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Original article

Osteoporosis treatment rates after hip fracture 2011–2019 in Hawaii: Undertreatment of men after hip fractures

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ABSTRACT

Objectives: To investigate trends of osteoporosis treatment rates, and factors affecting osteoporosis treatment after hip fracture admission within a single health care system in Hawaii.
Methods: A retrospective chart review was conducted of patients aged 50 years or older and hospitalized for hip fractures between January 1, 2011 and December 31, 2019 at Hawaii Pacific Health, a large health care system in Hawaii. We collected data on basic demographics and osteoporosis medication prescription from electronic medical records. We evaluated trends of osteoporosis treatment rates and performed logistic regression to determine factors associated with osteoporosis treatment.
Results: The mean for treatment rates for osteoporosis from 2011 to 2019 was 17.2% (range 8.8%–26.0%). From 2011 to 2019 there was a small increase in treatment rates from 16.3% in 2011 to 24.1% in 2019. Men were less likely to receive osteoporosis treatment after admission for hip fracture. Patients discharged to a facility were more likely to receive osteoporosis treatment. As compared to women, men who had a hip fracture were less likely to receive dual-energy X-ray absorptiometry scan, and osteoporosis medication before hip fracture admission.
Conclusions: The use of osteoporosis medication for secondary prevention after admission for hip fracture in Hawaii from 2011 to 2019 was low. However, there was a small increase in treatment rates from 2011 to 2019. Disparities in treatment of osteoporosis after hip fracture were noted in men. Significant work is needed to increase treatment rates further, and to address the disparity in osteoporosis treatment between men and women.
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1. Introduction

Osteoporosis is a skeletal disorder in which bone strength is decreased leading to increased risk of fragility fracture. Osteoporotic hip fractures are one of the most important fragility fractures leading to significant comorbidity, mortality and health care cost in older individuals [1]. Secondary prevention is critical in patients following an osteoporotic hip fracture, because they are at high risk of developing subsequent fragility fractures. Strong evidence from randomized controlled trials show that osteoporosis treatment is beneficial and reduces subsequent fractures [2,3]. Despite the benefits of secondary prevention, many studies have shown low rates of treatment after hospital admission for osteoporotic hip fracture [4,5].

National studies in the United States (US) investigating osteoporosis treatment rates demonstrate decreasing rates of treatment since the early 2000s. In a retrospective, observational cohort study based on US administrative insurance claims data utilizing commercial or Medicare supplemental health insurance (96 886

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beneficiaries admitted for hip fracture), Solomon et al. [6] reported decreasing rates of osteoporosis treatment from 40.2% in 2002 to 20.5% in 2011. In a review of 97 619 hip fracture patients in the US, Desai et al. [7] similarly reported that medication initiation rates declined from 9.8% in 2004 to 3.3% in 2015.

Hawaii has a distinct racial composition (higher proportion of Asians, Pacific Islanders, and multi-racial individuals) [8], and differs geographically and culturally from the rest of the United States [9]. Racial differences may affect adherence to treatment and healthcare utilization [10,11]. Yet there is a paucity of data regarding osteoporosis treatment following an admission for hip fracture in Hawaii. Previous reports indicate that osteoporosis medication treatment rates in Hawaii following hospitalization for hip fracture remain low [4]. However, trends in osteoporosis care following admission for hip fracture in Hawaii are largely unknown. Local factors may significantly impact trends in treatment rates. For example, in 2016, the Hawaii Medical Service Association and the Blue Cross Blue Shield of Hawaii, launched the Population-based Payments for Primary Care (3PC) system [12]. 3PC is a new population based primary care payment model with quality bonuses and a global budget shared savings incentive designed to improve the quality of care in Hawaii. Treatment for osteoporosis is part of providing quality care. The impact of such policies on osteoporosis care is still unclear.

Our objective in this study is to determine trends of osteoporosis treatment rates (specifically osteoporosis medication) after patients were admitted for hip fractures at 3 major hospitals within Hawaii Pacific Health, the largest healthcare system in Hawaii, from 2011 to 2019. We hypothesized that osteoporosis treatment rates after hip fracture admission were decreasing in Hawaii, as seen nationally in the United States. We also assessed factors associated with osteoporosis treatment to try to evaluate disparities in osteoporosis care. Identifying gaps in health status of vulnerable populations is an essential component of public health surveillance efforts. Identification of these gaps will help determine specific domains of clinical need and opportunities to improve health care equity, quality, and cost.

2. Methods

2.1. Research setting and design

We conducted a retrospective chart review of patients admitted for hip fracture to 3 medical centers within the Hawaii Pacific Health healthcare system from 2011 to 2019. Hawaii Pacific Health is a non-for-profit health care network of hospitals, clinics, and physicians and other care providers that covers the state of Hawaii. It is Hawaii's largest health care provider [13]. The health care network comprises of 3 hospitals, a medical center located in downtown Honolulu on the Island of Oahu (Facility A), a medical center located on the west side of the Island of Oahu (Facility B), and a medical center on the Island of Kauai (Facility C). The study was reviewed by the Hawaii Pacific Health Research Institute and determined to be exempt from Institutional Review Board review and patient consent (HPHRI Study Number: 2020-059).

Compared to the contiguous United States, Hawaii has a distinct racial composition, where non-Hispanic whites do not form the majority of the population [14]. In Hawaii, there is a higher proportion of Asians, Pacific Islanders, and multiracial persons [4,8]. According to 2018 census data, 25.6% of the individuals living in Hawaii identified themselves as being white, while 37.6%, 10.2%, 10.7% identified themselves as Asian, Native Hawaiian/Pacific Islander or Hispanic/Latino, respectively [15]. The health care system in Hawaii is uniquely characterized by strong health outcomes as compared to the rest of the United States, associated with relative longevity, low rates of uninsured patients, and good access to healthcare [4,16].

2.2. Study participants and analysis variables

Patients aged 50 years or older who had a hospitalization for hip fracture were identified from January 1st, 2011 to December 31st, 2019. Hip fracture cases were identified by searching for patients with a primary discharge diagnosis ICD-9 code (or corresponding ICD-10 codes) of 820.0 (S72019A, S72023A, S72026A, S72033A, S72036A, S72043A, S72046A, S72099A), 820.2 (S72109A, S721143A, S72146A, S7223XA, S7226XA), and 820.8 (S72009A). Cases with a diagnostic ICD-9 code of 733.14 were not included because this code is frequently associated with femur fractures related to malignancy. Patients admitted for fractures multiple times during the study period were included if the subsequent fracture occurred more than 180 days after the previous one, because more recent admissions likely represent readmissions from medical/surgical complications (363 cases excluded). Osteoporotic hip fractures were defined as those resulting from a fall from standing height or less. Open fractures with ICD-9 codes of 820.1, 820.3, 820.9 (5 cases), subtrochanteric fractures, pathological fractures, and non-specific fractures were excluded. Non-specific fractures included acetabular fractures, or pelvic fractures.

Data collected included the age of the patient at the time of admission, gender, height, weight, body mass index (BMI), race, treatment facility, insurance, calcium and vitamin D supplementation, dual-energy X-ray absorptiometry (DXA) scan (prior to admission, and 1 year after admission) and osteoporosis treatment. Osteoporosis treatment was defined as receiving osteoporosis medication within 1 year of discharges. Osteoporosis medications included were bisphosphonates (ibandronate, zoledronic acid, risedronate, and alendronate), denosumab, calcitonin, raloxifene (only approved for women), teriparatide, abaloparatide, and romosozumab. Discharge disposition included home or self-care, facility (nursing home or rehabilitation facility), in-hospital death. The admission date was defined as the index date for each hip fracture case.

Descriptive statistics using two-sample *t* tests and Chi-square tests were used to find an association between variables. Possible predictor variables of treatment for the dataset were selected based on previous literature. Logistic regression was then conducted on the associated variables to determine predictive factors for osteoporosis treatment. Osteoporosis treatment rates were calculated by year, and adjusted by age, sex, race, and treatment facility. The trends of treatment rates were evaluated using the Cochran–Armitage test for trend to test if the rates of treatment had changed over time. P-values were 2-sided with a significance threshold of less than 0.05.

3. Results

3.1. Characteristics of the study population

Fig. 1 demonstrates the number of identified and included study subjects. There were 2208 hospitalizations with osteoporotic hip fracture from 2011 to 2019. Patient characteristics are summarized in Table 1. Approximately 70% of the patients were female. The mean patient age was 80.9 years. Approximately 60% of osteoporotic hip fracture patients were 80 years or older. The patients were 36% Caucasian and 64% non-Caucasian. The non-Caucasians mainly consisted of Japanese (36.0%), Filipino (10.5%), Chinese (4.6%), and Native Hawaiians/Pacific Islander (5.1%) ethnicity. Approximately 90% of osteoporotic hip fracture patients had Medicare or Medicaid as the primary payer. Prior to hip fracture, only 6.7% of patients

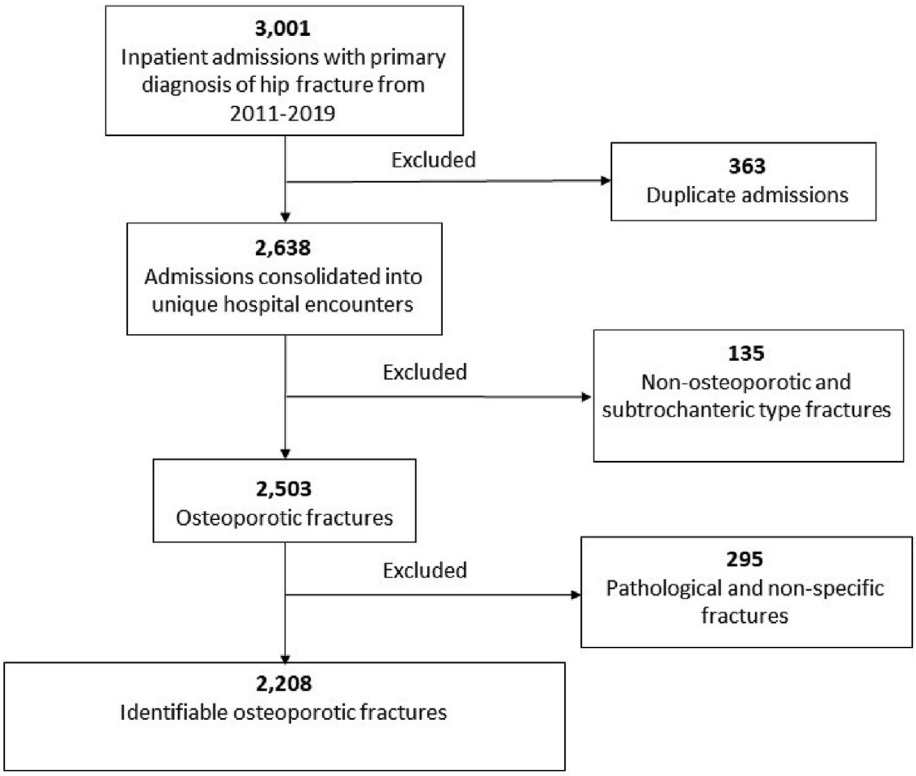

Fig. 1. Flowchart of hip fracture identification.

Table 1
Baseline characteristics of patients with hip fracture.

Variables	Mean ± SD or n (%)
Age, yr	80.93 ± 11.00
Age group, yr	
50-59	110 (5.2)
60-69	291 (13.2)
70-79	429 (19.6)
80-89	839 (38.0)
90 or more	539 (24.4)
Female	1569 (71.1)
Race	
Caucasian	804 (36.4)
Native Hawaiian and other Pacific Islander	113 (5.1)
Chinese	101 (4.6)
Filipino	232 (10.5)
Japanese	795 (36.0)
Other	163 (7.4)
Body mass index	22.8 ± 4.8
Treatment facility	
Facility A	942 (42.7)
Facility B	710 (32.2)
Facility C	556 (25.2)
Primary insurance	
Private health insurance	191 (8.7)
Medicare	1441 (65.3)
Medicaid	515 (23.3)
Other	61 (2.8)
Discharge disposition	
Home or self-care	514 (23.3)
Facility	1635 (74.4)
In-hospital mortality	56 (2.5)
Other	3 (0.1)

Facility A, Medical Center located in downtown Honolulu on the Island of Oahu; Facility B, Medical Center located on the west side of the Island of Oahu; Facility C, Medical Center on the Island of Kauai.

received osteoporosis treatment. 3.4% of men received osteoporosis treatment prior to hip fracture, as compared to 8.0% of women ($P < 0.0001$).

3.2. Osteoporosis treatment after hip fracture hospitalization

Table 2 shows osteoporosis treatment rates by admission year, adjusted by age, sex, race, and treatment facility. The mean rate of osteoporosis treatment after hip fracture hospitalization from 2011 to 2019 was 17.2% (range 8.8%–26.0%). From 2011 to 2019 there was a gradual increase in treatment rates (Fig. 2) ($P < 0.0001$). Oral bisphosphonates were the most commonly prescribed treatment (183 patients). Of the oral bisphosphonates, most patients received alendronate (158 patients). Other treatments that were prescribed post hip fracture included intranasal calcitonin (134), denosumab (73), teriparatide (22), raloxifene (19), intravenous zoledronic acid (8), and romosozumab (1).

Table 2
Osteoporosis treatment (medication) rates by year, adjusted by age, sex, race, and treatment facility.

Year	Number of hip fracture patients	Treatment rates (%) (95% CI)
2011	203	16.3 (15.4, 17.1)
2012	239	8.8 (8.3, 9.3)
2013	232	10.8 (10.2, 11.4)
2014	255	12.9 (12.3, 13.6)
2015	232	19.4 (18.4, 20.3)
2016	296	14.5 (13.8, 15.2)
2017	282	21.3 (20.3, 22.2)
2018	311	26.0 (25.0, 27.1)
2019	158	24.1 (22.7, 25.4)

CI, confidence interval.

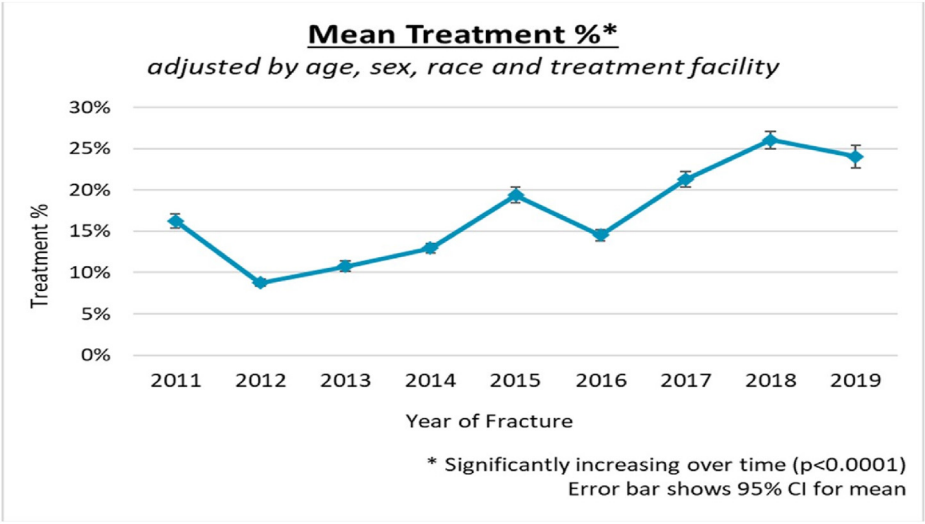

Fig. 2. Osteoporosis treatment rates after admission for fracture 2011–2019.

3.3. Factors predicting osteoporosis treatment after hip fracture hospitalization

Table 3 shows the results of logistic regression analysis to investigate factors associated with osteoporosis treatment after hospitalization for hip fracture. In the univariable model, older age, female sex, Japanese race/ethnicity, and patients who were discharged to facility were associated with osteoporosis treatment after admission for hip fracture. Osteoporotic hip fracture admissions to Medical Center B were associated with an increased likelihood of osteoporosis treatment, while osteoporotic hip fracture admissions to Medical Center C were associated with a lower likelihood of receiving osteoporosis treatment (reference Medical Center A). In the multivariable model adjusting for age, sex, BMI, race, treatment facility, insurance status, and discharge disposition, male sex (odds ratio (OR) 0.59; 95% confidence interval (CI), 0.44–0.80), and admission to Medical Center C (reference Medical Center A) (OR 0.47; 95% CI, 0.33–0.69) were less likely to be associated with osteoporosis treatment after discharge. Discharge from a hospital to a facility such as nursing home was associated with higher rates of treatment (OR 2.23; 95% CI 1.53–3.24).

3.4. Osteoporosis care in men

Fig. 3 shows osteoporosis treatment rates by admission year for males and females, adjusted by age, race, and treatment facility. Treatment rates increased for men ($P = 0.012$) and women ($P < 0.0001$) from 2011 to 2019. Treatment rates were lower in men as compared to women, and the difference was statistically significant in 2014, 2016, and 2017. Table 4 highlights the differences

Table 3
Factors predicting osteoporosis treatment (medication).

Variable	Univariable model		Multivariable model[b]	
	Odds Ratio [95% CI]	P-value	Odds Ratio [95% CI]	P-value
Age, yr	1.02 [1.01, 1.03]	0.0039	1.00 [0.99, 1.02]	0.78
Body mass index	0.98 [0.96, 1.01]	0.14	1.00 [0.97, 1.02]	0.69
Male (reference: female)	0.56 [0.43, 0.74]	< 0.0001	0.59 [0.44, 0.80]	0.0005[c]
Race (reference: Caucasian)				
Chinese	1.35 [0.78, 2.34]	0.28	0.86 [0.48, 1.54]	0.56
Filipino	1.11 [0.74, 1.67]	0.62	0.74 [0.46, 1.19]	0.20
Japanese	1.71 [1.32, 2.22]	< 0.0001	1.11 [0.82, 1.52]	0.50
Native Hawaiian/Pacific Islander	0.96 [0.54, 1.71]	0.88	0.71 [0.38, 1.31]	0.24
Other	1.35 [0.86, 2.12]	0.19	0.99 [0.61, 1.59]	0.92
Treatment Facility (Reference: Medical Center A)				
Medical Center B	1.33 [1.05, 1.70]	0.020	1.22 [0.93, 1.61]	0.14
Medical Center C	0.41 [0.29, 0.57]	< 0.0001	0.47 [0.33, 0.69]	< 0.0001[c]
Insurance (reference: private health insurance)				
Medicare	1.46 [0.95, 2.26]	0.086	0.98 [0.58, 1.62]	0.95
Medicaid	1.18 [0.74, 1.91]	0.49	0.72 [0.41, 1.26]	0.26
Other	0.22 [0.050, 0.93]	0.040	0.31 [0.079, 1.20]	0.072
Discharge disposition (reference: home or self-care)				
Facility	2.73 [1.96, 3.80]	< 0.0001	2.23 [1.53, 3.24]	< 0.0001[c]
In-hospital death	0.094 [0.006, 1.58]	0.90	0.11 [0.006, 1.75]	0.96
Other	1.51 [0.049, 46.90]	0.98	n/a[a]	

Medical Center A, Medical Center located in downtown Honolulu on the Island of Oahu; Medical Center B, Medical Center located on the west side of the Island of Oahu; Medical Center C, Medical Center on the Island of Kauai.

[a] Not available.

[b] Variables included in the multivariable model-age, BMI, gender, race, treatment facility, primary insurance and discharge disposition.

[c] Statistically significant P-value of less than 0.05.

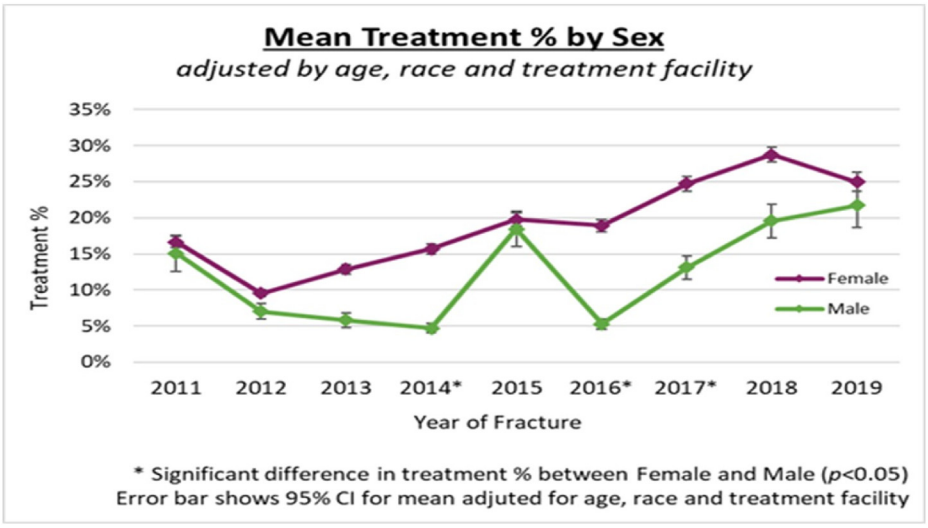

Fig. 3. Osteoporosis treatment rates of men and women after admission for fracture 2011–2019.

Table 4
Comparison of osteoporosis care of female and male patients.

Variable	Mean ± SD or n (%)		P-value
	Female (n = 1569)	Male (n = 639)	
DXA scan ordered	667 (42.5)	64 (10.0)	< 0.0001[b]
Prior to admission for hip fracture			
Calcium supplementation	109 (7.0)	29 (4.5)	0.034[b]
Vitamin D supplementation	80 (5.1)	29 (4.5)	0.58
Osteoporosis Treatment.	125 (8.0)	22 (3.4)	< 0.0001[b]
After admission for hip fracture			
Calcium supplementation	319 (20.3)	88 (13.8)	0.0003[b]
Vitamin D supplementation	226 (14.4)	74 (11.6)	0.079
Osteoporosis Treatment.	303 (19.3)	76 (11.9)	< 0.0001[b]
Calcitonin	104 (6.6)	30 (4.7)	0.084
Bisphosphonates	142 (9.1)	41 (6.4)	0.042[b]
Denosumab	61 (3.9)	12 (1.9)	0.017[b]
Teriparatide/Abaloparatide	19 (1.2)	3 (0.5)	0.16
Raloxifene[a]	19 (1.2)	–	–
Romosozumab	1 (0.06)	0 (0.00)	1.00

DXA, dual-energy X-ray absorptiometry.
[a] Raloxifene is approved for women only.
[b] Statistically significant P-value of less than 0.05.

of osteoporosis care in men and women. Men were less likely than women to have a DXA scan ordered before and after the hip fracture. Men were less likely to have calcium supplementation and osteoporosis treatment before admission for hip fracture. After hip fracture, they were less likely to receive any osteoporosis treatment. They were also less likely to receive calcium supplementation, bisphosphonates, denosumab and raloxifene.

4. Discussion

Our study shows low rates of osteoporosis treatment after hip fracture hospitalization within a major health care system in Hawaii. From 2011 to 2019 the treatment rates ranged 8.8%–26.0%. In contrast to national studies in the United States, there was a small gradual increase in treatment rates from 2011 to 2019. Low rates of osteoporosis treatment after hip fracture have been noted in many studies, both nationally and at local levels. Findings from national databases are complemented by local studies showing a concerning and recurring theme of low rates of treatment after hip fracture admission [4,17,18]. Disparities in treatment rates were noted, where men were less likely to receive treatment after hip fracture. Furthermore, men who had a hip fracture were less likely to receive a DXA scan, and osteoporosis medication before hip fracture admission. Our study calls attention to critical disparities of osteoporosis treatment in men after hip fracture, as well as the urgent need for concerted efforts in improving the rate of secondary prevention treatment.

The reasons for low rates of treatment after hip fracture admission are likely multifactorial. At the physician level, cost and concern of possible side effects to medications are major barriers in providing osteoporosis care post fracture [19]. At the health care system level, system level complexities and lack of financial resources leading to poor care coordination pose major barriers towards providing optimal care [3]. Patients' unequal access to medical care because of physical, geographic or financial limitations may also contribute to low osteoporosis treatment rates after hip fracture admission [4]. Patient perceptions and beliefs about treatment post fracture are potential obstacles [20]. For example, even after sustaining a fragility fracture, most patients do not perceive osteoporosis as a serious problem, and many patients are

not concerned about their risk for future fractures [20].

Although low treatment rates in women and men are of concern, our study highlights a critical issue: the disparity of osteoporosis treatment in men. A few studies from the late 1990s-early 2000s in the United States have shown that men are much less likely to receive osteoporosis treatment after hip fracture [21–24]. For example, in a study by Kiebzak et al. [21] of 363 hip fracture patients admitted from 1996 to 2000, only 4.5% of men had treatment of any kind for osteoporosis, compared to 27% of women. Antonelli et al. [25] studied 417 patients with hip fracture from 2000 to 2010 and noted that women were 3 times more likely to receive treatment than men. Our study provides contemporary data in regard to lack of osteoporosis care in men after hip fracture. Unfortunately, despite increasing osteoporosis treatment options that have been approved for men [1], and more recent consensus guidelines [26–28] (Endocrine Society guidelines published in 2012, National Osteoporosis Foundation guidelines published in 2014) recommending osteoporosis treatment in men after hip fracture, osteoporosis treatment in men who have had a hip fracture remains lower than in women.

There may be a lack of awareness among physicians of the risk of osteoporosis and fracture in men, because of the general belief that osteoporosis is a woman's disease [21]. Due to a lack of awareness, men may not be aware that their hip fractures are related to osteoporosis [21]. Insurance coverage in the United States for DXA in men remains limited and may contribute to lack of screening and treatment for osteoporosis [29]. Men are less likely to receive osteoporosis treatment after a diagnosis of osteoporosis or fragility fracture [30]. Although osteoporosis is more common in women than in men, men comprise approximately 20% of Americans with osteoporosis or low bone mass [24]. Notably, men with hip fracture also have higher mortality than women. Further research is needed to determine ways to improve treatment rates in men and to increase awareness about osteoporosis in men. Crucial tools that could potentially be effective include the implementation of fracture liaison services, which has been found to be the most effective organizational structure for risk evaluation, and treatment of osteoporosis. More educational efforts are needed to improve awareness of osteoporosis in men among health care professionals, and the general public [31]. Discharge to a facility (rehabilitation center or nursing home) was associated with increased treatment of osteoporosis. This could be possibly due to greater awareness among physicians at these facilities in regard to osteoporosis care post hip fracture [32].

Post fracture osteoporosis treatment is variable at local levels due to differences in patient population, practice standards, availability of specialists, and resources to address osteoporosis after hip fracture [4]. This study showed that Medical Center C had lower treatment rates when compared to Medical Centers A and B. This could be due to the rural geographic location of Medical Center C, where access to care is often limited when compared to more urban locations [33]. Also, in contrast to national trends which show decreasing osteoporotic treatment rates post hip fracture [6,7], osteoporotic treatment rates post hip fracture within Hawaii Pacific Health showed a small increase from 2011 to 2019. Osteoporosis medication treatment rates remained at a low level, although higher than the national average [7]. Regional factors may play a role in the small increase in osteoporotic treatment rates post fracture. Few regional studies have shown increasing rates of osteoporosis treatment, including a population based study from 1995 to 2002 of enrollees in the Pennsylvania Pharmaceutical Assistance Contract for the Elderly, where treatment within 6 months after hip fracture improved from 7% in 1995 to 31% in 2002, and then remained stable until 2004 [34]. One factor that may have contributed to the increase in prescribing rates, and higher treatment rates includes the implementation of the 3 PC system by the primary insurer in the state of Hawaii in 2016. It has been reported in the first year of implementation that small improvements in quality of care have been noted. As previously noted, the health care system in Hawaii is characterized by good access to health care and low rates of uninsured patients.

There were several limitations of this study. Firstly, we were not able to identify osteoporosis medications if they were ordered outside our healthcare system. Secondly, due to the retrospective nature of our study, the information in our study is limited to what could be obtained from medical records. There is a possibility that data within the medical records contained errors, and inconsistencies. Furthermore, we were unable to assess whether medications were prescribed but the patient did not fill the prescription. Our study reports on treatment rates, and trends of treatment in Hawaii. While this information is helpful in policy and organizational planning for osteoporotic hip fracture care in Hawaii, and some general inferences may be made in regard to the state of osteoporosis care, our findings may not be generalizable to other healthcare settings. Due to limitations of the study related to lack of data, we were unable to identify exact reasons/mechanisms for increasing rates of osteoporosis treatment as well as why osteoporosis treatments rates were higher in Hawaii as compared to rates in the United States. We discussed several possibilities of interest that can be addressed in future research studies. In our study, we included patients with only specific ICD diagnostic codes to improve validity of identification of hip fracture cases. Therefore, some patients with osteoporotic hip fracture who had a different ICD-10 diagnostic code may have not been included in the study.

5. Conclusions

This study shows low rates of osteoporosis treatment after hip fracture. However, a small increase in treatment rates was noted from 2011 to 2019. Men are less likely to receive treatment after admission for osteoporotic hip fracture. Efforts are needed to address the disparity in osteoporosis care in men. Furthermore, significant work is still needed to increase treatment rates further, which remain low in the face of the aging population in Hawaii.

CRediT author statement

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Conflicts of interest

The authors declare no competing interests.

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