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Economic Burden of Osteoporosis-Related Fractures in Medicaid

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ABSTRACT

Objective: There are limited studies concerning the economic burden of osteoporosis in the Medicaid population. This study estimated the direct cost of osteoporosis-related fractures (OPFx) to state Medicaid budgets.

Methods: This retrospective analysis utilized Medicaid claims databases from three states, which included approximately 8 million Medicaid recipients. The study sample had at least one claim for an osteoporosis diagnosis (733.0x) between January 1, 2000 and December 31, 2001. Beneficiaries with a fracture and a diagnosis of osteoporosis were assigned to the case cohort. A propensity score-based matching method was used to select a cohort of controls with osteoporosis but without a fracture. An exponential conditional mean model was used to estimate the incremental annual cost associated with fractures.

Results: The study cohort (n = 7626) and a 1:1 matched control group were identified. The study cohort was 85.8% female, had an average age of 65 years, were 53.2% white, and 48.9% were eligible for Medicare. There were significant increases (all $P < 0.05$) from the preperiod to study period for this cohort in the proportion that had at least one hospital admission (14.0% vs. 26.5%), nursing home admission (9.2% vs. 17.2%), home health (39.1% vs. 49.3%), or emergency room visit (21.3% vs. 31.9%). In contrast, the control cohort had very little increase in utilization. The regression-adjusted incremental cost for osteoporosis-related expenses in the year after fracture was estimated at $4007 per patient. The estimated incremental cost was $5370 for the subset of patients who were eligible for Medicare.

Conclusion: The economic burden of osteoporosis-related fractures on state Medicaid budgets is substantial.

Keywords: claims analysis, fracture, Medicaid, osteoporosis.

Introduction

Osteoporosis places a large medical and economic burden on the health-care system. Low bone mass and deterioration of the skeletal microarchitecture resulting from osteoporosis increase the risk of fragility fractures [1]. In 1994, the World Health Organization (WHO) Study Group established formal diagnostic criteria for osteoporosis based on bone mineral density (BMD) and the presence of a fragility fracture [1]. The four categories include normal, osteopenia, osteoporosis, and established/severe osteoporosis. The WHO defines osteoporosis as a BMD score of at least 2.5 standard deviations lower than the young-adult normal mean, and osteopenia or low bone mass as a BMD score between 1 and 2.5 standard deviations lower than the young-adult normal mean [1,2].

As of 2002, approximately 8 million postmenopausal women in the United States received a diagnosis of osteoporosis. An additional 22 million had low bone mass indicating they were at high risk of developing the disease. More than 2 million individuals experience an osteoporosis-related fracture (i.e., established/severe osteoporosis) each year in the United States [3]. In the United States, nearly one-third of patients with a hip fracture are admitted to nursing facilities in the year after a fracture, and the incidence mortality rate increases to 20% during that year [4,5]. Vertebral fractures are the most common osteoporotic fracture, with more than 700,000 annual cases. Like hip fractures, vertebral fractures are also associated with increased mortality and morbidity [6]. Epidemiological data show that women more than 50 years old with low bone mass have a 42% lifetime risk of a fracture, while white women more than 50 years old have nearly a 40% lifetime risk of hip, spine, or distal forearm fractures [7,8]. As 20% of women who already have a vertebral fracture will have another vertebral fracture within 1 year, there is a potential "fracture cascade," which demonstrates the need for effective prevention and treatment strategies [9].

Severe or established osteoporosis is defined by the WHO as a BMD score of at least 2.5 standard deviations lower than the young-adult normal mean and one or more fragility fractures. Patients with severe osteoporosis require treatment and subsequent care

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that results in substantial economic burden [10–12]. In a study of a commercial claims database, patients with a diagnosis of osteoporosis and a concurrent fracture had more than twice the annual health-care expenditures compared with patients with osteoporosis and without a fracture ($15,942 vs. $6476) [13]. In a study of the burden of osteoporosis in California during 1998, an estimated $2.4 billion in direct health costs and more than $4 million in lost productivity were attributed to osteoporosis [14]. In addition, 59% of all direct medical costs associated with osteoporosis were associated with nursing home expenses [14]. Sasser et al. estimated that female employees with osteoporosis would incur more than $4000 in lost productivity as compared with approximately $2300 for the typical older female employee [15]. On a national level, the burden of osteoporosis was estimated in 1995 at $13.8 billion per year [16]. The total, annual cost burden, including opportunity costs, was estimated at $34.0 billion [17].

Most of the claims-based analyses for osteoporosis have used data from commercial plans. The direct cost for osteoprosis-related fractures, however, is largely covered by public payers. Medicare and Medicaid covered 48% and 24% of these medical expenditures, respectively [18]. One recently published study included Medicare Supplemental and Coordination of Benefits data along with commercial plans [15]. Medicaid beneficiaries are of particular interest because they have longer inpatient stays and higher total hospital charges than Medicare beneficiaries [19]. Private and self-pay patients paid less for their care and had shorter lengths of hospital stay [19]. Medicaid beneficiaries, when other factors such as age, race, and specialty of treating physician are controlled for, were found to be 55% less likely to receive an osteoporosis-related prescription [20]. There are limited studies concerning osteoporosis in the Medicaid population, with most of these studies focusing on outpatient care [20,21] or focused only on hip fractures [22,23]. Results from 1993 Medicaid data indicated that expenditures during the month of a fracture significantly increased immediately after the fracture but returned to the baseline trend within a 12-month period [24]. The primary objective of the current study is to investigate the annual direct medical expenditures associated with osteoporosis-related fractures that are covered by Medicaid. An additional objective was to investigate the drivers of the cost to Medicaid by examining the differences in resource utilization.

Materials and Methods

Data Source

This retrospective analysis used Medicaid claims for services incurred from January 1, 1999 through December 31, 2002 from three states. The database contains the inpatient, outpatient, outpatient prescription drug, and long-term care claims experience of approximately 8 million Medicaid recipients covered under both fee-for-service and capitated health plans. All services delivered to patients dually eligible for both Medicaid and Medicare are included in the database as long as Medicaid paid some portion of the claim. The Medicaid paid portion of the bill is delineated from the Medicare paid portion of the claim. Because Medicare requires a deductible or coinsurance on almost all services, the vast majority of services received by Medicaid beneficiaries should be incorporated into the database. No personally identifiable information is available in the database (i.e., names, social security numbers, medical record numbers, addresses, birth dates); however, persons can be tracked longitudinally using encrypted identification numbers. Medstat's contracts with the state Medicaid agencies that provide these data for research purposes preclude the release of the states' identities.

Study Population

Individuals with 24 months of continuous enrollment and at least one claim containing a diagnosis of osteoporosis (733.0x) between January 1, 2000 and December 31, 2001 were identified for the initial study sample population. Persons with evidence of malignant neoplasm or carcinoma (International Classification of Diseases, 9th Edition (ICD-9) 140.x–208.x, 230.x–239.x), with the exception of melanoma (ICD-9 172.x, 173.x), or Paget's disease of bone (ICD-9 731.0) between 1999 and 2002 were excluded.

Identified patients were classified into one of two groups. The osteoporosis with fracture cohort (OPFx) consisted of patients with a claim for a fracture and at least one claim containing an osteoporosis diagnosis code during the observation period. The osteoporosis-related fracture codes were adapted from the National Committee for Quality Assurance guidelines on osteoporosis [25]. The remaining patients with an osteoporosis diagnosis but no claims for osteoporosis-related fractures were classified as the osteoporosis without fracture (OP) cohort. The patient selection criteria are summarized as a flow chart in Figure 1.

For patients in the OPFx cohort, the service date of the first observed medical claim with an osteoporosis-related fracture diagnosis was assigned as the index date. The service date of the first observed medical claim with an osteoporosis diagnosis after January 1, 2000 was assigned as the index date for the cohort without fracture. Patients in the OP cohort may contain both newly diagnosed and patients with a history of osteoporosis, because no "clean" period before the index date was required. By using these criteria, we hoped to gain a wide representation of osteoporosis patients at all stages of the disease. All qualifying patients in both cohorts were required to have at least

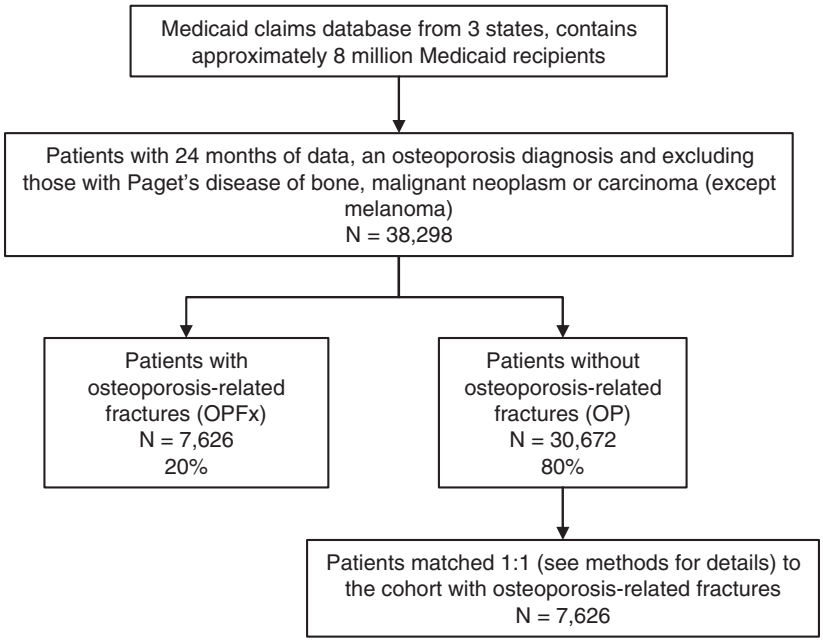

Figure 1 Schematic of patient flow.

12 months of continuous enrollment before and after the index date.

Outcomes Measures and Covariates

Annual rates of health-care utilization and expenditures were categorized by service area (hospitalizations, nursing home stays, home health visits, emergency department services, outpatient services, and outpatient pharmaceutical prescriptions) in the year before and year after the index date. Only those patients with an indemnity/fee-for-service type of plan were included in the summary of utilization and expenditures. Claims were further categorized as being osteoporosis-related and non–osteoporosis-related in the two osteoporosis cohorts. Osteoporosis-related claims were those with a coded primary diagnosis of osteoporosis. In the cohort with fractures, claims with one of the specified fracture diagnoses were also classified as osteoporosis-related costs. Nursing home care was classified as osteoporosis-related if there was at least one claim with a diagnosis of osteoporosis or fracture at any point during a nursing home episode (until a gap of more than 60 days of nursing home services). Expenditures documented in the database include the total gross reimbursed payment to a provider for specific services before application of deductibles, copayments, and coordination of benefits, but after applying pricing guidelines such as fee schedules and discounts. Expenditures for services delivered in 1999 through 2001 were inflated to 2002 equivalents using changes in the medical component of the Consumer Price Index between these years and 2002.

Baseline demographic characteristics for the sample included sex, age, insurance plan type, Medicare eligibility, race, and Medicaid eligibility reason. A Charlson comorbidity index (CCI) score was also created for each patient as a way to measure concurrent comorbidity [26]. Among the cohort of patients with fracture, the fracture location(s) were also identified, as well as the number of fractures incurred during the study period.

Statistical Analyses

Descriptive summary statistics on health-care utilization, expenditures, and key demographic and clinical characteristics for the osteoporosis cohort were produced, stratified by fracture status. Nonparametric Mann–Whitney *U*-tests were used to assess statistical differences in utilization and expenditure statistics across the cohorts. Chi-square tests and *t* tests were used to determine whether differences in proportions and rates, respectively, varied across the groups.

In addition to the nonfracture osteoporosis cohort, a propensity score matched control group with a similar likelihood of acquiring a fracture was also created for comparison of health-care expenditures. Using the osteoporotic without fracture group as the sample pool, a control was matched to each patient with an osteoporotic fracture based on propensity scores. A logistic regression model, using osteoporotic fracture in the study period as the dependent variable, was used to assign each individual with and without fracture a propensity score. Independent variables in the model included age, race, geographic location, sex, CCI score, plan type, osteoporosis medication use, and Medicare eligibility. A control was matched to each case by this score using the Nearest Neighbor Matching (Without Replacement) technique, which identifies

each case and searches for the control with the closest propensity score, i.e., the Nearest Neighbor.

To evaluate the incremental economic impact of osteoporotic facture in the osteoporosis population, controlling for other factors not addressed by the propensity score match, a series of second-stage 12-month expenditure models were estimated. The dependent variables were annual overall expenditures in the 12-month study period and annual osteoporosis-related expenditures in the 12-month study period. Covariates in the model included presence of fracture, demographic characteristics, geographic location, health plan type, and baseline health characteristics. Baseline health characteristics included the CCI score in the preperiod, other comorbidity indicator variables, and variables describing the presence of osteoporosis-related medications in the preperiod. We did not use interaction terms in the models, as they were not relevant to the research objective. One set of models included the osteoporotic fracture cohort (OPFx) versus all osteoporosis patients (OP) in the study population. Another set of models included osteoporotic fracture cohort (OPFx) versus the propensity score matched osteoporosis patients.

For the multivariate models, ordinary least squares (OLS) models with log transformation and exponential conditional mean (ECM) models were considered [27–29]. A White–Huber test confirmed the heteroskedasticity and the data were found to be heavily tailed. Thus, an ECM model was determined as the appropriate functional form for the expenditure models, and OLS regression was used only for comparison. An ECM regression is a generalized linear model with a log link function; its use avoids many of the pitfalls of retransformation. The ECM model produced parameter estimates similar to those found in an OLS regression model. Nevertheless, because the exponential model is nonlinear, the estimated regression coefficients do not equal the marginal or incremental effect of a one-unit change in the covariate of interest on the conditional mean. Parameter estimates from the models were used to compute the marginal effects of osteoporotic fracture. Among the subset of patients with osteoporotic fracture, we also estimated total costs by primary fracture location. A Park test was used to select the Gamma family of model; the standard deviation was found to be proportional to the mean. Descriptive analyses were conducted using SAS version 8.0 (SAS Institute Inc., Cary, NC) and multivariate analyses were conducted using STATA Version 8 software (StataCorp, College Station, TX).

Results

State Medicaid and Study Population Characteristics

As the identity of the states cannot be revealed because of confidentiality agreements, we briefly summarize the characteristics of the beneficiaries in these states so that the external applicability of the results can be understood. For two of the states, the majority of the Medicaid beneficiaries were less than 18 years old. Indemnity coverage was the primary form of insurance in two of the states (67.55% and 50.14%), while the other state more commonly used primary care case management (65.93%). In 2002, less than 1% of the beneficiaries in any of the three states had a claim for osteoporosis or severe osteoporosis (range 0.22–0.76%). The cost to Medicaid for these patients, however, was disproportionately high. For example, in one state, about 0.76% of the Medicaid recipients had a claim related to osteoporosis, but these patients accounted for nearly 4% of the Medicaid medical claim outlays.

The demographic characteristics of the study population are summarized in Table 1. The OPFx cohort had a mean age of 65 years, almost 49% were eligible to receive Medicare, and 85.8% were female. For comparison, the Medicaid recipients with an osteoporosis diagnosis but without a fracture (OP cohort) were more than 2 years older, 51.6% were Medicare-eligible, and 88.2% were female. More than 83% of both the OP and OPFx cohorts had indemnity insurance coverage. The patients with capitated insurance coverage were slightly younger and had less comorbidity (not shown). A higher percentage of individuals with an osteoporosis-related fracture were white, although race data were missing or listed as unknown in nearly one-quarter of the population. Hip/pelvis (31.3%), clinical vertebral (17.1%), and forearm/wrist (13.8%)

Table 1 Demographic characteristics of patients with osteoporosis

Characteristic	OP	OPFx	Matched control
N	30,672	7,626	7,626
Age (mean years)	67.54*	65.14	65.49
Female (%)	88.20*	85.84	85.62
Eligible for Medicare (%)	51.63*	48.90	47.80
Plan type (%)			
Indemnity	83.12	83.43	84.26
PCCM	4.93	5.28	5.26
Managed care	11.95	11.29	10.48
Medicaid eligibility reason (%)			
Aged/SSI	49.57*	40.01	39.39
Disabled/SSI	42.30*	51.99	53.32
TANF/AFDC	5.49*	6.12	5.55
Other	2.64	1.88	1.74
Race/ethnic group (%)			
White	41.15*	53.15	54.35
Asian	19.65*	11.11	10.23
Black	5.69	5.99	5.77
Hispanic	5.17	4.89	4.66
Unknown	28.17*	24.51	24.73
Propensity score (mean)	NA	0.253	0.244

*$P < 0.05$ for comparison of cohort without fractures (OP) to cohort with fractures (OPFx). No significant differences were seen for comparison of cohort without fractures propensity score matched (matched control) with cohort with fractures (OPFx).

NA, not applicable; PCCM, primary care case management; SSI, supplemental security income; TANF/AFDC, temporary assistance for needy families/aid to families with dependent children.

fractures accounted for more than 60% of the index fractures in the OPFx cohort (not shown). Only 30% of the population had a fracture in more than one location at index or during the follow-up year (not shown). The characteristics of the propensity score matched control group are also summarized in Table 1. The propensity score methodology worked well (area under the receiver operating characteristic curve, 0.67), with the OPFx cohort and the matched control having no significant differences in baseline demographic and clinical characteristics after matching.

Resource Utilization and Annual Median Health-Care Expenditures

In Figure 2, resource utilization data for all diagnoses are provided for the subset of patients enrolled in a fee-for-service insurance plan. For the OPFx study cohort, there was a significant increase in the percentage of beneficiaries, with at least one claim for hospitalization, admission to a nursing home, visit from home health care, visit to the emergency room, or outpatient services from the year before the fracture (preperiod) to the year after a fracture (study period). For the control group, significant increases in resource utilization were seen with nursing home, home health services, and outpatient services. There was more utilization of all types of health-care services in the study cohort compared with the control cohort, both before and during the study period, although the differences seen with home health services in the preperiod and overall outpatient services in the preperiod and study period were not statistically significant.

The subset of services that could be directly attributed to osteoporosis is reported in Table 2. For the OPFx study cohort, there was a large increase in the proportion of patients with claims for osteoporosis-related services after a fracture. Most of the beneficiaries in both the OPFx group and the control group filled a prescription related to osteoporosis or had a claim for outpatient service.

Table 2 also shows the mean osteoporosis costs by category among service users and for all patients in the cohort for the preperiod and the study period. These cost data were skewed and not normally distributed, which is common for health-care cost data. Total osteoporosis costs for the OPFx group increased by $3443, while the nonfracturing cohort had a $575 increase in costs for delivery of osteoporosis-related services. Thus, there was an incremental increase of $2868 in osteoporosis-related costs due to fracture in the year after the fracture. In both cohorts, the driver of increases between pre- and postperiod costs was spending on outpatient service delivery; this was followed closely by increases due to nursing home-related expenditures. Pharmaceuticals were the only expenditures that increased by similar amounts for the fracturing and nonfracturing osteoporosis cohorts between the pre- and postperiods.

Table 3 presents total expenditure comparisons for all services delivered to the OPFx and non-OPFx cohorts during the pre- and postperiods. The total mean cost for the OPFx cohort increased from $14,782 during the year before the fracture to $23,005 in the study period. The increase in Medicaid cost was nearly $8223 per beneficiary without controlling for the differences in explanatory variables. Approximately 42% ($3443 out of $8223) of the increase in costs was directly attributable to osteoporosis-related claims.

Marginal Effect of Fracture on Annual Health-Care Expenditures

Table 4 presents the parameter estimates for variables used in the ECM model for all costs and for osteoporosis-related costs. Significant variables included having

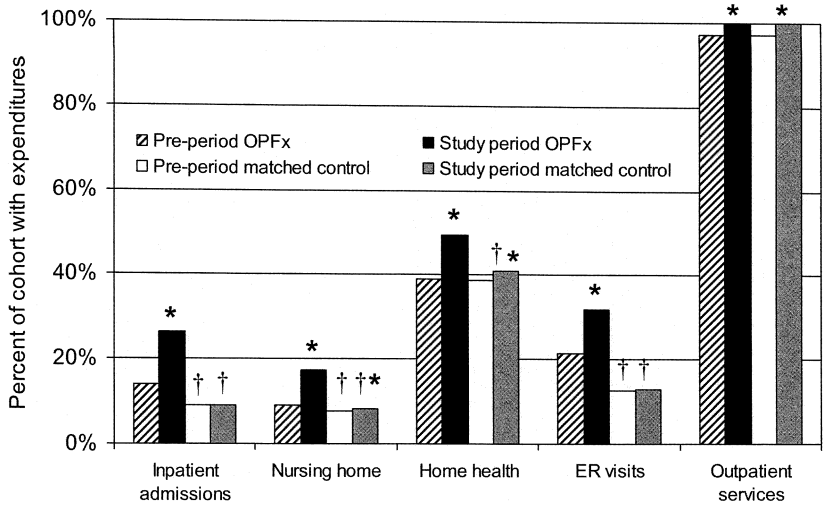

Figure 2 Annual health-care utilization for patients with osteoporosis enrolled in a fee-for-service insurance plan. *$P < 0.05$ for comparison of preperiod costs to study period costs; †$P < 0.05$ for comparison of propensity score matched cohort without fractures (matched control) to cohort with fractures (OPFx). ER, emergency room.

Table 2 Osteoporosis-related expenditures for the subset of patients enrolled in a fee-for-service insurance plan

	Severe osteoporosis (Fracture + Osteo dx) (n = 5002)					PS matched sample (n = 5830)				
	% With any use	% Changes in utilization	Mean among users ($)	Mean among all patients ($)	Changes in expenditures among all patients ($)	% With any use	% Changes in utilization	Mean among users ($)	Mean among all patients ($)	Changes in expenditures among all patients ($)
Inpatient										
Preperiod	0.04		9,239.89	3.69		0.00		NA	NA	
Study period	8.82	8.78*	8,897.73	784.47	780.77*	0.05†	0.05†	18,428.17	9.48†	9.48†
Nursing home										
Preperiod	4.90		28,667.29	1,404.14		4.12		31,531.50	1,298.04	
Study period	11.72	6.82*	22,048.19	2,583.02	1,178.88*	4.49†	0.37*†	33,754.83†	1,516.94†	218.9*†
Home health										
Preperiod	0.28		1,052.15	2.94		0.62†		1,118.34	6.91	
Study period	7.96	7.68*	568.46	45.23	42.29	2.32†	1.70*†	710.77	16.46†	9.55*†
Emergency room										
Preperiod	0.04		12.42	0.00		0.02		63.72†	0.01	
Study period	15.59	15.55*	136.16	21.23	21.23*	0.67†	0.65*†	60.43†	0.40†	0.39*†
Outpatient										
Preperiod	8.94		200.54	17.92		10.75†		206.88	22.25	
Study period	96.36	87.42*	1,392.84	1,342.16	1,324.24*	95.64	84.89*†	271.55†	259.72†	237.47*†
Outpatient pharmaceutical										
Preperiod	37.11		325.46	120.76		41.25†		337.28	139.14†	
Study period	54.78	17.67*	394.79	216.26	95.50*	56.24	14.99*†	424.14†	238.55†	99.42*
Total										
Preperiod	43.66		3,548.72	1,549.46		48.59†		3,017.56	1,466.34	
Study period	99.06	55.40*	5,039.71	4,992.36	3,442.90*	98.80	50.21*†	2,066.37†	2,041.56†	575.22*†

*$P < 0.05$ for comparison of preperiod costs with study period costs.
†$P < 0.05$ for comparison of propensity score matched cohort without fractures (matched control) with cohort with fractures (OPFx).
NA, not applicable; PS, propensity score.

an osteoporosis-related fracture and being dual-eligible for Medicare and Medicaid, both of which were associated with a significant increase in total and osteoporosis-related expenditures. Interestingly, older patients were associated with less total expenditures but greater osteoporosis-related costs. In addition, patients with more comorbities as measured by the CCI score in the preperiod were associated with higher total expenditures but lower osteoporosis-related costs.

Table 3 Overall expenditures for the subset of patients enrolled in a fee-for-service insurance plan

	Severe osteoporosis (Fracture + Osteo dx) (n = 5002)					PS Matched Sample (n = 5830)				
	% With any use	% Changes in utilization	Mean among users ($)	Mean among all patients ($)	Changes in expenditures among all patients ($)	% With any use	% Changes in utilization	Mean among users ($)	Mean among all patients ($)	Changes in expenditures among all patients ($)
Inpatient										
Preperiod	13.95		13,272.35	1,852.08		9.14*		12,285.38	1,123.17*	
Study period	26.45	12.50†	15,230.71	4,028.44	2,176.36†	9.01*	–0.14*	12,825.18	1,154.93*	31.75*
Nursing home										
Preperiod	9.16		37,205.19	3,406.63		7.58*		39,979.46	3,031.03	
Study period	17.19	8.04†	31,083.15	5,344.16	1,937.53†	8.11*	0.53*†	41,571.63*	3,372.79*	341.76*†
Home health										
Preperiod	39.12		4,692.50	1,835.91		38.73		3,909.72*	1,514.26*	
Study period	49.34	10.22†	4,985.46	2,459.84	623.93†	41.03*	2.30*†	4,718.44	1,935.93*	421.67*†
Emergency room										
Preperiod	21.31		262.49	55.94		12.68*		230.43*	29.21*	
Study period	31.91	10.60†	340.99	108.80	52.86†	12.97*	0.29*	263.60*	34.18*	4.97*†
Outpatient										
Preperiod	97.30		4,811.65	4,681.79		97.22		3,495.41*	3,398.29*	
Study period	99.96	2.66†	7,268.60	7,265.69	2,583.90†	99.90	2.68†	4,357.85*	4,353.37*	955.08*†
Outpatient pharmaceutical										
Preperiod	95.76		3,080.16	2,949.61		96.91*		2,834.51*	2,746.99*	
Study period	98.28	2.52†	3,864.25	3,797.81	848.20†	97.56*	0.65*†	3,439.20*	3,355.43*	608.44*†
Total										
Preperiod	99.00		14,931.21	14,781.96		99.66*		11,883.72*	11,842.96*	
Study period	100.00	1.00†	23,004.74	23,004.74	8,222.78†	100.00	0.34*†	14,206.63*	14,206.63*	2,363.68*†

*$P < 0.05$ for comparison of propensity score matched cohort without fractures (matched control) with cohort with fractures (OPFx).
†$P < 0.05$ for comparison of preperiod costs with study period costs.
PS, propensity score.

Table 4 Exponential conditional mean model results for total expenditures and osteoporosis-related expenditures

	Total expenditures			Osteoporosis-related expenditures		
	Parameter estimate	Standard error	*P*-value	Parameter estimate	Standard error	*P*-value
Osteoporosis-related fracture	0.526	0.025	0.000	1.234	0.070	0.000
Age	–0.007	0.001	0.000	0.023	0.003	0.000
Female	–0.290	0.037	0.000	–0.339	0.103	0.001
State A	0.308	0.060	0.000	–0.071	0.166	0.667
State B	0.080	0.063	0.203	–1.087	0.176	0.000
Race						
Black	0.027	0.054	0.626	0.215	0.147	0.143
Native American	–0.414	0.234	0.077	–0.169	0.648	0.794
Hispanic	0.028	0.069	0.688	0.162	0.187	0.386
Asian	–0.389	0.044	0.000	–0.471	0.122	0.000
Unknown	–0.283	0.031	0.000	–0.533	0.087	0.000
Medicare dual-eligible	0.320	0.031	0.000	0.155	0.085	0.070
Eligibility reason						
Aged/SSI	0.113	0.037	0.002	0.428	0.109	0.000
TANF	–0.841	0.072	0.000	–0.785	0.196	0.000
Other	–0.014	0.151	0.927	0.222	0.409	0.587
Plan type — PCCM	–0.227	0.072	0.002	0.448	0.206	0.030
Urban	–0.045	0.041	0.270	–0.147	0.115	0.202
Index year 2001	0.149	0.029	0.000	0.114	0.077	0.141
Preperiod CCI score	0.121	0.007	0.000	–0.044	0.019	0.018
Treatment (preperiod)						
Alendronate (Fosamax, Merck)	0.022	0.035	0.534	–0.056	0.096	0.559
Risedronate (Actonel, P&G)	–0.102	0.192	0.597	–0.398	0.521	0.446
Raloxifene (Evista, Lilly)	–0.159	0.062	0.010	–0.151	0.167	0.367
Estrogen	–0.107	0.032	0.001	0.036	0.089	0.690
Calcitonin (Miacalcin, Novartis)	0.243	0.046	0.000	0.424	0.126	0.001
Etidronate (Didronel, P&G)	–0.140	0.284	0.621	–0.146	0.768	0.850
Constant	9.945	0.073	0.000	6.138	0.199	0.000

CCI, Charlson comorbidity index; PCCM, primary care case management; TANF/AFDC, temporary assistance for needy families/aid to families with dependent children.

From the multivariate ECM model, the difference in the annual, per beneficiary expenses for the OPFx study cohort versus the control cohort was $9677. Of this amount, more than $4000 was estimated to be related to osteoporosis-specific expenses. If the study cohort is compared with the osteoporosis-only group, the marginal difference in cost was $9503, with $4614 attributable to osteoporosis-specific claims. The marginal costs for the OPFx cohort were similar between the ECM model and a log transformed OLS model. The estimated marginal cost for the OPFx cohort with the OLS model was $11,553 against the control group ($11,570 vs. the osteoporosis-only group). For the subset of the study cohort who were dual-eligible, the ECM model estimated that the marginal cost versus the entire osteoporosis-only cohort was approximately $11,000, with $5,300 related to osteoporosis-specific claims. The predicted expenditures and marginal effects associated with various fracture locations are presented in Table 5. Predicted expenditures were highest for hip/pelvis fractures and lowest for patients with fractures of foot/toes.

Table 5 Marginal effects by types of fracture among severe osteoporosis patients

	Exponential conditional mean results	
	Predicted expenditures ($)	Marginal effect ($)
Hip/pelvis	33,238.12	13,864.83
Leg/ankle	28,668.58	4,731.84
Thigh/knee	25,957.05	4,646.66
Spine	24,199.92	4,415.05
Shoulder	28,233.57	3,190.11
Trunk/ribs	21,716.82	1,991.64
Unspecified	20,583.01	1,158.45
Neck	21,271.24	645.04
Hand/fingers	19,671.70	–629.32
Upper arm/elbow	24,693.71	–1,142.45
Forearm/wrist	18,982.42	–1,302.09
Foot/toes	17,704.94	–2,636.13

Discussion

Information is scarce on the costs associated with osteoporosis in the Medicaid population. As osteoporosis is prevalent in postmenopausal women, this study is important not only to state Medicaid agencies, but also to private carriers and the Centers for Medicare and Medicaid Services (CMS). The importance to CMS is even greater with the recent addition of Medicare coverage of outpatient pharmaceuticals. In particular, patients dually eligible for both Medicare and Medicaid are of high interest.

As with all claims-based analyses, there are known issues such as the incomplete nature of the data and the possibility of coding errors or coding omissions. Claims data also lack detailed clinical information on BMD results that would allow us to assess disease severity at baseline and during the study period more precisely. Thus, the undercoding or miscoding of data

may have resulted in the control group including individuals who recently had a fracture and were receiving follow-up care that was not coded on claims, potentially biasing downward the estimated incremental cost of fracture (by biasing upward the estimates of cost in the nonfracture group). Furthermore, the criteria used for the analysis (e.g., a 1-year clean period free of fracture) may have resulted in a more conservative estimate of the cost burden of osteoporosis-related fractures to Medicaid. Some patients may have incurred a fracture before Medicaid eligibility, and as a result of the catastrophic fracture event "spent down" into Medicaid eligibility and after enrolling in the program continued to receive care associated with the fracture. An additional limitation is that for the nursing home expenses, the costs could not be allocated specifically to osteoporosis-related items, so the entire nursing home costs were included as osteoporosis-related if there was a diagnosis for osteoporosis or fracture at any point during the nursing home stay.

All patients in the databases used in this study were derived from three unidentified Medicaid states, and there were differences in the characteristics of the study population from each state. Therefore, the findings from these Medicaid programs may not be applicable to other state Medicaid programs. Only those patients with fee-for-service insurance coverage were used to estimate economic burden of illness. Although this represented the majority of patients with osteoporosis, this may have introduced bias because patients with capitated insurance coverage were slightly younger and had fewer comorbidities.

Few studies have examined the economic burden of osteoporosis-related fractures on Medicaid expenditures. One report using data from the early 1990s demonstrated that Medicaid expenditures increased sharply after a fracture but found that the costs approached baseline trends after approximately 1 year [24]. Our results on the marginal costs after a fracture are similar, although we did not examine the longitudinal changes in expenditures beyond the annualized estimates. Regardless, the impact of fractures due to osteoporosis on Medicaid expenditures is substantial and increasing the implementation of preventive strategies could help ameliorate some of this burden.

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