The performance of osteoporosis self-assessment tool for Asians (OSTA) in assessing the risk of osteoporosis in postmenopausal women aged 45 years and older

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Abstract

Objectives: Application of the OSTA (Osteoporosis Self-Assessment Tool for Asians) in assessing the risk of osteoporosis in postmenopausal women aged 45 years and older; Evaluation of the relationship between OSTA and bone mineral density measured by dual-energy X-ray absorptiometry (DEXA). **Subjects and methods:** A cross-sectional descriptive study was performed on 430 postmenopausal women aged 45 years and older who were treated at Hue University of Medicine and Pharmacy Hospital from 9/2021 to 6/2022. Bone mineral density was measured by dual-energy X-ray absorptiometry (DEXA). Diagnosis and classification of osteoporosis are based on the T-score (WHO 1994). Calculating the OSTA according to the formula: OSTA = 0.2 x [weight (kg) - age (years)]. **Results:** The average OSTA value is -2.97 ± 3.35, the minimum value is -12.8, and the maximum value is 7.0. Osteoporosis risk ratios according to the OSTA (using cut-offs 0 and -3) were: high risk (46.1%), moderate risk (35.3%), and low risk (18.6%). The predictive value of osteoporosis risk of the OSTA was ranked as good with the area under the curve (AUC) of 0.823 ($p < 0.001$). At cut-off -3, the OSTA has a sensitivity of 70.3%, and a specificity of 78.4%. At cut-off 0, the OSTA has a sensitivity of 96.8%, and a specificity of 33.1%. The prevalence of osteoporosis in the high-, intermediate- and low-risk groups (using cut-offs 0 and -3) was 69.2%, 28.3%, and 6.3%, respectively. **Conclusion:** OSTA can be used as a simple and convenient tool for self-assessment or screening for osteoporosis risk.

Key words: *OSTA, osteoporosis, post-menopause.*

1. INTRODUCTION

Nowadays, osteoporosis has become a common global health problem. According to the report of the International Osteoporosis Foundation, about 200 million people are diagnosed with osteoporosis every year around the world, of which one-third of women over 50 and one-fifth of men will have a fracture due to osteoporosis [1]. Osteoporosis is common in women, especially in postmenopausal women due to a decrease of estrogen. In Vietnam, the number of people with osteoporosis is about 3.2 million people, including more than 2.4 million women. It is estimated that the country will have more than 4.5 million people with osteoporosis by 2030, of which women account for 70-80% [2].

Early diagnosis and treatment of osteoporosis before fracture significantly reduces the risk of fracture. Bone mineral density measurement by dual-energy X-ray absorptiometry (DEXA) is considered the gold standard in the diagnosis of osteoporosis. However, this method is not yet popular in developing countries due to its high cost and lack of equipment. Therefore, it is essential to have a tool that can predict osteoporosis risk accurately, simply with a reasonable price. In 2001, Koh and his partners introduced the Osteoporosis Self-Assessment Tool for Asians (OSTA). This is a simple and effective self-assessment tool for the primary screening of osteoporosis, based on the weight and age of the screening subjects, and can be used as an alternative to the ultrasound measurement of bone density [3]. There have been studies on the effectiveness of OSTA in predicting the risk of osteoporosis in postmenopausal women in the world, but there are not many studies in Vietnam. Therefore, we conducted a study on the topic: "The performance of osteoporosis Self-Assessment Tool for Asians (OSTA) in assessing the risk of osteoporosis in postmenopausal women aged 45 years and older" with two objectives:

1. Application of the OSTA (Osteoporosis Self-Assessment Tool for Asians) in assessing the risk of osteoporosis in postmenopausal women aged 45 years and older.

2. Evaluation of the relationship between OSTA and bone mineral density measured by dual-energy X-ray absorptiometry (DEXA).

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DOI: 10.34071/jmp.2024.2.2
Recieved: 10/7/2023; Accepted: 19/2/2024; Published: 25/2/2024

2. SUBJECTS AND METHODS

2.1. Subjects

Subjects were 430 postmenopausal women aged 45 years and older who were admitted and measured bone mineral density by DEXA method at Hue University of Medicine and Pharmacy Hospital from September 2021 to June 2022.

Excluding from the study the subjects with contraindications to bone mineral density measurement by the DEXA method.

2.2. Methods

This is a cross-sectional descriptive study using sample size formula for studies finding the sensitivity or specificity of a diagnostic method [4].

$$n_{se} = \frac{Z_{\alpha}^2 . p_{se}(1 - p_{se})}{p_{dis} . w^2}$$

With 95% confidence (α = 0.05), estimated sensitivity of OSTA p_{se} = 0.91, desired error w = 0.05, estimated prevalence of osteoporosis p_{dis} = 40.1% [1], according to the above formula, the required minimum sample size is 314.

There were 430 subjects in this study. Subjects were inteviewed about medical history, examined clinically, measured bone mineral density by dual-energy X-ray absorptiometry (DEXA) with Medix DR machine manufactured by MEDILINK (France) in 2017. Bone mineral density was measured at the lumbar spine and femoral neck.

Diagnosis of osteoporosis is based on T-score (WHO 1994) [5]:

T-score ≥ -1	: Normal
-2.5 < T-score < -1	: Osteopenia
T-score ≤ -2.5	: Osteoporosis
T-score ≤ -2.5 with history of fracture	: Severe osteoporosis

Classification of osteoporosis and non-osteoporosis based on T-score:

Osteoporosis: T-score ≤ -2.5 at one of 3 sites: the femoral neck, the whole hip (total hip) or the lumbar spine (lumbar spine).

Non-osteoporosis: T-score > -2.5 at all 3 sites.

Calculate the OSTA according to the formula: OSTA = 0.2 x [weight (kg) - age (years)]

Analyzing and processing data by medical statistical methods with the support of SPSS version 26.0.

3. RESULT

3.1. Applying the OSTA in assessing the risk of osteoporosis in postmenopausal women aged 45 years and older

The mean OSTA value was -2.97 ± 3.35, the smallest value was -12.8, the largest value was 7.0.

Table 1. Osteoporosis risk according to OSTA (Using the scale of L.K.H Koh [5])

Osteoporosis risk	n	%
High risk (OSTA < -4)	152	35.4
Moderate risk (-4 ≤ OSTA ≤ -1)	151	35.1
Low risk (OSTA > -1)	127	29.5
Total	430	100.0

Comment: The high-risk group accounted for 35.4%, while the low-risk group accounted for 29.5%.

Table 2. Osteoporosis risk according to OSTA (Using the rating with cut-offs 0 and -3)

Osteoporosis risk	n	%
High risk (OSTA < -4)	198	46.1
Moderate risk (-4 ≤ OSTA ≤ -1)	152	35.3
Low risk (OSTA > -1)	80	18.6
Total	430	100.0

Comment: The high-risk group accounted for 46.1%, the low-risk group accounted for 18.6%.

Table 3. Sensitivity and specificity of the OSTA corresponding to the cut-offs

OSTA	Sensitivity	Specificity
-13	0	100
-12	0.5	100
-11	1.1	100
-10	2.7	100
-9	9.2	100
-8	17.8	99.6
-7	27.0	98.0
-6	36.2	93.5
-5	50.8	87.3
-4	61.6	84.5
-3	70.3	78.4
-2	85.4	63.7
-1	92.4	49.0
0	96.8	33.1
1	98.9	21.2
2	99.5	9.8
3	100	4.1
4	100	1.2
7	100	0

Comment:

- At cut-off -3, sensitivity of the OSTA is 70.3% and its specificity is 78.4%.
- At cut-off 0, sensitivity of the OSTA is 96.8% and its specificity is 33.1%.

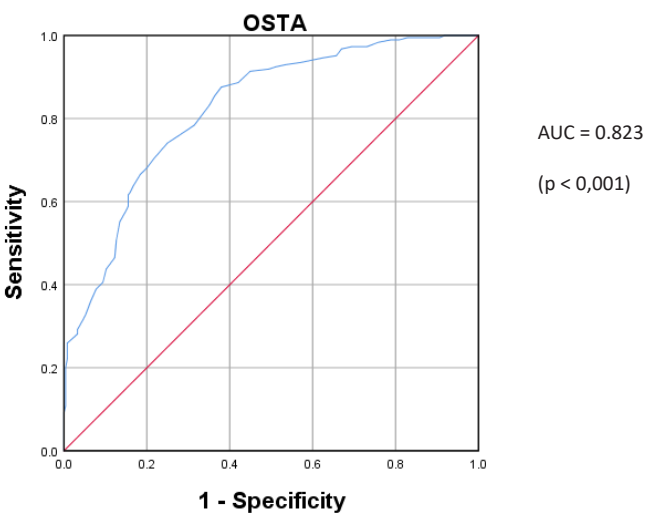

Chart 1. ROC curve showing the sensitivity and specificity of the OSTA

Comment: With an area under the curve (AUC) of 0.823, the predictive value of osteoporosis risk of the OSTA is ranked as good ($p < 0.001$).

3.2. Evaluating the relationship between OSTA and bone mineral density measured by dual-energy X-ray absorptiometry

3.2.1. Characteristics of bone mineral density

Table 4. Characteristics of bone mineral density

Position	BMD (X ± SD)	T-score (X ± SD)
L1	0.660 ± 0.160	-1.984 ± 1.526
L2	0.716 ± 0.172	-2.162 ± 1.640
L3	0.780 ± 0.188	-2.028 ± 1.785
L4	0.842 ± 0.209	-1.831 ± 1.825
Lumbar spine	0.759 ± 0.180	-1.982 ± 1.618
Femoral neck	0.771 ± 0.184	-0.374 ± 1.736
Total hip	0.848 ± 0.179	-0.716 ± 1.347

Comment: The average bone mineral density in the lumbar spine is 0.759 ± 0.180 g/cm^2, in the femoral neck is 0.771 ± 0.184 g/cm^2 and the total hip is 0.848 ± 0.179 g/cm^2.

3.2.2. Relationship between OSTA and T-score at cut-offs 0 and -3

Table 5. Relationship between OSTA (at cut-off 0) and T-score

OSTA	Osteoporosis (T-score ≤ -2.5)		Non-osteoporosis (T-score> -2.5)		OR (95% CI)
	n	%	n	%	
< 0	179	96.8	164	66.9	14.73 (6.25 - 34.48)
≥ 0	6	3.2	81	33.1	
Total	185	100	245	100	

Comment: There is a close relationship between OSTA and T-score. Subjects with OSTA < 0 have the risk of osteoporosis which is 14.73 times higher than that of subjects with OSTA ≥ 0.

Table 6. Relationship between OSTA (at cut-off -3) and T-score

OSTA	Osteoporosis (T-score ≤ -2.5)		Non-osteoporosis (T-score> -2.5)		OR (95% CI)
	n	%	n	%	
< -3	130	70.3	53	21.6	7.70 (3.87 - 7.96)
≥ -3	55	29.7	192	78.4	
Total	185	100	245	100	

Comment: There is a close relationship between OSTA and T-score. Subjects with OSTA ≥ -3 have the chance of non-osteoporosis which is 7.70 times higher than that of subjects with OSTA < -3.

3.2.3. Relationship between the risk of osteoporosis classified by OSTA and osteoporosis based on T-score

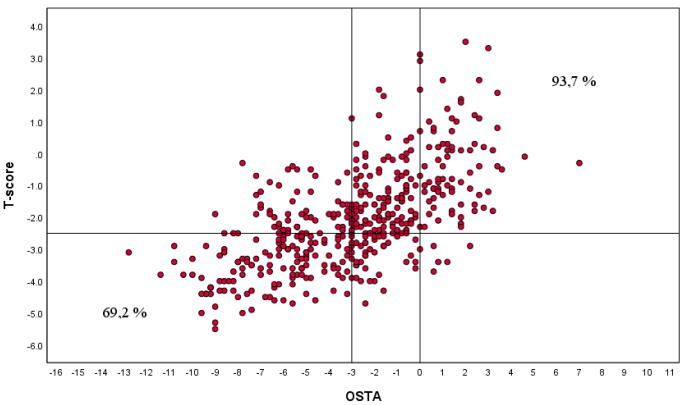

Chart 2. Distribution of subjects according to OSTA (at cut-off 0 and -3), compared with T-score

Comment:

- With OSTA > 0, 93.7% of subjects do not suffer osteoporosis (with T-score > -2.5).
- With OSTA < -3, 69.2% of subjects suffer osteoporosis (with T-score ≤ -2.5).

Table 7. Relationship between the risk of osteoporosis classified by OSTA and osteoporosis based on T-score

OSTA	Osteoporosis		Osteopenia		Normal		p
	n	%	n	%	n	%	
High risk (OSTA <-3) (n = 198)	137	69.2	50	25.2	11	5.6	0.000
Moderate risk (-3 ≤ OSTA ≤ 0) (n = 152)	43	28.3	74	48.7	35	23.0	
Low risk (OSTA > 0) (n = 80)	5	6.3	30	37.5	45	56.2	
Total (n = 430)	185	43.0	154	35.8	91	21.2	

Comment: The rate of T-score-based osteoporosis in the OSTA-classified high-risk group (69.2%) is significantly (p < 0.05) much higher than that in the OSTA-classified low-risk group (6.3%)

4. DISCUSSION

4.1. Applying the OSTA in assessing the risk of osteoporosis in postmenopausal women aged 45 years and older

In our study, the average OSTA value was -2.97 ± 3.35, the smallest value was -12.8, and the largest value was 7.0. This average OSTA value was lower than that in the studies of other authors. Author Yong Yang (2013) surveyed 1,201 postmenopausal women in China, and the average OSTA value was -0.35 ± 2.52, and the minimum and maximum values were -10 and 8, respectively [6]. Author Muslim (2012) surveyed 152 postmenopausal women in Malaysia and recorded the average OSTA value as 0.3 ± 2.7, the minimum and maximum values being -6.7 and 6.7, respectively [7]. Author Fu-Mei Su (2015) surveyed 12,175 postmenopausal women in Taiwan, and the mean OSTA value was -1.82 ± 2.77, the minimum and maximum values were -12 and 8, respectively [8]. This difference may be due to different sampling methods and/or lower weight of Vietnamese people compared to foreigners of the same age.

When using Koh's scale with cut-offs -4 and -1 (table 1), among 430 postmenopausal women aged 45 years and older, 152 are at high risk of osteoporosis (35.4%), 151 with moderate risk (35.1%), 127 with low risk (29.5%). When the scale was replaced with

cut-offs -3 and 0 (table 2), there were 198 women at high-risk of osteoporosis (46.1%), 152 with moderate risk (35.3%), and 80 with low risk (18.6%). Thus, with the new scale, the high risk rate of osteoporosis of subjects has increased from 35.4% to 46.1%, which helps to avoid the risk of missing 10.7% of subjects screened for osteoporosis.

In our study, the high risk rate for osteoporosis was 35.4% (applying the scale of the author Koh), this result was higher than the studies applying the same scale of the author Koh (2001) in Asia, Muslim (2012) in Malaysia and Fu-Mei Su (2015) in Taiwan with high risk rates for osteoporosis of 8%, 8.6% and 26.5% [7], [8], [9]. This difference may be due to the sampling method and/or the higher prevalence of osteoporosis in postmenopausal women in Vietnam than in other countries.

Table 3 shows the sensitivity and specificity of the OSTA for each of its cut-off values, from -13 to 7. The cut-offs with high sensitivity allow the elimination cases of false negatives, and avoid the risk of missed disease. The cut-offs with high specificity allow to elimination of cases of false positives, which means the risk of misdiagnosis is avoided. When the OSTA value changes, the sensitivity, and specificity also change inversely: as the sensitivity increases, the specificity decreases, and vice versa. Therefore, it is difficult to select an OSTA cut-off that meets both two criteria of sensitivity and specificity. To resolve this problem, two cut-offs can be selected: one with high sensitivity for purpose of screening for subjects at low disease risk and one with high specificity for purpose of diagnosing subjects at high-risk.

According to Koh, the two selected cut-offs are -4 and -1 [9], and these two cut-offs have been adopted by many other countries in Asia to screen for osteoporosis risk. However, during data processing, we found that if we choose the cut-off of -4, specificity is high at 84.5% but subjects with OSTA from -3 or less will be missed. In addition, the rate of osteoporosis in Vietnamese women is quite high [3], so we decided to take a cut-off of -3 to ensure that OSTA has good specificity (78.4%) and screening for osteoporosis better suited to Vietnamese conditions. If taking the upper limit of OSTA as -1 as author Koh, the sensitivity of the OSTA is 92.4%, lower than the sensitivity at cut-off 0 (96.8%). To match the osteoporosis situation in Vietnam, we decided to move up the cut-offs of OSTA from (-4; -1) to (-3; 0), so the sensitivity at cut-off 0 is 96.8% and the specificity at cut-off -3 is 78.4%.

According to our study, the area under the curve (AUC) of the OSTA is 0.823, which is ranked as good ($p < 0.001$) (chart 1). These results show that OSTA is a good tool that can be applied in screening for osteoporosis risk. Our result is similar to the results of studies applying OSTA in Malaysia, China, Taiwan, and Singapore with the areas under the curve respectively: 0.895 [7], 0.824 [6], 0.739 [8] and 0.759 [10].

4.2. Evaluating the relationship between OSTA and bone mineral density measured by dual energy X-ray absorptiometry

4.2.1. Characteristics of bone mineral density

Our study results showed that the average bone mineral density in the lumbar spine (0.759 ± 0.180 g/cm^2) was lower than that in the femoral neck (0.771 ± 0.184 g/cm^2) and bone density in the total hip (0.848 ± 0.179 g/cm^2) (table 4). This result is similar to the research results of Nguyen Thi Ngoc Lan (2016) which showed the average bone mineral density in the lumbar spine was 0.7322 ± 0.4572 (g/cm^2) and average bone mineral density in the femoral neck was 0.8170 ± 0.1686 (g/cm^2) [11]. Research by author Yong Yang in China (2013) on postmenopausal women [6] had a difference: the average bone mineral density in the lumbar spine is higher than the average bone mineral density in the femoral neck.

4.2.2. Relationship between OSTA and T-score at the cut-offs 0 and -3

The results in Table 5 show that at cut-off 0, subjects with OSTA < 0 had a risk of osteoporosis which was 14.73 times higher than those with OSTA ≥ 0, with 95% CI (6.25-34.48). The sensitivity and specificity of the OSTA at cut-off 0 were 96.8% and 33.1%, respectively. Our results are similar to those of author Koh which gave a sensitivity of 91% and a specificity of 45% [9] with the cut-off -1. Our results also have better sensitivity than some studies in other countries such as Malaysia (sensitivity: 87.5%, specificity: 95.8%) [7], China (sensitivity: 66%, specificity: 76%) [6], Taiwan (sensitivity: 73.1%, specificity: 62.0%) [8] with the cut-off -1. This shows that OSTA at cut-off 0 is very valuable in screening for osteoporosis.

The results in Table 6 show that at the cut-off of -3, subjects with OSTA ≥ -3 had a chance of non-osteoporosis that was 7.70 times higher than with OSTA < -3, which was statistically significant with 95% CI: 3.87 - 7.96. The sensitivity and specificity of OSTA at cut-off -3 were 70.3% and 78.4%, respectively. Our specificity is lower than that of OSTA at cut-off -3 of the study of author Yong Yang (86.46%) [6] and

author Huang in China (88.7%) [12].

The results of OSTA sensitivity and specificity in our study were different from previous studies, possibly due to the following reasons: In our study, the diagnosis of osteoporosis was based on T-score in one of three positions: lumbar spine, femoral neck, or the total hip. However, in other studies, the diagnosis of osteoporosis may be based on the T-score of the femoral neck or lumbar spine. According to many studies, there are significant differences in the rate of osteoporosis when measuring in these different sites. In addition, bone mineral density varies by ethnicity, region, and age. Therefore, the selection of subjects may contribute to this difference.

4.2.3. Relationship between the risk of osteoporosis classified by OSTA and osteoporosis based on T-score

Chart 2 illustrates the distribution of subjects classified by OSTA at cut-off 0 and -3, compared T-score, showing that with OSTA > 0, the majority of subjects had T-score >-2.5 (93.7%), with OSTA < -3, most of the study subjects had T-score ≤ -2.5 (69.2%). In the group with OSTA ranging from -3 to 0, the subjects are equally distributed for both areas with T-score > -2.5 and T-score ≤ -2.5.

With two cut-offs of 0 and -3 of OSTA, the risk of osteoporosis is divided as follows:

- OSTA < -3: high risk
- OSTA from -3 to 0: moderate risk
- OSTA > 0: low risk

Osteoporosis risk ratio is classified by OSTA with these two cut-offs: high risk (46.1%), moderate risk (35.3%), low risk (18.6%) (table 2).

According to the results in Table 7 and Figure 2, the rate of osteoporosis based on the T-score in the high-risk group was very high (69.2%) while the osteoporosis rate in the low-risk group classified by OSTA was very small (6.3%).

Here are comparisons of our results with some other studies around the world on the relationship between the risk of osteoporosis classified by OSTA and osteoporosis based on T-score:

- Comparison with results of author Yong Yang in China (2013) [6]:

Risk of osteoporosis	Our research		Yong Yang's research	
	Rate (%)	Osteoporosis rate (%)	Rate (%)	Osteoporosis rate (%)
High risk	46.1	69.2	7	42
Moderate risk	35.3	28.3	43	13
Low risk	18.6	6.3	50	1

- Comparison with results of author Muslim in Malaysia (2012) [7]:

Risk of osteoporosis	Our research		Muslim's research	
	Rate (%)	Osteoporosis rate (%)	Rate (%)	Osteoporosis rate (%)
High risk	46.1	69.2	8.6	46
Moderate risk	35.3	28.3	21.7	0
Low risk	18.6	6.3	69.7	1

- Comparison with results of author Fu-Mei Su in Taiwan (2015) [8]:

Risk of osteoporosis	Our research		Fu-Mei Su's research	
	Rate (%)	Osteoporosis rate (%)	Rate (%)	Osteoporosis rate (%)
High risk	46.1	69.2	26.5	70.0
Moderate risk	35.3	28.3	26.0	44.7
Low risk	18.6	6.3	47.5	23.4

Although the rate of osteoporosis classified by OSTA in countries varies between groups, the rate of osteoporosis in the high-risk group classified by OSTA is much higher than that in the low-risk group. This shows that in the context of our country as well as some other developing countries, where bone

mineral density measured by DEXA is not popular, OSTA is still valuable in screening for osteoporosis. Specifically, with OSTA < -3, that means the subject is in the high-risk group for osteoporosis, subjects may be advised to have their bone mineral density measured immediately to confirm the diagnosis, or should be treated for osteoporosis without bone densitometry results. With OSTA between -3 and 0, bone density should be measured and osteoporosis treatment should be considered; with OSTA > 0, bone densitometry may be delayed.

5. CONCLUSION

Through a study of 430 postmenopausal female patients aged 45 years and older at Hue University of Medicine and Pharmacy Hospital from September 2021 to June 2022, the mean OSTA value was -2.97 ± 3.35, minimum value is -12.8, maximum value is 7.0. The rate of osteoporosis classified by OSTA (using cut-offs 0 and -3) were: high risk (46.1%), moderate risk (35.3%), low risk (18.6%). The predictive value of OSTA for osteoporosis risk was ranked as good with the area under the curve (AUC) of 0.823 (p < 0.001). At cut-off -3, the OSTA has a sensitivity of 70.3% and a specificity of 78.4%. At cut-off 0, the OSTA has a sensitivity of 96.8%, a specificity of 33.1%. The rate of osteoporosis in the high-, intermediate- and low-risk groups (using cut-offs 0 and -3) was 69.2%, 28.3% and 6.3%, respectively.

In the condition of lack of equipment, OSTA can be used as a simple, convenient and cost-effective tool to effectively screen the risk of osteoporosis.

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