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A New Predictive Index for Osteoporosis among a Sample of Postmenopausal Egyptian Women.

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ABSTRACT

Dual energy x-ray absorptiometry (DEXA) is the gold standard for diagnosis of osteoporosis. The Osteoporosis Self-assessment Tool (OST) is a clinical diagnostic method designed to select patients at risk of osteoporosis, who would benefit from a bone mineral density measurement. Aims: are to investigate performance of the OST score as a screening tool for osteoporosis among postmenopausal Egyptian women in comparison to DEXA and to determine the cutoff point of appropriately identified patients at high risk for osteoporosis using OST. Methods: the performance of the OST among 1546 postmenopausal Egyptian women was assessed. DEXA scan of left hip was obtained. Patients were classified as either osteoporotic (458), osteopenia (714) or normal (374) according to their T-score. Osteoporotic patients had significantly lower OST scores ($p < 0.000$). A receiver operating characteristic (ROC) curve showed an area under the curve of 78% ($p < 0.017$), with a sensitivity of 83% and a specificity of 55% for a cut-off value of 4. Positive predictive value was 65% and negative predictive value was 77% with accuracy of 69%. OST is useful for selecting postmenopausal women; those with OST $\leq$4; for DEXA testing in the studied Egyptian population.
Keywords: osteoporosis, postmenopausal Egyptian women, DEXA, OST.

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INTRODUCTION

Osteoporosis has been increasingly recognized as a major global health problem over the last decades. It has enormous health and socioeconomic implications in terms of morbidity, mortality and disability worldwide. Thus, there is interest in identifying people at high risk who should receive targeted therapeutic interventions [1]. Currently the recommended method for the diagnosis of osteoporosis is bone mineral density (BMD) measurement by dual-energy X-ray absorptiometry (DEXA) especially in hip [2].

DEXA is the gold standard for diagnosis of osteoporosis. However, it remains expensive and is not widely available [3]. Many women have been undiagnosed and untreated for osteoporosis and have fractures, which can be prevented if osteoporosis was diagnosed earlier [4].

The Osteoporosis Self-Assessment Tool for Asians (OST) score was developed by the World Health Organization (WHO) to identify Asian women at risk. It takes into account their age and weight only [5].

The OST score was developed based on data from some countries for Asian women, and later validated for European and North American white women [6- 8]. Furthermore, BMD measurements should be targeted to subjects with risk factors for osteoporosis due to limited availability of BMD technology in some communities and cost considerations. So, the objectives of this study is to investigate performance of the OST score as a screening tool for osteoporosis among postmenopausal Egyptian women in comparison to the golden standard DEXA and to determine the cutoff point that appropriately identifies Egyptian patients at high risk for osteoporosis using OST.

Subjects and Methods

The current study is a retrospective cross sectional study; included data of 1546 postmenopausal Egyptian women referred to the "Bone densitometry Unit" of the "Medical Unit" in "National Research Centre"; for diagnostic DEXA scan of left hip. Their ages ranged between 45 up to 76 years.

The height and weight of each woman were measured while she stood without shoes, wearing light clothing. The body mass index (BMI) was calculated as her weight in kg divided by her height in m squared (kg/m2).

DEXA scan of the left hip was performed using a pencil beam Norland (XR-46) densitometry with host software version: 3.9.6 in the medical unit of the National Research Centre. Average BMD is expressed in grams per square centimeter. The DEXA T-score was calculated on the basis of the reference database. The diagnostic criteria established by the World Health Organization [9] (WHO) in adults were used. Osteoporosis and osteopenia are defined as a BMD T-score of -2.5 and between -1 <-2.5 respectively [10].

Since diagnosis of osteoporosis by DEXA is based on a T-score at −2.5 or below at any of the recommended sites (lumbar spine, femoral neck, or total hip), the lowest T-score was taken to dichotomously assign each result to a nonosteoporotic or osteoporotic group.

The OST score was calculated by subtracting age from weight and multiplying by 0.2 and rounded up to the closest integer. This can be written as: OST = 0.2[weight (kg) – age (year)]. For example, a 64-year-old woman weighing 50 kg has an OST score of 0.2 (50 − 64) = −2.8, which would be rounded up to −3, and a 52-year-old woman weighing 67kg has an OST score of 0.2 (67 − 52) = 3.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS/Windows Version 16, SPSS Inc., Chicago, IL, USA). Statistical significance was set at $P < 0.05$. Normality of the data was verified with the Kolmogorov-Smirnov test. All the variables showed normal distribution. Parametric data were expressed as mean $\pm$ SD, minimum and maximum values. Frequency of participants who suffer from osteopenia / or osteoporosis; according to bone mineral density-T score; were calculated. Comparisons between the different variables; including OST scores; between women with DEXA diagnosis of osteoporosis (T-score of −2.5 and below), osteopenia (-1>T-score >- 2.5) and those with normal BMD-T score were analyzed by ANOVA test. The validity of OST in the diagnosis of osteoporosis; using DEXA as standard tool; was examined by using a receiver operating characteristic (ROC) curve to assess the area under the curve (AUC), sensitivity, and specificity. Negative and positive predictive values were calculated. Sensitivity was calculated as true-positives/ (true-positives + false-negatives); specificity as true negatives/ (true-negatives + false-positives). True-positive subjects were those with low BMD by DEXA and OST. True-negative subjects were those with normal BMD by DEXA and OST. False-positive subjects were those with low BMD by OST and normal BMD by DEXA. False-negative subjects were those with normal BMD by OST and low BMD by DEXA. Positive predictive value (PPV) was defined as the percentage of subjects with low BMD by DEXA and OST. Negative predictive value (NPV) was defined as the percentage of subjects with normal BMD by DEXA and OST. Maximal accuracy and PPV/NPV closest to 1 were used for cut-off level determination.

RESULTS

The current study was conducted on 1546 Egyptian women. Their mean age was 57 $\pm$ 8.17 years, and their BMI was 33.25 $\pm$ 5.77 Kg/m^2 (range 17- 55 Kg/m^2); 1085/1546 (70.2%) were obese; with BMI $\geq$ 30 Kg/m^2. The mean BMD-T score was -1.76 $\pm$ 1.21(ranged between -5.96 up to 3.9) while the mean OST was 5 $\pm$ 3.39(with range of -6 up to 15) (table 1).Frequency distribution of the participants according to OST was presented in figure 1.The highest % of the participants had OST ranged between 4 up to 6.

Table 1: Characteristics of the study sample

Variables	Mean	SD	Minimum	Maximum
Age (year)	57.33	8.17	45.00	76.00
Weight (Kg)	81.31	14.07	41.00	128.00
Height (cm)	156.49	6.61	135.00	188.00
BMI (Kg/m^2)	33.25	5.77	16.91	54.55
BMD(gm/cm^2)	0.79	0.14	0.30	1.46
BMD- Z score	-0.25	1.09	-4.94	3.87
BMD- T score	-1.76	1.21	-5.96	3.90
OST	5	3.39	-6	15

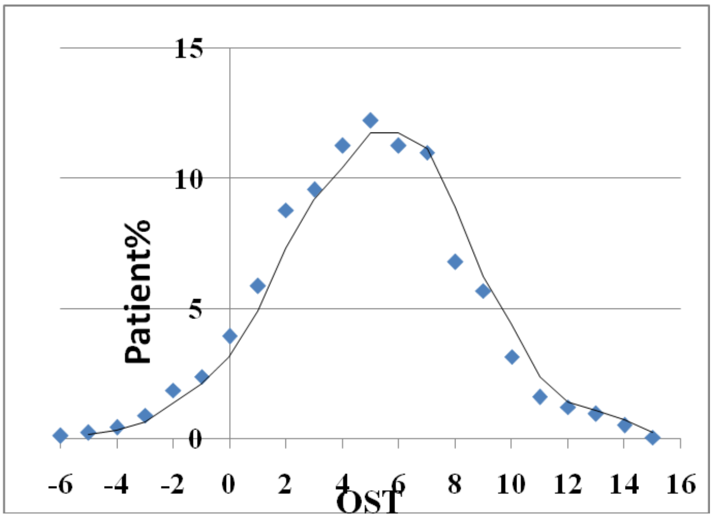


Figure 1: Frequency distribution of the current sample according to OST

Table 2: Frequency distribution of the current sample according to BMD-t score (Prevalence of low BMD)

	N	%	Obese%	Overweight%
Normal (BMD-t score $\leq$ -1)	374	24.2	80.5	17.1
Osteopenia (-1<BMD-t score>-2.5)	714	46.2	72.0	21.7
Osteoporosis(BMD-t score $\leq$= -2.5)	458	29.6	59.0	29.7
Total	1546	100	70.2	23.0

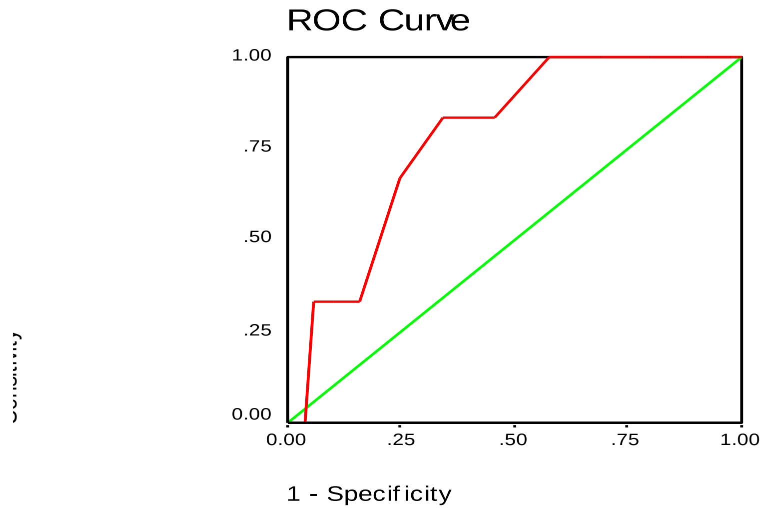
Table 3: Comparisons between different variables in studied categories of participants classified according to BMD-t score

	Normal (N=374)		Osteopenia (N=714)		Osteoporosis (N=458)		F	P
Age (year)	53.37	6.62	56.49	7.32	61.86	8.48	138.94	0.000**
Weight (Kg)	86.63	13.63	81.78	13.21	76.20	13.98	61.79	0.000**
Height (cm)	158.25	6.14	156.78	6.20	154.61	7.12	33.79	0.000**
BMI (Kg/m^2)	34.66	5.58	33.35	5.56	31.96	5.97	23.39	0.000**
BMD(gm/cm^2)	0.96	0.09	0.79	0.05	0.64	0.07	2338.77	0.000**
BMD- Z score	1.03	0.75	-0.24	0.58	-1.29	0.77	1173.46	0.000**
BMD- T score	-0.14	0.75	-1.73	0.41	-3.10	0.54	3002.17	0.000**
OST	7	3.07	5	2.94	3	3.28	160.27	0.000**

N.B.: p< 0.01= Highly significant differences.

Table 4: Sensitivity and specificity of the OST score for predicting a T-score of −2.5 or below at any site, according to the cut-off value

OST cut-off	Sensitivity	Specificity	PPV	NPV	Accuracy
-1	0	96	0	49	48
0	33	94	85	59	64
1	33	90	77	57	62
2	33	84	68	56	59
3	67	76	73	69	71
4	83	66	71	80	75
5	83	55	65	77	69
6	100	42	63	100	71



Diagonal segments are produced by ties.

Area Under the Curve	Std. Error	Asymptotic Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
0.783	0.066	0.017	0.653	0.912

Figure 2: Receiver operating characteristic (ROC) curve for OST scores to identify osteoporosis among Egyptian women older than 45 years. The area under the curve is 0.78 (p < 0.017) with 95% Confidence intervals ranged between 0.653 to 0.912 . The straight line is the line of identity, corresponding to an area under the curve of 50%.

According to BMD-T score (table 2), 29.6% of the participants had osteoporosis (BMD-T-score ≤ -2.5), and 46.2% of them had osteopenia (-1< BMD-t score>-2.5). Among the osteoporotic ones, 270/ 458 (59%) were obese, while 514/714 (72%) of the osteopeanic women and 301/374 (80.5%) of normal weight ones were obese. While, 64/374 (17.1%) of normal weight participants, 155/714 (21.7%) of osteopeanic and 136/458

(29.7%) of the osteoporotic ones were overweight. This means that most of the participants were obese or overweight in the 3 categories of BMD-t score.

Comparing the participants belonging to the different categories according to BMD-t score (table 3), it was found that osteoporotic ones had highly significant oldest age and least values of BMD and its T and Z scores, and OST, followed by osteopenic then normal BMD participants. However, they had highly significant least values of body weight, height and BMI, while normal participants had the highest values.

A receiver operating characteristic (ROC) curve (Figure 2) showed an area under the curve of 78% ($p < 0.017$), with a sensitivity of 83% and a specificity of 55% for a cut-off value of 4. Positive predictive value was 65% and negative predictive value was 77% with accuracy of 69% (table4).

DISCUSSION

Osteoporosis is a disorder enhanced skeletal fragility due to a reduction in both bone quantity and quality [11]. There is general agreement that postmenopausal women with a fragility fracture are at high risk for subsequent fractures as they usually accompanied by low BMD [12].

Current results showed significantly higher mean values of age, low BMD and its T score among osteoporotic than normal and osteopenic women. These results are in accordance with the fact that osteoporosis are among the main concerns of elderly population (physiological) .Also Obesity exacerbates the age-related decline in physical function and causes fragility in older adults [13]. The prevalence of obesity (BMI $\geq$ 30 Kg/m^2) among the whole studied sample was (70.9%) and among the osteoporotic ones was (59%). Moreover, overweight was detected among 23% of whole studied sample and 29.7% among the osteoporotic ones.

For years, it was believed that obese women were at lower risk for developing osteoporosis. In fact, obesity has a damaging effect on bone health, as many recent studies added increased risk of osteoporosis to the list of health problems linked to obesity. Rosen and Bouxsein [11] reported that osteoporosis and obesity are two congruent disorders of body composition, which are growing in prevalence. Moreover, researches of Bredella et al,[14] and Interim Health Care; in Florida State University; [15] revealed a link between obesity, bone density loss and muscle tissue loss.

In clinical practice, DEXA is the standard technology for measuring BMD. Hassan et al. [2], stated in their study for comparison between different tools of diagnosis of osteoporosis among Egyptians of both sexes that the preferred sites for diagnostic purposes of BMD were measurements made at the hip, either at the total hip or the femoral neck. Also, the availability of new effective treatments for osteoporosis emphasized to recommend BMD measurements for patients considered at high risk.

Many guidelines have been developed to select which patients should undergo DEXA testing. Many epidemiological studies have identified clinical risk factors for osteoporosis to develop risk assessment indices. The purpose of these risk assessment indices is not to diagnose osteoporosis or low BMD, but to identify women who are more likely to have low BMD. These patients can then be referred for BMD measurements [16, 17].

Several studies show that OST is an effective method for identifying people at risk of osteoporosis. Among Asian women, Caucasian women and Moroccan women, the OST was found to be as well as or better than more complicated osteoporosis screening tools [5, 6, 18].

OST is a simple noninvasive diagnostic tool for detecting osteoporosis and predicting fracture risks in postmenopausal women. It is e very important; particularly in places such as Egypt; where DEXA technology is expensive and not available wide-spread .Inspite of that, previous studies among Egyptian population [2, 19], reported that OST had poor performance, as it tended to have low sensitivities and out of range. So, they recommended developing new cut off points or modifying the original tool to screen of women with high risk for osteoporosis.

Application of such model in a country needs a full knowledge of the epidemiology of osteoporosis and benefits of the intervention plans. Furthermore, the scoring cutoff value might be changed based on population characteristics [20, 21]. Previous researches developed different OST score cutoff points for differentiation between high and low risk osteoporotic patients. In Argentine, Saravi [16] considered women with an OST score of 2 or lower are considered at high risk, and those above 2 are at low risk of osteoporosis. In Moracoo, El Maghraoui and Habbassi [18] reported that those with OST score >1 are at low risk, between - 3 and 1 are moderate risk and those below -3 are at high risk of osteoporosis. While for Malay women, Muslim et al, [22] used cutoff points of -1 and -4: those with OST score >-1 are low risk category, between -1 and -4 are moderate risk and those below -4 are at high risk of osteoporosis.

The current study demonstrated strong discriminatory performance of OST score at 4 in the prediction of osteoporosis among Egyptian postmenopausal women based on the WHO criteria (BMD T-score ≤ −2.5). When women with an OST score of 4 or lower are considered at high risk, and those above 4 are deemed at low risk of osteoporosis, the area under the curve (AUC) obtained from a ROC analysis was 78% ($p < 0.017$), with a sensitivity of 83% and a specificity of 55% . Positive predictive value also was 65% and negative predictive value was 77% with accuracy of 69%.

The AUC obtained from ROC analysis can range (expressed as a percentage) from 0 up to 100, with 50 being the line of identity. AUC at or above 70% are deemed acceptable for screening test. In the present study, the AUC was 78%. In comparison, previous studies; which provide further evidence of validation of the OST among different populations; reported the following AUC values for osteoporosis: (a) Koh et al. [5]: 85% from Asian; (b) Geusens et al.[23] : 85 % from white women in the US and the Netherlands; (c) Richy et al.[24]: 81 % from white Belgian women; and (d) Cadarette et al. [25]: 81 % from Canadian women, which, presumably, predominantly consisted of Caucasian women.

In this study, the use of the OST tool was found to have high sensitivity and good specificity for identifying osteoporosis in postmenopausal women in Egypt. Reviewing literatures, this research can be considered the first one regarding evaluating cut-off values of for OST identifying osteoporosis subjects; in general among Egyptian postmenopausal women , depending on age and weight as standards. The best cut-off points of OST for osteoporosis were found to be 4. This method seems to be clinically applicable and easy to use.

CONCLUSION

The use of the OST in postmenopausal Egyptian women is effective and has high sensitivity and specificity in relation to the golden standard DEXA. The standard cutoff score of 4 effectively identifies patients at high risk for osteoporosis. Using this simple tool, identification of postmenopausal Egyptian women at risk of osteoporosis will be easier. Hence, more prudent use of limited resources can be concentrated on the use of diagnostic and therapeutic modalities for high risk women.

Declaration: all the authors declare that the manuscript is original and is not published or communicated for publication elsewhere either in part or full.

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