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Economic Evaluation

Healthcare Resource Utilization and Direct Medical Costs for Patients With Osteoporotic Fractures in China

Jing Wu, PhD [1,*], *Yi Qu, MM* [1], *Ke Wang, PhD* [2], *Yu Chen, MD* [2]

[1]*School of Pharmaceutical Science and Technology, Tianjin University, Tianjin, China;* [2]*Lilly Suzhou Pharmaceutical Co, Ltd, Shanghai, China*

ABSTRACT

Objectives: To estimate annual healthcare resource utilization and direct medical costs for patients with osteoporotic fractures in China. **Methods:** Data were obtained from the Tianjin Urban Employee Basic Medical Insurance database (2008-2011). Included patients were 50 years or older with one or more diagnoses of osteoporotic fractures between 2009 and 2010. The annual healthcare resource utilization and direct medical costs were estimated. Regression model was applied to identify factors associated with the direct medical costs. **Results:** A total of 5941 patients were included (mean age, 65.9 years; women, 62.1%; retired, 88.2%). During the 12 months after a fracture, the annual mean all-cause cost was $2549 per patient. Osteoporosis-related costs accounted for 53.8% of the total costs; 92.0% of these costs were for inpatient services. For osteoporosis-related health services, 33.2% of the patients experienced at least 1 hospitalization, with a mean cost of $3010 per admission; 83.2% of the patients experienced at least 1 outpatient visit, with a mean cost of $18 per visit during the 12-month follow-up period. The regression model revealed that osteoporosis-related costs tended to increase with age, and patients with hip, vertebral, lower leg, and multiple fractures were more likely to have higher costs. **Conclusions:** Costs for patients with osteoporotic fractures were considerable in China, driven mainly by osteoporosis-related hospitalizations. Efforts focused on reducing the utilization of inpatient services by lowering the fracture risks may lighten the economic burden of osteoporotic fractures in China.

Keywords: China, direct medical cost, fractures, health resource utilization, osteoporosis

Introduction

Osteoporosis is a systemic disease characterized by low bone mineral density (BMD) and microarchitectural deterioration of bone tissues.[1] Osteoporosis causes bones to become fragile, which often leads to skeletal fractures.[2] In China, the prevalence of osteoporosis is approximately 13%.[3] Epidemiological data show that lifetime risk of an osteoporotic fracture is 40% to 50% for women and 13% to 22% for men aged 50 years and older.[4] The osteoporotic fracture is more prevalent in women mainly because the speed of bone loss in women after menopause is much more rapid than in men, as the result of a significant decrease in estrogen.[5] Osteoporotic fracture causes more than 9.0 million fractures annually worldwide, including 1.6 million hip fractures, 1.4 million vertebral fractures, 1.7 million forearm fractures, 0.7 million humerus fractures, and 3.6 million fractures in other sites.[6] In China, the number of patients with any osteoporotic fracture in 2010 was 2.33 million, which is projected to increase to 5.99 million by 2050.[5] Vertebral and hip fractures are the most common osteoporotic fractures that account for more than half the fractures in China. As the most fatal fracture, hip fracture is associated with devastating and expensive consequences because of significant morbidity and excess mortality.[5]

Clinical and humanistic implications of osteoporotic fractures extend beyond the fracture, and studies around the world have shown that the treatment and subsequent care required for patients with osteoporotic fractures represent a substantial burden on both individuals and society.[7–9] About 25% to 35% of patients with fractures will be permanently disabled, requiring nursing facilities to conduct activities of daily living,[10] which can place a huge burden on lifestyles, families, and society. Fractures also have been shown to be associated with premature death; a study in the United States showed that nearly 20% of patients with a hip fracture will die in their first year after fracture.[11]

Conflicts of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

* *Address correspondence to:* Jing Wu, PhD, School of Pharmaceutical Science and Technology, Tianjin University, No. 92 Weijin Rd, Nankai District, Tianjin 300072, China.

Email: jingwu@tju.edu.cn

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China is likely to carry a heavy burden of osteoporotic fractures because the population of China is quickly aging; nevertheless, few studies specifically focusing on the burden of osteoporotic fracture in China have been conducted.[12–14] Available studies were limited to a small sample size or used the inpatient data only, and most studies' reports are outdated, and so healthcare and economic outcomes may not accurately represent current conditions and costs. Therefore, it is necessary to have a more comprehensive study on the costs of osteoporotic fractures in China; the findings may prove useful for identifying cost drivers, developing strategies to manage costs, and better allocate osteoporosis-related health resources.

This study was designed to estimate the annual healthcare resource utilization and direct medical costs for patients (aged ≥50 years) with a diagnosis of osteoporotic fractures in Tianjin, China.

Methods

Data Source

This retrospective analysis used data derived from the Urban Employee Basic Medical Insurance (UEBMI) claims of Tianjin, China, from January 2008 to December 2011. The UEBMI database is 1 of the 3 basic medical insurance systems in China, covering employed workers and retirees in the public and private sectors. The data contain information on enrollment history, demographic characteristics, and claims for inpatient, outpatient, and pharmacy services for all beneficiaries. Tianjin is a municipality city under the central government and has 10.2 million residents. By 2011, the Tianjin UEBMI database had included almost 5.1 million unique members, representing 51.7% of the registered residences in Tianjin city.[15] The analytical sample for this study included a 30% random sample of all enrollees from the Tianjin UEBMI.

Study Sample

Patients who had at least 1 osteoporotic fracture diagnosis (*International Classification of Diseases, Tenth Revision* code as listed in Appendix Table 1 in Supplemental Materials found at https://dx.doi.org/10.1016/j.vhri.2018.11.008, supplemented by Chinese description) between January 1, 2009, and December 31, 2010, were included in the study; patients with a diagnosis of osteoporosis pathological fractures but unspecified sites and with a diagnosis of multiple fractures during that period were also included. Because no BMD data were used to validate osteoporotic status, this is not an exhaustive list of osteoporosis-related fractures. The first observed diagnosis of osteoporotic fracture with the studied window was defined as the index fracture for each patient, and 12 months before and after the index fracture date were separately defined as the baseline and follow-up period. Patients included in this study had to be at least 50 years old at index fracture and continuously insured during the baseline and follow-up period. To ensure that the study samples were limited to newly diagnosed osteoporotic fractures, patients were excluded if they had an osteoporotic fracture diagnosis in the baseline period. Other exclusion criteria were diagnoses of malignant neoplasm or carcinoma, multiple myeloma, and Paget disease of bone between 2008 and 2011.[16,17]

Outcome Measures

Patients' social demographic and clinical characteristics were identified using UEBMI claims during the 12-month baseline period. Demographic characteristics included age (at index fracture date), sex, and working status. Clinical characteristics focused on the index fracture type and Charlson comorbidity index (CCI),[18,19] which represents each patient's concurrent comorbidity conditions, with a higher score indicating a worse condition.

From the healthcare system perspective, both osteoporosis-related and all-cause healthcare resource utilization and direct medical costs were estimated in the baseline and follow-up period. Medical claims under the primary diagnosis associated with osteoporosis and osteoporotic fractures (*International Classification of Diseases, Tenth Revision* code supplemented by Chinese description) were identified as osteoporosis-related.

For healthcare resource utilization, the proportion of patients with at least 1 hospitalization and outpatient visit was calculated separately. The number of hospitalizations, length of stay per hospital admission, number of days between inpatient visits, and costs per hospital admission were analyzed in hospitalized patients. The number of outpatient visits, number of days between outpatient visits, and costs per outpatient visit were analyzed for the outpatients. Annual direct medical costs were estimated, including inpatient and outpatient costs. This study also estimated the costs of the 3 most common osteoporotic fracture types (hip, vertebral, and arm fractures). In addition, on the basis of the UEBMI costs classification, the total direct medical costs were also broken down into drug costs, treatment costs, examination costs, medical device costs, surgery costs, and costs of other services (including bed, blood transfusion, and air conditioning and heating fees). Drug costs were composed of osteoporosis-related drugs (eg, selective estrogen receptor modulators and bisphosphonates), fracture-related drugs (eg, opioids and nonsteroidal anti-inflammatory drugs), and other drugs. Treatment costs corresponded to the costs of nursing, monitoring, disinfection, and intervention. Examination costs included the costs of physical examinations and biochemical/pathology tests. Medical device costs referred to costs of materials for the bone fracture fixation or repair and other consumables. All costs were converted into US dollars with an exchange rate in 2018 (¥6.61 = $1).[20]

Statistical Analysis

Descriptive statistical analyses were performed, providing means and standard deviations for continuous variables and frequencies and percentages for categorical variables. A log-transformed ordinary least squares (OLS) model was used to investigate factors associated with direct medical costs. Covariates included in the OLS model include baseline demographic characteristics (age at index date, sex, and working status), index fracture type (hip, vertebral, arm, rib, lower leg, pelvis, multiple, and other sites), baseline CCI score, baseline healthcare resource utilization, and direct medical costs. All statistical analyses were conducted using STATA version 12.0 (StataCorp, College Station, TX). A *P* value of less than .050 was considered to indicate statistical significance.

Results

Baseline Characteristics

On the basis of the inclusion criteria, we identified a total of 5941 patients with osteoporotic fractures in the Tianjin UEBMI (Table 1). The mean age of the study patients was 65.9 years; the largest proportion of patients (34.9%) fell into the age group of 50 to 59 years, followed by the age groups of 60 to 69 years, 70 to 79 years, and 80 years and older. Women constituted 62.1% of the study population, and retired represented 88.2%. The mean of the CCI score was 1.3 ± 1.6 for the study patients. As with the distribution of index fracture type, the largest proportion of index fracture type was arm fractures (26.0%), followed by hip (21.6%),

Table 1 – Baseline social demographic and clinical characteristics.

Variable	Total cohort (N = 5941)
Age, mean ± SD	65.9 ± 10.5
Age group (y), n (%)	
50-59	2075 (34.9)
60-69	1594 (26.8)
70-79	1547 (26.0)
≥80	725 (12.2)
Sex, female, n (%)	3692 (62.1)
Retired, n (%)	5240 (88.2)
Index fracture type, n (%)	
Arm	1546 (26.0)
Hip	1284 (21.6)
Vertebral	1253 (21.1)
Lower leg	742 (12.5)
Rib	704 (11.8)
Other sites	226 (3.8)
Multiple sites	123 (2.1)
Pelvis	63 (1.1)
Charlson comorbidity index,* mean ± SD	1.3 ± 1.6
Osteoporosis-related resource utilization and costs†	
Any hospitalizations, n (%)	0 (0)
Mean length of stay‡ (d), mean ± SD	–
Any outpatient visits, n (%)	639 (10.8)
Direct medical costs ($), mean ± SD	26 ± 234
All-cause resource utilization and costs†	
Any hospitalizations, n (%)	797 (13.4)
Mean length of stay,‡ (d), mean ± SD	22.5 ± 29.3
Any outpatient visits, n (%)	4556 (76.7)
Direct medical costs ($), mean ± SD	875 ± 1753

Note. All costs were exchanged to US dollars with an exchange rate in 2018 (¥6.61 = $1).
* Charlson comorbidity index was estimated during the 12-mo baseline period.
† 12-mo before index date.
‡ Length of stay was estimated only for those patients who had at least 1 hospitalization during the 12-mo baseline period.

Table 2 – Healthcare resource utilization during 12-mo follow-up period.

Variable	Total cohort (N = 5941)	
	Osteoporosis-related	All-cause
Inpatient service, n (%)	1973 (33.2)	2520 (42.4)
Number of admissions, mean ± SD	1.3 ± 0.8	1.5 ± 1.2
Rehospitalization rate, n (%)	381 (19.3)	775 (30.8)
Length of stay per admission (d), mean ± SD	18.0 ± 14.4	16.7 ± 13.5
Number of days between inpatient visit,* mean ± SD	101.8 ± 108.3	110.5 ± 99.2
Cost per admission ($), mean ± SD	3010 ± 2800	2567 ± 2664
Outpatient service, n (%)	4945 (83.2)	5642 (95.0)
Number of visits, mean ± SD	7.4 ± 8.7	59.3 ± 58.1
Number of days between outpatient visit,† mean ± SD	32.4 ± 53.6	11.9 ± 23.2
Cost per visit ($), mean ± SD	18 ± 26	16 ± 26

Note. All costs were exchanged to US dollars with an exchange rate in 2018 (¥6.61 = $1).
* Number of days between inpatient visit for patients with >1 inpatient admission.
† Number of days between outpatient visit for patients with >1 outpatient visit.

vertebral (21.1%), lower leg (12.5%), and rib (11.8%) fractures. The least common index fracture type was pelvis (1.1%), multiple sites (2.1%), and other osteoporosis pathological fractures (3.8%). During the 12-month baseline period, none of the patients were hospitalized because of osteoporosis or osteoporotic fractures. Approximately 13.4% of the patients were hospitalized because of any reason, with a mean length of stay of 22.5 days. An estimated 10.8% and 76.7% had at least 1 osteoporosis-related and all-cause outpatient visit. The mean total osteoporosis-related cost in the 12-month baseline period was $26 per patient, and the all-cause cost was $875 per patient.

Healthcare Resource Utilization

During the 12-month follow-up period (Table 2), the annual mean number of osteoporosis-related hospitalizations was 1.3 per patient, with a mean length of stay of 18.0 days and a mean total cost of $3010 per admission. Among patients with osteoporosis-related hospitalizations, 19.3% had more than 1 osteoporosis-related hospitalization, with an average interval between 2 admissions of 101.8 days. The mean number of outpatient visits per patient per year was 7.4, with an average 32.4-day interval between 2 outpatient visits and a mean total cost of $18 per visit. When looking at the utilization of all-cause health services, there was a little higher average number of hospitalizations (1.5) and a higher average number of outpatient visits (59.3%), as well as lower costs per hospitalization ($2567) and outpatient visit ($16) compared with the osteoporosis-related health service estimates.

Direct Medical Costs and Associated Factors

The mean total osteoporosis-related cost in the 12-month follow-up period was $1370 per patient, and the all-cause cost was $2549 per patient (Table 3). Costs varied by fracture type; the mean osteoporosis-related direct costs per patient during the follow-up period were $3753 for hip fractures, $692 for vertebral fractures, $511 for arm fractures, and $895 for patients with other fractures, whereas the all-cause costs were $4970, $1999, $1619, and $2017, respectively. For osteoporosis-related costs, 92.0% was attributable to inpatient services costs ($1261) for the total cohort, and inpatient services costs accounted for 98.1%, 79.6%, 77.7%, and 87.3% for patients with hip, vertebral, arm, and other fractures, respectively. For all-cause costs, inpatient services costs accounted for 83.1%, 52.4%, 45.4%, and 56.0% for patients with hip, vertebral, arm, and other fractures, respectively, which were much lower than those for the osteoporosis-related costs.

Among the annual osteoporosis-related costs for the total cohort during follow-up period, medical device costs were the most important component, accounting for 38.5% of total costs, followed by drug costs (31.1%), examination costs (11.7%), and treatment costs (8.2%) (Fig. 1). When considering the different service-sector costs composition for the inpatient services, medical device costs were the largest component (41.6%), followed by drug costs (27.8%), examination costs (10.9%), and treatment costs (8.4%) (see Appendix Figure 1 in Supplemental Materials found at https://dx.doi.org/10.1016/j.vhri.2018.11.008). Most of the costs for outpatient services were drug costs (68.8%) and examination costs (20.6%) (see Appendix Figure 1 in Supplemental Materials).

Table 3 – Direct medical costs during 12-mo follow-up period.

Variable	Total (N = 5941)	Fracture type			
		Hip (n = 1284)	Vertebral (n = 1253)	Arm (n = 1546)	Other sites (n = 1858)
Osteoporosis-related costs ($)	1370 ± 2579 (100%)	3753 ± 3709 (100%)	692 ± 1820 (100%)	511 ± 1228 (100%)	895 ± 277 (100%)
Cost of inpatient services	1261 ± 1084 (92.0%)	3680 ± 2404 (98.1%)	551 ± 655 (79.6%)	397 ± 353 (77.7%)	781 ± 715 (87.3%)
Cost of outpatient services	110 ± 180 (8.0%)	72 ± 160 (1.9%)	141 ± 180 (20.3%)	114 ± 222 (22.4%)	114 ± 149 (12.8%)
All-cause costs ($)	2549 ± 3382 (100%)	4970 ± 4392 (100%)	1999 ± 3136 (100%)	1619 ± 2361 (100%)	2017 ± 2596 (100%)
Cost of inpatient services	1661 ± 1583 (65.1%)	4129 ± 2965 (83.1%)	1048 ± 1384 (52.4%)	735 ± 742 (45.4%)	1130 ± 1107 (56.0%)
Cost of outpatient services	889 ± 1230 (34.9%)	841 ± 1319 (16.9%)	952 ± 1205 (47.6%)	884 ± 1235 (54.6%)	887 ± 1167 (44.0%)

Note. Cost variables are shown as mean ± SD. All costs were exchanged to US dollars with an exchange rate in 2018 (¥6.61 = $1).

The OLS regression results revealed that age, fracture type, baseline resource utilization, and baseline costs had a significant impact on annual direct osteoporosis-related costs (Table 4). These costs tended to increase with age. In comparison with the costs for arm fractures, costs were higher for hip, vertebral, lower leg, and multiple fractures, and lower for rib fractures. Patients with baseline outpatient visits incurred lower annual direct osteoporosis-related medical costs, whereas patients with more osteoporosis-related costs in the baseline period incurred higher annual direct osteoporosis-related medical costs. The analysis of all-cause costs presented a similar trend, with the exception of rib fractures and baseline hospitalizations, which did not show significant differences as a predictor of costs. Patients with higher CCI scores in the baseline period were associated with higher all-cause costs.

Discussion

This comprehensive, retrospective claims-based study analyzed the disease-specific and all-cause direct medical costs for patients with osteoporotic fractures from the healthcare system perspective in China. Mean annual osteoporosis-related and all-cause healthcare costs were $1370 and $2549 for patients with osteoporotic fractures. The total cost for patients with osteoporotic fractures was nearly one-half of the national gross domestic product per capita in 2011 (¥36 403, ie, $5 507),[21] which confirmed that total annual direct medical costs for patients with osteoporotic fractures were considerably heavy and brought a substantial economic burden on the Chinese healthcare system.

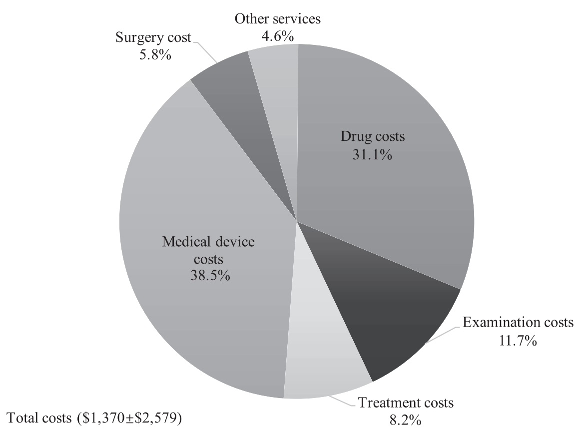

Fig. 1 – Composition of osteoporosis-related direct medical costs among total cohort during 12-month follow-up period.

Existing literature reported a wide variation in the proportion of rates of hip and vertebral fractures as a proportion of osteoporotic fractures. In our study, 43% of observed osteoporotic fractures occurred at the hip and vertebra, which makes up a larger proportion of all patients with osteoporotic fractures. A study based on German sickness fund data reported a similar rate of 42%,[22] whereas 2 claims-based studies in the United States reported this rate to be between 21% and 34%.[23,24] The methods used to identify osteoporotic fractures and the demographic differences across populations may be the major reasons leading to the variation in this rate.

Our estimate of annual total costs for all-type osteoporotic fractures in Tianjin is $2549 per patient, and the annual total costs were $4970, $1999, and $1619 per patient for hip, vertebral, and arm fractures, respectively. Researchers in many countries around the world have conducted economic models and prospective and retrospective studies to estimate costs of osteoporotic fractures. Nevertheless, most studies have focused on the costs of one or several specific fracture types. We found a wide variation within the comparison between our estimates and studies from other countries, because of differences in demographic variables, methods, data source, or healthcare delivery systems. Our estimates were much lower compared with the costs in the United States of $23 005 (2002) for all fracture types,[25] $18 613 (2006) for hip fractures, and $11 326 (2006) for arm fractures[26]; in Sweden of €14 221 (2004) for hip fractures[11]; and in Germany of €11 435 (2010) for vertebral fractures.[27] Our estimates were a little higher than the costs in Mexico of $4366 for hip fractures,[28] and much higher than the costs in Thailand of $1075 (2008) for all fracture types[29] and the costs in South Korea of $1228 (2004) for vertebral fractures.[30] Annual direct medical costs associated with osteoporotic fractures varied between different countries; while considering the economic status of China, costs attributed to osteoporotic fractures in China were disproportionately high in our study. Besides, this study verified the previous findings that hip fractures were the most expensive type among osteoporotic fractures on a per-person basis.[11,24,26]

In the present study, costs associated with drugs constitute a large proportion (31.1%) of the osteoporosis-related costs, mainly because of the differences in the healthcare delivery systems and the relatively lower health service cost in China. The drug cost proportion in China was much higher than in other Western countries, which was approximately 5 to 20 times as that in Western countries.[11,22,26,31]

It is also noteworthy that the osteoporosis-related treatment costs for patients with hospitalizations were considerably high in China. In our study, nearly one-third (33.2%) of study patients were hospitalized because of osteoporosis or osteoporotic fractures

Table 4 – OLS model results on factors associated with direct medical costs (N = 5941).

Variable	Osteoporosis-related		All-cause	
	Coefficient (SE)	P value	Coefficient (SE)	P value
Age group (y) (vs 50-59 y)				
60-69	0.034 (0.009)	<.001	0.023 (0.007)	<.001
70-79	0.046 (0.010)	<.001	0.040 (0.007)	<.001
≥80	0.037 (0.012)	.003	0.019 (0.009)	.028
Female (vs male)	0.006 (0.008)	.463	−0.005 (0.005)	.299
Retired (vs employed)	−0.009 (0.013)	.486	−0.006 (0.009)	.485
Charlson comorbidity index	−0.001 (0.002)	.533	0.023 (0.002)	<.001
Fracture type (vs arm fractures)				
Hip fractures	0.320 (0.010)	<.001	0.171 (0.007)	<.001
Vertebral fractures	0.026 (0.010)	.009	0.015 (0.007)	.026
Rib fractures	−0.038 (0.012)	.001	−0.003 (0.008)	.731
Pelvic fractures	−0.039 (0.033)	.239	0.013 (0.023)	.562
Lower limb fractures	0.170 (0.012)	<.001	0.081 (0.008)	<.001
Multiple fractures	0.157 (0.024)	<.001	0.085 (0.017)	<.001
Other type fractures	−0.019 (0.019)	.313	0.001 (0.013)	.913
Baseline osteoporosis-related resource utilization and costs				
Any hospitalizations (vs no)	–	–	–	–
Any outpatient visits (vs no)	−0.114 (0.032)	<.001	–	–
Direct medical costs ($), mean ± SD	0.022 ± 0.005	<.001	–	–
Baseline all-cause resource utilization and costs				
Any hospitalizations (vs no)	–	–	<0.001 (0.008)	1.000
Any outpatient visits (vs no)	–	–	−0.153 (0.013)	<.001
Direct medical costs ($), mean ± SD	–	–	0.020 ± 0.002	<.001

OLS indicates ordinary least squares; SD, standard deviation; SE, standard error.

during the 12-month follow-up period, with a cost of $3010 per hospitalization. For patients with osteoporosis-related hospitalizations, 19.3% of them had a rehospitalization, and mean osteoporosis-related length of stay per admission was 18.0 days, which was greater than the average length of stay for all diseases (10.5 days) in China.[32] In comparison with the United States,[33] the number of osteoporosis-related inpatient admissions was higher and the mean length of stay was much longer for patients with osteoporotic fractures in China, which was only 21.5% and 4.8 days, respectively, in the United States. The high inpatient services rate, inpatient admission costs, and inpatient resources utilization make the inpatient services costs for patients with osteoporotic fractures account for more than 92.0% of the annual osteoporosis-related costs.

Several limitations of this study should be noted. First, Tianjin is 1 of the 4 municipal cities and a typical tier 2 city of China. Because direct medical costs may vary across developed and less developed regions in China, the generalizability of our findings may be limited to the urban areas of China, such as Tianjin. Second, the claims data did not contain detailed clinical information, such as BMD results, which would make it difficult to verify whether the fractures were due to osteoporosis. Because most of the fractures in people aged 50 years or older were believed to be associated with osteoporosis,[34,35] we limited our study to patients aged 50 years or older. For these patients, following the methodology of Kanis et al,[36] we used fracture sites to identify osteoporotic fractures. Fractures that happened at the skull, face, hands, fingers, feet, toes, and ankles were excluded; fractures at the following sites were classified as osteoporotic: hip, vertebral, arm (scapula, clavicle, humerus, ulna, radius, and wrist), rib, lower leg (fibula, patella, tibia, and other femoral), and pelvis. Therefore, in the present study that was limited to patients aged 50 years or older, it is unclear whether the results will change if generalized to younger patients with osteoporotic fractures. In addition, it is possible that a small proportion of fractures were wrongly recognized as osteoporosis-related. Third, the present analysis focused on costs of newly diagnosed patients; even though we had imposed a 12-month baseline washout period, it is possible that a portion of patients may have had fractures before the baseline period. Finally, we were unable to capture the information of lifestyles including dietary habit, physical activities, and so forth in this study because of the limitation of the claims database, which may also affect the rate of fractures.

Conclusions

The present study quantified the healthcare resource utilization and direct medical costs for patients with osteoporotic fractures in Tianjin, China. The results demonstrated that osteoporotic fractures were associated with significant direct medical costs, and the costs were primarily driven by osteoporosis-related hospitalizations. Increasing awareness of the disease and adopting treatments that can effectively reduce the fracture risk may ultimately lower the associated economic burden of osteoporotic fractures in China.

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Supplemental Materials

Supplementary data associated with this article can be found in the online version at https://dx.doi.org/10.1016/j.vhri.2018.11.008.

REFERENCES

1. Kaplan FS. *Prevention and Management of Osteoporosis*. Geneva, Switzerland: World Health Organization; 2003:53–71.
2. Chinese Society of Osteoporosis and Bone Mineral Research. Guideline for diagnosing and treatment of primary osteoporosis. *Chin J Osteoporos Bone Miner Res*. 2011;1:2–17.
3. Wang Y, Tao Y, Hyman ME, Li J, Chen Y. Osteoporosis in China. *Osteoporos Int*. 2009;20(1):1651–1662.
4. Johnell O, Kanis J. Epidemiology of osteoporotic fractures. *Osteoporos Int*. 2005;16(suppl 2):S3–S7.
5. Lin X, Xiong D, Peng YQ, et al. Epidemiology and management of osteoporosis in the People's Republic of China: current perspectives. *Clin Interv Aging*. 2015;10:1017–1033.
6. Johnell O, Kanis J. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int*. 2006;17(12):1726–1733.
7. Burge R, Dawson-Hughes B, Solomon DH, et al. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. *J Bone Miner Res*. 2007;22(3):465–475.
8. Bleibler F, Konnopka A, Benzinger P, Rapp K, König HH. The health burden and costs of incident fractures attributable to osteoporosis from 2010 to 2050 in Germany—a demographic simulation model. *Osteoporos Int*. 2013;24(3):835–847.
9. Borgström F, Zethraeus N, Johnell O, et al. Costs and quality of life associated with osteoporosis-related fractures in Sweden. *Osteoporos Int*. 2006;17(5):637–650.
10. Lin JT, Lane JM. Rehabilitation of the older adult with an osteoporosis-related fracture. *Clin Geriatr Med*. 2006;22(2):435–447.
11. NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy. Osteoporosis prevention, diagnosis, and therapy. *NIH Consens Statement*. 2000;17:1–45.
12. Luo LZ, Xu L. Study on direct economic-burden and its risk factors of osteoporotic hip fracture [in Chinese] *Zhonghua Liu Xing Bing Xue Za Zhi*. 2005;26(9):669–672.
13. Dai K, Zhang Q, Fan T, Sen SS. Estimation of resource utilization associated with osteoporotic hip fracture and level of post-acute care in China. *Curr Med Res Opin*. 2007;23(12):2937–2943.
14. Qu B, Ma Y, Yan M, et al. The economic burden of fracture patients with osteoporosis in western China. *Osteoporos Int*. 2014;25(7):1853–1860.
15. Tianjin Daily. Tianjin's permanent population totaled 135.548 million at the end of 2011. http://www.gov.cn/gzdt/2012-05/09/content_2132977.htm. Accessed August 14, 2013.
16. Chen Z, Maricic M, Aragaki AK, et al. Fracture risk increases after diagnosis of breast or other cancers in postmenopausal women: results from the Women's Health Initiative. *Osteoporos Int*. 2009;20(4):527–536.
17. Abelson A. A review of Paget's disease of bone with a focus on the efficacy and safety of zoledronic acid 5 mg. *Curr Med Res Opin*. 2008;24(3):695–705.
18. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373–383.
19. D'Hoore W, Bouckaert A, Tilquin C. Practical considerations on the use of the Charlson comorbidity index with administrative data bases. *J Clin Epidemiol*. 1996;49(12):1429–1433.
20. Bank of China. Foreign exchange rate. http://srh.bankofchina.com/search/whpj/search.jsp. Accessed October 4, 2018.
21. National Bureau of Statistics of China. National data. http://data.stats.gov.cn/easyquery.htm?cn=C01. Accessed October 4, 2018.
22. Häussler B, Gothe H, Göl D, et al. Epidemiology, treatment and costs of osteoporosis in Germany: the BoneEVA Study. *Osteoporos Int*. 2007;18(1):77–84.
23. Christensen L, Iqbal S, Macarios D, Badamgarav E, Harley C. Cost of fractures commonly associated with osteoporosis in a managed-care population. *J Med Econ*. 2010;13(2):302–313.
24. Shi N, Foley K, Lenhart G, Badamgarav E. Direct healthcare costs of hip, vertebral, and non-hip, non-vertebral fractures. *Bone*. 2009;45(6):1084–1090.
25. Rousculp MD, Long SR, Wang S, Schoenfeld MJ, Meadows ES. Economic burden of osteoporosis-related fractures in Medicaid. *Value Health*. 2007;10(2):144–152.
26. Pike C, Birnbaum HG, Schiller M, et al. Direct and indirect costs of non-vertebral fracture patients with osteoporosis in the US. *Pharmacoeconomics*. 2010;28(5):395–409.
27. Lange A, Zeidler J, Braun S. One-year disease-related health care costs of incident vertebral fractures in osteoporotic patients. *Osteoporos Int*. 2014;25(10):2435–2543.
28. Carlos F, Clark P, Galindo-Suárez RM, Chico-Barba LG. Health care costs of osteopenia, osteoporosis, and fragility fractures in Mexico. *Arch Osteoporos*. 2013;8:1–2.
29. Pongchaiyakul C, Songpattanasilp T, Taechakraichana N. Burden of osteoporosis in Thailand. *J Med Assoc Thai*. 2008;91(2):261–267.
30. Kang HY, Kang DR, Jang YH, et al. Estimating the economic burden of osteoporotic vertebral fracture among elderly Korean women [in Korean]. *J Prev Med Public Health*. 2008;41(5):287–294.
31. Tarride JE, Guo N, Hopkins R, et al. The burden of illness of osteoporosis in Canadian men. *J Bone Miner Res*. 2012;27(8):1830–1838.
32. Ministry of Health China. China's health statistics yearbook. http://www.moh.gov.cn/htmlfiles/zwgkzt/ptjnj/year2011/index2011.html. Accessed October 26, 2018.
33. Orsini LS, Rousculp MD, Long SR, Wang S. Health care utilization and expenditures in the United States: a study of osteoporosis-related fractures. *Osteoporos Int*. 2005;16(4):359–371.
34. Papaioannou A, Morin S, Cheung A, et al. 2010 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada: summary. *CMAJ*. 2010;182(17):1864–1873.
35. Melton LJ, Thamer M, Ray NF, et al. Fractures attributable to osteoporosis: report from the National Osteoporosis Foundation. *J Bone Miner Res*. 1997;12(1):16–23.
36. Kanis JA, Oden A, Johnell O, et al. The burden of osteoporotic fractures: a method for setting intervention thresholds. *Osteoporos Int*. 2001;12(5):417–427.