

## Prevalence of Osteoporosis in Men in a VA Rehabilitation Center

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**O**steoporosis is a significant health problem in the United States, and its impact is growing as the population ages. The annual financial burden from osteoporosis has been estimated at \$13.9 billion (in 1995), primarily reflecting the cost of hip fracture, surgical repair, nursing home stays, and rehabilitation.<sup>1</sup> A similar impact has been reported in other industrialized countries such as Belgium,<sup>2</sup> and this impact will be felt throughout the world.<sup>3,4</sup> To date, most of the studies on osteoporosis have focused on women, but it is increasingly apparent that men are affected as well. Estimates of osteoporosis in men have varied, but available data suggest that up to 30% of elderly (age >65 years) men will have an osteoporotic fracture in their lifetime.<sup>5-9</sup> Available data on osteoporosis in nursing home patients are sparse, especially in men, but published estimates of prevalence of subnormal bone density range between 40% and 60%.<sup>10,11</sup> Given that many high-risk patients (eg, patients on chronic glucocorticoids<sup>12-14</sup> or those with chronic liver disease<sup>15-18</sup>) are not being screened in a systematic manner, available screening and treatment data may underestimate the total prevalence of osteoporosis in our population.

Nursing home patients are at significant risk from osteoporosis and its sequelae, due in part to immobility, concurrent medical problems, poor nutrition, and especially the risk of falls.<sup>19,20</sup> The potential benefits of exercise and hip pads to reduce the risk of hip fracture have been studied.<sup>21,22</sup> We evaluated the prevalence of osteoporosis in a high-risk population: the largely male, elderly veteran population at the Center for Rehabilitation and Extended Care (CREC) of the VA Northern California Health Care System. In addition, we estimated factors that may contribute to metabolic bone disease.

### METHODS

The CREC currently houses up to 120 patients on 3 wards. These patients are mostly male and elderly. Since January 1999, we have been using an on-site dual-energy x-ray absorptiometry (DEXA) machine to evaluate both trabecular and cortical bone density in the lumbar spine and hip.

**Objective:** To evaluate the prevalence of previously unrecognized osteoporosis in men admitted for long-term rehabilitation nursing home care.

**Design:** Cross-sectional study.

**Methods:** A total of 1179 consecutive admissions to a VA rehabilitation center were reviewed. Men who were already diagnosed with osteoporosis, had confounding medical illness, were unable to complete the study, or who declined to participate were excluded. A total of 153 patients were enrolled and 106 were evaluated. Measurements included dual-energy X-ray absorptiometry of the hip and lumbar spine, biochemical and hormonal studies, and functional evaluation.

**Results:** A total of 33 patients (31.1%) had osteoporosis (T-score at any site lumbar spine, total hip, or femoral neck <-2.5). Patients with osteoporosis were significantly older than those without: 68.4 ± 13.2 years versus 62.7 ± 12.1 years ( $P < .05$ ), respectively. Body mass index (BMI) and weight were lower in men with osteoporosis: 23.4 ± 3.9 kg/m<sup>2</sup> versus 28.7 ± 7.08 kg/m<sup>2</sup> and 72.6 ± 14.4 kg versus 90.3 ± 23.8 kg, respectively (both,  $P < .001$ ). There were no differences in use of medications thought to affect bone metabolism or functional status, or in hormonal and metabolic measurements. Hip and spine bone density were correlated ( $r = 0.3$ ,  $P < .05$ ). Multivariate analysis showed that hip bone density was independently associated with BMI.

**Conclusion:** Hip osteoporosis is common in this unscreened population, suggesting that screening should be more widely performed in veterans admitted to rehabilitation units. These data suggest that nutritional status could impact osteoporosis risk.

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#### Patient Population

Consecutive male patients admitted to the CREC were recruited for

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### Take-Away Points

The prevalence of previously unrecognized osteoporosis in men admitted for long-term rehabilitation nursing home care was evaluated in a cross-sectional study.

- Of the men admitted to a VA rehabilitation unit, 31.1% had osteoporosis.
- Men with osteoporosis were older and thinner than those without osteoporosis, but both groups had similar hormonal measurements, estimates of nutritional status, and functional status.
- Because of the substantial morbidity and costs associated with osteoporosis in men, as well as our failure to identify simple predictors, it is important to emphasize screening programs to identify men at risk and institute appropriate interventions.

Because of the variable and occasionally prolonged in-facility residence, laboratory data closest to the DEXA scan were selected if an analyte was measured more than once. Assayed but undetectable prostate-specific antigen was entered as “0” in the analysis. Parathyroid hormone that was assayed but not detected was entered as one-half the lower limit of detection in the analysis.

the study. We excluded “short-stay” individuals (eg, those recovering from procedures and admitted for  $\leq 23$  hours). We also excluded patients admitted for respite care, those with an inability to cooperate because of dementia or other conditions, those with cancer metastatic to bone or known metabolic bone disease, and patients previously evaluated, diagnosed, or treated for osteoporosis. We obtained approval to approach the patients from providers caring for them; this step also gave us an opportunity to confirm, for example, exclusion for dementia. Patients also were approached in person; if they were off the ward for a home visit, physical therapy, and so forth, they might have been excluded. Written informed consent was obtained from each patient or his legal guardian. The study was approved by the Human Studies Subcommittee of the VA Northern California Health Care System.

### Screening for Osteoporosis

Screening was performed by DEXA, using an on-site Lunar XRC-1 (GE-Lunar, Madison, WI), which results in modest radiation exposure and allows serial measurements and evaluation of therapy.<sup>23-25</sup> This instrument has a precision of 2% to 3% on repeated measurements of bone density. Osteoporosis was defined by World Health Organization criteria using T-scores of  $-2.5$  or greater at either the lumbar spine, total hip, or the femoral neck. Bone density data were stratified by race-specific criteria in the Lunar database, in keeping with station policy.

Laboratory evaluation of osteoporosis<sup>26-39</sup> included overall nutritional health estimated by complete blood count (providing data on white blood cell count and hematocrit) and routine chemistries, including albumin and 25-hydroxy vitamin D. To estimate calcium absorption, 24-hour urinary calcium was used. The prostate-specific antigen and serum protein electrophoresis tests were used to estimate the possibility of occult malignancy contributing to poor bone density. Bone turnover was estimated by total alkaline phosphatase. Bone-active hormones were estimated by measurement of testosterone, parathyroid hormone (PTH), thyroid-stimulating hormone (TSH), and free thyroxine (to assess the thyroid axis<sup>40</sup>).

Overall health was estimated in part by documenting active medical problems. We also calculated functional status both through case mix index (CMI) and activities of daily living (ADL) scores through the minimum data set package.<sup>41</sup>

### Statistical Analysis

Data are expressed as mean  $\pm$  SD. The *t* test was used to compare continuous characteristics of the populations diagnosed with and without osteoporosis. The  $\chi^2$  test was used to compare discontinuous variables such as ethnicity and use of bone-active medications such as phenytoin, barbiturates, and systemic glucocorticoids. Multivariate analysis using multiple linear regression (SigmaStat version 3.0; Systat Software, Inc, Point Richmond, CA) was used to identify predictors of bone density from variables including age, comorbidity (number of active diagnoses, functional status), nutrition (albumin, hematocrit, white blood cell count, vitamin D, and urinary calcium), and bone-active hormones (testosterone, PTH, TSH, and thyroxine). These variables were adapted from widely accepted causes of secondary osteoporosis in adults.<sup>42</sup>  $P < .05$  was considered significant.<sup>43</sup> The sponsor had no role in the collection of data, its analysis or interpretation, or approval of the manuscript.

## RESULTS

Between July 2000 and April 2006, 1179 consecutive admissions of men were reviewed. A total of 116 patients (9.84%) had already been screened or were receiving therapy for osteoporosis. Of the remaining 1063, 113 men (10.6%) were considered to be too demented on initial chart review to participate, 93 (8.7%) had cancer metastatic to bone or were receiving end-of-life care, and 17 (1.6%) died or were discharged prior to the study. The providers for all other patients were contacted to ascertain whether they were capable of participating. A total of 687 men were approached and either declined to participate, participation was discouraged by their provider, or participation was impractical for logistical reasons during the patient’s inpatient stay. Of the remainder, 153 patients met study criteria and gave written consent; 106

## Osteoporosis in Male VA Patients

**Table.** Clinical Characteristics of Male Rehabilitation Center Patients With and Without Osteoporosis

Measure	Men With Osteoporosis	Men Without Osteoporosis	P
Number (%)	33 (31.1)	73 (68.9)	
Age, y	68.4 ± 13.2	62.7 ± 12.1	<.05
Hip T-score	-2.9 ± 0.6	-0.76 ± 1.15	<.001
Spine T-score	-1.0 ± 1.75	0.31 ± 1.87	<.001
Testosterone, ng/dL (normal: 241-827 ng/dL)	410.1 ± 203.2	349.1 ± 259.4	NS
PTH, pg/mL (normal: 10-65 pg/mL)	54.5 ± 51.6	48.1 ± 32.9	NS
TSH, $\mu$ IU/mL (normal: 0.5-6 $\mu$ IU/mL)	2.28 ± 2.13	2.50 ± 2.15	NS
25-hydroxy vitamin D, ng/mL (normal: 8.9-46.7 ng/mL)	23.3 ± 9.18	22.3 ± 9.6	NS
Calcium, 24 h, mg (normal: 100-250 mg)	116.3 ± 90.6	83.7 ± 75.8	NS
PSA	1.34 ± 1.6	2.49 ± 7.8	NS
Alkaline phosphatase	86.9 ± 51.7	102.1 ± 53.4	NS
Weight, kg	72.6 ± 14.4	90.3 ± 23.8	<.001
BMI, kg/m <sup>2</sup>	23.4 ± 3.9	28.7 ± 7.08	<.001
Number of diagnoses	11.1 ± 6	10.9 ± 6.9	NS
ADL scores	6.29 ± 2.9	6.05 ± 3.42	NS
CMI scores	20 ± 10.6	20.65 ± 10.1	NS

ADL indicates activities of daily living; BMI, body mass index; CMI, case mix index; NS, not significant; PSA, prostate-specific antigen; PTH, parathyroid hormone; TSH, thyroid-stimulating hormone.

completed the studies. A total of 33 men (31.1%) were diagnosed with osteoporosis in any site; 26 had hip only, 4 both hip and spine, and 2 had spine only. One man had osteoporosis at Ward's triangle only, but he was not included in the analysis. A total of 42 men had osteopenia (T-scores of -1 to -2.5 at lumbar spine or hip sites), 32 men had no evidence of osteoporosis or osteopenia, and 46 men enrolled in but did not complete the study, usually because of being discharged from the facility prior to completion. Of the 106 men who completed the study, 66 (62.3%) were self-described as white, 33 (31.1%) as African American, 6 (5.7%) as Hispanic, and 1 (0.9%) as Asian. This proportion is similar to the veteran population in our catchment area.

The study was suspended in May 2002 due to a suspension of the facility Federalwide Assurance (FWA); with the restoration of the FWA, the study recommenced in spring 2003. This hiatus allowed us to estimate changes in practice patterns in osteoporosis screening. Prehiatus, 42 of 565 admitted patients (7.43%) had been screened or were treated; posthiatus, 74 of 614 patients (12%) had been screened or were treated. This difference in rates was statistically significant by the  $\chi^2$  test.

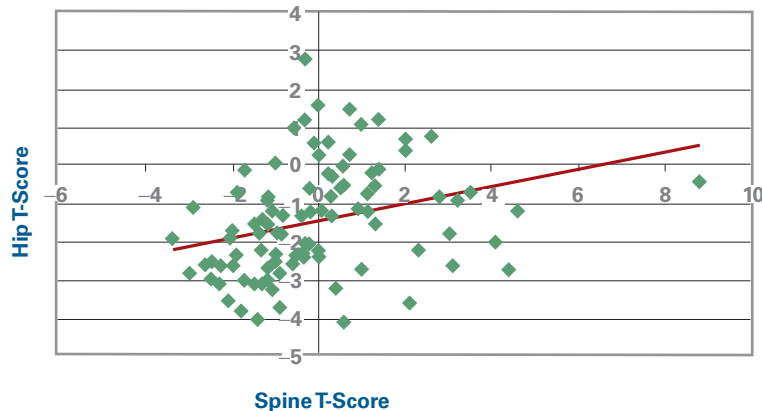
Results comparing men with and without osteoporosis are shown in the **Table**. The men with osteoporosis were slightly, but significantly, older than those without osteoporosis. Other clinical markers, including 24-hour urinary cal-

cium, PTH, and alkaline phosphatase, were similar in men with and without osteoporosis. Both groups had low-normal 25-hydroxy vitamin D and low urinary calcium. Thyroid-stimulating hormone was slightly but not significantly lower in men with osteoporosis compared with men without osteoporosis, although generally in the normal range. Weight and body mass index (BMI) were both significantly lower in men with osteoporosis than in those without.

Comorbidity—as manifested by length of stay, number of active diagnoses on the problem list, ADL scores, and CMI scores—was comparable between the 2 groups. The number of men receiving medications thought to have bone activity, specifically barbiturate, phenytoin, and systemic glucocorticoids, was too small to calculate significant differences between the groups of men with and without osteoporosis. (Among men identified with osteoporosis, 1 man was on phenobarbital and 1 man was on ongoing glucocorticoids; none were on Dilantin. Among men without osteoporosis, none were taking phenobarbital or Dilantin, and 4 were taking glucocorticoids.) The men who enrolled in but did not complete the study were not significantly different from those with osteoporosis (data not shown) in terms of age and indices of comorbidity. The data were too incomplete otherwise to permit a more thorough comparison.

Because only 153 of 840 men who were eligible and approached for the study agreed to participate, we were

■ **Figure.** Correlation of Hip and Lumbar Spine Bone Density (T-Score) for 100 Paired Studies<sup>a</sup>



<sup>a</sup>The correlation coefficient is 0.31,  $P < .001$ .

concerned that this sample be representative of the CREC population over the time frame of the study. Thus, we reviewed the roster of men deemed eligible for the study and identified a sample: All those whose Social Security number ended in “7” had their data reviewed (number chosen by a random number generator). This “unstudied” group ( $n = 63$ ) had a self-described ethnic distribution similar to that of the study population. The “unstudied” group was slightly, but significantly, older ( $70.5 \pm 11.7$  years vs  $64.5 \pm 12.7$  years;  $P < .01$ ), but otherwise was similar in terms of active diagnoses, functional status, weight, and BMI.

There was no difference in ethnic composition between men with and without osteoporosis by the  $\chi^2$  test. Multiple linear regression analysis showed that the significant predictors of hip bone density were lumbar spine bone density ( $P < .05$ ) and BMI ( $P < .001$ ). Although lumbar spine bone density predicted hip density, very few men had overt osteoporosis of the spine. Because degenerative changes in the spine can contribute to spuriously high bone density readings, we evaluated our osteoporosis patients for spine degeneration. Lumbar DEXA readings were reviewed, and any patient who was described as having scoliosis, compression, spurring, degeneration, arthritis, or deformity was labeled. When these “degenerative” patients ( $n = 23$ ) were compared with osteoporotic patients without degenerative changes ( $n = 10$ ), there was a significant difference in lumbar T-score ( $-2.19 \pm 0.7$  compared with  $-0.51 \pm 1.8$ , respectively;  $P < .001$ ). Age, biochemical measurements, ADL scores, and CMI scores did not contribute significantly. There was no seasonal variation in 25-hydroxy vitamin D (not shown).

The **Figure** illustrates the correlation of hip bone density and spine bone density, as measured by T-score.

## DISCUSSION

In this study, we found that approximately 30% of a sample of men admitted to a VA rehabilitation unit had osteoporosis, and despite being older and thinner than a control group, they had no demonstrable metabolic, functional, or ethnic differences. In a very broad sense, our data are consistent with those of other recent studies. A study of men from the Miami VA nursing home demonstrated that slightly more than 62% had low bone mass (~36% with osteopenia, ~27% with osteoporosis), obesity seemed to correlate with osteoporosis (unlike our study), and ambulatory status did not predict bone mass.<sup>11</sup> Although the overall prevalence of osteoporosis in the study by Paniagua et al was comparable to that reported here, their study was unlike ours in other ways<sup>11</sup>: they used heel densitometry, exclusion criteria were not defined, and demented patients were included and indeed made up a majority of the population. In another study that used heel densitometry as a screening technique, Gloth and Simonson evaluated more than 30,000 skilled nursing facility residents in 26 states; ~42% had T-scores below  $-2.5$ . Bedbound patients, those being treated for osteoporosis, and those with a “short life expectancy” were excluded.<sup>10</sup> Although these reported prevalence statistics for osteoporosis were comparable to those in our study, our project reported vitamin D, testosterone, TSH, and PTH data, which these earlier reports did not. In a UK study, Aspray et al reported that nursing home residents have an osteoporosis prevalence of 69%; however, the majority of their patients were women.<sup>44</sup> A study from New York suggested that elderly men and women admitted to an urban tertiary care hospital with osteoporotic fractures were a heterogeneous group, without clearly consistent predictors.<sup>45</sup> In recognition of the enormous morbidity, mortality, and financial impact of osteoporosis, Tucci emphasized the need to screen and treat aggressively to prevent future fractures,<sup>46</sup> particularly since osteoporotic fractures in men carry greater morbidity and mortality than those in women.<sup>47</sup>

Our data provide indirect evidence in support of the need to screen veterans admitted to rehabilitation facilities aggressively, because we were so limited in our ability to identify key factors that might predispose to osteoporosis in men. A randomized controlled trial comparing screening and not screening with respect to fracture outcome might be of value. Similarly, a study demonstrating that treatment prevents fracture in this population would be of interest. It also may be that enough data have accrued in a similar population to allow a modeling study.

Inadequate calcium absorption and vitamin D may contribute to osteoporosis in a nursing home population. Although there was no clear difference in these parameters for patients with and without osteoporosis, both calcium absorption (as measured by 24-hour urine calcium) and circulating vitamin D were at the lower end of normal. Recent studies<sup>48</sup> have suggested that the optimal circulating vitamin D concentration is 30 ng/mL or above; both our study populations were well below that level. This may be related to an age-associated decline in skin synthesis<sup>49</sup> and appears to transcend age and race distinctions.<sup>50</sup> Our assay did not distinguish between 25-hydroxy vitamin D<sub>3</sub> and 25-hydroxy vitamin D<sub>2</sub>. The importance of nutrition may be indicated by our observation that hip bone mass density (T-score) was significantly related to BMI and body weight. Although bone mass is a component of lean body mass, BMI may reflect global nutrition as well as ongoing mechanical bone loading. These findings are distinct from those of Paniagua et al, who reported an increase in osteoporosis in heavier patients,<sup>11</sup> suggesting that factors other than BMI alone (eg, activity level) play an important role.

Our assessment of comorbidity, using active diagnoses, ADL scores, and CMI scores, was crude. It may be that more formal instruments such as a Charlson comorbidity scale<sup>51</sup> or a functional assessment such as time-to-get-up-and-go<sup>52</sup> might provide a better estimate of comorbidity and functional status, and might be a stronger predictor of osteoporosis than the instruments used in our study. In a study of elderly women, strength was positively associated, and BMI was negatively associated, with ADL functional score.<sup>53</sup> A study from a rural Japanese community documented that bone loss in both men and women was correlated with decreased ADLs, determined by various reaching and lifting as well as household tasks.<sup>54</sup>

We found that hip osteoporosis was more common than spine osteoporosis. On the other hand, we also found that a substantial number of our patients with osteoporosis had various degenerative conditions that might artefactually elevate bone density; the actual prevalence of spinal osteoporosis may be underestimated by our data.

It is of interest that there was an apparent improvement in the observed rate of population screening and treatment for osteoporosis in our study population (7% at the onset of the study had been screened for osteoporosis compared with 12% by the end of the study). This improvement may reflect a local idiosyncrasy in evaluation patterns uncovered by the unexpected hiatus in recruitment, as well as a real improvement in provider awareness of osteoporosis and, as a result, screening. On the other hand, other studies have shown a similar poor rate of screening and treatment. Our own group

recently reported that only a minority of men who sustained a vertebral fracture were diagnosed with or treated for osteoporosis.<sup>55</sup> Feldstein and coworkers reported a very poor rate (<10%) of further evaluation<sup>51</sup> after an index fracture in a nationalized healthcare system, where access and cost are not major impediments to care. Other data have showed equally poor rates in other healthcare systems. For example, Rojas-Fernandez and colleagues demonstrated in a nursing home study that only 25% of patients with diagnosed osteoporosis were receiving any antiosteoporosis drugs.<sup>56</sup>

Our data suggest that men with osteoporosis were older than those without osteoporosis. Although we were not able to document significant metabolic differences between these 2 groups, several explanations are possible. One explanation is that mobility may be impaired in the older men,<sup>57</sup> for which we did not adequately screen with our limited functional assessment. Another explanation relates to recent data suggesting that saturated fat intake may be a risk factor; our older veterans may have had a longer exposure to this dietary component.<sup>58</sup> Unknown metabolic differences (eg, production of estradiol) also may be factors. Clearly, further study is needed to evaluate this issue.

Age and weight are relative terms. Although we were able to state that in our study population being "older" and "lighter" appeared to predispose men to osteoporosis, we were not able to establish thresholds for these parameters.

A substantial number of our admitted patients did not participate in our study, primarily because of their lack of interest and secondarily for reasons pertaining to their ability to adhere to the requirements. It is possible that our data may represent a select population and that those individuals who could not or would not participate were in fact sicker and might have displayed differences in the various metabolic parameters studied. On the other hand, our analysis of a sample of nonparticipants did not reveal significant differences in parameters of overall health such as length of stay, active medical problems, weight, or BMI.

Another limitation to our study is the use of Lunar rather than National Health and Nutrition Examination Survey hip bone mass density reference data. Although the Lunar database was used consistently to evaluate all patients in this study, it may not be as widely representative as the National Health and Nutrition Examination Survey.<sup>59</sup>

Furthermore, by restricting our analysis to men who had served in active military duty, we might have distorted our data to include individuals who at one time were healthy and in good physical condition. As such, we might in fact underreport the prevalence of osteoporosis in a middle-aged, infirm male population. Patients admitted to the CREC frequently go home and may be more functional than other institution-

alized men. Thus, our data represent an analysis of a relatively narrow spectrum of society, and extrapolating to a larger segment could be unfounded. Nonetheless, it is clear that osteoporosis is rarely screened for in an ambulatory population and may be more prevalent than had been appreciated.

The underappreciated prevalence of osteoporosis and the significant potential burden from morbidity in men make it imperative for healthcare providers to evaluate at-risk patients. This situation obviously has huge financial importance for healthcare organizations. Our inability to identify clear distinguishing markers for men at risk—even recognizing the caveats outlined above—suggests that aggressive bone density screening, particularly of frail, thin, or elderly men, may be the most cost-effective intervention at this time.

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