Risk assessment instruments for screening bone mineral density in a Mediterranean population

Sotirios Christodoulou, Georgios I Drosos, Athanasios Ververidis, Antonios Galanos, George Anastassopoulos, Konstantinos Kazakos

Sotirios Christodoulou, Georgios I Drosos, Athanasios Ververidis, Konstantinos Kazakos, Department of Orthopaedic Surgery, Democritus University of Thrace, University General Hospital of Alexandroupolis, Dragana, 68100 Alexandroupolis, Greece
Antonios Galanos, Laboratory for Research of the Musculoskeletal System, University of Athens, KAT Hospital, Kifissia, 14561 Athens, Greece
George Anastassopoulos, Medical Informatics Laboratory, Medical School, Democritus University of Thrace, Dragana, 68100 Alexandroupolis, Greece

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Correspondence to: Georgios I Drosos, MD, PhD, Associate Professor of Orthopaedics, Department of Orthopaedic Surgery, Democritus University of Thrace, University General Hospital of Alexandroupolis, St. Niarhos Street 1, Dragana, 68100 Alexandroupolis, Greece. drosos@otenet.gr
Telephone: +30-6944-380694
Fax: +30-25510-30370

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Abstract

AIM
To evaluate the power of six osteoporosis-screening instruments in women in a Mediterranean country.

METHODS
Data concerning several osteoporosis risk factors were prospectively collected from 1000 postmenopausal women aged 42-87 years who underwent dual-energy X-ray absorptiometry (DEXA) screening. Six osteoporosis risk factor screening tools were applied to this sample to evaluate their performance and choose the most appropriate tool for the study population.

RESULTS
The most important screening tool for osteoporosis status was the Simple Calculated Osteoporosis Risk Estimation, which had an area under the curve (AUC) of 0.678, a sensitivity of 72%, and a specificity of 72%, with a cut-off point of 20.75. The most important screening tool for osteoporosis risk was the Osteoporosis Self-assessment Tool, which had an AUC of 0.643, a sensitivity of 77%, and a specificity of 46%,...
with a cut-off point of -2.9.

CONCLUSION
Some commonly used clinical risk instruments demon-
strate high sensitivity for distinguishing individuals with
DEXA-ascertained osteoporosis or reduced bone mineral
density.

Key words: Osteoporosis; Bone mineral density; Risk
assessment; Dual X-ray absorptiometry; Osteopenia

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Core tip: Bone mineral density (BMD) measurement using
dual-energy X-ray absorptiometry (DEXA) is currently
the most widely used method for osteoporosis screening,
treatment and patient monitoring. Nevertheless, perform-
ing routine BMD measurements of all women is not
feasible for most populations, and at present there is no
universally accepted policy for population screening in
Europe to identify patients with osteoporosis or those at
high risk of fracture. Osteoporosis risk factor screening
tools have been developed to identify postmenopausal
women in need of DEXA screening and possible inter-
vention for osteoporosis.

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INTRODUCTION
Osteoporosis is the most common bone disease, charac-
terized by low bone mass and microarchitecture deteri-
oration, which increase bone fragility and susceptibility
to fracture[1]. Distal forearm fractures, vertebra fractures
and proximal femoral (hip) fractures are typical osteo-
porotic fractures. However, patients with low bone
mineral density (BMD) are at high risk for all types of
fractures, irrespective of fracture site[2].

An estimated 50% of Caucasian women and 20%
of Caucasian men older than 50 years will experience a
fragility fracture in their lifetime[3]. This is an important
public health issue because many of these fractures are
associated with increased mortality, morbidity or
permanent disability, as well as high societal and per-
sonal costs[4]. Identification and treatment of patients,
particularly women, at risk for osteoporosis is of great
importance for the prevention of osteoporotic fractures[5].

BMD measurement using dual-energy X-ray absorpti-
ometry (DEXA) is currently the most widely used
method to diagnose osteoporosis (i.e., provide criteria
for fracture risk), to guide treatment decisions and to
monitor patient course after receiving or not receiving
treatment[6]. Nevertheless, routine BMD measurement of
all women is not feasible for most populations because
of lack of scanners, lack of awareness or lack of widely
accepted guidelines. At present, there is no universally
accepted policy for population screening in Europe to
identify patients with osteoporosis or those at high risk of
fracture.

Additionally, the various osteoporosis-screening in-
struments that exist to help clinicians identify women
at increased risk for osteoporosis who should undergo
further testing in combination with DEXA screening[7].

The aim of this survey was to evaluate the power of
six osteoporosis-screening instruments[8-13] in identifying
postmenopausal women at risk of developing osteo-
porosis in a Mediterranean country. More specifically, our
aim was to evaluate these clinical risk estimation instru-
ments in distinguishing individuals with DEXA-identified
osteoporosis or reduced BMD while sustaining specific
levels of sensitivity and specificity for select cut-off values
to identify individuals with BMD T-scores beneath a
defined DEXA score.

MATERIALS AND METHODS

Patients
This cross-sectional study utilized prospectively collected
data from the Bone Density Measurement Unit of the
Department of Orthopaedic Surgery at University General
Hospital of Alexandroupolis, a tertiary hospital. The study
was approved by the Ethics Committee of the hospital,
and informed consent was obtained from all participants.

The study included postmenopausal women (> 12 mo
since last menstrual period). Women receiving medica-
tion for either the prevention or treatment of diagnosed
osteoporosis were excluded.

All the study subjects underwent DEXA screening
between October 1, 2012 and October 1, 2014. Con-
firmation of osteoporosis occurred through BMD mea-
surements, which were compared with the results of the
other analytical tools used.

Additionally, the following information was obtained
from each patient: Age, weight, height, various osteo-
porosis risk factors (i.e., a history of fragility fractures
of the spine or hip that occurred after age 50 years),
parental hip fracture, ever or current long-term use of
steroids (> 3 mo use), current smoking, small stature
(body mass index < 21 kg/m²), medical history of
rheumatoid arthritis, other medical causes of bone loss
(i.e., hyperthyroidism, hyperparathyroidism, kidney
failure, or anorexia), use of long-term therapy with medi-
cations known to adversely affect BMD (i.e., heparin or
anticonvulsants), use of arms to stand up (as an indicator
of physical activity), ever or current hormonal therapy,
concomitant medications, and family and personal
medical histories. The results from each DEXA screen
were obtained and incorporated into the database.

Screening tools
In this study, six screening tools[8-13] were applied to
evaluate a sample of Greek postmenopausal women. The performance of the tools was compared to select the most suitable instrument for this population.

The simple calculated osteoporosis risk estimation (SCORE) was formulated by Lydick et al[9] and accounts for 6 risk factors (Table 1). The SCORE possesses a sensitivity ranging from 0.80 to 1.00 and a specificity ranging from 0.40 to 0.50.

The osteoporosis risk assessment instrument (ORAI) was formulated by Cadarette et al[10] and accounts for 3 risk factors (Table 1). The ORAI has a sensitivity of 0.90 and a specificity of 0.45.

The osteoporosis self-assessment tool (OST) was formulated by Geusens et al[11] for evaluation of Asian and Caucasian women. It utilizes 2 factors (Table 1) and shows a sensitivity of 0.88 and a specificity of 0.52.

The body weight criterion (BW) was formulated by Michaëllson et al[12] and accounts for only one factor (Table 1). It has a sensitivity of 0.94 and a specificity of 0.36.

The osteoporosis index of risk (OSIRIS) was formulated by Sedrine et al[13] using four factors (Table 1). It has a sensitivity of 0.79 and a specificity of 0.51.

Weinstein and Ullery[14] formulated the Age, Body size, No Estrogen tool (ABONE) (Table 1), which has a high specificity of 0.84 but a low sensitivity of 0.56.

### Statistical analysis

Data are expressed as the mean ± SD or the median (IQR) for quantitative data and as percentages for qualitative data. The Kolmogorov-Smirnov test was utilized for normality analyses of the parameters. A receiver operating curve (ROC) analysis was conducted to determine the diagnostic abilities and obtain the cut-off levels of the various osteoporosis-screening tools in classifying patients as osteoporotic or at high osteoporotic risk. This was accomplished according to T-score classification by calculating the areas under the curve (AUC) and their standard errors and 95% CIs. To evaluate the internal credibility of the indices, sensitivity was delineated as the proportion of the population with reduced BMD who were correctly categorized by the risk index (true positive fraction), and specificity was delineated as the proportion of the population with normal BMD who were correctly categorized by the risk index (true negative fraction).

We also measured the positive predictive value (PPV) and negative predictive value (NPV) of each instrument to measure their external credibility. The PPV and NPV corresponded to the average numbers of women who were deemed as positive or negative (as compared by the four instruments), respectively, who truly had or did not have BMD values beneath the T-score cut-off.

The ROC curves were used to provide a graphical interpretation of the general quality of each test by plotting sensitivity against (1–specificity) for all thresholds, while the AUC values were used to indicate test quality. Multiple logistic regression analysis using the enter method was performed with the dependent variables (T-score ≤ -2.5 vs T-score > -2.5) and (T-score ≤ -2 vs T-score > -2) and the osteoporosis-screening indices as the independent variables. All the tests were two-sided, and statistical significance was set at P < 0.05. All analyses were carried out using SPSS ver 17.00 (Statistical Package for the Social Sciences, SPSS Inc., Chicago, Ill., United States).

### Results

One thousand women with a mean age of 63.41 years (minimum 42 years and maximum 87 years) were included in this study. The mean age at menarche was 13.2 years (minimum 8 years and maximum 18 years), and the mean weight and height were 73.52 kg (minimum 40 kg and maximum 120 kg) and 1.59 m (minimum 1.42 m and maximum 1.80 m). The mean number of pregnancies was 2.3 (0-12 pregnancies), the mean alcohol consumption was 0.37 drinks weekly (0-7 drinks), and the mean coffee consumption was 1.60 cups daily (0-6 cups). Additionally, 12.1% of the population were smokers, 64.5% had previously experienced a graduated fracture, 20% regularly exercised, 20% had kyphosis, 2.7% had rheumatoid arthritis, 3.8% had received hormone therapy, and 3.2% had received cortisone.

The following indicator values were obtained: BW: 73.52 ± 11.32, OST: -2.02 ± 2.94, ORAI: 10.05 ± 5.02, SCORE: 20.54 ± 3.70, OSIRIS: 0.68 ± 3.14 and ABONE: 1.54 ± 0.66. The AUC ratios and the sensitivities and specificities of the instruments for identifying high osteoporotic risk and osteoporosis were assessed using cut-off points from the literature. The tool with the highest AUC value was the ABONE (AUC: 0.628), followed by the ORAI (AUC: 0.608).

The highest levels of sensitivity and accuracy in identifying patients at high risk of osteoporosis were obtained by the ORAI (72%) and the ABONE (65%). The highest levels of sensitivity and accuracy in diagnosing osteoporosis were obtained by the OSIRIS (63%) and the BW (67%).

### Table 1 Criteria for clinical decision rules and osteoporotic risk factors

| Instrument | Criteria |
|------------|----------|
| SCORE      | Age, body weight (kg), race, hormone therapy use, fracture history, history of rheumatoid arthritis |
| ORAI       | Age, body weight (kg), hormone therapy use |
| OST        | Age, body weight (kg) |
| BW         | Body weight (kg) |
| OSIRIS     | Age, body weight (kg), hormone therapy use, fracture history |
| ABONE      | Age, body size, lack of estrogen |

SCORE: Simple calculated osteoporosis risk estimation; ORAI: Osteoporosis risk assessment instrument; OST: Osteoporosis self-assessment tool; BW: Body weight; OSIRIS: Osteoporosis index of risk; ABONE: Age, body size, no estrogen.
Table 2 Receiver operating curve analysis using international guidelines

|          | AUC  | 95% CI | Sensitivity | Specificity | P-value |
|----------|------|--------|-------------|-------------|---------|
| SCORE1   |      |        |             |             |         |
| ORAI1    | 0.608| 0.57   | 0.65        | 0.716       | 0.498   | < 0.0005 |
| ABONE2   | 0.628| 0.59   | 0.67        | 0.650       | 0.610   | < 0.0005 |
| BW3      | 0.535| 0.49   | 0.58        | 0.400       | 0.667   | 0.109   |
| OST4     | 0.586| 0.54   | 0.63        | 0.515       | 0.312   | < 0.0005 |

1Osteoporosis risk T-score < -2; 2Osteoporosis status T-score < -2.5.
AUC: Area under the curve; SCORE: Simple calculated osteoporosis risk estimation; ORAI: Osteoporosis risk assessment instrument; ABONE: Age, body size, no estrogen; BW: Body weight; OST: Osteoporosis self-assessment tool; OSIRIS: Osteoporosis index of risk.

The AUC, sensitivity, and specificity values and the cut-off points for the indicators of osteoporosis risk are presented in Table 3. The clinical tool with the highest AUC value was the OST (AUC: 0.643), followed by the ORAI (AUC: 0.640) and the ABONE (AUC: 0.631). The highest sensitivity in identifying patients at high risk for osteoporosis was obtained with the OST (77%), followed by the ORAI (72%) and the ABONE (65%). The highest accuracy for identifying individuals at high osteoporotic risk was obtained by the BW (61%), followed by the SCORE (60%). The sensitivity of the BW was 51%, and its specificity was 61%. The sensitivity and specificity for the SCORE were 61% and 60%, respectively.

The AUC, sensitivity, and specificity values and the cut-off points for the indicators of osteoporotic condition are shown in Table 4. The clinical tool with the highest AUC value was the SCORE (AUC: 0.678), followed by the OST (AUC: 0.644) and the OSIRIS (AUC: 0.641). The highest sensitivity in diagnosing osteoporosis was obtained with the OST (80%), followed by the OSIRIS (76%) and the SCORE (65%). The highest accuracy for assessing osteoporotic status was obtained with the ORAI (60%) and the SCORE (60%).

The sensitivity for the OST was 80%, and its specificity was 43%. The sensitivity and specificity for the OSIRIS were 76% and 44%, respectively. For the SCORE, the sensitivity and specificity were 72% and 60%, respectively. For the ORAI, the specificity and sensitivity were 65% and 60%, respectively.

The results from the multiple logistic regression analysis for the variable high osteoporotic risk are presented in Table 5. For this analysis, we introduced each of the variables into a multiple linear regression model (known as the enter method) to identify the independent effects of each instrument on the variable high osteoporotic risk. We found that the OST (P = 0.012), ABONE (P = 0.051) and SCORE (P = 0.081) each had a statistically significant effect on this variable.

The results from the multiple logistic regression analysis for the variable osteoporosis are presented in Table 6. Similar to the above, we used the enter method to identify the independent effects of each instrument on the variable osteoporosis. Only the SCORE (P < 0.0005) had a statistically significant effect on this variable.

**DISCUSSION**

In this survey, we assessed the performance of six osteoporosis pre-screening models in evaluating a sample of Greek postmenopausal women and selected the most suitable instrument for that population. Our results exhibited that, assuming a -2.5 cut-off for T-score in three areas of concern, the OST and the OSIRIS had equal predictive precision (AUCs between 0.586 and 0.6). Additionally, assuming a -2 cut-off for T-score in three areas of concern, the ORAI and the ABONE had equal predictive precision (AUCs between 0.608 and 0.628).

The least suitable and least useful model based on AUC was the BW, which had only 0.40% sensitivity. The ABONE and the ORAI were more suitable models, each with an AUC of approximately 0.628.

When considering the AUCs, sensitivities, specificities and cut-off points for the indicators of patients at high-risk of osteoporosis, the clinical tool with the highest AUC value was the OST (AUC: 0.643), followed by the ORAI (AUC: 0.640) and the ABONE (AUC: 0.631).

With regard to the AUCs, sensitivities, specificities and cut-off points for osteoporosis, the clinical tool with the highest AUC value was the SCORE (AUC: 0.678), followed by the OST (AUC: 0.644) and the OSIRIS (AUC: 0.641).

Combining the above criteria, in the Greek postmenopausal population, the most important screening tool for osteoporosis status is the SCORE, and for osteoporotic risk, it is the OST. In our study, the SCORE had an AUC of 0.678, a sensitivity of 72%, and a specificity of 72%, with a cut-off point of 20.75, for osteoporosis status. Additionally, the screening tool most important for osteoporosis risk was the OST. The OST had an AUC of 0.643, a sensitivity of 77%, and a specificity of 46%, with a cut-off point of -2.9.

These results must be interpreted with caution, as they are based on a sample of only 1000 patients and may not represent the entire Greek population.

As clinical decision tools, instruments used to predict osteoporosis risk and to identify osteoporosis should be straightforward and convenient to apply in clinical practice in addition to being accurate. Nevertheless, when applying such instruments to different countries or populations, their reported utility has varied amongst different studies. It has been found that they perform well in classifying the risk of osteoporosis and that applying them is more prudent than the use of the BMD. However, clinical decision-making tools were found to have limited utility for predicting osteoporosis in patients with rheumatoid arthritis. Wallace et al reported sensitivities of 83% for the SCORE and 65% for the ORAI. Martínez-Aguilà et al found sensitivities of 64% for the ORAI and 83% for the BW in Spanish women, while Cass et al reported sensitivities of 66% for the SCORE and 68% for the ORAI in a group of Caucasian (non-Hispanic and Hispanic) and African-American postmenopausal women.

|          | AUC  | 95% CI | Sensitivity | Specificity | P-value |
|----------|------|--------|-------------|-------------|---------|
| SCORE1   |      |        |             |             |         |
| ORAI1    | 0.608| 0.57   | 0.65        | 0.716       | 0.498   | < 0.0005 |
| ABONE2   | 0.628| 0.59   | 0.67        | 0.650       | 0.610   | < 0.0005 |
| BW3      | 0.535| 0.49   | 0.58        | 0.400       | 0.667   | 0.109   |
| OST4     | 0.586| 0.54   | 0.63        | 0.515       | 0.312   | < 0.0005 |
| OSIRIS2  | 0.600| 0.56   | 0.64        | 0.631       | 0.570   | < 0.0005 |
Table 3  Receiver operating curve analysis using Greek population values for osteoporosis risk

| Area   | 95%CI  | Cut-off | Sensitivity | Specificity | PPV  | NPV   | P-value |
|--------|--------|---------|-------------|-------------|------|-------|---------|
| SCORE  | 0.613  | 0.576  | 0.650       | 20.75 >     | 61%  | 60%   | 46%     |
| ORAI   | 0.640  | 0.603  | 0.676       | 9.5 >       | 72%  | 52%   | 46%     |
| ABONE  | 0.631  | 0.595  | 0.668       | 10.5 >      | 62%  | 62%   | 48%     |
| OST    | 0.643  | 0.607  | 0.678       | -2.9 >      | 77%  | 46%   | 45%     |
| BW     | 0.592  | 0.555  | 0.630       | 70.5 <      | 51%  | 61%   | 42%     |
| ORAI   | 0.609  | 0.572  | 0.645       | 0.5 <       | 59%  | 59%   | 44%     |

Table 4  Receiver operating curve analysis using Greek population values for osteoporosis status

| Area   | 95%CI  | Cut-off | Sensitivity | Specificity | PPV  | NPV   | P-value |
|--------|--------|---------|-------------|-------------|------|-------|---------|
| SCORE  | 0.678  | 0.640  | 0.717       | 20.75 >     | 72%  | 60%   | 36%     |
| ORAI   | 0.632  | 0.591  | 0.673       | 10.5 >      | 65%  | 60%   | 33%     |
| ABONE  | 0.618  | 0.576  | 0.659       | 1.5 >       | 66%  | 60%   | 48%     |
| OST    | 0.644  | 0.604  | 0.684       | -2.9 >      | 80%  | 43%   | 30%     |
| BW     | 0.591  | 0.549  | 0.633       | 75.5 <      | 69%  | 41%   | 26%     |
| ORAI   | 0.641  | 0.601  | 0.681       | 0.5 <       | 63%  | 57%   | 31%     |
| OSIRIS | 0.615  | 0.572  | 0.645       | 1.5 <       | 76%  | 44%   | 30%     |

Table 5  Multiple logistic regression model (T-score ≤ -2)

| Reference category | Odds ratio | 95%CI     | P-value |
|--------------------|------------|-----------|---------|
| SCORE              | 20.75 <    | 1.36     | 0.96   | 1.91 | 0.081 |
| ORAI               | 10.5 <     | 1.30     | 0.8    | 2.09 | 0.287 |
| ABONE              | 1.5 <      | 1.64     | 1.00   | 2.70 | 0.051 |
| OST                | -2.9 <     | 1.81     | 1.14   | 2.88 | 0.012 |
| BW                 | 70.5 <     | 1.05     | 0.75   | 1.47 | 0.772 |
| OSIRIS             | 0.5 >      | 0.78     | 0.52   | 1.16 | 0.214 |

Table 6  Multiple logistic regression model (T-score ≤ -2.5)

| Reference category | Odds ratio | 95%CI     | P-value |
|--------------------|------------|-----------|---------|
| SCORE              | 20.75 <    | 2.87     | 1.92   | 4.29 | <0.0005 |
| ORAI               | 10.5 <     | 1.42     | 0.81   | 2.48 | 0.215 |
| ABONE              | 1.5 <      | 0.95     | 0.53   | 1.70 | 0.865 |
| OST                | -2.9 <     | 1.35     | 0.90   | 2.65 | 0.115 |
| BW                 | 70.5 <     | 1.10     | 0.76   | 1.60 | 0.600 |
| OSIRIS             | 0.5 >      | 0.88     | 0.56   | 1.39 | 0.586 |

**Study limitation**

The main limitation of our study is the small population evaluated. The information we gathered specifically pertains to women who were seen at university hospital in Alexandroupolis, Eastern-Macedonia and Thrace. However, as a notable strength, our study is the most inclusive evaluation of clinical risk assessment instruments for distinguishing Greek postmenopausal women with osteoporosis or reduced BMD.

In conclusion, our study identified clinical risk instruments that showed high sensitivity for identifying individuals with DEXA-determined osteoporosis or low BMD, but with lower specificity. Further studies with larger sample sizes are needed to confirm these findings.
We believe that further studies from other centers in our region concerning the effectiveness of these instruments are required.

COMMENTS

Background
Osteoporosis is the most common bone disease, characterized by low bone mass and microarchitecture deterioration, which increase bone fragility and susceptibility to fracture. Dual-energy X-ray absorptiometry (DEXA) is currently the most widely used method to diagnose low bone mass, but routine bone mineral density (BMD) measurement of all women is not feasible for most populations, and universally accepted guidelines do not exist.

Research frontiers
Clinical risk assessment instruments for distinguishing individuals with osteoporosis or reduced BMD have been formulated to identify postmenopausal women who should undergo DEXA measurement for osteoporosis. Nevertheless, applying these instruments in different countries or populations has shown varied utility amongst previous studies.

Innovations and breakthroughs
In the current study, the authors utilized six osteoporosis pre-screening instruments on a sample of Greek postmenopausal women to standardize their interpretation and select the most suitable instrument for that population. With consideration of the factors identified in other instrument validations, we showed that using -2.5 as a cut-off T-score in three areas of interest for the studied osteoporosis self-assessment tools and osteoporosis index of risk produced the highest precision [area under the curve (AUC) between 0.586 and 0.6]. At the same time, using -2 as a cut-off T-score in three areas of interest in the studied osteoporosis risk assessment instruments while accounting for age, body size, and lack of estrogen produced the highest precision (AUC between 0.608 and 0.628).

Applications
The purpose of this study was to measure the performance of a panel of clinical risk instruments in identifying individuals with DEXA-determined osteoporosis or reduced BMD in a Mediterranean population. Specifically, the authors measured the sensitivity and specificity associated with different cut-off values to identify individuals with BMD T-scores below a nominal DEXA threshold.

Terminology
Osteoporosis is a skeletal disease characterized by low bone mass and microarchitecture deterioration, which increase bone fragility and susceptibility to fracture. BMD measurement using DEXA is currently the most widely used method to diagnose osteoporosis (i.e., provide criteria for fracture risk), guide its treatment and monitor patient course after receiving or not receiving treatment. Osteoporosis risk factor clinical risk assessment instruments for distinguishing individuals with osteoporosis or reduced BMD were formulated to identify postmenopausal women who should undergo DEXA measurement for osteoporosis.

Peer-review
This is an interesting paper with regards to the argument of screening tools for osteoporosis and identification of the patients that need to have DEXA measurement. Furthermore, it adds information missing in this area of the Mediterranean Sea.

REFERENCES

1 Cummings SR, Melton LJ. Epidemiology and outcomes of osteoporotic fractures. Lancet 2002; 359: 1761-1767 [PMID: 12049882 DOI: 10.1016/S0140-6736(02)08657-9]
2 Kanis JA, Johnell O, De Laet C, Johansson H, Oden A, Delmas P, Eisman J, Fujiwara S, Garnero P, Kroger H, McCloskey EV, Mellström D, Melton LJ, Pols H, Reeve J, Silman A, Tenenhouse A. A meta-analysis of previous fracture and subsequent fracture risk. Bone 2004; 35: 375-382 [PMID: 15268886 DOI: 10.1016/j.bone.2004.03.024]
3 Melton III L, Cooper C. Magnitude and impact of osteoporosis and fractures. In: Marcus R, Feldman D, Kelsey J. Osteoporosis. 2nd ed. San Diego: Academic Press, 2001: 557-567
4 Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int 2006; 17: 1726-1733 [PMID: 16983459 DOI: 10.1007/s00198-006-0172-4]
5 Johnell O. The socioeconomic burden of fractures: today and in the 21st century. Am J Med 1997; 103: 205-25S; discussion 25S-26S [PMID: 9302804 DOI: 10.1016/S0002-9343(97)90023-1]
6 Kanis JA, McCloskey EV, Johansson H, Cooper C, Rizzoli R, Reginster JY. European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporos Int 2013; 24: 23-57 [PMID: 23079689 DOI: 10.1007/s00198-012-2074-y]
7 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 2006; 162: 1289-1294 [PMID: 18013010 DOI: 10.1007/s00198-008-0560-z]
8 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 [PMID: 10179905]
9 Cadarette SM, Jaglal SB, Murray TM, McIsaac WJ, Joseph L, Brown JP. Evaluation of decision rules for referring women for bone densitometry by dual-energy x-ray absorptiometry. JAMA 2001; 286: 57-63 [PMID: 11434827 DOI: 10.1001/jama.286.1.57]
10 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: 629-637 [PMID: 12108600 DOI: 10.4065/77.7.629]
11 Michaelsson K, Bergström R, Mallmin H, Holmberg L, Wolk A, Ljunghall S. Screening for osteopenia and osteoporosis: selection by body composition. Osteoporos Int 1996; 6: 120-126 [PMID: 8704349 DOI: 10.1007/BF01623934]
12 Sedrine WB, Chevallier T, Zegels B, Kvasz A, Micheletti MC, Gelas B, Reginster JY. Development and assessment of the Osteoporosis Index of Risk (OSIRIS) to facilitate selection of women for bone densitometry. Gynecol Endocrinol 2002; 16: 245-250 [PMID: 12192897 DOI: 10.1080/gex.16.3.245.250]
13 Weinstein L, Uller B. Identification of at-risk women for osteoporosis screening. Am J Obstet Gynecol 2000; 183: 547-549 [PMID: 10992172 DOI: 10.1067/mob.2000.106594]
14 Koh LK, Sedrine WB, Torralba TP, Kung A, Fujwara S, Chan SP, Huang QR, Rajatanaiv R, Tsai KS, Park HM, Reginster JY. A simple tool to identify asian women at increased risk of osteoporosis. Osteoporos Int 2001; 12: 699-705 [PMID: 11580084 DOI: 10.1007/s00198-01070070]
15 Brand C, Lowe A, Hall S. The utility of clinical decision tools for diagnosing osteoporosis in postmenopausal women with rheumatoid arthritis. BMC Musculoskelet Disord 2008; 9: 13 [PMID: 18230132 DOI: 10.1186/1471-2474-9-13]
16 Wallace LS, Ballard JE, Holiday D, Turner LW, Keenun AJ, Pearman CM. Evaluation of decision rules for identifying low bone density in postmenopausal African-American women. J Natl Med Assoc 2004; 96: 290-296 [PMID: 15040510]
17 Martínez-Aguilá D, Gómez-Vaquero C, Rozadilla A, Romero M, Navázquez J, Nolla JM. Decision rules for selecting women for bone mineral density testing: application in postmenopausal women referred to a bone densitometry unit. J Rheumatol 2007; 34: 1307-1312 [PMID: 17552058]
18 Cass AR, Shepherd AJ, Carlson CA. Osteoporosis risk assessment and ethnicity: validation and comparison of 2 clinical risk stratification instruments. J Gen Intern Med 2006; 21: 630-635 [PMID: 16805748 DOI: 10.1111/j.1525-1479.2006.0459.x]
19 Rud B, Hildén J, Hyl dyslup, L, Hróbjartsson A. Performance of the Osteoporosis Self-Assessment Tool in ruling out low bone mineral density in postmenopausal women: a systematic review.
Christodoulou S et al. Risk assessment instruments for screening BMD

Osteoporos Int 2007; 18: 1177-1187 [PMID: 17361324 DOI: 10.1007/s00198-006-0319-3]

20 Rud B, Hilden J, Hyldestup L, Hróbjartsson A. The Osteoporosis Self-Assessment Tool versus alternative tests for selecting post-menopausal women for bone mineral density assessment: a comparative systematic review of accuracy. Osteoporos Int 2009; 20: 599-607 [PMID: 18716823 DOI: 10.1007/s00198-008-0713-0]

Kanis JA, Melton LJ, Christiansen C, Johnston CC, Khaltaev N. The diagnosis of osteoporosis. J Bone Miner Res 1994; 9: 1137-1141 [PMID: 7976495 DOI: 10.1002/jbmr.5650090802]

22 Looker AC, Borrud LG, Dawson-Hughes B, Shepherd JA, Wright NC. Osteoporosis or low bone mass at the femur neck or lumbar spine in older adults: United States, 2005-2008. NCHS Data Brief 2012; (93): 1-8 [PMID: 22617299]

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