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Direct healthcare costs of hip, vertebral, and non-hip, non-vertebral fractures.

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"Direct healthcare costs of hip, vertebral, and non-hip, non-vertebral fractures"

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ABSTRACT

Limited data exist regarding the cost of non-hip, non-vertebral (NHNV) fractures. Although NHNV fractures may be less expensive than hip and vertebral fractures, they have a higher incidence rate. The objective of this study was to quantify first-year healthcare costs of hip, vertebral, and NHNV fractures. This was a claims-based retrospective analysis using a case-control design among patients with commercial insurance and Medicare employer-based supplemental coverage. Patients were ≥ 50 years old with a closed hip, vertebral, or NHNV fracture between 7/1/2001 and 12/31/2004, and continuous enrollment 6 months prior to and 12 months after the index fracture. Adjusted mean first-year healthcare costs associated with these fractures were determined. Six cohorts were identified. Patients 50–64 years: NHNV (n=27,424), vertebral (n=3,386) and hip (n=2,423); Patients ≥65 years: NHNV (n=40,960), vertebral (n=11,751) and hip (n=21,504). The ratio of NHNV to hip fractures was 11:1 in the 50–64 cohort and 2:1 in the ≥65 cohort. Adjusted mean first-year costs associated with hip, vertebral, and NHNV fractures were $26,545, $14,977, and $9,183 for the 50–64 age cohort, and $15,196, $6,701, and $6,106 for patients ≥65 years. After taking prevalence rate into account, the proportion of the total fracture costs accounted for by NHNV, hip, and vertebral fractures were 66%, 21% and 13% for the 50–64 age cohort, and 36%, 52% and 12% for the ≥65 age cohort. Limitations included the exclusion of the uninsured and those covered by Medicaid or military-based insurance programs. The results of this study demonstrate that osteoporotic fractures are associated with significant costs. Although NHNV fractures have a lower per-patient cost than hip or vertebral fractures, their total first-year cost is greater for those 50–64 because of their higher prevalence.

Key Words:

Fracture

Hip

Vertebral

NHNV

Cost

Introduction

A major public health threat, osteoporosis is estimated to affect 44 million Americans. About 40%–50% of women and 13%–22% of men are at risk of having an osteoporotic fracture in their lifetime [1]. Burge et al. estimate that 2 million fractures related to osteoporosis occurred in 2005 and project that 3.5 million osteoporotic fractures will occur in 2025. The associated costs of these osteoporotic fractures were estimated to be $19 billion in medical costs in 2005, with an anticipated increase to $25.3 billion in 2025, given the aging population [2].

In addition to the substantial cost burden, hip fractures are also associated with a high mortality rate. Approximately 24% of hip fracture patients ≥50 years of age die in the year following their fracture [3]. As expensive as hip fractures are, Gabriel et al. found that they represent only 37% of the total incremental cost of all moderate-trauma fractures combined [4]. While hip fractures remain a key driver of osteoporosis-related costs, some research indicates that osteoporosis-related, non-hip fractures, such as those of the spine, wrist/forearm, pelvis, humerus, and leg, are more prevalent than hip fractures [2,5]. Burge et al. report that, of the 2 million osteoporotic fractures estimated in 2005, hip fractures account for only 14%, while spine fractures represent 27%, and the remaining 59% includes fractures of the wrist, pelvis, and other sites (clavicle, scapula, humerus, carpal bone, metacarpal, other femur, patella, tibia and fibula) [2]. Much is known about the health and economic impact of hip and vertebral fractures; however, to accurately characterize the burden of all osteoporotic fractures, further research is needed on the clinical and economic burden associated with NHNV fractures, which account for more than half of the total number of osteoporotic fractures.

Numerous studies conducted in various countries [6-11] using both retrospective [6] and prospective study designs [7-9], as well as case-control comparisons [10,12,13] have analyzed the cost of hip fractures. While there is growing literature examining the cost of vertebral and non-vertebral fractures, many of the studies estimate cost based on economic models instead of data from real-world practice settings [2,14-17]. Other studies are confined to a specific gender or age cohort [12,14,18] or use data drawn from a single county in the US [4,19]. Lack of comparison cohorts makes it difficult to gauge the incremental cost associated with these fractures [20]. To better understand the economic burden of osteoporotic fractures in our healthcare system, this study estimated the incremental cost associated with closed hip, vertebral, and NHNV fractures by comparing healthcare cost in the first year following the fracture among fracture patients and their age-gender-region-comorbidity-matched controls who were fracture-free during the study period. Additionally, given that NHNV fractures are more prevalent in the younger population [20], costs were analyzed separately for patients of 50–64 years and ≥65 years.

Methods

Data Source

This retrospective study was based on Thomson Reuters MarketScan® Commercial Claims and Encounters, and Medicare Supplemental and Coordination of Benefit (COB) Databases. The commercial database contains individual-level healthcare claims, encounters, enrollment, and drug data on approximately 166 million covered lives in the working population and is contributed to by employers and health plans for individuals under fee-for-service, fully capitated, and partially capitated health plans (PPOs and HMOs). Enrollees maintain their unique identifier even if they change health plans as long as they continue to work for the same employer.

The Medicare database includes patient-level medical and pharmacy claims histories of 33 million covered lives belonging to 12 national and regional health plans in the U.S. It is representative of the national commercially insured population and those who have both Medicare coverage and supplemental employer-sponsored coverage. All claims reflect the coordination of benefits between the commercial insurer and Medicare such that all costs of services paid for under either entity are captured in the database. Any services a patient may have received from another insurer, such as the Veteran's Administration, would not be captured in this database. The overall age distribution of the MarketScan® Medicare population is similar to that of a nationally representative population in the Medical Expenditure Panel Survey (MEPS) and the Medicare Beneficiary Survey (MCBS). Among enrollees ≥65 years, the distribution of age in 15-year increments is also similar to that of the national Medicare population, with a somewhat higher proportion of individuals aged 65–74. The Medicare database includes the Medicare-covered portion of payment, the employer-paid portion, and any patient out-of-pocket expenses. The patient data used in this analysis have been de-identified in compliance with Health Insurance Portability and Accountability Act (HIPAA) regulations and therefore, the study is exempt from Institutional Review Board approval.

Patient Selection

Patients who were ≥50 years of age with a primary or secondary diagnosis for closed hip, vertebral, or NHNV (pelvis, humerus, wrist, clavicle, leg) fracture between July 1, 2001 and December 31, 2004 were identified (Fig. 1). Osteoporosis diagnosis was not required for patient eligibility because it would be unlikely for a clinician to code for osteoporosis when evaluating a fracture. Osteoporosis is often undetected until a fracture occurs, and the requirement of a diagnosis that might have been made months or years earlier would exclude relevant fractures from the analysis. Radiology claims were ignored since they can be used to rule out fracture and do not improve the positive predictive value of probable fractures [21]. In an effort to limit the analyses to osteoporotic fractures, open fractures and closed cervical and sacrum/coccyx fractures were excluded as they are more often associated with trauma rather than osteoporosis. A list of ICD-9-CM fracture diagnosis codes is provided in Table 1.

The first observed fracture during the index period was denoted as the index fracture. Eligible patients were required to be continuously enrolled 6 months prior to, and 12 months after the index fracture. Patients were excluded if they had any fracture during the pre-period or did not have complete medical and pharmacy data available during the study period. Six fracture cohorts were selected and analyzed individually: hip, vertebral, and NHNV, for patients 50–64 years and ≥65 years.

To estimate the incremental healthcare costs associated with fractures, comparison groups were identified that consisted of enrollees who were fracture-free during the study period. For each of the 6 fracture cohorts, patients were matched to controls based on exact age, gender, and region, as well as ± 3 diagnostic cluster score (DCS). The diagnosis clusters (version 4.2, 2001) classify clinical conditions into 120 clusters, including osteoporosis and fracture, based on almost 90% of all diagnoses recorded by family physicians in different settings. These clusters are adapted for use with ICD-9-CM diagnoses. Fifteen supplemental clusters are added for the ≥65 population. The DCS is regarded as one of the best individual predictors of future healthcare expenditures [22,23]. A patient-level summary score based on the total count of diagnostic clusters was generated in this study. The highest possible DCS was 120 for patients <65 and 135 for patients ≥65.

Matching was achieved through a 2-stage process. Fracture patients and controls were first matched 1:10 based on exact age, gender, and region. Subsequently, the controls were assigned the same index date as that of their matched fracture patient. The controls were required to be continuously enrolled 6 months prior to and 12 months after the acquired index date. DCS was calculated from the claims during the 6-month pre-period. A 1:1 matching was performed to pair fracture patients with controls within ± 3 DCS.

Outcomes

The outcome of this study was the incremental healthcare costs associated with hip, vertebral, and NHNV fractures during the first year following the fracture. A 12 month period was chosen because fractures, especially in the elderly, can have long-term effects and treatments, such as rehabilitation and physical therapy, which can extend beyond 3 to 6 months. Total healthcare costs were assessed separately for the fracture and the control cohorts. The difference in healthcare cost between the comparison cohorts served as an estimate of the incremental cost associated with fracture. Costs were also categorized into inpatient, outpatient, and pharmacy expenses to depict the care setting of fracture-related expenditures. Outpatient expenses included physician visits and other services rendered in the outpatient setting.

A generalized linear model with the variance proportional to the mean and a log link was used to estimate total incremental healthcare cost associated with fracture, adjusting for differences in the DCS and pre-period medical expenditures. Additionally, fracture-associated confounding conditions, such as endocrine disease, cancer, alcoholism, and rheumatoid arthritis were included in the multivariate models where significant differences were detected between groups. Due to differences in fracture type and age group, confounding conditions varied for the 6 models, as shown in Table 2.

Cost was defined as the total net payment from paid and adjudicated claims, including payment by both health plans and patients. All costs were inflated to 2006 dollars by multiplying each year's cost by the Medical Care Consumer Price Index. Costs for services provided under capitation insurance coverage were estimated from encounter records using fee-for-service equivalents defined by procedure code and region.

Results

Patient Characteristics

Six study samples were identified and over 89% of fracture patients were matched to a control. Unmatched patients were removed from the study. Comparison of pre- and post-matching patient profiles indicated the matched samples resembled the pre-match samples. Fig. 1 shows the post-matching sample sizes: Hip fracture/50–64 years (n=2,423), hip fracture/≥65 years (n=21,504), NHNV fracture/50–64 years (n=27,424), NHNV fracture/≥65 years (n=40,690), vertebral fracture/50–64 years (n=3,386), and vertebral fracture/≥65 years (n=11,751). NHNV fractures were more prevalent than either hip or vertebral fractures in both age groups. In the 50–64 cohort, NHNV fractures accounted for 82% of total fractures identified, with hip and vertebral fractures representing 8% and 10%, respectively. The ratio between NHNV and hip fracture was 11:1. Similarly, but to a lesser extent, NHNV fracture was the most prevalent fracture in the ≥65 cohort, comprising 55% of total fractures, followed by hip (29%) and vertebral (16%) fractures. The ratio between NHNV and hip fracture was 2:1.

Table 2 presents demographic and clinical characteristics of the 6 comparison cohorts. The mean age ± SD of the 2 age cohorts was 60 years (59.9 ± 4.7/hip; 58.7 ± 4.0/NHNV; 59.1 ± 4.3/vertebral) and over 80 years (83.2 ± 7.2/hip; 79.8 ± 7.5/NHNV; 81.1 ± 7.2/vertebral), respectively. NHNV fracture patients were 1–3 years younger than those with hip or vertebral fractures. Women consisted of more than half of the study population for the 50–64 groups (61%/hip, 65%/NHNV, 52%/vertebral) and over 71% for the ≥65 groups (74%/hip, 77%/NHNV, 71%/vertebral). Compared to their controls, fracture patients incurred a higher total healthcare cost (*P*<0.001) and osteoporosis-related cost (*P*<0.001) during the pre-period. Their average DCS was also higher (*P*<0.001).

Prior to their fracture, 14% of fracture patients were diagnosed with endocrine disease. Cancer, other than breast or bone cancer, was detected in 10%–14% of both age fracture cohorts. Between 5%–6% of fracture patients had thyroid disease. The prevalence rates of other confounding conditions in the fracture cohorts were lower than 4%. The prevalence of confounding conditions among the 6 comparison cohorts are displayed in Table 2. With some variations, patients in the fracture cohorts had higher rates of select conditions than their controls. For example, hip fracture patients of 50–64 years had higher rates of breast cancer (2.6% vs. 1.6%, *P*=0.015), alcoholism (0.9% vs. 0.2%, *P*<0.001), nephritis, nephritic syndrome and nephrosis (2.3% vs. 0.5%, *P*<0.001), and rheumatoid arthritis (2.8% vs. 1.2%, *P*<0.001) than their controls. Given that some of these conditions can be costly, their potential impacts on first-year cost following fracture were subsequently controlled for through multivariate models.

Cost of Fractures

The unadjusted mean healthcare costs during the first year following fracture were 1–4 times higher for the fracture patients than their matched controls depending on the fracture type (Table 3). Among the 3 types of fractures examined, hip fractures were associated with the highest mean incremental cost: $31,047 (*P*<0.001) for the 50–64 cohort and $16,823 (*P*<0.001) for the ≥65 cohort. This was followed by vertebral fracture: $18,603 (*P*<0.001) and $8,242 (*P*<0.001) in incremental costs for the 50–64 years and the ≥65 cohort, respectively. The mean incremental cost associated with NHNV fracture was $10,533 (*P*<0.001) for the 50–64 cohort and $7,140 (*P*<0.001) for the ≥65 cohort.

In the 50–64 cohort, hip fracture patients incurred 69% ($21,423) of their total incremental cost from inpatient services, followed by 23% ($7,277) from outpatient services and 8% ($2,347) from pharmacy. Over half of the total incremental cost of vertebral fractures was spent on hospitalizations ($9,783), while one third was spent on outpatient services ($6,480), and 13% ($2,340) on pharmacy. Outpatient services (48%, $5,028) contributed slightly more than inpatient services (44%, $4,620) to incremental cost for NHNV fracture patients, leaving pharmacy expenses at 9% ($905).

For the ≥65 cohort, inpatient services accounted for 58% ($9,740) of the incremental cost among hip fracture patients, followed by outpatient (39%, $6,592) and pharmacy (3%, $491). For NHNV and vertebral fractures, expenditures incurred in the outpatient setting (53%, $3,789 and 44%, $3,654, respectively) surpassed that of inpatient services (39%, $2,007; 38%, $3,167, respectively), while pharmacy expenses accounted for 8% ($584) and 17% ($1,421), respectively.

After multivariate adjustment, hip fracture patients in both age cohorts had the highest adjusted incremental costs: $26,545 (95% CI: $26,003–$27,096, P<0.001) for the 50–64 cohort and $15,196 for the ≥65 group (95% CI: $15,070–$15 322, P<0.001, Fig. 2). Vertebral fractures remained as the second most costly fracture (50–64 cohort: $14,977, 95% CI: $14,660–$15,299, P<0.001; ≥65 cohort: $6,701, 95% CI: $6,584–$6,818, P<0.001). NHNV fracture patients had the lowest incremental cost (50–64 cohort: $9,183, 95% CI: $9,097–$9,269, P<0.001; ≥65 cohort: $6,106, 95% CI: $6,046–$6,167, P<0.001).

While NHNV fracture had the lowest incremental first-year cost among the 3 fracture types, it was 10 times more prevalent than hip fracture in the 50–64 cohort. We estimated the total first-year fracture costs per 100,000 lives insured by private health insurance or Medicare by applying our cost estimates to the fracture prevalence rates per 100,000 women covered in these data sources. Fig. 3 presents first year post-fracture healthcare cost associated with each type of fracture and age group for a 100,000 member health plan. The estimated cost was calculated by multiplying the estimated number of patients with each fracture type per 100,000 patients in MarketScan during the study period by the estimated fracture cost during the first year. The first-year incremental cost per 100,000 lives for the 50-64 cohort was \$1.5 million for NHNV fracture, \$0.5 million for hip fracture, and \$0.3 million for vertebral fracture. The cost of NHNV fractures contributed 66% of the total fracture cost for the 50-64 cohort. This far exceeded the 13% and 21% estimated for hip and vertebral fractures, respectively, for the same age cohort. Total first-year NHNV, hip, and vertebral fracture-related cost per 100,000 lives for the ≥65 cohort was \$14.8 million, \$21.2 million, and \$4.8 million, of which 52% was accounted for by hip fractures followed by 36% due to NHNV and 12% from vertebral fractures.

Discussion

While previous research has demonstrated the economic burden associated with osteoporotic hip and vertebral fractures, this paper is one of the first to highlight the significant proportion of osteoporotic fracture costs that are due specifically to NHNV fractures. The adjusted first-year healthcare costs associated with fractures were highest for hip fracture patients, followed by vertebral and NHNV fractures. However, the overall cost impact of NHNV fractures matched or exceeded that of hip fractures after accounting for the prevalence rates. NHNV fractures represented 82% and 55% of all fractures identified in the matched samples for the 50–64 cohort and the ≥65 cohort, respectively. These fractures accounted for 69% and 38% of the total first-year post-fracture cost in each age cohort, respectively.

Our results are consistent with previous findings on the economic burden of osteoporotic fractures [4,6,11-12,15,17,20], with some variations due to differences in research design. Ohsfeldt et al. assessed fracture-related medical cost in the first year following non-vertebral fracture using the MarketScan® databases [20]. Costs were estimated based on resource utilization identified through diagnoses and procedures on medical claims related to fractures. Unit cost was assigned according to various standard fee schedules. After adjusting to 2006 dollars, the estimated costs of NHNV fracture were $7,093 for the 45–64 age cohort and $5,621 for the ≥65 cohort. These figures are roughly comparable to our estimates ($9,183 and $6,106, respectively) given that the Ohsfeldt et al. study may have failed to account for cost for outpatient pharmacy. However, the inflation-adjusted cost of hip fracture was $37,567 for the 45–64 cohort, and $30,038 for the ≥65 cohort, both of which are higher than those of our study ($26,545 and $15,196, respectively). To some extent, the lower figures for hip fracture from our study are not completely unexpected since the incremental cost estimation approach can yield lower estimates as it may over-adjust for unobserved differences between cases and controls [20]. The direct measurement method used by Oshfeldt et al., on the other hand, may overestimate costs because both primary and secondary diagnoses were used to identify resource utilization and, as a result, the costs of coincidental treatment for comorbid conditions during an episode of care for fracture may be inadvertently attributed as fracture-related cost. The hip fracture cost for the ≥65 cohort in our study was close to the estimate of $16,834 from another study examining the cost of hip fracture among elderly women [10].

Gabriel et al. also estimated the direct medical cost of osteoporotic fracture based on matched case and control comparison [4]. The estimated costs were: $12,890/hip fracture, $5,272/spine fracture, $2,862/wrist fracture, $8,659/“hip-like” fracture, $3,155/ “spine-like” fracture, and $3,810/“wrist-like” fracture. These estimates are lower than our estimates, in part, because these numbers were expressed in 1995 dollars and ours were valued in 2006 dollars. However, the underlying differences are likely due to the omission of several important categories of healthcare cost, including nursing home, outpatient prescription drugs, durable medical equipment, ambulance, and outpatient services provided by allied health professionals in the Gabriel et al. study. Using samples from a single county in Minnesota limited the ability of the study to generalize its findings, whereas our samples were drawn from 166 million covered lives in the working population and 33 million retirees in the US Medicare population. Other studies using economic models provided wide ranges of estimates for the first-year cost after hip fracture, from US $10,000/year in the Netherlands [11] to $69,389 for elderly male veterans covered by Medicare in the US [6].

Our estimated medical costs for patients 50–64 were consistently higher than that of the ≥65 cohort across all fracture types. This is partly due to the lower reimbursement rates paid by Medicare than commercial payers. Additionally, readmission within 60 days is covered by the payment from the first admission in Medicare, while commercial payers typically pay in full. Medicare pays for the first 21 days when a patient is transferred to a skilled nursing facility after hospitalizations. Since no payment is required from the supplemental side, which is the data source for MarketScan Medicare databases, no claim for services is incurred. As a result, the overall medical cost of the Medicare population may be slightly underestimated when Medicare pays 100% of the healthcare event. However, the data presented here accurately reflected the costs to employers and health plans for Medicare patients. Our inclusion requirement of having 1 year of data post-fracture excluded patients who died shortly after their fracture, particularly those who had a hip fracture. The exclusion may further explain the lower costs observed among Medicare patients in this study.

There are limitations inherent in using an administrative healthcare database. Information on race, socioeconomic status, anthropometrics, and mortality were unavailable. We were only able to capture clinically-diagnosed fractures and excluded patients with sub-clinical fractures that did not reach medical attention. While we identified fracture by diagnosis on non-radiology claims, we did not require patients to have fracture-related procedures during the period surrounding the initial fracture diagnosis. Ray et al. suggested that using only hospital and ER diagnosis of fracture in claim data yielded a positive predictive value (PPV) of 90% for hip, 89% for humerus, 88% for radius/ulna, 85% for pelvis, and 70% for tibia/fibula fractures, which are lower than the overall 94% PPV when both diagnosis and procedure codes are required [21]. Consequently, we may have classified some patients into the fracture cohorts who did not have fractures and thus underestimated the cost of fracture. This, however, does not change the principle conclusion of the study.

Closed fracture diagnoses were used to rule out trauma-related fractures but we were unable to review patient's medical records to validate this assumption. We may also have underestimated the prevalence of vertebral and hip fractures that were coded as pathological fractures since these codes were excluded from this study under the assumption that they were likely due to a malignancy or rare disease. A recent study indicated that half of patients with a pathologic fracture diagnosis of the vertebrae or hip had no evidence of malignancy [24]. The fracture cohorts had higher DCS than the controls post-matching, indicating they were sicker than the controls prior to entering the study. These differences were controlled through multivariate regressions. Finally, uninsured fracture patients and those covered by Medicaid or military-based insurances were not included in this study. Findings in this study may not be representative of the whole US population.

This study focused solely on the estimation of direct medical costs for patients with osteoporotic fractures. Future studies that examine the impact of osteoporotic fractures on work and productivity loss are also warranted, especially for NHNV fractures which are the most frequent type of fracture among women aged 50-65.

This study confirmed that closed hip, vertebral, and NHNV fractures produced a substantial economic impact during the first year post-fracture. While NHNV fractures may have lower healthcare costs than hip or vertebral fractures at the patient level, they produced the highest total costs in the 50–64 cohort and accounted for 69% of the total cost of all fractures in this age group.

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Table 1. ICD-9-CM Diagnosis Codes for Hip, Vertebral, and NHNV Fractures

Fracture Type	ICD-9-CM Diagnosis Codes
Hip Fracture	820.0x, 820.2x, 820.8
Vertebral Fracture	805.2, 805.4, 805.8
NHNV Fracture - Pelvis	808.0, 808.2, 808.4x, 808.8
NHNV Fracture - Clavicle	810.0x
NHNV Fracture - Humerus	812.0x, 812.2x, 812.4x
NHNV Fracture - Wrist/forearm	813.0x, 813.2x, 813.4x, 813.8x
NHNV Fracture - Leg	821.0x, 821.2x, 823.0x, 823.2x, 823.4x, 823.8x

Table 2. Patient Demographic and Clinical Characteristics

Demographic & Clinical Characteristics	Hip	Control	*P* -Value	NHNV	Control	*P* -Value	Vertebral	Control	*P* -Value
50-64 Age Cohort									
Number of subjects	2423	2423		27424	27424		3386	3386	
Age, mean (SD)	59.9 (4.7)	59.9 (4.7)		58.7 (4.0)	58.7 (4.0)		59.1 (4.3)	59.1 (4.3)	
Gender/Female, no (%)	1470 (60.7)	1470 (60.7)		17840 (65.1)	17840 (65.1)		1760 (52.0)	1760 (52.0)	
Geographic region									
North East, no (%)	234 (9.7)	234 (9.7)		2455 (9.0)	2455 (9.0)		257 (7.6)	257 (7.6)	
North Central, no (%)	720 (29.7)	720 (29.7)		8863 (32.3)	8863 (32.3)		1135 (33.5)	1135 (33.5)	
South, no (%)	931 (38.4)	931 (38.4)		10159 (37.0)	10159 (37.0)		1323 (39.1)	1323 (39.1)	
West, no (%)	531 (21.9)	531 (21.9)		5900 (21.5)	5900 (21.5)		656 (19.4)	656 (19.4)	
Diagnosis Clusters Comorbidity, mean (SD)	3.77 (2.79)	3.24 (2.60)	<0.001*	3.09 (2.52)	2.75 (2.29)	<0.001*	3.84 (2.78)	3.22 (2.56)	<0.001*
Pre-Period Costs, mean (SD), $									
Osteoprosis-Related[§]	303 (678)	171 (468)	<0.001	211 (522)	154 (417)	<0.001	329 (1386)	156 (336)	<0.001
Total Medical Costs	9002 (19392)	3543 (8698)	<0.001*	3939 (11288)	2810 (8256)	<0.001*	6586 (17668)	3350 (8580)	<0.001*
Pre-Period Confounding Conditions									
Endocrine Disease, no (%)	334 (13.8)	299 (12.3)	0.136	3167 (11.5)	2700 (9.8)	<0.001*	405 (12.0)	401 (11.8)	0.881
HIV, no (%)	4 (0.2)	2 (0.1)	0.414	23 (0.1)	20 (0.1)	0.647	2 (0.1)	4 (0.1)	0.414
Liver Disease, no (%)	40 (1.7)	27 (1.1)	0.110	368 (1.3)	287 (1.0)	0.002*	82 (2.4)	47 (1.4)	0.002*
Breast Cancer, no (%)	62 (2.6)	38 (1.6)	0.015*	531 (1.9)	422 (1.5)	<0.001*	61 (1.8)	46 (1.4)	0.144
Bone Cancer, no (%)	4 (0.2)	1 (0.04)	0.180	13 (0.05)	4 (0.01)	0.029*	6 (0.2)	0 (0)	0.014*
Other Cancer, no (%)	220 (9.1)	202 (8.3)	0.359	1969 (7.2)	1814 (6.6)	0.009*	330 (9.7)	268 (7.9)	0.008*
Alcoholism, no (%)	23 (0.9)	4 (0.2)	<0.001*	81 (0.3)	21 (0.1)	<0.001*	20 (0.6)	2 (0.1)	<0.001*
Osteodystrophies, no (%)	1 (0.04)	0 (0)	0.317	5 (0.02)	0 (0)	0.025*	1 (0.03)	0 (0)	0.317
Nephritis, Nephritic syndrome & Nephrosis, no (%)	55 (2.3)	11 (0.5)	<0.001*	236 (0.9)	120 (0.4)	<0.001	32 (0.9)	18 (0.5)	0.047*
Paget's Disease, no (%)	0 (0)	0 (0)	n/a	5 (0.02)	3 (0.01)	0.480	1 (0.03)	2 (0.1)	0.564
Thyroid Disease, no (%)	112 (4.6)	138 (5.7)	0.091	1444 (5.3)	1532 (5.6)	0.097	184 (5.4)	185 (5.5)	0.957
Rheumatoid Arthritis, no (%)	69 (2.8)	29 (1.2)	<0.001*	360 (1.3)	201 (0.7)	<0.001*	59 (1.7)	33 (1.0)	0.006*
≥65 Age Cohort									
Number of subjects	21504	21504		40690	40690		11751	11751	
Age, mean (SD)	83.2 (7.2)	83.2 (7.2)		79.8 (7.5)	79.8 (7.5)		81.1 (7.2)	81.1 (7.2)	
Gender/Female, no (%)	15905 (73.9)	15905 (73.9)		31419 (77.2)	31419 (77.2)		8377 (71.3)	8377 (71.3)	
Geographic region									
North East, no (%)	2166 (10.1)	2166 (10.1)		4002 (9.8)	4002 (9.8)		937 (8.0)	937 (8.0)	
North Central, no (%)	7668 (35.7)	7668 (35.7)		15792 (38.8)	15792 (38.8)		4691 (39.9)	4691 (39.9)	
South, no (%)	5425 (25.2)	5425 (25.2)		10534 (25.9)	10534 (25.9)		3100 (26.4)	3100 (26.4)	
West, no (%)	6219 (28.9)	6219 (28.9)		10308 (25.3)	10308 (25.3)		3006 (25.6)	3006 (25.6)	
Diagnosis Clusters Comorbidity, mean (SD)	4.08 (3.01)	3.74 (2.82)	<0.001*	3.86 (2.87)	3.55 (2.70)	<0.001*	4.85 (3.07)	4.28 (2.97)	<0.001*
Pre-Period Costs, mean (SD), $									
Osteoprosis-Related[§]	275 (635)	221 (556)	<0.001	276 (548)	227 (615)	<0.001	380 (595)	241 (590)	<0.001
Total Medical Costs	5228 (11758)	3826 (8436)	<0.001*	4142 (8839)	3665 (9000)	<0.001*	5339 (11742)	4196 (7877)	<0.001*
Pre-Period Confounding Conditions									
Endocrine Disease, no (%)	2512 (11.7)	2451 (11.4)	0.357	5278 (13.0)	4729 (11.6)	<0.001*	1264 (10.8)	1525 (13.0)	<0.001*
HIV, no (%)	5 (0.02)	2 (0.01)	0.257	8 (0.02)	4 (0.01)	0.248	0 (0)	1 (0.01)	0.317
Liver Disease, no (%)	143 (0.7)	116 (0.5)	0.092	343 (0.8)	234 (0.6)	<0.001*	112 (1.0)	93 (0.8)	0.183
Breast Cancer, no (%)	378 (1.8)	529 (2.5)	<0.001*	958 (2.4)	1038 (2.6)	0.070	248 (2.1)	309 (2.6)	0.009*
Bone Cancer, no (%)	12 (0.1)	6 (0.03)	0.157	16 (0.04)	10 (0.02)	0.239	15 (0.1)	2 (0.02)	0.002*
Other Cancer, no (%)	2535 (11.8)	2894 (13.5)	<0.001*	4756 (11.7)	5091 (12.5)	<0.001*	1713 (14.6)	1791 (15.2)	0.153
Alcoholism, no (%)	19 (0.1)	6 (0.03)	0.009*	33 (0.1)	9 (0.02)	<0.001*	9 (0.1)	4 (0.03)	0.165
Osteodystrophies, no (%)	3 (0.01)	0 (0)	0.083*	7 (0.02)	9 (0.02)	0.617	7 (0.1)	0 (0)	0.008*
Nephritis, Nephritic syndrome & Nephrosis, no (%)	591 (2.7)	270 (1.3)	<0.001*	797 (2.0)	455 (1.1)	<0.001*	227 (1.9)	179 (1.5)	0.016
Paget's Disease, no (%)	17 (0.1)	18 (0.08)	0.866	23 (0.1)	32 (0.08)	0.225	11 (0.1)	11 (0.1)	1.000
Thyroid Disease, no (%)	1030 (4.8)	940 (4.4)	0.038*	1721 (4.2)	1785 (4.4)	0.269	598 (5.1)	579 (4.9)	0.570
Rheumatoid Arthritis, no (%)	333 (1.5)	194 (0.9)	<0.001*	553 (1.4)	422 (1.0)	<0.001*	205 (1.7)	129 (1.1)	<0.001*

P values were calculated using chi-square test for categorical variables and t-test for continuous variables.

*Variables were included in multivariate models.

[§]Included costs of claims with a diagnosis for osteoporosis (ICD-9-CM 733.0x) and costs of osteoporosis medications, pain medications, and sleep medications.

Table 3. Unadjusted Mean Incremental Healthcare Costs Associated With Fracture During the First Year Following the Fracture

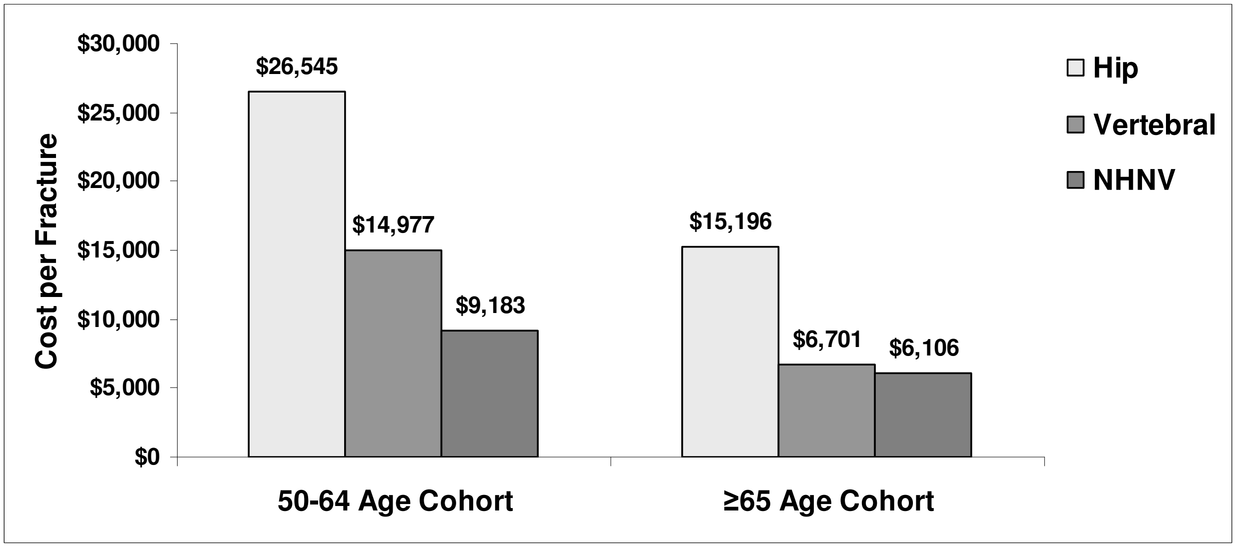
Direct Medical Cost	Hip	Control	Incremental Cost*	NHNV	Control	Incremental Cost*	Vertebral	Control	Incremental Cost*
50-64 Age Cohort									
Inpatient	$23,280	$1,857	$21,423	$5,910	$1,289	$4,620	$11,314	$1,531	$9,783
Outpatient	$10,719	$3,442	$7,277	$7,967	$2,939	$5,028	$9,731	$3,252	$6,480
Pharmacy	$4,663	$2,316	$2,347	$2,899	$1,994	$905	$4,616	$2,276	$2,340
Total Medical	**$38,662**	**$7,615**	**$31,047**	**$16,775**	**$6,222**	**$10,553**	**$25,662**	**$7,059**	**$18,603**
≥65 Age Cohort									
Inpatient	$11,925	$2,185	$9,740	$4,774	$2,007	$2,768	$5,424	$2,257	$3,167
Outpatient	$10,017	$3,425	$6,592	$7,056	$3,267	$3,789	$7,272	$3,618	$3,654
Pharmacy	$3,390	$2,899	$491	$3,432	$2,849	$584	$4,490	$3,069	$1,421
Total Medical	**$25,332**	**$8,509**	**$16,823**	**$15,262**	**$8,122**	**$7,140**	**$17,186**	**$8,944**	**$8,242**

*** *P* <0.001; *P* values were calculated using t-test for continuous variables.**

Fig. 1.


Study Sample
Age Group: 50-64 Years Fracture Type: Hip
Age Group: ≥65 years Fracture Type: Hip
Age Group: 50-64 Years Fracture Type: Vertebral
Age Group: ≥65 years Fracture Type: Vertebral
Age Group: 50-64 Years Fracture Type: NHNV
Age Group: ≥65 years Fracture Type: NHNV
Having a fracture diagnosis during 7/1/12001 – 12/31/2004 N=14,734
Having a fracture diagnosis during 7/1/12001 – 12/31/2004 N=57,642
Having a fracture diagnosis during 7/1/12001 – 12/31/2004 N=21,543
Having a fracture diagnosis during 7/1/12001 – 12/31/2004 N=30,025
Having a fracture diagnosis during 7/1/12001 – 12/31/2004 N=338,348
Having a fracture diagnosis during 7/1/12001 – 12/31/2004 N=94,426
Meeting pre and post period continuous enrollment requirement N=7,718
Meeting pre and post period continuous enrollment requirement N=31,709
Meeting pre and post period continuous enrollment requirement N=11,762
Meeting pre and post period continuous enrollment requirement N=19,146
Meeting pre and post period continuous enrollment requirement N=189,376
Meeting pre and post period continuous enrollment requirement N=60,175
Age between 50 and 64 years N=4,270
Age ≥65 years N=30,741
Age between 50 and 64 years N=5,553
Age ≥65 years N=19,134
Age between 50 and 64 years N=40,922
Age ≥65 years N=58,376
Having no fracture during pre-period and having pharmacy data available during study period N=2,669
Having no fracture during pre-period and having pharmacy data available during study period N=23,411
Having no fracture during pre-period and having pharmacy data available during study period N=3,739
Having no fracture during pre-period and having pharmacy data available during study period N=13,171
Having no fracture during pre-period and having pharmacy data available during study period N=28,741
Having no fracture during pre-period and having pharmacy data available during study period N=43,521
A total of 2,669 patients qualified for the study (of these, a total of 2,423 were matched to controls)
A total of 23,411 patients qualified for the study (of these, a total of 21,504 were matched to controls)
A total of 3,739 patients qualified for the study, a total of 3,386 were matched to controls
A total of 13,171 patients qualified for the study (of these, a total of 11,751 were matched to controls)
A total of 28,741 patients qualified for the study (of these, a total of 27,424 were matched to controls)
A total of 43,521 patients qualified for study (of these, a total of 40,690 were matched to controls)

Fig. 2.



$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
Cost per Fracture
$26,545
$14,977
$9,183
$15,196
$6,701
$6,106
Hip
Vertebral
NHNV
50-64 Age Cohort
≥65 Age Cohort

Fig. 3.

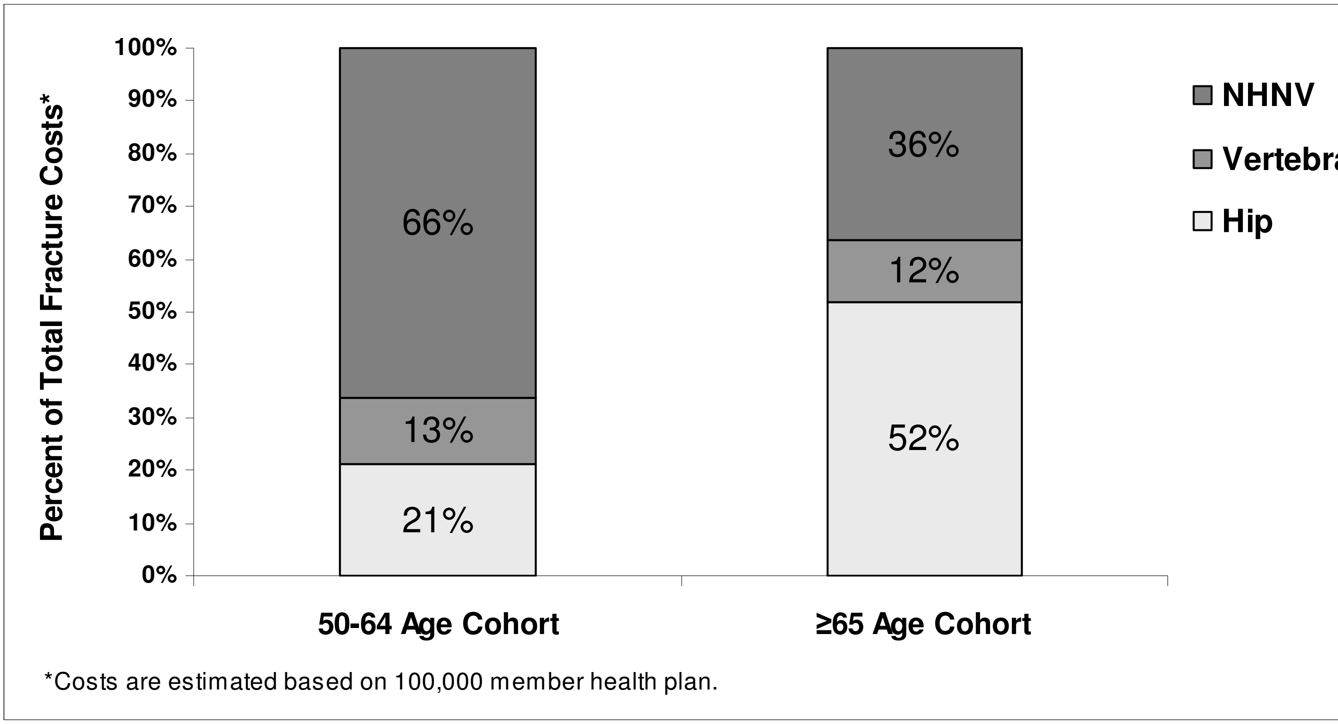

Percent of Total Fracture Costs*
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
66%
13%
21%
36%
12%
52%
50-64 Age Cohort
≥65 Age Cohort
NHNV
Hip
*Costs are estimated based on 100,000 member health plan.

FIGURE LEGENDS

Fig. 1. Study sample selection. Six fracture cohorts were selected and analyzed individually: hip, vertebral, and NHNV, for patients 50-64 years and ≥65 years.

Fig. 2. Adjusted mean per-patient healthcare costs (dollars) associated with hip, vertebral, and NHNV fracture during the first year following the fracture.

Fig. 3. Estimated total first-year healthcare costs (millions) associated with fracture among hip, vertebral, and NHNV fracture patients (based on the number of patients in the fracture cohort and the estimated mean cost of fracture per patient during the first year following fracture).