast, the oldest participants (80+ years) had no increased intermediate or long-term mortality risk after a hip fracture, regardless of their health status. Our data suggest that previous mixed results with regard to mortality, especially long-term mortality, after hip fracture may have been due to differences in the underlying age and health status of the population being studied.

Our finding that short-term mortality risk was only elevated in the exceptionally healthy over the age of 80 and not the whole population of over 80 suggests that hip fracture itself may contribute to increased mortality in these older women. Most, but not all,<sup>9, 14</sup> prior studies have concluded that increased mortality risk after hip fracture was due to underlying comorbidities such as cardiovascular disease, stroke, respiratory disease, diabetes, or cancer.<sup>2-4, 6, 14, 15, 19, 22</sup> An earlier study conducted in the SOF cohort concluded that a two-fold increased mortality risk in hip or pelvic fracture cases compared to non-fracture controls during 5.9 years of study (n=64 deaths)<sup>2</sup> was a consequence of increased comorbid conditions in hip fracture cases.

Because the background mortality rate is very high in women age 80 and older, especially with poor health, it would be more difficult to distinguish an additional independent risk of hip fracture on mortality. Our purpose in evaluating the exceptionally healthy subset was to better isolate the independent effects of hip fracture on mortality from that of comorbidities, and indeed we found an increased risk in the first year after hip fracture compared to their similarly healthy age-matched controls.

Consistent with hip fracture being a contributor to death, among the whole cohort we also found the highest increase in mortality risk was in the first 3 months after hip fracture. Although in our study less than 15% of the deaths were due to infection or osteoporosis, the most likely causes of death to be directly attributed to the fracture itself, hip fracture could have been a contributing cause in many of the remaining deaths, including those attributed to coronary heart disease and stroke.

Our finding that younger women have the highest mortality risk is consistent with some<sup>9, 13, 23</sup> but not all previous studies.<sup>6, 12, 24-26</sup> However, prior studies were unable to disentangle the effects of age from health status. Our identification of women prior to their fracture, prospective study design, and extensive data on co-morbidities allowed us to better examine how age and health status each influence mortality after hip fracture. We hypothesize that age influences risk of death after hip fracture by affecting the baseline death rate in the population. Those who are younger and/or healthier have a low risk of dying from other causes. Therefore, suffering a hip fracture may increase their mortality risk compared to nonfracture controls. In contrast, octogenarians generally have a relatively high risk of dying from other causes and so suffering a hip fracture does not actually result in an increased risk of death over the next year compared to other women their age, unless they are exceptionally healthy. This hypothesis is supported by the recent meta-analysis on the association between hip fracture and mortality;<sup>16</sup> in that analysis, mortality from other causes increased rapidly with age, reducing the absolute excess mortality after hip fracture in the oldest group of patients.

Our study has important strengths. It was set within a large community-based prospective study of older women, with rigorous quality control of BMD measurements and study physician-adjudicated hip fracture data. Retention of survivors was excellent, with well over 95% completion of follow-up information—including women who became too frail to attend subsequent visits. We were able to adjust for several important covariates.

Our study also has several limitations. It was conducted in postmenopausal white women age 65 years or older and may not be generalizable to men, other ethnic groups, and younger women. However, it provides important information on the group most likely to suffer from hip fracture—older white women. One of our study's strengths—its long observation period—is also a limitation in that standard care for treatment of hip fractures has changed over time.<sup>34</sup> However, as mortality rates after hip fracture have not decreased much, if at all, over the past 10 to 40 years,<sup>7, 35, 36</sup> our results are likely still relevant to considerations for prevention of hip fracture and its associated mortality.

Despite our selection of a healthy subset and adjustment for multiple risk factors, we cannot exclude residual confounding by other diseases or frailty. We often measured covariates months to years prior to the time of fracture and during that period, women's health status may have changed. In the healthy subcohort, women may have developed new comorbidities that might have changed their health status between the year 10 visit (when the healthy subcohort was defined) and fracture occurrence. It is also important to note that in age-stratified analyses, because of decreased overall survival, the number of cases and events in the oldest population was lower than in the younger age groups, and so we had decreased power to detect a significant association if it were present.

## Conclusions

Because hip fracture risk increases with age, hip fractures are expected to become an even larger public health issue as the population ages; some experts predict there will be 6.3 to 8.2 million hip fractures annually worldwide in 2050.<sup>1, 37</sup> Overall, older women who suffer a fracture have a two-fold increased mortality in the first year after hip fracture. Women who are either less than 80 or 80+ and healthy have the highest risk of dying in the first year compared to women of similar age and health status. If our findings are replicated, they would suggest that research should focus on hip fracture prevention and interventions in these groups that could decrease mortality during that high-risk period. Women who are between the age of 65 and 70 continue to have an increased risk of mortality for up to 5 to 10 years and so prevention of hip fractures in these women should be of high priority.

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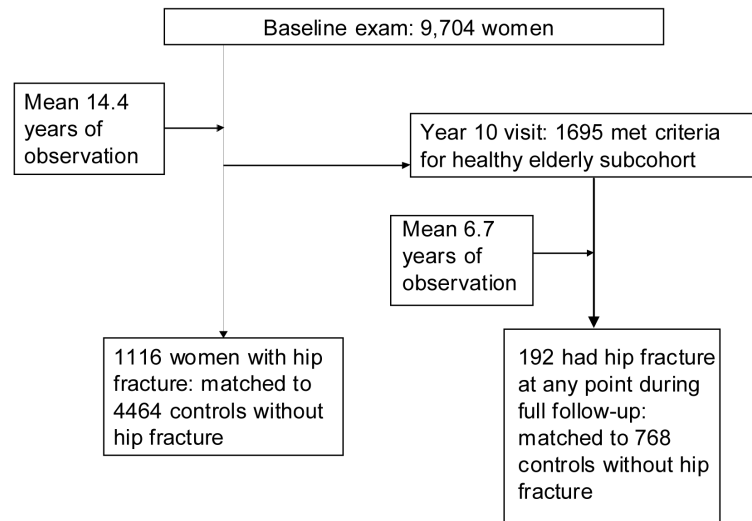
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**Figure 1.**  
Flow of Study Participants

Table 1

## Characteristics of Study Participants

	Overall			Healthy Elderly Subset		
	Hip Fractures (N=1116)	Non-Fractures (N=4464)	p-Value	Hip Fractures (N=192)	Non-Fractures (N=768)	p-Value
Age, years (mean, SD)	73.0 (5.1)	73.0 (5.1)	*	83.7 (3.2)	83.7 (3.2)	*
Body mass index, kg/m <sup>2</sup> (mean, SD)	25.4 (4.1)	26.7 (4.6)	.0001	24.3 (4.0)	26.1 (4.2)	.0001
Total hip BMD, grams/cm <sup>2</sup> (mean, SD)	0.69 (0.1)	0.76 (0.1)	.0001	0.63 (0.1)	0.72 (0.1)	.0001
Current smoker (n, %)	120 (10.8)	334 (7.5)	.001	10 (5.2)	19 (2.5)	.05
Self-rated health, good/excellent (n, %)	925 (82.9)	3761 (84.3)	.27	192 (100.0)	768 (100.0)	-
Diabetes (n, %)	85 (7.6)	280 (6.3)	.10	6 (3.1)	21 (2.7)	.77
Hypertension (n, %)	446 (40.0)	1761 (39.5)	.76	65 (33.9)	249 (32.4)	.71
Stroke (n, %)	37 (3.3)	129 (2.9)	.45	9 (4.7)	29 (3.8)	.56
Parkinson's disease (n, %)	13 (1.2)	21 (0.5)	.01	††	††	-
MMSE score (mean, SD) †	24.6 (1.7)	24.6 (1.7)	.99	27.7 (2.0)	27.8 (2.2)	.46
Uses arms to stand from chair (n, %)	58 (5.2)	171 (3.8)	.04	24 (12.5)	121 (15.8)	.26

\* Hip fracture cases and non-fracture controls were matched on exact year of age at baseline

† Modified Mental Status Exam

†† Data not available

**Table 2**

## Effects of Hip Fracture on Subsequent Mortality

	Hip fracture participants No. Deaths /Total No. * (%)	Non-fracture participants No. Death/ Total No. * (%)	Unadjusted OR <sup>†</sup>	Multivariable Adjusted OR <sup>††</sup>
<b>OVERALL</b>	655 / 1116 (58.7)	2035 / 4464 (45.6)	2.0 (1.7, 2.3)	2.0 (1.6, 2.4)
<b>0 to &lt;1 YEAR</b>	189 / 1116 (16.9)	374 / 4464 (8.4)	2.2 (1.8, 2.7)	2.4 (1.9, 3.1)
<b>1 to 5 YEARS</b>	164 / 668 (24.6)	585 / 2672 (21.9)	1.2 (1.0, 1.5)	1.2 (0.9, 1.5)
<b>5 to 10 YEARS</b>	36 / 253 (14.2)	101 / 1012 <sup>‡‡</sup> (10.0) <sup>‡‡</sup>	1.6 (1.0, 2.6)	1.4 (0.8, 2.6)

\* Decrease in total number of deaths with each time strata reflects removal of entire quintuplets (case and 4 matching controls) from analysis upon death of any member of quintuplet.

<sup>†</sup> Odds ratios based on conditional logistic regression.

<sup>††</sup> Multivariable model (n=4716) includes age, BMI, pack years of smoking, clinic, history of diabetes, hypertension, stroke, MMSE score, ability to stand from chair at baseline exam, self-reported health, Parkinson's disease, and total hip BMD.

<sup>‡‡</sup> The participants remaining in the analysis by 5 to 10 years after their hip fracture were younger, had a higher hip BMD, had higher self rated health, had less diabetes and hypertension, had higher MMSE scores, and were less likely to use their arms to stand from a chair compared to those not remaining the analysis. These differences likely account for the lower absolute death rate in years 5 to 10 compared to years zero to five. This decrease in mortality rate at the 5 to 10 year time point also occurred when all 5,580 women in the cohort were considered, confirming that cases and controls remained comparable over time.

**Table 3**

Odds of death after hip fracture according to age strata

	Age <70 N=1630	Age 70-79 N=3235	Age 80+ N=715
<b>OVERALL</b>	2.9 (2.0, 4.1)	1.8 (1.4, 2.2)	0.9 (0.5, 1.7)
<b>0 to &lt; 1 YEAR</b>	5.0 (2.6, 9.5)	2.4 (1.8, 3.3)	1.1 (0.6, 2.1)
<b>1 to 5 YEARS</b>	1.9 (1.1, 3.2)	1.1 (0.8, 1.5)	0.7 (0.3, 1.7)
<b>5 to 10 YEARS</b>	3.2 (1.0, 10.2)	0.9 (0.4, 2.0)	0.5 (0.1, 3.7)

Odds ratios are based on conditional logistic regression and adjusted for age, BMI, pack years of smoking, clinic, history of diabetes, hypertension, stroke, MMSE score, ability to stand from chair at baseline exam, self-reported health, Parkinson's disease, and total hip BMD. If model variables were non-estimable because of small cell size, we removed them.

**Table 4**

Effects of Hip Fracture on Subsequent Mortality in Healthy Subset of Elderly Women

	Hip fracture participants No. Death /Total No. (%)	Non-fracture participants No. Death /Total No. (%)	Unadjusted OR <sup>†</sup>	Multivariable Adjusted OR <sup>††</sup>
<b>OVERALL</b>	66 / 192 (34.4)	214 / 768 (27.9)	1.4 (1.0, 2.0)	1.3 (0.9, 2.0)
<b>0 to &lt;1 YEAR</b>	29 / 192 (15.1)	55 / 768 (7.2)	2.3 (1.4, 3.7)	2.8 (1.5, 5.2)
<b>1 to 5 YEARS</b>	18 / 120 (15.0)	94 / 480 (19.6)	0.7 (0.4, 1.2)	0.4 (0.2, 0.8)
<b>5 to 10 YEARS</b>	3 / 53 (5.7%)	7 / 212 (3.3) <sup>‡‡</sup>	2.2 (0.4, 11.7)	2.3 (0.3, 19.0)

\* Decrease in total number of deaths with each time strata reflects removal of entire quintuplets (case and 4 matching controls) from analysis upon death of any member of quintuplet.

<sup>†</sup> Odds ratios based on conditional logistic regression.

<sup>††</sup> Multivariable model (n=891) includes age, BMI, current smoke status, clinic, history of diabetes, hypertension, stroke, MMSE score, ability to stand from chair at baseline exam, and total hip BMD. If model variables were non-estimable because of small cell size, we removed them.

<sup>‡‡</sup> The participants remaining in the analysis by 5 to 10 years after their hip fracture were younger, had a higher hip BMD, had higher self rated health, had less diabetes and hypertension, had higher MMSE scores, and were less likely to use their arms to stand from a chair compared to those not remaining the analysis. These differences likely account for the lower absolute death rate in years 5 to 10 compared to years zero to five. This decrease in mortality rate at the 5 to 10 year time point also occurred when all 5,580 women in the cohort were considered, confirming that cases and controls remained comparable over time.