

## Performance of the osteoporosis risk assessment tool in Moroccan men

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**Abstract** Measuring bone mineral density (BMD) is a widely accepted strategy for identifying subjects with an increased risk of fracture. However, because of limited availability of BMD technology in some communities and cost considerations, it has been proposed that BMD measurements be targeted to subjects with risk factors for osteoporosis. Osteoporosis self-assessment tool (OST) using age and weight have been developed to identify women who are more likely to have low BMD and thus undergo BMD testing. To study the performance of OST in identifying osteoporotic white men in Morocco. We analysed in an epidemiological cross-sectional study the records for 229 white Moroccan men seen at an out-patient rheumatology centre. OST was compared to bone density T scores and the ability of OST to identify men with osteoporosis ( $T < -2.5$ ) was evaluated. Using an OST score  $< 2$  to recommend dual X-ray absorptiometry (DXA) referral, sensitivity ranged from 63% at the lumbar spine to 87% at the total hip to detect BMD T scores of  $-2.5$  and specificity from 58 to 59%. The negative predictive value was high at all skeletal sites (87–98%), demonstrating the usefulness of the OST to identify patients who have normal BMD and should not receive DXA testing. The performance of OST among men in Morocco was similar to that reported earlier for the other samples in Asian countries and the USA. The OST is an effective and efficient tool to help target high-risk men for DXA measurement.

**Keywords** Bone mineral density · DXA · Morocco · Osteoporosis · Risk indices

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Osteoporosis has enormous health and socioeconomic implications in terms of morbidity, mortality and disability worldwide. For a 50-year-old white woman, the lifetime risk of suffering a fragility fracture is estimated to be 30–40% [1, 2]. The problem of osteoporosis is often neglected in men, despite the fact that about 30% of all hip fractures occur in men, and the mortality after hip fracture is significantly higher in men than in women. In Morocco (30 million inhabitants) for example, the age-adjusted 1-year cumulative incidence of hip fracture has been estimated to be 43.7/100,000 [95% confidence interval (CI) 33.3–52.2] in men and 52.1/100,000 [95% CI 40.9–63.3] in women in 2002 [3]. Recently, various efficient treatments for preventing fractures have been developed. Scans to measure bone mineral density (BMD) using the technique of dual-energy X-ray absorptiometry (DXA) are widely believed to be the most effective way of identifying patients at risk of fracture and targeting these treatments appropriately. However, mass screening is not recommended without some selection of the target population. Moreover, because of limited availability of BMD technology in some communities and cost considerations, it has been proposed that BMD measurements be targeted to subjects with risk factors for osteoporosis. Recently, many epidemiological studies have validated risk assessment indices for osteoporosis in women. The purpose of the risk assessment indices is not to diagnose osteoporosis or low BMD, but to identify people who are more likely to have low BMD. Such indices, while not identifying all cases of osteoporosis, increase the efficiency of BMD measurement by focusing on subjects who are at an increased risk [4–7].

The easiest to use in clinical practice is certainly the osteoporosis self-assessment tool (OST) [8]. The calculated risk index is based on self-reported age and weight:  $[(\text{weight in kilograms} - \text{age in years}) \times 0.2]$ , truncated to an integer. It was developed and validated in several studies

in Asian and white women including Moroccans [9–13]. Relatively few studies have been performed in men. Then, we aimed in this study to assess the validity of the OST in a population of 229 white men from Morocco in identifying those at risk of low BMD and who could benefit from definitive osteoporosis evaluation using DXA.

## Materials and methods

### Patients

We analysed a database that included medical data on patients referred for a BMD measurement between April 2004 and July 2006 to our department located at the Rheumatology and Physical Rehabilitation Centre, Military Hospital Mohammed V (University of Rabat) in Morocco. All men older than 50 registered in our database were included in the study: These patients were either consulting spontaneously in our centre or referred based on diagnostic judgment of the referring physician. Patients with Paget's disease, osteogenesis imperfecta and advanced osteoarthritis were excluded. All participants underwent a structured questionnaire, which concentrated on those variables for which published evidence suggested an association with osteoporosis or low BMD: current treatment for health complaints (including the presence of low back pain), fractures, presence of a disease, family history of osteoporosis, use of toxic substances (alcohol and tobacco), calcium intake and occupational exercise and sports in the present and past.

### Densitometry measurements

All BMD measurements were performed on a Lunar Prodigy Vision machine (General Electric). The DXA scans were obtained by standard procedures supplied by the manufacturer for scanning and analysis. The BMD measurements were carried out by two experienced technicians. Daily quality control was carried out by measurement of a Lunar phantom. At the time of the study, phantom measurements showed stable results. The phantom precision expressed as the CV (%) was 0.08. Moreover, reproducibility as assessed in clinical practice showed a smallest detectable difference of 0.02 g/cm<sup>2</sup> at the hips [14, 15]. Patient BMD was measured at the femurs (dual femur), and the mean result of the measure of the two femurs (total hip) was used. BMD values, expressed in g/cm<sup>2</sup>, were converted into T scores expressed in standard deviations (SDs) using white reference values that have been shown to be the closest to Moroccan values in women [16, 17]. We used the total hip T score to categorise subjects as normal ( $T > -1$ ), osteopenic ( $-2.5 < T \leq -1$ ) or osteoporotic ( $T \leq -2.5$ ).

### Statistical analysis

Three risk categories were used according to the index developer's recommendations using different cut-offs. Prevalence of osteoporosis in each of these three categories was determined using the WHO criteria. Receiver operating characteristic (ROC) analyses were performed to evaluate the discriminatory performances of OST, and the area under the curve (AUC) was computed. To assess the internal validity of the indice, sensitivity was defined as the proportion of the population with low BMD correctly classified by the risk index (true positive fraction), and specificity was defined as the proportion with normal BMD correctly identified by the risk index (true negative fraction). ROC curves provided a graphical representation of the overall accuracy of a test by plotting sensitivity against (1-specificity) all thresholds, while the AUC quantified the accuracy of the test. We also calculated the positive predictive value (PPV) and negative predictive value (NPV) to evaluate the external validity of the OST. The PPV and NPV represent the proportion of men who tested positive or negative (as classified by the OST) and who truly had, or did not have, BMD below the T-score threshold being tested, respectively.

We evaluated the OST at the BMD T-score threshold of  $-2.5$  to assess the performance of this indice in predicting hip and spine osteoporosis. Statistical analysis used SPSS statistical software (SPSS, Chicago, IL).

## Results

The mean age of the men in our sample was 62.3 ( $\pm 8.1$ ) years, ranging from 50 to 85 years. Table 1 shows their basic demographic data. Eight percent reported a non-traumatic fracture after the of age 50 at the wrist, rib or hip. The prevalence of osteoporosis at all sites increased progressively with age. Of the men in our study, 21.8% were osteoporotic ( $T < -2.5$ ) at one or more skeletal sites according to the WHO operational definition.

Using the dichotomous cut-off value of  $< 2$ , the sensitivity of the OST in identifying individuals at an increased risk of osteoporosis ranged from 63.6% for the lumbar spine to

**Table 1** Characteristics of the participants ( $n=229$ )

	Mean	SD	Minimum	Maximum
Age (years)	62.3	8.1	50	85
Weight (kg)	73.2	12.9	47	104
Body mass index (kg/m <sup>2</sup> )	25.2	3.6	15.1	36.1
Spine BMD (g/cm <sup>2</sup> )	1.066	0.19	0.404	1.605
Spine T score	-1.09	1.40	-6.60	3.30
Total hip BMD (g/cm <sup>2</sup> )	0.953	0.15	0.463	1.355
Total hip T score	-0.72	1.20	-4.40	2.50

**Table 2** Performance of the OST by BMD measurement site and by cut-off (%)

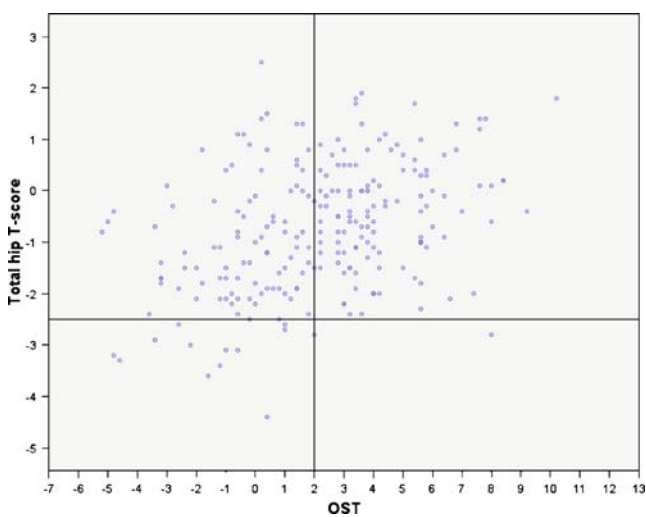
	Total hip				L1–4 spine				Any site			
	Se	Sp	PPV	NPV	Se	Sp	PPV	NPV	Se	Sp	PPV	NPV
Cut-off=0	62.5	79.3	18.5	96.6	36.4	79.5	29.6	84.0	40.0	81.0	37.0	82.9
Cut-off=1	75.0	70.0	15.8	97.4	52.3	71.4	30.3	86.3	54.0	72.6	35.5	85.0
Cut-off=2	87.5	58.2	13.6	98.4	63.6	59.5	27.2	87.3	64.0	60.3	31.1	85.7

NPV Negative predictive value, PPV positive predictive value, Se sensitivity, Sp specificity

87.5% at the total hip region. The corresponding specificity of OST ranged from 58.6% at the total hip to 60.3% at any given site (Table 2). At the OST cut-off point of 2, and using a BMD T-score threshold of  $-2.5$  for any site, 45% of the subjects were misclassified (most of these were false positives); the proportion of misclassified patients for single BMD sites was 41.8% at the total hip and 40.5% at the lumbar spine site. Figure 1 shows the distribution of an individual T score at the total hip by the OST index. The AUC was consistently high (around 0.79) for the two hip sites and somewhat lower for the spine (Table 3), indicating a good test performance at the hip level.

**Discussion**

The National Institutes of Health consensus conference defined osteoporosis as a disease of increased skeletal fragility accompanied by low BMD (T score below  $-2.5$ ) and micro-architectural deterioration [18]. The preferred sites for diagnostic purposes are BMD measurements made at the hip, either at the total hip or the femoral neck [19]. The availability of new effective treatments for osteoporosis emphasised to recommend BMD measurements for patients considered at high risk. Several guidelines have been developed to select which patients should undergo DXA testing [20–23].



**Fig. 1** Scatter plot of the OST according to the total hip T score

In Asian women as in Moroccan women, the OST has performed as well as or better than more complicated osteoporosis screening tools (Simple calculated osteoporosis risk estimation [SCORE], osteoporosis risk assessment instrument [ORAI] and osteoporosis index of risk [OSIRIS]) [24]. The simplicity of the tool makes it more useful in clinical practice than other screening indices, which are based on a larger number of risk factors. In this study involving white men aged 50 years and more, the OST, using a cut-off of 2, successfully identified most men with hip osteoporosis with a sensitivity of 87.5%, specificity of 58.2% and NPV of 98.4% at the total hip site. In other words, the OST, based only on age and weight, permits identifying men at low risk of osteoporosis who would not need DXA testing (98% of patients classified as low risk with OST do not have osteoporosis at the total hip). Hochberg et al. [25] applied the OST index to two large groups of men in Baltimore and Rotterdam. They found that the OST predicted osteoporosis as measured by DXA, using cutoffs similar to ours. In a sample of men extracted from pulmonary and rheumatology clinics at an American veteran’s hospital [25] and using an OST cut-off score of 3, the OST had a sensitivity of 93% and specificity of 66%. This tool was similarly validated in a big sample of Chinese men [26]. The OST values of  $\leq -1$  had a sensitivity of 81% and specificity of 66%, and the area under the receiver operating characteristics curve was 0.83.

Avoiding unnecessary testing among low risk patients can substantially reduce cost for the community and the patient (social health insurance only covers 15% of the Moroccan population). For example, in this sample of Moroccan men, 55% were classified as low risk using OST and thus would not need to be referred to DXA testing. Of these, only 1.6% actually had osteoporosis based upon total hip BMD. A risk assessment tool such as OST does not need to have both high sensitivity and high specificity.

**Table 3** Areas under the ROC curves for the OST by BMD measurement site

Tool	Total hip	L1–L4 spine	Any site
OST	0.787	0.660	0.667

Indeed, there is no risk of harm to the patient from unnecessary treatment or invasive diagnostic testing in case of a false-positive result from OST. Although some men who do not have low BMD were classified as increased risk (false positives) and would be referred for testing, some of these men would have undergone testing anyway if OST was not used. Furthermore, treatment for low BMD would only be initiated upon confirmation by DXA: a safe and non-invasive diagnostic procedure.

Despite differences in ethnicity of the studied populations and the reference databases used to calculate T scores, we found the performance of OST in this sample similar to that reported among Asian and American men especially at the hip level [27]. As it was the case in the study of Richey et al. [11], the results were slightly less concordant at the lumbar spine. We tested three risk tool categories and found that results were better for the OST cut-off of 2. The OST is a validated risk index that can help physicians and public health authorities to focus DXA testing on individuals at increased risk of osteoporosis.

As with most studies, our study has limitations. For example, the subjects in our sample were either referred or selected from rheumatology outpatient consultations for osteoporosis evaluations and may differ in some ways from the general population. Another limitation of this kind of study is that it does not take into account the risk of fracture, which is the main purpose of treating osteoporosis. DXA itself has a low sensitivity, and about half of the patients who were fractured do not have densitometric osteoporosis. However, the main objective of our study and similar studies is to identify patients with low BMD to avoid unnecessary exams, which is very important in developing countries, while developing a fracture risk assessment tool needs prospective longitudinal cohorts.

In summary, measuring BMD is the best method of identifying patients with osteoporosis to consider for treatment. However, measuring BMD in all men more than 50 is not feasible especially in developing countries such as Morocco. The OST tool can help target BMD measurements in men at risk as it has been validated in women. Its high sensitivity, acceptable specificity and very high negative predictive value allow for the safe exclusion of healthy men to reduce unnecessary bone density examinations in those who are at lowest risk.

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