Early detection of osteoporosis in premenopausal Egyptian women

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Background
Osteoporosis, chronic diseases, or conditions that may start early in the premenopausal period have become a real well-being medical issue worldwide.
Aim
The aim was to assess the accuracy of Osteoporosis Self-Assessment Tool (OST) score as a screening method for detection of osteoporosis among Egyptian premenopausal women compared with dual-energy radiographic absorptiometry.
Participant and methods
This was a retrospective cross-section study including 539 premenopausal Egyptian women, and their age ranged from 20 to 44 years. They underwent evaluation by dual-energy X-Ray absorptiometry examination of the left femoral neck at the 'Bone Densitometry Unit' of the 'Medical Excellence Research Center (MERC)', 'National Research Centre (NRC)', and then BMI and OST score were calculated from the data.
Results
The cutoff value of OST among premenopausal women was 7.5 to detect the risk of osteoporosis using the receiver operating characteristic curve, with 71% area under the curve ($P<0.000$), 71% sensitivity, 59% specificity, 65% accuracy, 63% positive predictive value, and 67% negative predictive value.
Any form of bone loss 'osteopenia or osteoporosis' could be suspected if there is decreased BMI in the presence of risk factors.
Conclusion
The Egyptian premenopausal women OST score is 7.5. If it is lower this value, osteoporosis will be predict and needs further management..

Keywords:
dual-energy X-Ray absorptiometry, Egyptian, Osteoporosis Self-Assessment Tool, osteoporosis, pre-menopausal

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Introduction

Osteoporosis is a chronic progressive bone mass loss with decreased bone strength that leads to increase fracture risk, and ~8.9 million fractures annually mostly occur in postmenopausal women [1], but the bone mass loss can be started early in the premenopausal period [2]. These days osteoporosis has become a real well-being medical issue worldwide, affecting ~200 million women [3]. In Egypt, 30% of the population was affected, mostly postmenopausal women (54% had osteopenia and 28.4% had osteoporosis) [4]. It is a hidden disease [5], especially in the premenopausal women, as it is associated with risk factors such as inadequate nutrition, physical inactivity, hormonal, drugs, and medical diseases [2]. So, early detection gives a chance for better management and decreases its progression pattern, with long life expectancy [6].

Bone mineral density (BMD) reaches the highest peak at adulthood among fertile woman; any loss of this density could cause osteopenia or osteoporosis [5], which could be detected by the most accurate method, dual-energy X-Ray absorptiometry (DEXA). This method is considered the golden standard for diagnosis of osteoporosis [7]. However, its cost, unavailability in rural areas and exposure to a small amount of radiation (should be avoided in pregnancy) [8] gave us the idea to use a simple method, such as Osteoporosis Self-Assessment Tool (OST), to detect cases that need further assessment by DEXA.

The first use of OST was by Koh *et al.* [9] on postmenopausal Asian women during a screening project to detect the risk of osteoporosis, using two simple data: the age of the women and her body weight.

OST is considered a simple method to identify osteoporosis risk, with high sensitivity [10].

Many studies have been done to assess OST among postmenopausal women, especially in North American and Europe [11]. One of the studies was done in Egypt to predict the risk of osteoporosis in postmenopausal women [12]. However, the validity and accuracy of OST in premenopausal women to predict osteoporotic risk have not been assessed yet, which is the purpose of this research. Moreover, it determines the cutoff value to identify the osteoporotic risk for further assessment of secondary cause for early management.

Participants and methods

Design

A retrospective cross-sectional study was conducted.

Participants

A total of 539 premenopausal Egyptian women were included, and their age ranged from 20 to 44 years. They were evaluated by DEXA examination at the 'Bone densitometry Unit' of 'Medical Excellence Research Center (MERC)', 'National Research Centre (NRC)' during the period 2013–2017. This study was approved by the Ethical Committee of the National Research Centre (Approval No. 17/148), and it removed the participants' names for privacy.

Measurements

Body weight and height of each woman were taken from her DEXA reporting system. Then, BMI was calculated as weight in kilogram divided by height in meter squared. Then, the women were classified according to BMI as follows: normal (18<25), overweight (≥25 to <30), and obese (≥30) [13].

DEXA of the left femoral neck was performed with Norland (XR-46) densitometry, with software (version: 3.9.6), America, USA, and then, BMD g/cm^2 and T-score were taken. According to the reference database established by the WHO [14], normal bone density has T-score more than or equal to −1.0, osteopenia is −1 greater than T-score greater than −2.5, whereas osteoporosis has T-score less than or equal to −2.5 [15].

OST score was calculated as follows: 0.2 multiplied by the resulting number of subtracted age from weight to the closest integer:

$$\text{OST score} = 0.2 \times [\text{weight(kg)} - \text{age(year)}]$$

For example, a 44-year-old woman weighing 50 kg has the OST score of 0.2×(50–44)=1.2 (~1), whereas a 22-year-old woman weighing 67 kg has the OST score of 0.2×(67–22)=9.

Statistical analysis

The data was analyzed using Statistical Package for the Social Sciences SPSS (version 22 software; IBM Corporation, Armonk, New York, USA). Normal distribution of all variables was confirmed by the Kolmogorov–Smirnov test. These data were expressed as mean±SD for parametric, whereas by frequency (number and percentage) for nonparametric. Analysis of variance test was used to compare different variables, such as OST scores between women with DEXA examination and those with normal BMD, osteopenia (−1>T-score >−2.5), and osteoporosis (T-score ≤−2.5). Statistical significance was set at *P* greater than or equal to 0.05.

Receiver operating characteristic curve was used to assess sensitivity, specificity, and accuracy of OST in suspecting osteoporosis with respect to DEXA, which is the standard method of diagnosis osteoporosis. Those with normal bone density by both DEXA and OST were diagnosed as true negative, whereas those with low bone density by both DEXA and OST were diagnosed as true positive. On the contrary, those with low bone density by OST and normal by DEXA were diagnosed as a false positive, whereas those with low bone density by DEXA and normal by OST were diagnosed as a false negative. The calculations were as follows: sensitivity=true positives/'true positives+false negatives' and specificity=true negatives/'true negatives +false positive'(. The percentages of participants with low bone density by DEXA and OST were represented by positive predictive value, whereas the percentages of participants with normal bone density by DEXA and OST were represented by negative predictive value.

Results

The current study was conducted on 539 Egyptian women with mean age of 34.9±7 years, and their mean BMI was 29.7±6.0 kg/m^2 (range: 16–50 kg/m^2). The mean BMD was 0.88±0.14 (ranged between 0.53 and 1.41), whereas the mean T-score was −1.01±1.17 (ranged between −4.04 and 3.07). Frequency distribution of the participant premenopausal women according to OST is presented in Fig. 1. OST score ranged between 0 and 18. The highest percentage of the participants had OST 8.

Table 1 shows the frequency distribution of the premenopausal women regarding bone density (T-score) by DEXA and BMI classification. According

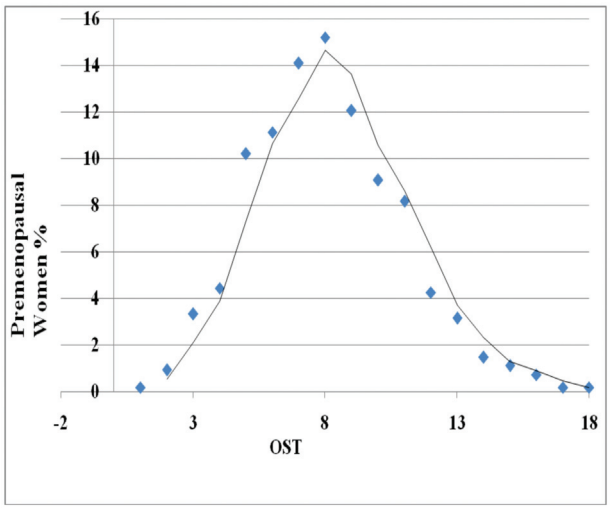
to T-score, 47% of the participated premenopausal women had normal bone density and normal weight, 42.5% had osteopenia (−1> T-score > −2.5), whereas 10.2% had osteoporosis (T-score ≤ −2.5). Among those osteopenic women, 58/229 (25.3%) were obese and 87/229 (38%) were overweight, whereas 23/55 (41.8%) of the osteoporotic women were obese and 15/55 (27.3%) were overweight. Regarding normal weight women, 17/55 (30.9%) had osteoporosis and 84/229 (36.3%) had osteopenia.

Further detailed assessment of each variable (mean and SD) with bone density (T-score) by DEXA (Table 2) revealed that highly statistically significant association was detected between bone density (T-score) and all variables (body weight, height, BMI, BMD, its *t* and *Z* scores, and OST value).

Regarding variables measured by DEXA (BMD and *t* and *Z*-scores), the least values were scored at the osteoporotic bone, although OST score with the highest value was detected with normal bone density (9.2±2.8) versus 6.1±2.6 at the osteoporotic bone.

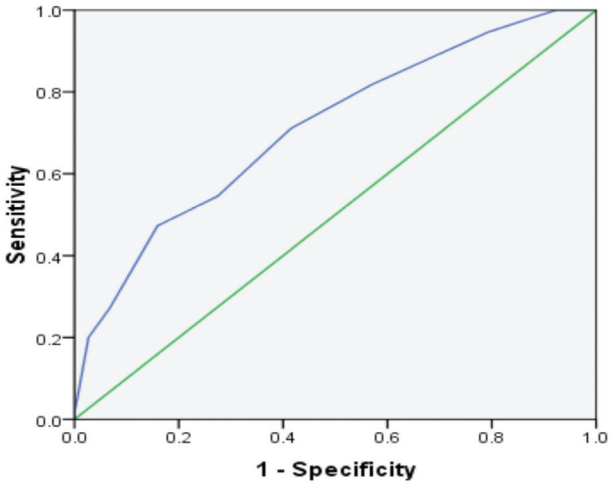
Then a receiver operating characteristic curve was done (Fig. 2), which showed an area under the curve of 71%

Figure 1



Frequency distribution of the premenopausal women according to Osteoporosis Self-Assessment Tool.

Figure 2



Receiver operating characteristic curve for Osteoporosis Self-Assessment Tool scores to identify osteoporosis among Egyptian premenopausal women younger than 50 years.

Table 1 Frequency distribution of the premenopausal women regarding bone density (T-score) by dual-energy radiographic absorptiometry and BMI classification

Bone density	*n* (%)	Obese [*n* (%)]	Overweight [*n* (%)]	Normal weight [*n* (%)]
Normal (T score≤ −1)	255 (47.3)	34 (13.3)	65 (25.5)	156 (61.2)
Osteopenia (−1 <T score> −2.5)	229 (42.5)	58 (25.3)	87 (38.0)	84 (36.3)
Osteoporosis (T score ≤ −2.5)	55 (10.2)	23 (41.8)	15 (27.3)	17 (30.9)

Table 2 The association between different variables and bone density (T-score) by dual-energy radiographic absorptiometry regarding mean and SD

	Normal Bone density (*N*=225)		Osteopenia (*N*=229)		Osteoporosis (*N*=55)		F	*P*
	Mean	SD	Mean	SD	Mean	SD		
Age (years)	34.7	7.1	34.9	6.9	35.56	6.9	0.33	0.720
Weight (kg)	80.4	15.5	71.2	13.5	65.78	14.1	36.2	0.000**
Height (cm)	159.9	6.2	158.3	6.5	156.25	8.1	8.7	0.000**
BMI (kg/m^2)	31.4	6.0	28.5	5.6	26.96	5.6	22.9	0.000**
BMD (g/cm^2)	0.99	0.09	0.80	0.05	0.65	0.05	690.7	0.000**
BMD – *Z* score	0.47	0.88	−1.05	0.53	−2.38	0.46	495.4	0.000**
BMD – *T* score	−0.02	0.74	−1.65	0.40	−2.96	0.39	812.7	0.000**
OST	9.2	2.8	7.3	2.4	6.1	2.6	48.9	0.000**

BMD, bone mineral density; OST, Osteoporosis Self-Assessment Tool. *P*<0.01, highly significant differences.

Table 3 The Osteoporosis Self-Assessment Tool score cutoff value, sensitivity and specificity according to *T*-score ≤–2.5

OST cutoff	Sensitivity	Specificity	PPV	NPV	Accuracy
1.0	2	100	100	50	51
2.5	5	99	90	51	52
3.5	20	97	88	55	59
4.5	27	93	80	56	60
5.5	47	84	75	61	66
6.5	55	73	66	61	64
7.5	71	59	63	67	65
8.5	82	43	59	70	62
9.5	89	30	56	74	60
10.5	95	21	54	79	58
11.5	98	12	53	87	55

NPV, negative predictive value; OST, Osteoporosis Self-Assessment Tool; PPV, positive predictive value.

($P<0.000$), with a sensitivity of 71% and a specificity of 59% at a cutoff value of 7.5. The positive predictive value was 63% and the negative predictive value was 67% with an accuracy of 65% (Table 3).

Discussion

Globally, osteoporosis is considered a silent problem, starting with reduction of the BMD and deterioration of microarchitectural of bone with the progressive course leading to the fragile bone with fracture susceptibility. As there is no clinical presentation until fracture happens, it remains undiagnosed. So the screening test is important, with no standard age for starting it [16].

Osteoporosis is less presented in premenopausal women compared with postmenopausal women. However, fractures may occur in young women before menopause. These may be owing to the underlying cause, which will need rapid management [17]. Moreover, there is increased susceptibility of postmenopausal fracture by 35% if there was a history of premenopausal fracture, as reported by the Osteoporotic Fractures Study [18]. Many studies had the same results [19,20]; one of them was done in New Zealand, which revealed increased risk of fracture of postmenopausal women above 50 years by 74% if there was a history of fracture between 20 and 50 years of age [17].

Most of the research studies were done to assess osteoporosis of postmenopausal women; some of them included both premenopausal and postmenopausal women, and few data were available for premenopausal women only [5]. Thus, identifying premenopausal women with osteoporotic risk is extremely important to prevent fracture [18]. DEXA is considered a cornerstone method for assessing BMD to decide therapeutic management if osteoporosis is detected [7]. The guidelines of the International Osteoporosis Foundation for premenopausal women recommend the use of T scores in those aged 20–50 years and suggest osteoporosis when T-score is less than or equal to −2.5 [21]. Screening BMD of premenopausal women by DEXA is not recommended, and it should be used for those who had a history of secondary cause of bone loss associated with fracture [22]. So the needs to use a simple method, OST, for prediction osteoporotic risk and detect those need DEXA scan is important. The OST has been validated as a useful tool in Western and Asian population to identify those who need BMD measurement [11]. Several studies were done to establish the accuracy of OST compared with the femoral neck BMD (T-score ≤ −2.5) by DEXA [23–25], as femoral neck is the most common site of fracture [26]. However, most of these research studies were done in postmenopausal women or in both premenopausal and postmenopausal women. Only one of them was done in postmenopausal Egyptian women [12], and no previously published studies were done for assessing premenopausal women. Therefore, the OST using the simple equation in premenopausal women should be done to identify the cutoff value to predict the osteoporotic risk and know its similarity to postmenopausal cutoff value.In the current study, the OST cutoff value to identify osteoporosis in the premenopausal women was 7.5, with 71% sensitivity, 59% specificity, and 65% accuracy. The cutoff value was variable with repsect to the race, sex, and age. Various cutoff values of OST score have been reported by many research studies at different population and ethnicities [11], as it was −1 for Asians populations [9,24,26] whereas it was less than or equal to 2 for white populations [27] and Pérez-Castrillón *et al*. [28] also recorded in a Spanish study the same sensitivity value. However, Chen *et al*. [29] predicted the risk of osteopenia among Taiwanese women aged between 40 and 55 years with OST cutoff 1 and 78% sensitivity.

The noticed higher cutoff value in the non-Asians populations could be owing to higher body weight and BMI.

No previous literature study reviewed premenopause women only, and this is the first one to assess women younger than 50 years; thus, other cutoff values from various studies are unfair to demonstrate the discrepancy, like those for the postmenopausal women. For example, in the Egyptian postmenopausal women, OST score was 4 and

suspected osteoporosis risk is if less than 4 [12], whereas score 5, for example, does not have the susceptibility of risk in postmenopausal women, but this score has the risk if it is used for premenopausal women, considering the same race, sex, and ethnicity but different age. We need more research studies on different populations to assess premenopausal women compared with postmenopausal women. Moon *et al.* [30] reported that in Korean research studies, the OST cutoff values were changed if the mean age changed, as the OST values were 2.5 and 0.5 to mean age 54.3±7.9 and 57.6±0.1 years, respectively.

An important subject in the current study, which should be concerning, was 61.2% of premenopausal participated women had normal BMD (T-score) by DEXA and normal body weight, which was expected in this age period (20–50 years), although the highest values of weight, height, and BMI were noticed with normal bone density, which means that increases in these values were associated with normal bone density, as mean BMI of normal weight was 31.4±6 comparing with BMI of 26.9±5.6 in those with osteoporotic bone. So any bone loss 'osteopenia or osteoporosis' could be detected if there is decreased BMI in presence of risk factors. Finally, OST is a simple tool to assess the osteoporotic risk, especially in pre-menopausal women who had secondary causes, for quick management.

Conclusion

The Egyptian premenopausal women OST score is 7.5, with 71% sensitivity and 59% specificity, if lower this value, will need further management for osteoporosis risk.

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Conflicts of interest

There are no conflicts of interest.

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