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Validation of a simple tool to identify osteoporosis risk of Egyptian Men

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Background: Osteoporosis represents a major public health problem, especially in developing countries. Purpose: to investigate validity of the Osteoporosis Self-Assessment Tool (OST) score as a screening tool for osteoporosis compared with DEXA, and determine its cutoff point that identifies Egyptian men at high risk for osteoporosis. Methods: This was a retrospective cross sectional study, based on data obtained from the “Bone Densitometry Research Unit”, of the “Medical Excellence Research Center (MERC)”- “National Research Centre”. It included reports of 615 Egyptian men, aged between 20 up to 80 years. They were classified according to their ages into 2 groups: those aged below 50 years and those aged 50 years or above. DEXA scan of left hip was obtained. Body mass index and OST score were calculated. Results: Osteoporosis was diagnosed among 28.5% of young men and 55.7% among old men. A receiver operating characteristic (ROC) curve for young men showed an area under the curve of 66% ($p < 0.01$), with a sensitivity of 62% and a specificity of 63% for a cut-off value of 7.5. While for old men, ROC curve showed an area under the curve of 67% ($p < 0.01$), with a sensitivity of 77% and a specificity of 51% for a cut-off value of 4.5. Conclusion: Egyptian men with OST score below 7 for those aged less than 50 years, or less than 4 for those aged 50 years or above can effectively identify patients at high risk for osteoporosis.

Keywords: osteoporosis, Egyptian men, DEXA, OST

INTRODUCTION

Attention to osteoporosis has been increased nowadays, as it is a major global health problem (Satyaraddi et al., 2017). Generally, the important strategy is early treatment for any disease to maintain high health and give a long life span. Osteoporosis is a deficiency in bone density and age-related incidence, leading eventually to fractures or frailty (Johnell and Kanis, 2006). It was important to identify populations at risk for development of osteoporosis and prevent its occurrence.

The most important method for diagnosis osteoporosis is dual-energy X-ray absorptiometry (DEXA) by accurate measurement of bone mineral density (BMD) (Cosman et al., 2014), as it is considered the golden standard method with widely acceptable (Hassan et al., 2014). In most developing countries, DEXA is expensive and not widely available. There are no DEXA machines in many cities in Egypt.

Koh and his colleges (2001) developed the simplest rule; among adult Asian populations; for easy screening of the risk of osteoporosis. This is Osteoporosis Self-assessment Tool (OST) used only the age and body weight, which are directly related to osteoporosis risk. This method is easy and effective for identifying people at high risk of osteoporosis. OST has high sensitivity and specificity, to assess the risk of osteoporosis in post-menopausal Asian women.

Numerous studies were assessed also the

performance of the OST among postmenopausal women (Yang et al., 2015) and (El-Masry et al., 2015). However, the validation of OST research to identify osteoporosis in men has little been published (Lin et al., 2016).

The study of Osteoporosis Self-assessment Tool was evaluated and conducted on Egyptian women by (El-Masry et al. 2015). However, OST conducted for Egyptian men is lacking. Therefore, the goal of the study was an equivalent work for men.

The objectives of this study; evaluate validity of the OST score as a screening tool for detection osteoporosis among Egyptian men compared to DEXA, and determine the OST cut-off value that identifies the Egyptian men at osteoporosis risk.

MATERIALS AND METHODS

Subjects

Data collections took place from the “Bone Densitometry Research Unit”, of the “Medical Excellence Research Center (MERC)”- “National Research Centre” between 2013 and 2017. The present study based on a retrospective cross sectional study involving 615 Egyptian men, aged from 20 up to 80 years. They were referred for diagnostic DEXA scan of left hip. Permission from the Head of the unit and removal of the participant’s names for privacy were done. The study was approved by the National Research Centre Ethical Committee (Approval N. 17/ 148).

Measurements

Body height (m) and weight (kg) were taken from the reports. Body mass index (BMI) was calculated: weight (Kg)/ height square (m^2). All data were gathered on standardized tools by well trained staff.

DEXA scan of the left femoral neck was done using Norland (XR-46) densitometry, with software (version: 3.9.6), in the Medical Excellence Research Center (MERC) of the National Research Centre. Persons with foreign bodies in the bones; as surgical prosthesis or old healed fracture were excluded from this study. Average BMD is expressed in gm/ cm^2, and T-score was calculated according to the reference database. The diagnostic criteria established by (NIH 2000). Bone density status was defined based on BMD criteria: osteoporosis if the T-score of the femoral neck was less than −2, osteopenia if the value was between −2 and −1.0, while normal if it was greater than −1.0. BMD T-score value of -2 was used to classify the participating men into non-osteoporotic or osteoporotic group.

Osteoporosis Self Assessment Tool (OST)

The OST score was calculated according to the formula used previously by (Koh et al., 2001) for women; and (Kim et al., 2014) for men; {OST = (Weight in Kg.- Age in years) × 0.2}.

Statistical analysis:

The analysis of data was done by SPSS (Windows Version 16), Inc., Chicago, IL, USA. Statistically significant if (P-value was <0.05). Kolmogorov-Smirnov test was verifying normal distribution of the data. The participants were classified into 2 age groups: 260 men below 50 years of age and 348 aged 50 years or above. Parametric data were expressed as mean + SD. Distribution of the participants according to BMD T-score; were calculated. ANOVA test was used to compare between the 3 groups (osteoporosis, osteopenia and normal BMD-T score) in different variables. ROC (receiver operating characteristic) curve was used to assess the validity of OST in osteoporosis diagnosis; depending on DEXA as gold standard method. Some calculations were done; as true-positives divided by (true-positives+ false-negatives) for sensitivity, true negatives divided by (true-negatives+ false-positive) for specificity. Those with low BMD by DEXA and OST were diagnosed as True-positive, While normal BMD by DEXA and OST were diagnosed as true-negative. On the other hand those with low BMD by OST and normal BMD by DEXA were diagnose as false-positive, while those with normal BMD by OST and low BMD by DEXA were diagnosed as false-negative. The percentage of subjects with low BMD by DEXA and OST represented by Positive predictive value (PPV), although the percentage of subjects with normal BMD by DEXA and OST represented by Negative predictive value (NPV). The accuracy and PPV/NPV closest to 1 were used to determine the cut-off value.

RESULTS

The current study included 608 men aged 21 – 80 years, mean age of 51.9 ± 16.5. The mean weight was 78.8 ± 15.3 and the mean of T-score was 0.18 ± 1.37. The prevalence of osteoporosis among total study group was 44.1%.

Descriptive characteristics of the studied two groups of men were summarized in Table 1.

Old men aged 50 up to 80 years were significantly heavier (weight), shorter and have higher value of BMI than young men aged 21 up to 50 years. However, they had significantly lower values of BMD, T-score and OST than the young men. This indicated the higher susceptibility for osteoporosis among old men than young ones.

Frequency distribution of the participants according to OST was different between the young and old men. Among young men aged 21 up to 49 years, their OST ranged between 1 and 16 with the mean at 8. While among men aged 50 years or above, their OST ranged between -5 up to 15 with mean of 3 (Figure 1) .

Osteoporosis was diagnosed among 28.5% of young men and 55.7% among old men, while osteopenia was diagnosed between 34.6% and 29.9% respectively. Moreover, 36.9% of young men had normal BMD T-score in comparison to 14.4% of old men (Table 2).

Table (3), summarized the characteristics of the two groups stratified according to whether or not they have osteoporosis. For both young and old men groups, the osteoporotic group were highly significant older and had least values of BMD, T- score and OST than the normal and osteopenic group.

For young men; ROC curve determined OST cut-off value of 7.5 for diagnosis of osteoporosis, with an area under the curve of 66% ($p < 0.01$) (Figure 2), 62% sensitivity, 63% specificity, 58% PPV and 63% NPV and 63% accuracy (Table 4). While for old men; ROC curve determined OST cut-off value of 4.5, with an area under the curve of 67% ($p < 0.01$) (Figure 3), 77% sensitivity, 51% specificity, 59% PPV and 69% NPV with 64% accuracy (Table 5).

Table (1): Characteristics of the study sample

Variables	Men aged 21- 49 years (N= 260)		Men aged 50- 80 years (N=348)		T	P
	Mean	±SD	Mean	±SD		
Age (year)	35.96	9.08	63.72	9.16	-37.11	0.000**
Weight (Kg)	76.42	15.90	80.56	14.68	-3.32	0.001**
Height (cm)	170.84	8.22	167.59	7.10	5.21	0.000**
BMI (Kg/m^2)	26.14	4.97	28.67	4.86	-6.30	0.000**
BMD(gm. /cm^2)	0.94	0.16	0.82	0.16	8.89	0.000**
Z-score	-0.56	1.26	-0.45	1.42	-1.00	0.318
T-score	-1.32	1.29	-2.20	1.31	8.26	0.000**
OST	8.14	3.32	3.35	3.76	16.32	0.000**

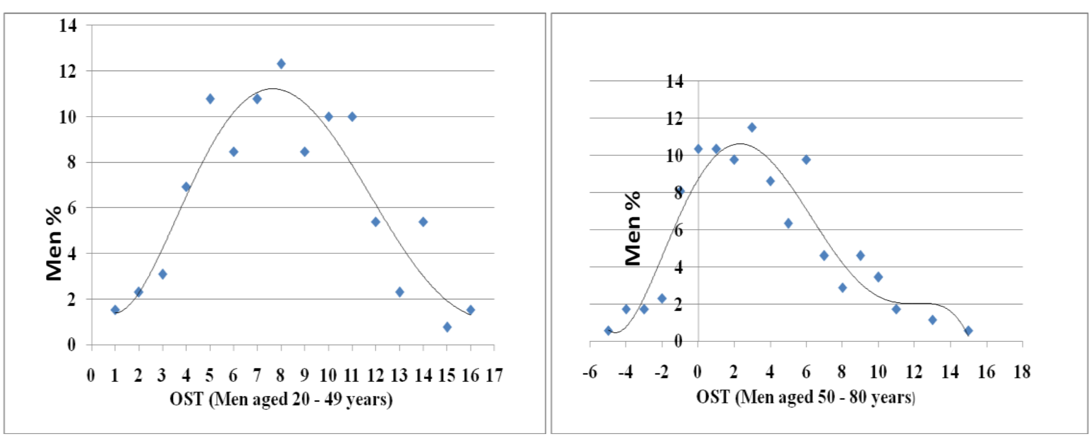


Figure. (1): Distribution of the participating men according to OST

Table (2): Distribution of the participating men according to their BMD (T-score)

	Total (N=608)		**Men aged 21- 49 years** (N= 260)		**Men aged 50- 80 years** (N=348)	
	N	**%**	**N**	**%**	**N**	**%**
Normal BMD (T-score≤ -1)	146	24.0	96	36.9	50	14.4
Osteopenia (-1< T-score>-2)	194	31.9	90	34.6	104	29.9
Osteoporosis (T-score ≤ -2)	268	44.1	74	28.5	194	55.7

Table (3): Means and standard deviations for the bone parameters in the studied groups

	Normal		**Osteopenia**		**Osteoporosis**		**F**	**P**
	Men < 50 years (N= 260)							
	Mean	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**		
Age (year)	33.29	9.54	37.44	8.98	37.62	7.80	6.89	0.001**
BMD(gm/cm²)	1.11	0.09	0.92	0.04	0.75	0.09	471.88	0.000**
T-score	-0.01	0.69	-1.47	0.28	-2.84	0.75	467.15	0.000**
OST	9.60	3.08	7.62	3.42	6.86	2.77	17.97	0.000**
	Men => 50years (N=348)							
Age (year)	60.48	8.67	62.94	8.62	64.97	9.35	5.45	0.005**
BMD(gm/cm²)	1.08	0.11	0.91	0.04	0.71	0.09	522.87	0.000**
T-score	0.07	0.77	-1.55	0.26	-3.13	0.67	661.72	0.000**
OST	5.24	4.03	4.38	3.75	2.31	3.35	19.56	0.000**

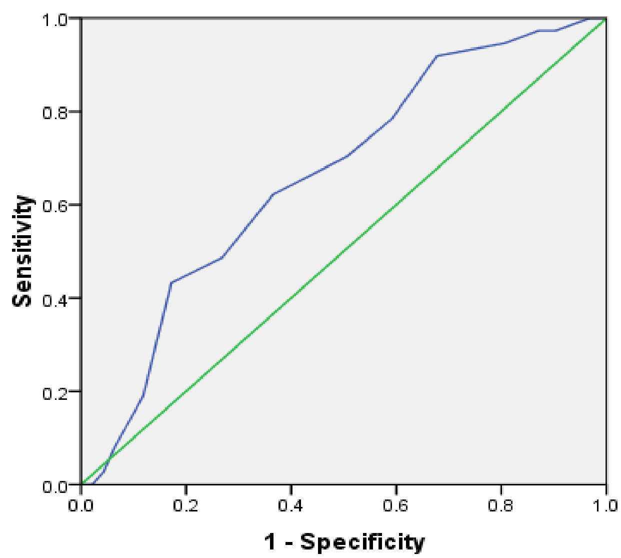
**Highly significant differences (p< 0.01)

Table (4): Validation of different cut-off values of the OST score to identify young men at risk of osteoporosis

Men aged 21 - 49 years					
Cut off	**Sensitivity**	**specificity**	**PPV**	**NPV**	**Accuracy**
0.00	0	100	0	50	50
1.50	0	98	39	49	49
2.50	3	96	56	50	49
3.50	8	94	62	50	51
4.50	19	88	72	52	54
5.50	43	83	64	59	63
6.50	49	73	63	59	61
7.50	**62**	**63**	**58**	**63**	**63**
8.50	70	49	57	62	60
9.50	78	41	58	65	60
10.50	92	32	54	80	62
11.50	95	19	53	78	57
12.50	97	13	52	83	55
13.50	97	10	51	78	53
14.50	100	3	51	100	52
15.50	100	2	50	100	51

Table (5): Validation of different cut-off values of the OST score to identify old men at risk of osteoporosis

Men aged 50 - 80 years					
Cut off	**Sensitivity**	**specificity**	**PPV**	**NPV**	**Accuracy**
-6.00	0	100	100	50	50
-4.50	1	100	70	50	51
-3.50	3	99	83	50	51
-2.50	6	99	78	51	52
-1.50	9	97	81	52	53
-0.50	22	95	70	55	58
0.50	33	86	64	56	59
1.50	43	75	60	57	59
2.50	53	65	62	58	59
3.50	68	58	61	65	63
4.50	**77**	**51**	**59**	**69**	**64**
5.50	82	43	56	71	63
6.50	90	30	55	74	60
7.50	93	23	53	76	58
8.50	93	17	52	70	55
9.50	96	10	52	72	53
10.50	100	8	51	100	54
12.00	100	4	50	100	52
14.00	100	1	50	100	51

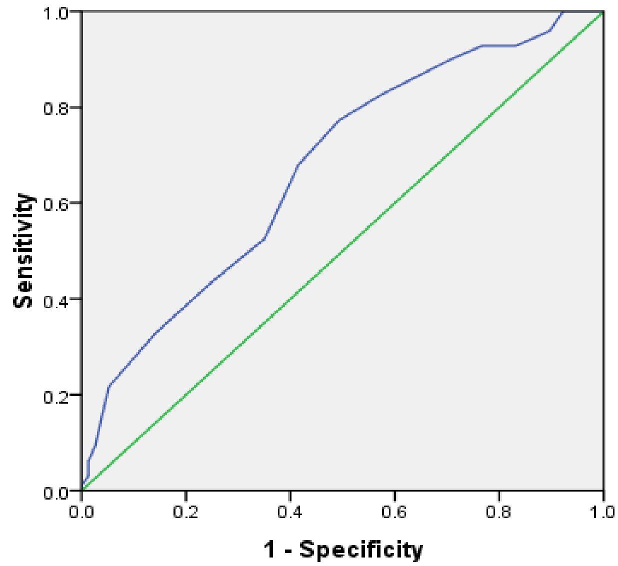


Area Under the Curve

Area	SD	Significant	95% Confidence Interval	
			Lower Bound	Upper Bound
0.663	0.036	0.000	0.592	0.733

Young Men aged 21 - 49 years

Figure 2: ROC curve for OST scores for identification of osteoporosis among younger men (< 50 years)



Area Under the Curve

area	SD	Significant	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0.674	0.029	0.000	0.617	0.730

Old Men aged 50 - 80 years

Figure 3: ROC curve for OST scores for identification of osteoporosis among older men (> 50 years)

DISCUSSION

Rapid changes in lifestyle have been associated with many diseases from last decade, especially osteoporosis (Zha et al., 2015). Osteoporosis is progressive systemic skeletal disease with susceptibility to fracture, which represents a major public health problem in the world, especially developing country. This leads to; increase the burden economically, psychologically and socially on society, families and individuals (Johnell et al., 2006). Osteoporosis not only occurs in females post menopause but also in males (Lin et al., 2017)**,** even at an early age. The prevalence of men osteoporosis was high in current population (44.1%). It was increased progressively with age, as osteoporosis was diagnosed among 28.5% of young men and 55.7% among old men. DEXA in femur is better, as DEXA of lumbar spine may give false results due to degenerative changes (Kohan et al., 2017). Therefore early detection of men with osteoporosis is the important strategy. It is well known that the gold standard for diagnosis of osteoporosis is bone density measurement by DEXA, but due to the unavailability and high cost of the DEXA equipment, OST can be an alternative method (Yang et al., 2015). The performance of the OST tool has been reported in post-menopausal Egyptian women (El-Masry et al., 2015). Therefore, the calculation of the equation must be made for men. The OST has been validated in Western and Asian population as a useful method to identify men who need measurement of BMD (Nayak et al., 2015).

In the current study the sensitivity and specificity of the OST index (cut-off = 7.5) to identify osteoporosis in young men were 62% and 63%, respectively. While old men cut-off value was 4.5 with a sensitivity of 77% and a specificity of 51%.

It has been clear from previous research that the cut-off points vary according to population, race and also ages. Various cut-off values have been studied with different population, countries and ethnicities and have been validated in various ethnic groups. Ghazi et al., (2007), in Moroccan men older than 50; found that OST cut-off point of 2, successfully identified most men with hip osteoporosis with a sensitivity of 87.5% and specificity of 58.2%. Adler et al., (2003), studied American men and defined OST cut-off score of 3, with a sensitivity and specificity (93% and 66%

respectively). Meta-analysis of the studies in south Indian men above 65 years from a rural community that look into the performance of OST showed that a cut-off threshold of 3 had a sensitivity 88 %and specificity 55%.

However, the similarity of cut-off value in men above 50 years of age was found in Korean men study by Lee et al., (2009) and in Chinese study by Kung et al., (2005). They reported cutoff value (0) of the OST in predicting osteoporosis with sensitivity of 85%, specificity of 62%, and sensitivity & specificity of 82% and 67%, respectively.

The cut-off values for OST changed due to differences in the mean age. Moon et al., (2016), explained the difference between the cut-off values in Korean in his study 2016 and those in the previous study by(Kim et al., 2014), due to the mean age. The cut-off values for OST were 2.5 in the Korean participants (2014) with mean age 54.3 ± 7.9 years. While the mean age in the moon et al., (2005) study was 57.6 ± 0.1 years with the cut-off values was 0.5. Another study by Yang et al., (2015), showed the OST cut-off values varied in Chinese elderly Males between -7 and 9 according to age group.

Cut-off values could be varied according to region as seen in (Satyaraddi et al., 2017), who assessed usefulness of the OST in a south Indian men above 65 years of age, and predicting osteoporosis cut-off value of +1 for OST with specificity (27%). But in north Indian study, it showed that OST index cut-off value ≤2 predicted osteoporosis with a sensitivity and specificity (95.7% and 33.6% respectively) (Bhat et al., 2016). Also, OST cut-off value for the osteoporosis diagnosis in old Chinese men among southeastern was -3.5; this yielded a sensitivity 47.3 % and specificity 76.8 % (Zha et al., 2015). However; at North in Beijing; the OST cut-off was -1.2 with sensitivity of 53.15% and specificity of 76.88% (Lin et al., 2016).

OST assessment performance found to have Different sensitivity and specificity in various study (Nayak et al., 2015).The value of specificity in current study for old age was similar to that in Hochberg et al., (2002), and Yang et al., (2015) report (51%), better than Lynn et al., (2008) result (36%), Bhat et al., (2016) (33.6%) and Satyaraddi et al., (2017) (27%).

In general, simple assessment method provides a fast and inexpensive way to identify individuals at osteoporosis risk.

CONCLUSION

OST score; below 7 for Egyptian men aged less than 50 years, or less than 4 for those aged 50 years; can perform well as screening tool in deciding which subset of Egyptian men needs DEXA scan for the assessment osteoporosis risk.

CONFLICT OF INTEREST

The authors declared that, the present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Rokia A El-Banna and Nayera E. Hassan: Conception and design of the study, Sahar A. El-Masry: Statistical analysis and interpretation of the data and Safenaz Y. El Sherity: (corresponding author) Collection and manipulation of the data, as well. All authors share in references collection, drafting the article and final approval of the version to be submitted.

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