Iranian Red Crescent Medical Journal

ORIGINAL ARTICLE

Osteoporosis Screening Tools in Iranian Postmenopausal Women

P Mottaghi[1]*, M Karimifar[1], M Salesi[1], A Mehrabi[2]

[1]Department of Internal Medicine/Division of Rheumatology, [2]Clinical Epidemiologist, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: Osteoporosis is a major health problem, but testing low bone mineral density is not practical for screening all postmenopausal women. The objective of this study was to evaluate the efficiency of the clinical tools to help clinicians to identify the Iranian women at an increased risk for osteoporosis.

Methods: The popular osteoporosis screening tools were evaluated in 341 postmenopausal women without secondary cause for osteoporosis, using data from a bone densitometry centre, and compared the results with their bone mineral density.

Results: National Osteoporosis Foundation recommendations had only a sensitivity of 48% for screening patients with low bone mass but the Osteoporosis Risk Assessment Instrument and the Simple Calculated Osteoporosis Risk Assessment Estimation with a sensitivity of 70.9% and 87.2%, respectively, showed better results in respect to the screening for osteoporosis of postmenopausal women.

Conclusion: The efficiency of these osteoporosis screening tools in our Iranian patients was relatively similar to that of other populations, and these screening tools accurately identify the vast majority of postmenopausal women likely to have low bone mineral density.

Keywords: Postmenopausal; Osteoporosis; Screening; Iranian

Introduction

Osteoporosis is a common disorder among postmenopausal women but it often progresses silently and commonly presents with fracture in the elderly.[1,2] With the increase in health care facilities and rise in the number of women reaching menopause, osteoporosis has become a global health problem worldwide. Determination of bone mineral density by dual X-ray energy absorptiometry (DXA) in postmenopausal women is an approved strategy for early detection of osteoporosis and many authors recommend DXA for estimation of bone density in high risk women.[3] But because of inaccessibility and high cost, it is not suitable to be used for all postmenopausal women and able to be used for all postmenopausal women and is not recommended in routine screening of postmenopausal women.

Due to the need to make osteoporosis screening more practical and simplified for clinicians, several clinical prediction rules (CPRs) have been developed. They stratify patients into risk subgroups on the basis of differing probabilities of disease as determined by summarizing risk factors with a point system.[4,5] Many CPRs have been developed and as osteoporosis screening tools, they attempt to predict BMD outcomes.[6] The two CPRs developed and tested in studies with good methodological ratings are the Simple Calculated Osteoporosis Risk Assessment Estimation (SCORE),[7] and the Osteoporosis Risk Assessment Instrument (ORAI).[8] However, these screening tools have been applied to different populations with inconsistent results.[9-11]

The ORAI assesses age, weight, and hormone replacement therapy for determination of risk category.

***Correspondence:** Peyman Mottaghi, MD, Assistant Professor of Department of Internal Medicine, *Division of Rheumatology,* Al Zahra Hospital, Isfahan University of Medical Sciences, Isfahan, Iran. Tel: +98-311-2293863, Fax: +98-311-2297448, e-mail: motaghi@med.mui.ac.ir

Received: May 10, 2009 Accepted: July 5, 2009

The SCORE is a more complicated decision rule that is scored according to race, presence of rheumatoid arthritis, history of low-impact fracture, age, estrogens use, and body weight. Selection of cut-off points that clinicians recommend in deciding which women should undergo bone densitometry is based on recommendations set by the developers of each rule.

To compare these tools in Iranian postmenopausal women, we applied the SCORE, ORAI, and National Osteoporosis Foundation (NOF) guidelines to a consequent group of postmenopausal women who referred to a bone densitometry centre to assess sensitivity, specificity and clinical usefulness of each tool as an osteoporosis screening method.

Materials and Methods

We evaluated the diagnostic performance of the ORAI, SCORE, and NOF recommendations to identify low bone mineral density (BMD) in 394 Iranian postmenopausal women aged 45 years and older presenting for BMD testing between February and September 2008 at a bone densitometry centre affiliated to Isfahan University of Medical Sciences .Women taking bone active medications (such as: calcitonin, bisphosphonates, raloxifen), or those with major risk factors for secondary osteoporosis (e.g. menopause before age 45, malabsorptive syndromes, hyperthyroidism, long-term glucocorticoid or levothyroxine use) were excluded.

According to the scoring methods for each clinical decision rule, as presented in Table 1, we calculated the total score for each woman. Age was calculated, using the date of BMD testing and date of birth, and weight was determined as recorded on the BMD report. For each decision rule, previously validated cut-off points for Caucasian women (ORAI ≥9, SCORE ≥ 6, and NOF≥ 1)[12] were used to determine whether a given woman would be recommended to undergo BMD testing. The femoral neck and the lumbar spine BMD of all the subjects were determined by the dual-energy x-ray absorptiometry method, using a Lunar DPX Alpha machine (Lunar Corporation, Madison, Wis).

The statistical analyses of the collected data were preformed, using SPSS (Version 13, Chicago, IL, USA). Basic demographic data and subject characteristics are reported as mean±SD for continuous variables. Sensitivity, specificity, and their corresponding 95% confidence intervals (CIs) were calculated at the recommended cut-off point for each CPR.

Sensitivity analyses were performed by comparing the predictive ability of different screening tools to identify normal BMD (< -1 SD of the young adult mean) and osteoporosis (≤ -2.5 SD of the young adult normal). We also calculated the positive predictive value (PPV) and negative predictive value (NPV) for each decision rule. The PPV was defined as the proportion of subjects with osteoporosis, who had a positive test result or true-positive findings (positive test result and osteoporosis), divided by the number of the subjects with a positive test result. The NPV was defined as the proportion of the subjects without osteoporosis, who had a negative test result or true-negative findings (negative test result and no osteoporosis), divided by the number of the subjects with a negative test result.

Results

After applying inclusion criteria and excluding those

Table1: Scoring System and Selection Cut-off Points for osteoporosis screening tools

Screening tools	(Cut-off Score)	Scoring Systems
SCORE	6	3 Times the first digit of age in years 5 points if not African American 4 points if rheumatoid arthritis present 4 points for each type of low-trauma fracture After 45 years 1 point if estrogen never used -1 *weight in pounds divided by 10 and truncated To an integer
ORAI	9	15 Points for age >75 y, 9 for 65-74 y, 5 for 55-64 y 9 points for weight 60 kg , 3 for 60-69 kg 2 points if not currently taking estrogen
NOF guidelines	1	1 Point each for: Age 65 y or more, Weight 57.6 kg or less, History of fracture, Family history of fracture, Current smoker

women who had one of the exclusion criteria, 341 postmenopausal women were eligible to be evaluated in this study. The women ranged in age from 45 to 90 years with a mean age of 59.7±7.8 years. The prevalence of RA in our sample was comparable with the SCORE cohorts (5%) and only 2.6% of the participant reported a non-traumatic fracture after age 45. The descriptive data for the study participants are shown in Table 2.

Among 341 evaluated postmenopausal women, according to the WHO reference standard (BMD < -1 SD of the young adult mean for osteopenia and ≤ −2.5 or less for osteoporosis), 71 (20.8%) had osteoporosis and 135 (39.6%) had osteopenia in one or two measured sites.

The sensitivity and specificity of decision rules and NOF guidelines to identify "at-risk" women at various thresholds of BMD (t score levels of -1, -2, and -2.5 SD) are summarized in Table 3. As shown, at the recommended threshold of 6, the SCORE had a sensitivity and specificity of 87.2 % and 37.9 %, respectively, with a PPV of 65.5 % and NPV of 100% for screening of women with low bone mass.

When we evaluated the ORAI at the cut-off point of 9, this instrument detected the low bone mass with a sensitivity of 70.9%, specificity of 66.9% and predictive value of 74.3%. The NOF guidelines had an overall sensitivity, specificity and PPV of 61.2 %, 76.5% and 51.3%, respectively in screening the postmenopausal women with low bone mass. The characteristics of each tool stratified by age group (45-60 vs. above 60 years) are shown in Table 4.

Although, these tools were more sensitive in older women (> 60 years), the specificity was higher in the younger postmenopausal women (< 60 years). The PPVs for both CPRs were higher in the older subgroup compared with the younger one.

Predictive errors of these screening tools for detection of postmenopausal osteoporosis were the highest for NOF guidelines (15%) and the lowest for SCORE (2.6%). The ORAI cannot detect 7.5% of the postmenopausal women with low bone mass.

Table 2: Demographic characteristics of Iranian women in validation study to evaluate performance of osteoporosis screening tool.

Variable		No. of women (%)
Mean age (and SD), yr	59.7 ± 7.8	341
Age, yr		
45-54		116 (34)
55-64		142 (42.5)
65-74		80 (23.5)
Weight, kg		
< 60		87 (25.5)
60-69		123 (36)
≥ 70		131 (38.5)
Rheumatoid arthritis		17 (0.5)
Minimal trauma fracture		9 (2.6)
Estrogen use*		41 (12)

BMD=bone mineral density, SD=standard deviation
* For more than 1 yr after menopause

Table 3: Discriminatory performance of screening tools for low bone mass in Iranian postmenopausal women

Tools	BMD value	Sensivity, %	Specificity, % (95% CI)	PPV, % (95% CI)
ORAI	> 1.0 SD below mean	70.9 (80.3-61.4)	66.9 (71.8-55.7)	74.3
	≥ 2.0 SDs below mean	83.7 (86-81.4)	56.8 (64- 49.5)	43.9
	≥ 2.5 SDs below mean	90.2 (99.3-69.4)	52.9 (51.4- 54.4)	29.4
SCORE	> 1.0 SD below mean	87.2 (97.2-76.4)	37.9 (44.2-31.6)	65.5
	≥ 2.0 SD below mean	92.9 (98.6- 75.5)	30 (33.7 -26.3)	34.9
	≥ 2.5 SD below mean	96.7 (99.8- 74.4)	27.9 (32.5-23.3)	22.6
NOF	> 1.0 SD below mean	48 (54.3-41.7)	84 (98.2-70)	80.3
	≥ 2.0 SD below mean	61.2 (72.6-49.8)	76.5 (86.3-66.7)	51.3
	≥ 2.5 SD below mean	75.4 (92.8-58.2)	74.6 (87.1-62.1)	39.3

Table 4: Discriminatory performance screening tools for low bone mass in postmenopausal women according to age category

Tools	Age, yr	No	Sensivity, %	Specificity, %	PPV, %
ORAI	45-60	193	52.3	81	69.7
	> 60	148	86.1	30	76.9
SCORE	45-60	193	76.1	48.6	55.4
	> 60	148	96.3	25.4	74.3

Discussion

Richy,[13] reported that when DXA was randomly used for finding the postmenopausal women with low bone density in a Caucasian population, 58% had low bone mass and 42% were normal, showing that this test was unnecessary for many of postmenopausal women.Thus, the aim of this study was to explore various strategies by which the demand on determination of bone mineral density by DXA services could be reduced by screening individuals who have shown themselves as normal upon DXA` examination.

The SCORE, ORAI and NOF recommendations are the most popular screening tools that attempt to develop a prediction rule for using bone densitometry to screen those in need of osteoporosis preventive treatment. Low BMD at either the femoral neck or the lumbar spine is clinically relevant for prophylactic treatment to prevent osteoporosis and possible fragility fractures.[14,15] Therefore, discriminatory performance of the screening tools was based on its ability to identify low BMD at either the femoral neck or the lumbar spine.

At original recommended threshold of 6, SCORE had a sensitivity of 90%, specificity of 32% and PPV of 64%.[7] That is, 90% of the individuals with low BMD, and 68% (100%-specificity of 32%) of those with normal BMD would be selected for DXA. This high false positive rate would result in unnecessary referrals for DXA.

For the prediction of osteoporosis, neither the 90% sensitivity, nor the sensitivity and specificity cut-off levels will provide a high probability of a positive test result. However, by using the suggested cut-off points, a clinician could confidently exclude an individual with a negative test result from any further diagnostic bone densitometry.

In one of the largest osteoporosis studies in Toronto, Canada, pre-screening of postmenopausal women for t score of lower than -2 with screening tools showed that the SCORE with sensitivity of 97.5% (95% CI, 96.3%-98.8%) and the ORAI with sensitivity of 94.2% (95% CI, 92.3%-96.1%) could detect women with low bone mass and so they were suitable for this propose.[9] In other studies in Belgium and Canada for detection of postmenopausal women with low bone density, the SCORE with a threshold of 6 score had a sensitivity of 91.5% and 90%, respectively, but specificity of this tool was 25% and 32%, respectively in those countries.

Some studies in Toronto and Ontario (Canada), using ORAI screening tool with a sensitivity of 94.2% and 93%, and specificity of 39% and 46.4 %, respectively, detected women with low bone mass t score<-1).[8,9] In spite of these, our study with the same cut-off point showed a reasonable sensitivity of 87 % and specificity of 38%, which was somehow lower but not significantly different from those results. According to the scoring of the ORAI , determination of bone density in women over 60 years old, postmenopausal women over 45 years weighing less than 60 kg, and women between 55-65 weighing less than 70 is indicated.[8,9]

Although according to NOF recommendations, determination of BMD is suggested for all postmenopausal women over 65 years and postmenopausal women with one or more risk factors, for Iranian postmenopausal women this tool has a low sensitivity and positive predictive value and is thus unsuitable for screening the postmenopausal women for low bone mineral density.

In our study, the SCORE had the highest sensitivity for detection of the severity of low bone mass and NOF recommendation had the lowest results. When these tools were evaluated in different age groups, all of them were more sensitive and specific for women aged above 60 years and also for screening of low bone mass in the spinal area.

Overall, although our results, using screening tools in postmenopausal women for pre- screening of low BMD, were somewhat lower as compared to the reports in western studies,[16-19] in Caucasian women, our results also showed it is reasonable to use both the SCORE and ORAI in Iranian postmenopausal women to find the

high risk cases for low bone mass that can be the candidates for preventive and treatment measures.

According to the sensitivity and positive predictive values of the ORAI and the SCORE, we concluded that these screening tools are suitable for the purpose of selection and referral of an appropriate population of postmenopausal women for bone densitometry. But, for the prediction of osteoporosis, neither of these screening tools will provide a high probability of a positive test result. However, by using the screening tools with suggested cut-offs, a clinician could confidently exclude an individual with a negative test result from any further diagnosis and thus screen a large population of postmenopausal women with low cost.

Acknowledgements

The authors would like to thank the secretaries of Isfahan bone densitometry unit and the Office of Vice Chancellor for Research for supporting this study.

Conflict of interest: None declared.

References

1 Cummings SR, Melton LJ. Epidemiology and outcomes of osteoporotic fractures. *Lancet* 2002;**359**:1761-7. [12049882] [doi:10.1016/S0140-6736(02)08657-9]

2 Riggs BL, Melton LJ 3rd. The worldwide problem of osteoporosis: insights afforded by epidemiology. *Bone* 1995;**17**:505S-511S. [8573428] [doi:10.1016/8756-3282(95)00258-4]

3 Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. *Lancet* 2002;**359**:1929-36. [12057569] [doi:10.1016/S0140-6736(02)08761-5]

4 Laupacis A, Sekar N, Stiell IG. Clinical prediction rules. A review and suggested modifications of methodological standards. *JAMA* 1997;**277**:488-94. [9020274] [doi:10.1001/jama.277.6.488]

5 Ribot C, Pouilles JM, Bonneu M, Tremollieres F. Assessment of the risk of post-menopausal osteoporosis using clinical factors. *Clin Endocrinol (Oxf)* 1992;**36**:225-8. [1563075] [doi:10.1111/j.1365-2265.1992.tb01436.x]

6 Cadarette SM, McIsaac WJ, Hawker GA, Jaakkimainen L, Culbert A, Zarifa G, Ola E, Jaglal SB. The validity of decision rules for selecting women with primary osteoporosis for bone mineral density testing. *Osteoporos Int* 2004;**15**:361-6. [14730421] [doi:10.1007/s00198-003-1552-7]

7 Lydick E, Cook K, Turpin J, Melton M, Stine R, Byrnes C. Development and validation of a simple questionnaire to facilitate identification of women likely to have low bone density. *Am J Manag Care* 1998;**4**:37-48. [10179905]

8 Cadarette SM, Jaglal SB, Kreiger N, McIsaac WJ, Darlington GA, Tu JV. Development and validation of the Osteoporosis Risk Assessment Instrument to facilitate selection of women for bone densitometry. *CMAJ* 2000;**162**:1289-94. [10813010]

9 Cadarette SM, Jaglal SB, Murray TM. Validation of the simple calculated osteoporosis risk estimation (SCORE) for patient selection for bone densitometry. *Osteoporos Int* 1999;**10**:85-90. [10501785] [doi:10.1007/s001980050199]

10 Ben Sedrine W, Devogelaer JP, Kaufman JM, Goemaere S, Depresseux G, Zegels B, Deroisy R, Reginster JY. Evaluation of the simple calculated osteoporosis risk estimation (SCORE) in a sample of white women from Belgium. *Bone* 2001;**29**:374-80. [11595621] [doi:10.1016/S8756-3282(01)00583-X]

11 Mauck KF, Cuddihy MT, Atkinson EJ, Melton LJ 3rd. Use of clinical prediction rules in detecting osteoporosis in a population-based sample of postmenopausal women. *Arch Intern Med* 2005;**165**:530-6. [15767529] [doi:10.1001/archinte.165.5.530]

12 The prevention and management of osteoporosis. Consensus statement. Australian National Consensus Conference 1996. *Med J Aust* 1997;**167**:S1-15. [9236768]

13 Richy F, Gourlay M, Ross PD, Sen SS, Radican L, De Ceulaer F, Ben Sedrine W, Ethgen O, Bruyere O, Reginster JY. Validation and comparative evaluation of the osteoporosis self-assessment tool (OST) in a Caucasian population from Belgium. *QJM* 2004;**97**:39-46. [14702510] [doi:10.1093/qjmed/hch002]

14 Clinical practice guidelines for the diagnosis and management of osteoporosis. Scientific Advisory Board, Osteoporosis Society of Canada. *CMAJ* 1996;**155**:1113-33. [8873639]

15 Guidelines for the early detection of osteoporosis and prediction of fracture risk. Council of the National Osteoporosis Foundation. *S Afr Med J* 1996;**86**:1113-6. [8888782]

16 Geusens P, Hochberg MC, van der Voort DJ, Pols H, van der Klift M, Siris E, Melton ME, Turpin J, Byrnes C, Ross P. Performance of risk indices for identifying low bone density in postmenopausal women. *Mayo Clin Proc* 2002;**77**:629-37. [12108600] [doi:10.4065/77.7.629]

17 Cadarette SM, Jaglal SB, Murray TM, McIsaac WJ, Joseph L, Brown JP; Canadian Multicentre Osteoporosis Study. Evaluation of decision rules for referring women for bone densitometry by dual-energy x-ray absorptiometry. *JAMA* 2001;**286**:57-63. [11434827] [doi:10.1001/jama.286.1.57]

18 Von Mühlen D, Visby Lunde A, Barrett-Connor E, Bettencourt R. Evaluation of the simple calculated osteoporosis risk estimation (SCORE) in older Caucasian women: the Rancho Bernardo study. *Osteoporos Int* 1999;**10**:79-84. [10501784] [doi:10.1007/s001980050198]

19 Ribot C, Pouilles JM, Bonneu M, Tremollieres F. Assessment of the risk of post-menopausal osteoporosis using clinical factors. *Clin Endocrinol (Oxf)* 1992;**36**:225-8. [1563075] [doi:10.1111/j.1365-2265.1992.tb01436.x]