# Suboptimal osteoporosis evaluation and treatment in older men with and without additional high-risk factors for fractures

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## ABSTRACT

We compared osteoporosis case-finding, evaluation and treatment in groups of Older Men and Older Women with age alone as a significant risk for fracture and Older Men with Higher Risk (older men additionally having previous hip fracture, corticosteroid use or androgen deprivation therapy). We studied 13,704 older men and women (≥70 years old) receiving care at a Veterans Affairs medical center from January 2000 to August 2010 whose 10-year hip fracture risk was assessed by limited FRAX score. The main outcome measures were the proportion of patients who had bone mineral density (by dual-energy X-ray absorptiometry [DXA]) and serum 25-hydroxy vitamin D (25-OH D) measurements performed, and calcium/vitamin D or bisphosphonates prescribed. The proportion of men with a 10-year hip fracture risk ≥3% with age alone as a risk was 48% and 88% in men aged 75–79 and ≥80 years, respectively. Compared with Older Women, fewer Older Men underwent DXA (12% vs 63%, respectively) and 25-OH D measurements (18% vs 39%), and fewer received calcium/vitamin D (20% vs 63%) and bisphosphonate (5% vs 44%) prescriptions. In Older Men with Higher Risk category, the proportion of men with 10-year hip fracture risk ≥3% ranged from 69% to 95%. Despite a higher risk and expectation that this group would have greater case detection and screening, few Older Men with Higher risk underwent DXA screening (27%–36%) and 25-OH D measurements (23%–28%), and received fewer calcium/vitamin D (40%–50%) and bisphosphonate (13%–24%) prescriptions. Considering the known morbidity and mortality, our findings underscore the need for improved evaluation and management of osteoporosis in older men at high risk for fracture.

## Significance of this study

### What is already known about this subject?

- There is much debate and ambiguity regarding which populations would benefit most from case detection, evaluation and treatment for osteoporosis.
- Male osteoporosis is a major health concern; the mortality and morbidity associated with male hip fractures are higher than that of women.
- Multiple studies published prior to the publication demonstrated poor rates of appropriate osteoporosis management in older men with these additional higher risk factors.
- Several years after the publication of various guidelines by major healthcare organizations, a key question is whether there has been an improvement in the identification and management of these older men at very high risk of osteoporosis.

### What are the new findings?

- We found that approximately half of men 75 years or older with age alone as a risk factor and a majority of men aged 70 years or older with additional high risk of fractures (previous fracture, chronic oral glucocorticoid use or androgen deprivation therapy) had a calculated 10-year hip fracture risk ≥3% on a limited FRAX.
- Despite meeting the threshold criteria for treatment, fewer Older men underwent dual-energy X-ray absorptiometry screening and 25-hydroxy vitamin D measurements and received less calcium/vitamin D (20% vs 63%) and bisphosphonate prescriptions compared with Older Women.
- In Older Men with Higher Risk, especially men with a history of hip fracture, case-finding, evaluation and treatment were strikingly low despite meeting the threshold criteria for treatment.
- Novel results are presented for men of advanced age (>80 years old) who were not screened and treated for osteoporosis.

## INTRODUCTION/BACKGROUND

Fractures are a frequent and serious complication of osteoporosis. Approximately 10 million people in the USA have osteoporosis, and 2 million osteoporotic fractures occur each year, which result in $19 billion in related costs.[1–4] By 2025, the incidence and expenses are predicted to be almost 3 million fractures

## Significance of this study

**How might these results change the focus of research or clinical practice?**

- It has been several years since several guidelines have been published on male osteoporosis.
- Our findings suggest that guidelines and education of providers are inadequate in effectively identifying older men who might benefit from evaluation for osteoporosis and fracture prevention treatment.
- We believe that there is a need for developing strategies to improve the evaluation and management of osteoporosis in all older men, particularly among elderly men with a very high risk of fracture, such as those men with previous osteoporotic fracture or who are on long-term corticosteroid or androgen deprivation therapy.

and $25 billion annually.[3] The prevention, detection, and treatment of osteoporosis are critical, particularly in men and women aged ≥70.[5]

There are many clinical guidelines for osteoporosis testing and management in women and some in men.[6–11] The Endocrine Society, the National Osteoporosis Foundation, and the International Osteoporosis Foundation guidelines recommend performing bone densitometry in women aged 65 and older, men aged 70 and older, and women and men >50 years old who have secondary causes of osteoporosis.[7–9] In these guidelines, experts have recommended that measurement of bone mineral density should be considered in the presence of secondary causes for bone loss, such as rheumatoid arthritis, hypogonadism, hyperparathyroidism, and use of gonadotropin-releasing hormone agonists.[7–9]

The Veterans Health Administration (VHA) guidelines in 2012 identified male osteoporosis as a major health concern as mortality and morbidity associated with male hip fractures are higher than that of women.[11–16] The VHA guidelines did not suggest an age cut-off for screening men with bone mineral densitometry, but focused on identifying and treating men who would be at the highest risk.[11]

In these recent osteoporosis guidelines, three categories of men have been identified as at a very high risk for fractures: posthip fracture patients, patients on chronic oral glucocorticoids for a prolonged period of time and patients on androgen deprivation therapy (ADT). Multiple studies published prior to the publication of the above guidelines demonstrated poor rates of appropriate osteoporosis management in older men with these additional higher risk factors.[17–26] Several years after the publication of these guidelines by major healthcare organizations, a key question is whether there has been an improvement in the identification and management of these older men at very high risk for osteoporosis.

We investigated the prevalence of case-finding, evaluation and therapeutic management of osteoporosis in older men and women treated in a large Veterans Affair (VA) medical center. We studied older men and women (≥70 years) with age alone as a significant risk factor for fracture (Older Men and Older Women) and older men at very high risk for fracture (Older Men with Higher Risk: men with previous hip fracture, chronic corticosteroid use, or ADT for treatment of prostate cancer). We hypothesized that (1) case-finding, evaluation and pharmacologic treatment of osteoporosis continue to occur in a minority of older men with and without additional higher risk for fracture; (2) these diagnostic and therapeutic interventions for osteoporosis occur less frequently in men than women of similar ages; and (3) men ≥70 years with age alone as a risk factor for fracture would justify screening with bone densitometry and meet the criteria to initiate pharmacologic therapy to reduce the risk of fracture.

## METHODS

We used an electronic computerized database from the Veterans Integrated Service Network 20 data warehouse to identify our study sample using demographic information, dates of clinic visits, laboratory results, pharmacy data, and the International Classification of Diseases, Ninth Revision (ICD-9) diagnostic codes.[27] Initiation of osteoporosis therapy was assessed by searching the pharmacy benefits management for each patient for bisphosphonate prescriptions. These included alendronate, risedronate and intravenous zoledronic acid and pamidronate prescriptions. Intravenous zoledronic acid and pamidronate were restricted but were registered as intravenous medications and in all medications in the VA electronic record, Computerized Patient Record System (CPRS. Data on the use of calcium and/or vitamin D were also extracted from the patient treatment file and outpatient care profile databases.

The study cohort comprised men and women who were ≥70 years of age at the start of the study period, January 1, 2000, or who turned 70 during the period January 1, 2000 through August 31, 2010. We included in our analytic sample only those who had had at least two clinic visits within 2 years after entry into the cohort. Within this cohort, we identified men and women ≥70 years old with age alone as a risk (Older Men and Older Women) and three groups of men ≥70 years old who had an additional high-risk factor for fracture defined as a previous hip fracture, chronic corticosteroid use or ADT treatment for prostate cancer (Older Men with Higher Risk). We defined Older Men with hip fracture based on the presence of an ICD-9 diagnosis code 820.0–820.9 on the electronic medical record at any time during the study period. Older Men with chronic corticosteroid use included men who were treated with prednisone totaling ≥450 mg in a 90-day period (ie, an average of ≥5 mg daily over 90 days) on at least one occasion at any time during the study period. Older Men with ADT exposure included men with advanced prostate cancer who had a prescription at any time during the study period for at least one of the following medications: leuprolide, goserelin, flutamide, bicalutamide and/or nilutamide.

To estimate the prevalence of men at risk of fracture based on age as the major factor, we calculated a limited FRAX score for 10-year hip fracture risk (http://www.shef.ac.uk/FRAX/index.jsp) electronically for all study participants at or closest to the time of cohort entry. In Older Men, FRAX scores were calculated using ethnicity, age, weight, and height, and in Older Men with Higher Risk, previous fracture, glucocorticoid use, or secondary osteoporosis (for ADT) were used additionally, if present. We excluded all participants who weighed >125 kg or who were from

ethnic groups not defined in the FRAX algorithm (American Indian or Pacific Islanders). For those aged >90 years, we used the age limit of 90 offered by the FRAX algorithm to obtain the best-estimated FRAX score.

We quantified the number of participants who underwent screening for osteoporosis by identifying those who had dual-energy X-ray absorptiometry (DXA). Because DXAs are usually ordered every 1–2 years, we included scans completed within 2 years prior to the study start date or any time thereafter. Older Men with hip fractures were identified by the ICD-9 diagnosis code (as above).

We assessed measurement of serum 25-hydroxy vitamin D (25-OH D) as an indicator of minimum diagnostic evaluation for prevention of osteoporosis in men and women. Although assessment of kidney, thyroid function and gonadal function and measurement of serum calcium concentrations may be important in the evaluation of any patient with osteoporosis, these assessments are commonly ordered in primary care clinics for indications other than osteoporosis.

We also quantified the number of participants who had treatment for osteoporosis based on prescriptions for calcium and vitamin D and bisphosphonates during the same time period. We looked at prescriptions of bisphosphonates as an indicator of an attempt at evidence-based pharmacologic prevention of osteoporotic fracture, because bisphosphonate therapy is considered first-line therapy due to cost, convenience and extensive evidence for effectiveness.[28–31] Denosumab and teriparatide were rarely prescribed at the VA Puget Sound Health Care System during the study period.

Descriptive statistics (means, SD, and percentages) were used to characterize patient demographics (age, sex, ethnicity) and clinical characteristics (body mass index [BMI]) and receipt of evaluation (DXA, 25-OH D level) and/or treatment (calcium, vitamin D, bisphosphonate) for osteoporosis. P values were calculated by one-way analysis of variance or the $\chi^2$ test. The locally weighted scatterplot smoothing (Lowess) technique was used to describe the relationship between age and 10-year risk of hip fracture for men and women. This technique is designed to produce a smooth fit to the data that also reduces the influence of extreme outliers.[32] Analyses were conducted stratifying by sex because it was expected that hip fracture risk, evaluation and management of osteoporosis would vary by sex. For men, analyses were further categorized by the presence or absence of any one additional higher risk factors for fractures (prior hip fracture, extended corticosteroid therapy, or ADT) and by two or more of these additional higher risk factors. Within sex, analyses were stratified by subgroups of age (70–74 years, 75–79 years, and 80 years or older) and the significance of between-stratum differences assessed with the $\chi^2$ test for trend to determine any stratum-specific differences in hip fracture risk and/or osteoporosis evaluation and management. All analyses were conducted using Stata V.12.

Two thousand and sixty-two medical charts were reviewed manually to assess the accuracy of the results (including diagnoses of fractures and non-VA prescribed sources of calcium, vitamin D or bisphosphonate) derived from the database queries. Every fifth patient was selected for manual review of the medical record. The electronic medical record of the patient was reviewed by either a single trained research nurse or internal medicine physician. The chart reviewer ensured the patient selected for the study cohort met both the inclusion and exclusion criteria by reviewing the medical records for the reference period. The manual review demonstrated high concordance with the results from the database queries.

## RESULTS

We identified a total of 13,704 patients who met the study criteria and had complete data, allowing for a modified FRAX score calculation. There were 463 Older Women, 11,604 Older Men and 1637 Older Men with Higher Risk. Of Older Men with Higher Risk, those with a previous hip fracture was the oldest group by age and had the lowest mean BMI. The vast majority of participants were non-Hispanic whites (table 1).

### Older Men and Women with age alone as a risk factor for fractures

As expected, the 10-year risk of hip fracture as assessed by a limited FRAX score increased with age for both Older Men and Older Women (figure 1A,B). For any given age, the proportion of FRAX hip fracture risk ≥3% (the threshold above which pharmacotherapy for osteoporosis is generally considered[5–9]) was higher among women than men. However, 48% of men aged 75–79 and nearly 90%

**Table 1** Characteristics of study patients: Older Men and Women with age as significant risk for fracture vs Older Men with Higher Risk (older men additionally having previous hip fracture, corticosteroid use, or androgen deprivation therapy).

| | Older Men and Women | | Older Men with Higher Risk | | |
|---|---|---|---|---|---|
| | Older Men | Older Women | Older Men with hip fracture | Older Men on prednisone | Older Men on ADT |
| n | 11,604 | 463 | 182 | 1126 | 329 |
| Age, years (mean±SD) | 77±5 | 79±6 | 81±6 | 76±5 | 79±5 |
| Ethnicity, n (%) | | | | | |
| White | 10,347 (89) | 443 (96) | 173 (95) | 972 (86) | 263 (80) |
| Black | 860 (7) | 13 (3) | 6 (3) | 110 (10) | 49 (15) |
| Asian | 278 (2) | 5 (1) | 3 (2) | 37 (3) | 10 (3) |
| Hispanic | 119 (1) | 2 (0.5) | 0 (0) | 7 (1) | 7 (2) |
| BMI (mean±SD) | 28±5 | 28±6 | 25±4 | 27±5 | 28±5 |

ADT, androgen deprivation therapy; BMI, body mass index.

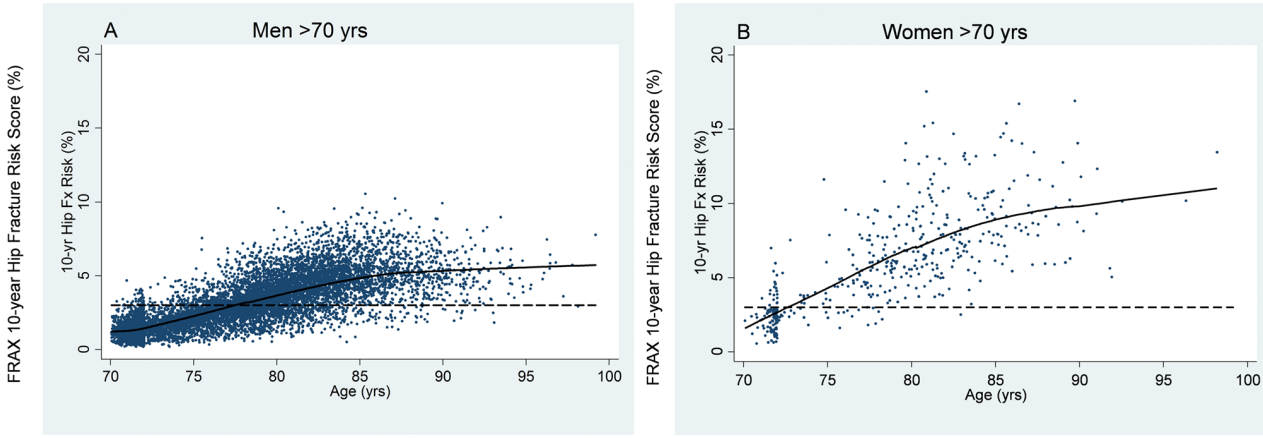


**Figure 1** (A and B) Relationship between FRAX 10-year hip fracture risk score versus age (years) in Older Men (A) and women (B) ≥70 years old with age as significant risk for fracture. - - - - FRAX hip fracture risk=3%, the guidelines threshold for pharmacotherapeutic prevention of fracture.

of men aged ≥80 had a 10-year estimated hip fracture risk of ≥3%. Despite this age-related increase in the proportion of men having a hip fracture risk sufficient to warrant osteoporosis treatment, the percentage who had undergone bone densitometry (10%–13%) and treatment (4%–7% bisphosphonate treatment) for osteoporosis in each of these oldest subgroups of men was low, and the percentage did not increase with age and increasing hip fracture risk (table 2A).

A higher percentage of women underwent bone densitometry and bisphosphonate treatment for osteoporosis (table 2A). While more than 60% of women ≥70 years old with age alone as a risk for fractures had bone densitometry checked and received calcium/vitamin D supplements, less than 20% of Older Men in the same age group had the same corresponding evaluation and treatment.

### Older Men with Higher Risk for fractures (history of hip fracture, chronic corticosteroid therapy or ADT)

The proportion of men with 10-year risk of hip fracture exceeding treatment thresholds was higher among each of the Older Men with higher risk: 95%, 69% and 74% in Older Men with hip fracture, chronic corticosteroid use and ADT, respectively (table 2B and figure 2). In spite of this very high 10-year risk of hip fracture, the percentage of Older men with the highest fracture risk who had bone densitometry and treatment for osteoporosis was strikingly low. Less than 40% in each subgroup had a bone densitometry obtained. Less than 30% in each subgroup had serum 25-OH D concentrations measured and less than 25% in each subgroup had received bisphosphonate treatment.

## DISCUSSION

Men who experience a fracture are more likely to die in the following year.[33] The VA inspector general reported in 2010 that the 1-year mortality after a fracture was found to be 20.5%, 25.1% for hip fracture and 14.4% for vertebral fracture among male veterans.[34 35] They urged implementation of plans to ensure more male veterans would be appropriately screened and treated. We assessed osteoporosis case-finding, detection and treatment among older veteran men and women with age alone as a risk factor for fractures and in older veteran men who had a higher additional risk for fracture.

We found that approximately half of men 75 years or older with age alone as a risk factor and a majority of men aged 70 years or older with additional high risk of fractures

**Table 2A** Percentage of Older Men and Women with age as a significant risk factor and a calculated 10-year hip fracture risk ≥3% who underwent evaluation of osteoporosis and pharmacotherapy to prevent osteoporotic fracture

| | Older Men | | | | Older Women | | | |
|---|---|---|---|---|---|---|---|---|
| | 70–74 years (%) (n=5189) | 75–79 years (%) (n=3004) | ≥80 years (%) (n=3411) | All >70 years (%) (n=11 604) | 70–74 years (%) (n=151) | 75–79 years (%) (n=118) | ≥80 years (%) (n=194) | All >70 years (%) (n=463) |
| 10-year hip fracture risk ≥3% | 2 | 48 | 88 | 39 | 24 | 89 | 99 | 72 |
| Evaluation | | | | | | | | |
| DXA obtained | 12 | 13 | 10 | 12 | 75 | 67 | 51 | 63 |
| Serum 25-hydroxy vitamin D measured | 22 | 17 | 14 | 18 | 56 | 28 | 32 | 39 |
| Treatment | | | | | | | | |
| Calcium/Vitamin D supplements | 20 | 19 | 18 | 20 | 74 | 64 | 54 | 63 |
| Bisphosphonate prescription (at least once) | 4 | 6 | 7 | 5 | 33 | 52 | 48 | 44 |

All tests for trend were significant at p<0.01 or p=0.01.
DXA, dual-energy X-ray absorptiometry.

**Table 2B** Percentage of Older Men with additional risk factors for fracture (Older Men with Higher Risk) and a calculated 10-year hip fracture risk ≥3% who underwent evaluation of osteoporosis and pharmacotherapy to prevent osteoporotic fracture

| | Older Men with Higher Risk | | |
|---|---|---|---|
| | Hip fracture (%) (n=182) | Prednisone (%) (n=1126) | ADT (%) (n=329) |
| 10-year hip fracture risk | 95 | 69 | 74 |
| Evaluation | | | |
| DXA obtained | 27 | 36 | 29 |
| Serum 25-hydroxy vitamin D measured | 23 | 28 | 27 |
| Treatment | | | |
| Calcium/Vitamin D supplements | 48 | 50 | 40 |
| Bisphosphonate prescription (at least once) | 20 | 24 | 13 |

ADT, androgen deprivation therapy; DXA, dual-energy X-ray absorptiometry.

(previous fracture, chronic oral glucocorticoid use, ADT therapy) had a calculated 10-year hip fracture risk ≥3% on a limited FRAX.[5–9] A calculated 10-year hip fracture risk ≥3% is a threshold where the benefit of therapy appears to exceed the cost and risk in most patients.[36] Moreover, the proportion of Older men who had an additional high-risk factor for fractures had a 10-year risk of hip fracture exceeding treatment thresholds that was substantially greater, ranging from 69% in the chronic corticosteroid group to 95% in the previous hip fracture group. The average absolute hip fracture risk in these Older men with the highest fracture risk was comparable with or greater than that of Older women (figure 2). These are novel data presented for the advanced age male category with men >80 years old who are not being identified and treated for osteoporosis. Similar results were reported in a small retrospective study of 147 men and 3 women receiving primary care at a VA hospital over a 3-year period.[37] They found only 25 of these men had

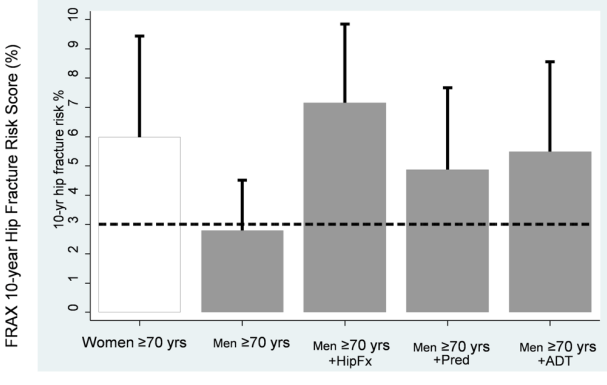


**Figure 2** Average (±SEM) FRAX 10-year hip fracture risk score in all Older women ≥70 years old (open bar); all Older men ≥70 years old with age as significant risk factor (Men ≥70yrs); Older men ≥70 years old with previous hip fracture (+HipFx); Older men ≥70 years old with chronic prednisone use (+Pred); and Older men ≥70 years old with androgen deprivation therapy exposure (+ADT). FRAX hip fracture risk=3%, the guidelines threshold for pharmacotherapeutic prevention of fracture.

received osteoporosis treatment. Of 122 untreated men, 74 (61%) met FRAX treatment criteria for pharmacotherapy for fracture prevention, including 14 who had a history of osteoporotic fracture.

We also found that despite an increasing risk of hip fracture with age, the proportion of Older age men and women with age alone as a risk factor for fracture who had evaluation and treatment for osteoporosis declined with age. Although it is intuitive that age and additional risk factors increase the FRAX score, our data show that a large number of clinicians do not know or at least act on the premise that age >70 plus ADT or corticosteroid therapy (or even hip fracture) justify osteoporosis evaluation and treatment. One likely reason is that competing comorbidities that increase with aging might take priority during visits to primary care providers. In addition, Older women were significantly more likely to have diagnostic evaluation and treatment to prevent osteoporotic fracture than men of advanced age. For example, women 70 years and older with age alone as a risk factor were more than five times as likely to have a DXA and around twice as likely to have serum 25-OH vitamin D measurement as men 70 years and older with age alone as a risk factor for fracture (DXA: 63% vs 12% and 25-OH: vitamin D 39% vs 18%). Although women ≥70 years old had more screening, evaluation and treatment, the percentages were still suboptimal given the very high proportion of women (72%) with 10-year hip fracture risk ≥3%.

The strengths of our study include the large number of older men (>13,000) and relatively large number of older female veterans from a single, integrated healthcare system over a 10-year period. By comparison, the Dubbo Osteoporosis Epidemiology Study, a longitudinal study of community-dwelling women and men that has provided many important clinical findings over a 25-yearlong period included only 1760 men aged ≥60.[14] Our study also provided initial assessment of evaluation and treatment of osteoporosis in older female veterans, a relatively small but growing segment of the VA population. There are limited studies assessing female veteran population. Interestingly, LaFleur and colleagues examined the association between older veteran women (mean age of 63 years) and fracture rate using the Women's Health Initiative cohort. They concluded that female veterans had an increased hip fracture rate not explained by differences in well-recognized fracture risk factors compared with non-veteran women.[38] Lastly, our study included a large number of very old men and women. Whereas prior studies have focused on patients 60–70 years old, the mean age of our sample was nearly 80 years.

We assessed a broad range of patients seen in referral center primary and specialty care clinics as well as community-based outpatient clinics, and we examined this cohort for a relatively long period (10 years), which provided ample opportunity for evaluation and treatment of osteoporosis to occur.[34 39] Furthermore,the study inclusion criteria required at least two visits within 2 years after cohort entry, providing opportunity for evaluation and treatment of osteoporosis in veterans at high risk for fracture. Finally, we verified the accuracy of information gleaned from the electronic database of information from medical records with a manual review of 20% (>2000) medical records.

There are limitations to our study. The study was retrospective, and the accuracy of data was dependent on the completeness and comprehensiveness of documentation. Our findings might not apply to non-veteran populations because veteran populations tend to have a higher comorbidity burden.[26 40] Our data set is likely to be incomplete because treatment and diagnoses provided outside of the VA system are not always recorded in the electronic medical record. Thus, it is possible that hip fractures diagnosed and treated outside of the VA system were not captured. We also do not have an estimate of subjects who had DXA outside the VA through Medicare. However, many patients still received rehabilitation, extended care, and primary care services after a hip fracture, and these encounters were likely to be coded with an ICD-9 code related to hip fracture. In addition, most veterans who seek care routinely within the VA system take advantage of the available diagnostic services and drug benefits such that if bone densitometry was obtained and bisphosphonate prescribed, they would have likely been performed and captured in the VA database. We did not abstract information on other risk factors for osteoporosis, such as family history of hip fracture, smoking or alcohol use, or secondary causes of osteoporosis, to assess fracture risk. It is possible that inclusion of these other risk factors into FRAX algorithm might have reduced the calculated hip fracture risk. However, it is likely that in most situations, including these factors in the FRAX calculations would have more often increased the estimates of 10-year hip fracture risk given the relatively high prevalence of smoking and alcohol use and comorbidity of the veteran population. FRAX was calculated at or closest to the time of cohort entry, but fracture risk prior to or after this time is not known.

We acknowledge that each individual had different amounts of follow-up time due to various circumstances (leaving the VA healthcare system, death, and so on), and some older men might have shorter follow-up times and have fewer opportunities to be screened. We were unable to account for differences in follow-up times after the FRAX calculation of fracture risk. Also, we did not have access to femoral neck bone mineral density results for patients who had a DXA scan, contributing to the main limitations to this study, Therefore, the limited FRAX hip fracture risk was estimated using only ethnicity, age, weight and height, and the presence of previous fracture, chronic glucocorticoid use or iatrogenic androgen deprivation alone. FRAX fracture risk estimation has been found to be similar using comparable risk factors with and without the addition of femoral neck bone mineral density.[41]

The reasons for low rates of evaluation and treatment of osteoporosis in men with significant known risk factors for fracture in this study are unknown. Other studies have demonstrated that the cost of diagnosis, cost of therapy, lack of access to bone densitometry testing, and fragmented care contribute to inadequate evaluation and treatment of osteoporosis, but these factors are not likely contributors in the VA healthcare system.[35 42] Another factor could be lack of awareness of evidence-based guidelines for screening male osteoporosis.[6–9 11 42 43] Also, there has been relatively little incentive or emphasis for risk assessment or fracture prevention in most practice settings, including the VA system.[44] Finally, a high comorbidity burden and competing priorities or performance measures in veterans of advanced age might have higher priority for busy clinicians over fracture risk assessment, resulting in less osteoporosis evaluation and treatment.

## CONCLUSIONS

It has been several years since several guidelines have been published on male osteoporosis. Our findings suggest that guidelines and education of providers are inadequate in effectively identifying older men who might benefit from evaluation for osteoporosis and fracture prevention treatment. Although our study was performed in a veteran population receiving care in the VA system, we believe that there is a need for developing strategies to improve the evaluation and management of osteoporosis in all older men, particularly among elderly men with a very high risk of fracture, such as those men with previous osteoporotic fracture or who are on long-term corticosteroid or ADT.

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**Correction notice** This article has been corrected since it was published Online First. In the Discussion, the sentence 'For example, women ≥70 years old with age alone as a risk factor were more than five times as likely to have a DXA and more than three times as likely to have serum 25-OH vitamin D measurement as men ≥70 years old with age alone as a risk factor for fracture (DXA: 63% vs 12% and and 25-OH vitamin D: 39% vs 12%)' has been amended to read: 'For example, women 70 years and older with age alone as a risk factor were more than five times as likely to have a DXA and around twice as likely to have serum-25-OH vitamin D measurement as men 70 years and older with age alone as a risk factor for fracture (DXA: 63% vs 12% and 25-OH: vitamin D 39% vs 18%)'.

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**Contributors** RRN: preparation of manuscript. LAH: creating initial study concept and design. SHYL: creating initial study concept and design. BDA: creating initial study concept and design, review of manuscript. EAP: review of manuscript. AMM: creating initial study concept and design, review of manuscript.

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