

## Utility of screening tools for the prediction of low bone mass in African American men

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**Abstract** *Introduction:* Osteoporosis remains under-diagnosed, particularly in African American men, despite the availability of reliable diagnostic tests. In women, several screening tools, including heel ultrasound and clinical assessment tools, reliably predict low bone mass, however the usefulness of these screening tools in African American men is unknown. The aim of this study was to determine the utility of screening tools, namely heel ultrasound, the osteoporosis self-assessment tool (OST), weight-based criterion (WBC) and body mass index (BMI), in screening for low bone mass in African American men. *Materials and methods:* African American men 35 years of age and older were invited to participate. The OST risk index is a score based on age and weight [(weight in kilograms – age in years) × 0.2]. Bone mineral density (BMD) of the heel was measured by heel ultrasound, and BMD of both the lumbar spine and hip were determined by dual energy X-ray absorptometry (DXA). One hundred and twenty-eight men fulfilled the inclusion criteria for our study. *Results:* The population prevalence of osteopenia and osteoporosis were 39% and 7%, respectively. Using a heel ultrasound T-score cut-off value of –1 or less, we predicted low bone mass (T-score of –2 or less at the hip) with a sensitivity of 83%, a specificity of 71% and an area under the curve (AUC) of 0.80. Using an OST cut-off value of 4, we predicted low bone mass with a sensitivity of 83%, a specificity of 57% and an AUC of 0.83. The OST risk index ranged from 18.1 to –6.1, based on which we categorized risk as: low, 5 or greater; moderate, 0–4; high, –1 or less. Of the men with a high-risk OST score, 87% had either osteopenia or osteoporosis based on World Health Organization (WHO) criteria. Using the WBC alone with a cut-

off value of 85 kg, we predicted low bone mass with a sensitivity of 74%, a specificity of 50% and an AUC of 0.70. A BMI cut-off value of 30 or greater yielded a sensitivity of 83%, a specificity of 43% and an AUC of 0.70 for the diagnosis of low bone mass. *Discussion:* The prevalence of osteopenia and osteoporosis were unexpectedly high in outpatient African American male veterans, who are considered to be at low risk for low bone mass. Heel ultrasound was able to predict low bone mass with sufficiently high sensitivity and specificity for use as a screening tool. Surprisingly, WBC and BMI proved ineffective in predicting low bone mass with adequate sensitivity and specificity. The OST, a clinical formula based on weight and age, appeared to be an easy and reliable screening tool for identifying men at high risk for low bone mass.

**Keywords** African American men · Low bone mass · Screening tools

### Introduction

Male osteoporosis is a worldwide health problem, and its incidence is expected to rise given present-day population demographics and increased life expectancy. It has been predicted that by the year 2040 the yearly incidence of hip fractures in men worldwide will be similar to the incidence in women in the year 2000 [1, 2]. However, despite these numbers, few studies have focused on screening modalities for male osteoporosis.

The early detection of low bone mass is particularly important in males given the fact that men are almost twice as likely to die during hospitalization for hip fractures as women [3]. A prospective cohort study in individuals >60 years showed that all major fractures were associated with increased mortality, especially in men [4]. A separate study demonstrated that low bone density at the hip is a strong and independent predictor of all-cause mortality in older men [5].

The internationally recognized definition of osteoporosis is that of “a skeletal disorder characterized by compro-

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mised bone strength predisposing to an increased risk of fracture. Bone strength reflects the integration of two main features: bone density and bone quality” [6]. This definition captures the notion that low bone mineral density (BMD) in addition to other micro-architectural abnormalities in the skeleton contribute to skeletal fragility. BMD as measured by dual energy X-ray absorptiometry (DXA), is considered the gold standard assessment of bone strength and the best predictor for risk of fractures [7–9]; however, its routine use in population screening is impractical. Quantitative ultrasound (QUS) is a less expensive, radiation-free and portable assessment technique that measures both BMD and the micro-architectural properties of bone [10]. While multiple studies in women have confirmed that calcaneal ultrasound can accurately measure BMD [11, 12] as well as calculate the fracture risk [13–15], relatively fewer studies have addressed this issue in men [11, 16–21], and the results obtained from these have been inconclusive.

Several clinical risk assessment tools have been developed that facilitate the appropriate and more cost-effective use of DXA and as such help clinicians determine the risk of osteoporosis in women [22–30]. Similar studies evaluating these clinical risk assessment tools in male populations are few. The weight-based criterion (WBC) is one of these clinical tools; it is based on weight alone and has been shown in cross-sectional studies to be useful in screening women for BMD assessment [23]. The osteoporosis self-assessment screening tool (OST) is another simple and effective clinical risk assessment tool for detecting female and male subjects at increased risk of osteoporosis [12, 24, 31–35]. The utility of OST in predicting low bone mass in an exclusively African American male population has not been investigated to date.

The aim of our study was to evaluate the effectiveness of screening tools, namely clinical risk assessment tools and heel ultrasound, in identifying African American men with low bone mass.

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## Materials and methods

### Study population and protocol

Subjects were recruited from outpatient general medicine clinics at the Jesse Brown VA Medical Center over an 11-month period in 2004. The inclusion criteria were: African American males aged 35 and older; willingness to participate in the study and ability to provide informed consent. Subjects were excluded from participation if they had a history or evidence of metabolic bone disease, including atraumatic fractures, a history of any medical conditions predisposing to low bone mass, such as endocrine disorders and renal insufficiency, a history of cancer in the preceding 10 years or the use of medications that precipitate bone loss or medications used to treat low bone mass with the exception of calcium and daily multivitamins.

The subjects were interviewed by MDs for demographic data, past medical history, medication use, personal history of fractures or family history of osteoporosis or fractures, social history including smoking and alcohol consumption (both past and current) and exercise (defined as 30 minutes three times per week). Height and weight without shoes were measured using a physician balance beam scale (Health-o-meter, Continental Scales, Chicago, Ill.). The basal metabolic index (BMI) was calculated as weight in kilograms divided by height in meters squared.

The study was approved by the IRB of the Jesse Brown VA Medical Center. All patients signed a consent form. In total, 128 subjects were eligible to participate in the study.

### Ultrasound densitometry

Ultrasound measurement of the calcaneus, of the non-dominant heel, was obtained using an Achilles Plus System (Lunar, Madison, Wis.). This machine measures speed of sound (SOS), broadband ultrasound attenuation (BUA) and a clinical index named the stiffness index (SI) which is a linear combination of SOS and BUA. The manufacturer's young Caucasian female reference values were used to compute SOS, BUA, SI and T-scores. The machine was calibrated according to the manufacturer's recommendations. The short-term in vivo precision determined in 30 healthy African American men, each measured twice with repositioning, was 1.5% for SI and 1.5% for T-scores.

### Dual energy X-ray absorptiometry

The BMD, expressed in grams per centimeter squared, of all the participants was measured by the same GE lunar machine (General Electric, Madison, Wis.) at the lumbar spine (L1–L4) and the non-dominant hip (femoral neck, trochanter, total hip). T-scores were calculated using the manufacturer's reference values, namely a young Caucasian male database for the hip and a Caucasian female database for the spine. BMD was classified as normal, osteopenic or osteoporotic based on the World Health Organization's (WHO) criteria of T-score evaluation at the lumbar spine, femoral neck, trochanter and total hip, unless otherwise stated in the text. A recent report from the International Society of Clinical Densitometry (ISCD) has affirmed that this evaluation is currently appropriate [36].

All DXA measurements were performed by one trained technologist. The DXA machine was calibrated daily using the anthropomorphic spine phantom supplied by the manufacturer. The mean daily quality assurance value was 0.08%. The coefficient of variation for our DXA machine is 1% at the spine and 1.67–1.88% at the hip.

There is no consensus on the densitometric definition of osteoporosis in non-Caucasian individuals or men. The ISCD recommends the use of a Caucasian male reference database for both Caucasian men and non-Caucasian men [36, 37]. Therefore, in the majority of our analyses we used DXA hip scores and excluded spine scores, as the hip

**Table 1** Characteristics of 128 African American male veterans expressed as means or percentage values. *SD* Standard deviation

Variable	Mean (SD)
Age (years)	63.8 (14.8)
Weight (kg)	86.5 (17.7)
Height (inches)	68 (3.9)
BMI (kg/m <sup>2</sup> )	28.9 (5.6)
Prior traumatic fractures (%)	40
OST score	4.5 (5.2)
Heel T-score	-0.46 (1.5)
Spine T-score	0.52 (1.8)
Spine (g/cm <sup>2</sup> )	1.28 (0.2)
Femoral neck T-score	-0.41 (1.37)
Femoral neck (g/cm <sup>2</sup> )	1.02 (0.18)
Trochanter T-score	-0.29 (1.4)
Trochanter (g/cm <sup>2</sup> )	0.89 (0.16)
Wards triangle T-score	-1.2 (1.5)
Wards triangle (g/cm <sup>2</sup> )	0.8 (0.19)
Total hip T-score	-0.19 (1.2)
Total hip (g/cm <sup>2</sup> )	1.07 (0.17)

scores were derived from a male database in contrast to the spine scores. We did not use T-scores interchangeably between different techniques of bone mass estimation, as recommended by the International Osteoporosis Foundation [38].

#### Clinical assessment tools

These are clinical variables which are used either alone or in formulae to calculate the risk for the presence of low bone mass. OST was calculated as follows for each patient:

$[(\text{weight in kilograms} - \text{age in years}) \times 0.2]$  truncated to an integer. The OST score was then converted into a risk index by using a cut-off value to differentiate between a low (5 or greater), moderate (0–4) or high risk (-1 or less) for low bone mass. The WBC was established based on weight alone, while the BMI was calculated based on weight in kilograms divided by height in meters squared.

#### Data analysis

Statistical analysis of the results was performed using SPSS software (SPSS, Chicago, Ill.) and Microsoft Excel Analyze-It and Clinical Laboratory 1.71 (Leeds, UK). Descriptive statistics of the study population, were expressed as either the mean  $\pm$  standard deviations or percentages. The analysis was stratified by BMD, based on WHO criteria, using a Caucasian male normative database for the hip and the manufacturer's female spine database. Significance was determined utilizing a two-sided  $\alpha$  level of 0.05. Logistic regression analysis was performed to determine the presence of any modifiable risk factors for low bone mass in the cohort population. Characteristics of the screening tests, namely sensitivity, specificity, positive predictive values and negative predictive values, were determined. Receiver operating characteristic (ROC) curves were performed to determine the cut-off values for optimal sensitivity and specificity of the screening tools using disease status defined – per DXA – as a T-score at the hip of -2 or less and -2.5 or less. The area under the curve (AUC), calculated using logistic regression, was used to compare the diagnostic performance of the tests. AUC values  $>0.75$  are generally considered to represent good performance. Correlation statistics were performed between heel T-scores, DXA T-scores and OST scores, respectively.

**Table 2** Characteristics of 128 African American male military veterans expressed as means or percentage values stratified on the basis of WHO BMD criteria at the lumbar spine and hip

Variables <sup>a</sup>	Normal (SD)	Osteopenia (SD)	Osteoporosis (SD)	ANOVA ( <i>p</i> value)
Number of subjects	69	50	9	–
Percentage of subjects	54	39	7	–
Age (years)	58.7 (13.4)	67.2 (14.2)	82.3 (6.7)	<0.0001
Weight (kg)	90.9 (18.1)	82.7 (15.7)	73.0 (15.4)	0.002
Weight at age 25 years	77.6 (14.5)	71.1 (9.1)	68.2 (6.7)	0.008
Height (inches)	68.3 (3.7)	67.9 (3.9)	65.9 (5.1)	0.21
BMI	30.1 (5.4)	27.8 (5.5)	26.3 (6.1)	0.03
PMHx traumatic fractures (%)	41	50	11	–
Family Hx osteoporosis or fractures (%)	10	18	0	–
Tobacco (%; past/current)	77/39	82/40	56/33	–
Alcohol (%; past/current)	70/35	70/32	44/11	–
Exercise (%)	59	56	33	–
Heel T-score	0.10 (1.48)	-0.85 (1.15)	-2.53 (0.79)	<0.0001
OST score	6.36 (4.8)	3.12 (4.7)	-1.86 (3.5)	<0.0001

<sup>a</sup>BMI, Body mass index; PMHx, past medical history; Hx, history

**Table 3** Areas under the curve for clinical risk assessment tools using DXA cut-off T-scores of  $-2$  and  $-2.5$  at the total hip, femoral neck or trochanter

ROC AUC <sup>a</sup> diagnostic variable	T-scores of $<-2$		T-scores of $<-2.5$	
	AU (95% CI) <sup>b</sup>	<i>p</i> values	AU (95% CI)	<i>p</i> values
Heel T-Score	0.80 (0.69–0.90)	$<0.0001$	0.93 (0.87–0.99)	$<0.0001$
Weight (kg)	0.70 (0.59–0.81)	0.0002	0.75 (0.57–0.92)	0.003
BMI	0.70 (0.58–0.81)	0.0004	0.67 (0.47–0.87)	0.05
OST index	0.83 (0.74–0.93)	$<0.0001$	0.89 (0.75–1.03)	$<0.0001$

<sup>a</sup>ROC, Receiver operating characteristic curves; AUC, area under the curve

<sup>b</sup>95% CI, 95% Confidence interval

## Results

The 128 African American men recruited in our study ranged in age from 35 to 90 years, with a mean age of 64 years. Baseline characteristic data of the whole population and the population stratified per WHO BMD criteria are presented in Tables 1 and 2, respectively. The prevalence of osteopenia and osteoporosis in our group were 39% and 7%, respectively. Of the participants in the study, 40% had a prior history of traumatic fractures. The average BMI was in the overweight range. The OST risk index varied between  $-6.1$  and  $18.1$ . The mean T-score of the spine was higher than the mean hip T-score value, likely reflecting the fact that the spine BMD is often increased by degenerative changes. Age, weight and BMI were significantly different between those individuals with normal, osteopenic and osteoporotic BMD values, respectively.

Based on logistic regression analysis, after controlling for age, there appeared to be no statistically significant association between possible osteoporotic risk factors (low BMI, personal history of traumatic fractures, family history of osteoporosis or fractures, use of tobacco or alcohol (past or current), weight at age 25 years, the absence of exercise

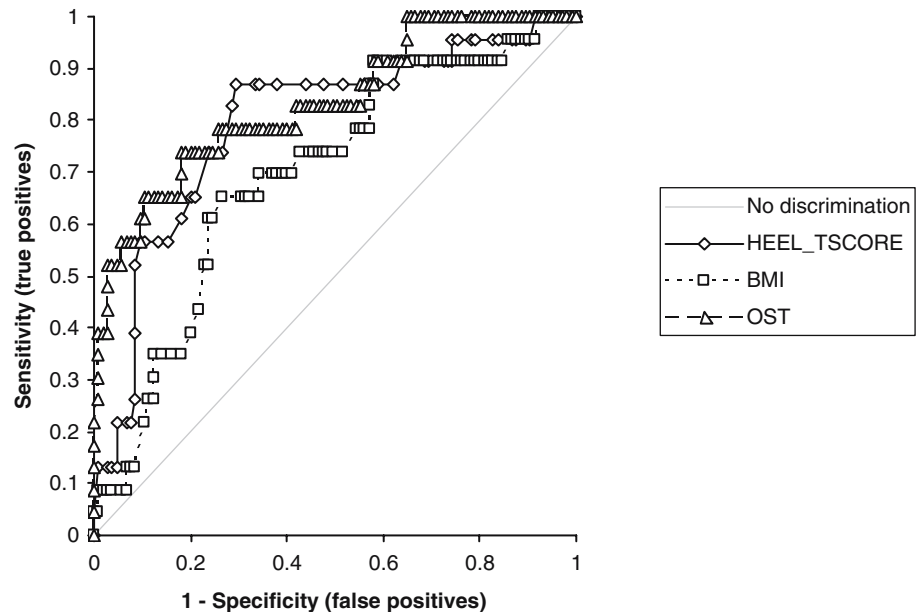
and low BMD as defined as a T-score of  $-2$  or less at either the total hip, trochanter or femoral neck.

The performance of each clinical risk assessment tool was evaluated by ROC analysis using DXA T-scores of  $-2$  and  $-2.5$  or less at the hip to define disease (Table 3). Figure 1 depicts ROC curves calculated for each screening tool. The AUC was calculated for both heel T-scores and OST at both DXA T-score cut-off values.

The observed sensitivities and specificities for low bone mass detection (DXA T-score of  $-2$  or less at the hip) using heel T-score cut-off values and OST cut-off values are shown in Table 4. A heel T-score of  $-1$  and an OST cut-point of 4 yielded adequate sensitivities and specificities for use as screening tools in our population.

Characteristics of the OST index at three different cut-off values are listed in Table 5, including cut-off values used in other studies of Caucasian elderly men [51] and a multi-ethnic male population [33]. Using an OST cut-off value of 4, we were able to identify 83% of our patients as having either severe osteopenia (T-score of  $-2$  or less at the hip) or osteoporosis (T-score of  $-2.5$  or less at the hip). Three risk categories – low, moderate and high – were created for the OST risk index (Fig. 2). Among the high-risk category of patients, 87% had either severe osteopenia or osteoporosis;

**Fig. 1** Receiver operating characteristic curve for clinical risk assessment tools using a DXA T-score of  $-2$  or less at the total hip, trochanter or femoral neck to define disease status



**Table 4** Observed sensitivity and specificity for severe osteopenia, defined as a T-score of  $-2$  or less at the total hip, femoral neck or trochanter, for a set of heel T-score cut-off values and OST values

	Sensitivity (%)	Specificity (%)
Heel T-scores		
-2	52	91
-1.5	61	82
-1	83	71
-0.5	87	52
OST		
1	65	82
2	74	76
3	78	68
4	83	57

in the low-risk category of patients, only 26% had either of these conditions. Therefore, we consider this categorization of OST index to be appropriate for our population. Our results illustrate that the prevalence of osteoporosis increases substantially across the three risk categories (Fig. 2). The distribution of African American male veterans was 18% in the high-risk OST category (OST:  $<-1$ ), 34% in the moderate-risk category (OST: 0–4) and 48% in the low-risk category (OST:  $>5$ ).

There was evidence of a strong correlation between heel T-scores and central BMD by DXA at the hip. The BMD at the hip sites measured correlated well with one another;

**Table 5** Test characteristics, expressed as percentages, at different cut-off scores of the OST risk index with disease status being defined as a DXA T-score of  $-2$  or  $-2.5$  or less at the total hip, femoral neck or trochanter sites

OST cut-off score		T-score of $<-2.5$	T-score of $<-2$
	Background prevalence	7%	22%
4 <sup>a</sup>	Sensitivity	89	83
	Specificity	54	57
	PPV <sup>d</sup>	13	30
	NPV <sup>e</sup>	98	94
3 <sup>b</sup>	Sensitivity	89	78
	Specificity	64	68
	PPV	16	35
	NPV	99	93
2 <sup>c</sup>	Sensitivity	89	74
	Specificity	71	76
	PPV	19	40
	NPV	99	93

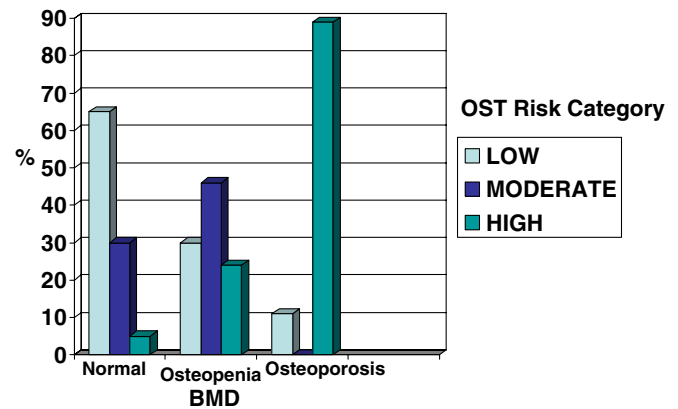
<sup>a</sup>Cut-off score that we consider to be optimal for our African American male population

<sup>b</sup>Cut-off score used by Adler et al. in a multi-ethnic male population [33]

<sup>c</sup>Cut-off score used by Hochberg et al. in a study of Caucasian elderly men [51]

<sup>d</sup>PPV, Positive predictive value

<sup>e</sup>NPV, Negative predictive value



**Fig. 2** OST risk prevalence for African American male military veterans (low:  $>5$ ; moderate: 0–4; high:  $<-1$ ) stratified based on BMD per WHO criterion at the lumbar spine and hip

however, the correlations between spine BMD, heel T-score and hip BMD, while statistically significant, were less robust. The correlation between heel T-score and OST was relatively low ( $r=0.27$ ), suggesting that heel T-scores and OST scores may have independent predictive values and are measuring different risk factors for low bone mass.

## Discussion

The prevalence of osteopenia and osteoporosis was high in our outpatient African American male veteran population which, prior to the study, had been considered to be a low-risk group with respect to osteoporosis. The present study revealed that one in every two men had either osteopenia or osteoporosis as defined by the WHO densitometric criteria, and one in every 14 men had osteoporosis. This high prevalence highlights the need for reliable screening tools for the identification of men at risk for fractures. The OST, a clinical formula based on weight and age, appeared to be an easy and reliable screening tool by which to identify men at high risk for osteoporosis. Additionally, in our population, heel ultrasound was able to predict low bone mass with sufficiently high sensitivity and specificity for use as a screening tool.

There are no consensus guidelines addressing the screening for osteoporosis in males. Additionally, there is no consensus on the densitometric definition of male osteoporosis [2, 36, 37] or appropriate BMD cut-off values for defining osteoporosis in men or non-Caucasian populations. Studies in men, however, have shown that the relationship between low BMD and the risk of fractures holds true in men [38, 39–41]. In fact, some studies have shown that there is a stronger association between hip fracture incidence and mortality in men than in women [4, 42, 43]. Based on such data, an international consensus development panel recommended that T-scores in males be derived from a male normative data source [36].

Our results showing a high prevalence of low bone mass in African American men are in agreement with those of Broussard and Magnus who analyzed NHANES III data

and found, unexpectedly, that African American men had a higher prevalence of low bone mass than Mexican American or Caucasian men when ethnic-specific T-scores were used; these results contrasted sharply to those they had obtained for African American women, who had the lowest prevalence of osteoporosis relative to other ethnic groups [44]. The prevalence of osteoporosis was 7% in our cohort of African American men, which had been regarded to be a low-risk group with respect to low bone mass, thereby highlighting the need for screening in this population. Several screening modalities, namely heel ultrasound and clinical assessment tools, have been developed to formalize selection criteria for DXA testing, however these have largely focused on female populations.

Several studies have examined the ability of risk factors for bone loss to identify individuals likely to have osteoporosis. In a study in which NHANES III data was used to evaluate risk assessment factors for bone loss, low BMI [odds ratio (OR): 6.5], current cigarette smoking status (OR: 1.3) and the absence of physical activity (OR 1.8) were statistically significant risk factors for low BMD among 50- to 79-year-old African American men – when ethnic- and gender-specific young adult mean values were applied for the calculation of T-scores [44]. Interestingly, these three factors are all modifiable risk factors for the development of low bone mass. In the present study, logistic regression analysis failed to demonstrate the presence of any significant modifiable risk factors for low bone mass after controlling for age. However, in contrast, a number of other studies have confirmed that low BMI is a strong modifiable determinant of low BMD in both men [17] and women [44–46]. Adler et al. [17] assessed 98 multi-ethnic patients attending a pulmonary clinic and concluded that BMI appeared to be a good predictor of central BMD, a conclusion also drawn by Edelstein and Barrett-Connor [45]. BMI alone, however, did not appear to be a good predictor of low BMD in our African American population. A possible cause of this discrepancy between the present results and those from other studies may be attributable to differences in body composition between our African American veteran population and the healthy African American males from the NHANES III data set or the predominantly Caucasian male populations in other studies.

Although BMD assessment by DXA is the gold standard for identifying asymptomatic individuals with low bone mass, it has been reported that BMD explains only 20% of the variance in fracture number [47]. This observation suggests that factors other than BMD influence bone strength, namely bone quality and micro-architecture, and that these could potentially play a significant role in fracture risk [47]. QUS is a useful surrogate measure of bone strength [48] and measures BMD in addition to other qualitative properties of bone such as elasticity, connectivity and homogeneity [49] and may have a role in low bone mass determination and fracture prediction [48]. Multiple prospective and cross-sectional studies in postmenopausal women have confirmed that calcaneal ultrasound can predict BMD measurements by DXA [11–15, 50]; similar

studies in men are few [11, 16–21]. In a prospective population-based cohort, the Rotterdam study [39], only 21% of all non-vertebral fracture occurred in men with hip T-scores of  $-2.5$  or less; in women, the incidence was 44%. This difference suggests that factors other than BMD may be especially important in men with respect to fracture risk and highlights the need for more sensitive risk assessment tools using not only BMD but also other clinical predictors of fracture risk in men.

In our study, the overall predictive value of QUS for osteopenia and osteoporosis, as assessed by ROC curve analysis, was good. Some cross-sectional and case control studies have demonstrated the effectiveness of QUS in the identification of osteoporotic fractures in men [16, 19–21] compared to healthy controls. In the EPIC-Norfolk prospective study of over 14,000 patients, ultrasound of the calcaneus predicted total and hip fracture risk in men and women, independent of known covariates [11]. However, when heel ultrasound has been evaluated as a screening tool for osteoporosis in other male populations, the results have been conflicting. In the study by Adler et al. on 98 multi-ethnic male veterans attending a pulmonary clinic, a heel ultrasound T-score of  $-1.0$  or less was used to predict a central DXA T-score of  $-2.0$ ; revealing a sensitivity of 61% and a specificity of 64% and did not provide additional diagnostic predictability beyond age and BMI [17]. In another study of 185 multi-ethnic male veterans, heel ultrasound initially failed to predict low bone mass with adequate sensitivity and specificity; however, following a review of the subgroup analysis by ethnicity, the AUC appeared to be greater for African American men than for Caucasian men, 0.82 versus 0.64, respectively [18]. Based on the current literature, the International Osteoporosis Foundation recommends the use of ultrasound techniques as tools for risk assessment and to aid treatment decisions [38]. In our population, our use of a heel T score of  $-1$  or less to predict a hip DXA T-score of  $-2$  or less yielded a sensitivity of 83%, a specificity of 71% and an AUC of 0.79, thus qualifying as a useful screening test.

Several clinical assessment tools have been developed to formalize the selection criteria for DXA testing, and these have been demonstrated to work reasonably well in female populations [22, 23, 25–29]. The primary goal of clinical assessment tools is not to diagnose osteoporosis but to assist clinicians in identifying asymptomatic individuals likely to have primary osteoporosis prior to sustaining a fracture. Earlier studies using clinical assessment tools have focused their attention on older men at high risk for osteoporosis. In our study, our objective was to determine the clinical utility of OST, WBC and BMI in a broader age range of exclusively African American male veterans that were considered to be at low risk for osteoporosis.

The simplest WBC uses weight alone; this assessment tool had a sensitivity of 74% and a specificity of 50% in detecting low bone mass in our male population when a cut-off value of 85 kg was used. Additionally, BMI proved ineffective for use as a screening tool to predict low bone mass.

Another assessment tool, OSTA (OST in Asians), was originally developed from a study of postmenopausal

Asian women aimed at assessing multiple clinical risk factors associated with bone loss and osteoporosis [24]. OST has been validated in Asian women [12, 24] and Asian men [31]. It has also been applied with success to American female [34], European female [32], Latin American female [35], Caucasian male [51] and multi-ethnic American male [33] populations. Studies in ethnicities other than Asian have used different index cut-off values than those of the original Asian studies, which may have been necessary given differences in body size and composition. OST has been applied to two cohorts of older Caucasian men by Hochberg et al. (Rotterdam study, Baltimore Mens OST study) using a cut-off value of 2. The authors reported a sensitivity and specificity of 79% and 51%, respectively, for the Rotterdam study and 88% and 32%, respectively, for the Baltimore cohort [51]. In a study of multi-ethnic male veterans, Adler et al. used a cut-off value of 3 to obtain a sensitivity of 93%, a specificity of 63% and an AUC of 0.84 for identifying male veterans with low bone mass attending two subspecialty clinics [33]. We used a cut-off value of 4, which yielded a sensitivity of 83%, a specificity of 57% and an AUC of 0.83 in our African American population. Additionally, we stratified the OST index into low-, moderate- and high-risk categories and determined that 87% of the patients in the high-risk category had either osteopenia or osteoporosis based on WHO criteria at the spine and hip; in contrast, only 26% of the patients in the low-risk group had either of these conditions. Our results demonstrate that the prevalence of osteoporosis increased substantially across the three risk categories.

Our study has some obvious strengths. We investigated the prevalence of low bone mass in a broad age range of exclusively African American male veterans considered to be low risk for osteoporosis. DXA measurements were calculated using a Caucasian male normative database at the hip and using the manufacturer's Caucasian female database for the spine. While the use of an American Caucasian male reference database for the definition of T-score values is currently recommended [36, 37], it very possibly resulted in an underestimation of the prevalence of low bone mass in our population, since it is known that Caucasian men have lower baseline BMD measurements than African American men [44]. Additionally, our use of the manufacturer's Caucasian female reference database for computing calcaneal ultrasound measurements has the potential for underestimating the prevalence of low bone mass. However, our findings should be interpreted within the context of several limitations: namely cohort size, an African American male veteran population, self-reported demographic data and limitations associated with DXA and QUS reference databases. Additionally, our study was not designed specifically to validate the OST.

In our population, the prevalence of low bone mass was clinically significant, with a combined prevalence of osteopenia and osteoporosis of 46% using WHO BMD criteria for the spine and hip. OST and heel ultrasound proved to be invaluable in identifying African American men with low bone mass. Interestingly, the weak correla-

tion between QUS and OST might indicate that they are measuring different risk factors for low bone mass. Therefore, QUS may play an independent and complimentary role with OST in enhancing the identification of low bone mass in males. Their combined use could facilitate the appropriate and more cost-effective use of DXA [52]. Although mass screening is not recommended, case finding of men at risk for osteoporosis is an important strategy for reducing fractures in this population.

To conclude, improvements in risk assessment for selection for DXA testing can be achieved by the use of heel ultrasound and OST in African American male veterans. Our study confirms that OST, a simple clinical risk assessment tool, was an effective, easily implemented screening tool for low bone mass in African American male veterans attending general medicine clinics. Converting clinical assessment tools into risk indices of low, moderate and high risk may be helpful to clinicians. These simple clinical risk assessment tools, as well as heel ultrasound, can be easily implemented and have great potential in the osteoporosis screening arena.

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