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Bone Mineral Density in Healthy Turkish Women

N. Paker, D. Soy, M. Erbil, E. Uysal, Z. Otlu

Most DXA (dual-energy x-ray absorptiometry) manufacturers are not able to provide specific reference values for their equipment yet. The mean bone mineral density can vary among different populations. The aim of this study was to identify local reference values from a group of Turkish women living in Istanbul, in order to compare with the results obtained from other countries. We measured BMD at the lumbar spine, proximal femur, forearm, and total body in 205 healthy women between ages 20–79. They are all residents in Istanbul. Bone mineral density measurement was performed by DXA equipment. All measurements were made by an experienced technician in our hospital, using the same DXA equipment. Subjects enrolled in the study also filled in a questionnaire before the test. The mean age at menopause was 46.29 ($\pm$ 14.28) years. Peak bone mineral density values were obtained in the 20–39 year age group when measured at the ultradistal radius, however, peak values were in the 30–39 age group when measurements were made at other sites. The number of women who had bone loss was higher with the forearm measurements compared to measurements made from the spine and femur. Bone mineral density values measured from the spine, hip, and forearm in our study group were lower than the values from American and European women, on the other hand, total body bone mineral density values from our group were higher than the values reported from western countries. Bone mass from different populations varies due to genetic and geographical factors. We, therefore, suggest that each country should use their localized reference values for bone mineral density measurement.

Die meisten DXA-Anbieter können keine spezifischen lokalen Referenzwerte für ihre Geräte anbieten. Die mittlere Knochenmineraldichte (BMD) ist zwischen verschiedenen Populationen variabel. Das Studienziel war die Identifizierung von lokalen Referenzwerten einer Gruppe türkischer Frauen aus Istanbul und der Vergleich dieser Daten mit jenen aus anderen Ländern. Die BMD wurde bei 205 gesunden Frauen aus Istanbul im Alter von 20 bis 79 Jahren an der Lendenwirbelsäule, dem proximalen Femur, am Unterarm und am gesamten Körper mittels DXA gemessen. Alle Messungen wurden von einem erfahrenen Untersucher mit dem gleichen Gerät durchgeführt. Die untersuchten Frauen füllten vor der Messung einen Fragebogen aus. Das mittlere Menopausenalter lag bei 46,29 ($\pm$ 14,28) Jahren. Spitzen-BMD-Werte wurden in der Altersgruppe 20–39 Jahre am ultradistalen Radius gemessen, in der Altersgruppe 30–39 Jahre an anderen Orten. Die Anzahl der Frauen mit Knochenmasseverlust war bei Messungen am Unterarm höher als bei Messungen an der LWS oder am Femur. Die an der Wirbelsäule, an der Hüfte und am Unterarm gemessenen BMD-Werte lagen niedriger als die Werte amerikanischer oder europäischer Frauen, andererseits war der BMD des Gesamtkörpers höher als in westlichen Ländern. Die BMD variiert in verschiedenen Populationen aufgrund genetischer und geographischer Faktoren. Wir schlagen daher vor, daß jedes Land lokale Referenzwerte für die BMD-Messung anwenden soll. *J Miner Stoffwechs* 2005; 12: 73–76.

Osteoporosis is an important health problem characterized by low bone mineral density (BMD) and a reduction in bone strength [1]. Osteoporosis increases morbidity and mortality, decreases quality of life, and also results in significant economic loss due to fracture complications [2–4]. Using the BMD measurement techniques, it is now possible to diagnose osteoporosis before fractures occur. DXA (dual-energy x-ray absorptiometry) is an accurate technique for measuring BMD [5, 6]. There is a correlation between low BMD and high fracture risk [5, 7]. BMD values show differences between populations [8–15]. BMD can be influenced by racial, hormonal, and lifestyle factors like dietary habits, physical activity, smoking, number of children, duration of lactation [11].

Our aim in this study was (1) to establish BMD values for the spine, proximal femur, forearm, and total body in a group of Turkish women living in Istanbul, (2) to compare these results with values obtained in other countries, and (3) to investigate the relationship between BMD values and menopause status, number of children, body weight, and daily tea consumption.

Materials and Methods

We enrolled 205 healthy female Istanbul residents in our study aged between 20–79 years. The subjects were chosen among responders to an advertisement given by our hospital. All women enrolled in the study were physically active. Women with a history of metabolic bone disease, pregnancy, fracture history from minimal trauma, immobilization, hepatic, intestinal or renal disease, amenorrhea, body weight over 100 kg, use of drugs that effect bone mass, cig-

arette smoking for more than 10/day, alcohol consumption over two glasses/day were excluded from the study. A questionnaire was used to document patients' age, daily coffee and tea consumption, age of menarche and menopause, and number of children. Body weight and height were measured using standard methods.

BMD was measured in the posterior-anterior projection at the lumbar spine (L2–L4), at the right hip (femur neck, total femur), at the dominant ultradistal radius and of total body by DXA (Lunar DPX, Madison, WI, USA). All measurements were done by the same qualified technician. DXA was calibrated daily. This study was approved by the Institutional ethical committee.

Data was tabulated on Microsoft Excel 97 spreadsheets and statistical analysis was performed with the SPSS 11.5. The difference between mean BMD values for age was tested using the Student's t-test. A p-value of 0.05 was considered statistically significant. The effect of various risk factors on BMD was determined by linear regression analyses.

Results

The demographic data of healthy Turkish women are given in Table 1. The mean age at menarche and menopause were 13.46 ($\pm$ 2.27) years and 46.29 ($\pm$ 14.28) years, respectively.

The study group was divided into 6 subgroups. The average BMD values according to ages are shown in Table 2. BMD was stable at all measurement sites between the ages of 20–39, and it decreased after the age of 40. BMD values were 0.358 (0.039) g/cm², 1.149 (0.057) g/cm², 1.178 (0.124) g/cm², 0.947 (0.109) g/cm² and 0.973 (0.231) g/cm² in young adults (age 20–39 years) for the ultradistal radius, total body, lumbar spine, femur neck and femur total respectively.

The peak BMD value measured at the radius was in the 20–39 age group. In the other regions, however, the meas-

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ured peak BMD was in the 30–39 age group. T-score is defined as the number of standard deviations above or below the mean BMD for young women.

The World Health Organisation (WHO) has defined osteoporosis as a T-score of < -2.5 SD and osteopenia as a T-score between -1 and -2.5 SD. This definition is restricted with lumbar spine and proximal femur T-scores. In our study T-scores according to the age groups are given in Table 3. These results show that bone mass is lower in the radius compared to values obtained at the spine and femur. The women diagnosed to have osteoporosis and osteopenia in the 50–79 age group are shown in Table 4.

Daily calcium intake was low in our study group. Traditional black tea was the most frequently consumed soft drink. Coffee consumption was less than 1 cup/day for the women we have studied. More than 5 glasses (75 cc/cup) of daily tea consumption had no negative effect on BMD at any site.

In women under 57 kg of weight, L2–L4 spine, femur neck, femur total and total body BMD values were statistically lower ($p < 0.014$, $p < 0.049$, $p < 0.014$, $p < 0.012$) than in heavier women. At the radius, no correlation was found between body weight and BMD values. There was no correlation between body mass index and BMD with regard to age at menopause. BMD decreased significantly after menopause ($p < 0.05$).

BMD values of women who had 3 or more children was found to be significantly lower at radius ($p < 0.017$), total body ($p < 0.039$), spine ($p < 0.037$), and femoral neck ($p < 0.017$) measurements. There was no significant correlation between femur total values and number of births.

Regression analysis of BMD values for L2–4 spine and femur neck are shown in Tables 5 and 6.

Discussion

Osteoporosis is a chronic disease that contributes substantially to decreased physical activity and decline in the quality of life [14]. Osteoporosis can be diagnosed easily with the use of DXA equipment [16]. In our study, BMD values of 205 healthy women aged 20–79 were evaluated at five different skeletal sites. The objectives of our study were to find out the BMD values of the Turkish women enrolled in the study and compare these results with values obtained from other countries, in order to investigate the relationship between bone loss and contributing risk factors. In our study, we found that BMD values from the spine and hip were lower than the values reported from the American, European, and Kuwaiti reference groups and higher than the Saudi Arabian and Lebanon average values [9, 11, 17, 18]. The total body BMD values of the Turkish women enrolled in our study were higher than the American and European reference values [18]. We, therefore, conclude that cortical bone mass was higher in the sample of Turkish women living in Istanbul than the values reported from the Western countries. This result may in part be related to geographic differences.

In a previous study, Turkish women were found to have 2–6 % lower BMD values than American and European women measured at spine, femur and forearm sites. The total body BMD values were higher in Turkish group. Results of our study correlate with the results from this study [13]. Low BMD values may be related to early menopause age, low peak bone mass, high birth rate and life style factors.

Table 1. Basic characteristics of subjects according to the age groups (SD in parenthesis, BMI: Body mass index)

Age group (years)	No of women	Mean height (cm)	Mean weight (cm)	Mean BMI (kg/cm ²)	No of children	Mean tea consumption (glasses/day)
20–29	19	160.5 (6.9)	56.7 (7.1)	22 (2.6)	0.32 (0.5)	5.52 (4.6)
30–39	48	159 (6.1)	63.5 (9.4)	25.2 (4.1)	1.6 (0.9)	5.33 (3.4)
40–49	35	158.86 (4.6)	66.8 (10.5)	26.5 (4.1)	1.91 (1.1)	5.68 (3.7)
50–59	50	157.3 (5.5)	72.1 (9.1)	29.1 (3.4)	2.16 (1.4)	5.14 (3.9)
60–69	38	155.9 (5.9)	73.7 (10.6)	30.4 (4.8)	3.92 (2.1)	4.07 (2.2)
70–79	15	148.3 (6.0)	63 (11.5)	28.6 (4.4)	2.67 (1.8)	3.13 (2.5)

Table 2. BMD (g/cm²) values of measurement sites (SD in parenthesis)

Age group (years)	Ultradistal radius	Total body	Lumbar spine	Femur neck	Femur total
20–29	0.357 (0.03)	1.139 (0.07)	1.146 (0.14)	0.945 (0.12)	0.963 (0.11)
30–39	0.358 (0.04)	1.153 (0.05)	1.191 (0.11)	0.947 (0.1)	0.976 (0.11)
40–49	0.346 (0.06)	1.145 (0.069)	1.132 (0.09)	0.927 (0.1)	0.969 (0.11)
50–59	0.345 (0.05)	1.118 (0.07)	1.093 (0.14)	0.897 (0.09)	0.950 (0.1)
60–69	0.304 (0.06)	1.079 (0.08)	1.023 (0.17)	0.834 (0.12)	0.912 (0.18)
70–79	0.250 (0.05)	1.053 (0.12)	0.909 (0.22)	0.702 (0.16)	0.759 (0.15)
20–79	0.327 (0.05)	1.115 (0.12)	1.082 (0.15)	0.876 (0.12)	0.922 (0.13)

Table 3. T-scores of the measurement sites (SD in parenthesis) (T-scores were calculated from the North American reference data provided by the manufacturer)

Age group (years)	Ultradistal radius	Total body	Lumbar spine	Femur neck	Femur total
20–29	–0.54 (0.79)	0.17 (0.88)	–0.43 (1.16)	–0.27 (1.04)	–0.30 (0.97)
30–39	–0.52 (1.19)	0.34 (0.64)	–0.05 (0.95)	–0.26 (0.87)	–0.20 (0.90)
40–49	–0.83 (1.83)	0.24 (0.80)	–0.47 (0.79)	–0.45 (0.90)	–0.27 (0.98)
50–59	–0.87 (1.5)	–0.12 (0.98)	–0.86 (1.2)	–0.65 (0.84)	–0.41 (0.89)
60–69	–2.01 (1.55)	–0.54 (1.08)	–1.47 (1.42)	–1.22 (0.97)	–0.88 (0.96)
70–79	–3.46 (1.39)	–0.88 (1.62)	–2.42 (1.9)	–2.31 (1.37)	–2.00 (1.27)
20–79	–1.37 (1.38)	–0.13 (1.00)	–0.95 (1.259)	–0.86 (1.00)	–0.68 (1.00)

In our study we used original American reference values given by the manufacturer. American reference values are being used in most of the DXA equipment currently in use in Turkey. However, some investigators have reported that localized reference values should be used in different populations [19].

Peak BMD values in our study were found at measurements taken from the radius in the 20–39 age group and peak values were in the 30–39 age group when measurements were taken at other sites. The spine, hip, total body peak BMD values in our study group showed correlation with the peak BMD values obtained from Lebanese women [5]. The “low” peak BMD values may be related to low bodyweight found in young women. In our group of healthy women under 30 years of age, body weight was 56.6 ± 7.10 kg. Genetic factors and life style may also influence these results. In a theoretical study by Hernandez et al, it was found that an increase in peak BMD by 10% postpones osteoporosis for 13 years [20].

In the 50–79 age group, osteoporosis rate in our study was 20% in lumbar spine, and 10% in the femoral neck. In a previous study this rate was reported to be approximately around 20% for the lumbar spine or for the femur neck in the women at the same age group [18]. Our results showed correlation with this study. In a report from Saudi Arabia among the women older than 50 years, osteopenia and osteoporosis rate was 66% when measured in the lumbar spine and 47% in femoral neck [11]. In our study osteopenia and osteoporosis rate was 59% and 55% for the age

group of 50–79 years when measured at L2–4 spine and femur neck regions, respectively.

The percentage of women who have osteoporosis can vary according to the measurement site [7]. Arlot et al found that prevalence of bone loss was higher when measured at the distal radius rather than at the hip [21]. Also, in our study, the number of women who have bone loss was higher in the group with measurements taken at the ultradistal radius than measurements taken at the femur and spine. The sites with the highest number of osteoporotic women were the spine and femur, respectively. Among these measurement sites, bone loss started in the ultradistal radius first. Following forearm, BMD values decreased in the order of spine and then in the femur. In postmenopausal women, bone loss occurs in trabecular bone first. In this study BMD values were lower in ultradistal radius, because this region contains more trabecular bone. In the 70–79 age group, osteopenia and osteoporosis rates were similar in spine and femur sites. In this age group, radial BMD values were lower than those of spine and femur.

DXA is the gold standard in the diagnosis of osteoporosis. BMD measurement is done mostly at the spine and proximal femur. In our study, forearm BMD values were important because it was the region where bone loss was higher in pre- and postmenopausal women. In a previous study performed on women who had early onset menopause, height loss, fractures, corticosteroid therapy, endocrinologic disorders or Crohn disease, Damilakis et al found that forearm BMD values could be used as a screening test in women with bone loss in the axial skeleton [22]. Furthermore, forearm fractures which are often encountered in the perimenopausal period can be prevented by measuring BMD of this region. Forearm BMD measurement is easy to perform and takes a short time. Bone mass decrease in this region can be expressed as increased fracture risk. Correlation was shown with axial and appendicular BMD values but BMD of one region could not be predicted with the BMD value of a different region in another skeleton [7]. Widgerowitz et. al showed that ultradistal radius BMD values were lower in 211 patients than the age-matched controls [23].

Table 4. Prevalence of women with osteoporosis and osteopenia

Measurement site		50–59 years	60–69 years	70–79 years	50–79 years
Lumbar spine	Osteopenia	40 %	45 %	20 %	39 %
	Osteoporosis	10 %	21 %	53 %	20 %
Femur neck	Osteopenia	40 %	58 %	27 %	45 %
	Osteoporosis	0 %	5 %	53 %	10 %
Femur total	Osteopenia	20 %	39 %	33 %	33 %
	Osteoporosis	0 %	5 %	47 %	9 %

Table 5. Regression coefficient for BMD of L2–L4

Coefficients	Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
		B	Std. Error			
1	(Constant)	–0.066	0.283		–0.233	0.816
	Age	–0.003	0.001	–0.268	–2.368	0.019
	Height	0.007	0.002	0.293	4.366	0.000
	Weight	0.004	0.001	0.277	4.091	0.000
	No of child	–0.015	0.007	–0.162	–2.302	0.022
	Consumption of tea	–0.001	0.003	–0.017	–0.283	0.778
	Consumption of coffee	0.001	0.012	0.007	0.111	0.912
	Menopause	–0.001	0.001	–0.095	–0.956	0.340
a	Dependent Variable: L2–L4 BMD					

Table 6. Regression coefficient for BMD of femur neck

Coefficients	Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
		B	Std. Error			
1	(Constant)	0.517	0.226		2.292	0.023
	Age	–0.005	0.001	–0.567	–4.963	0.000
	Height	0.003	0.001	0.124	1.845	0.067
	Weight	0.004	0.001	0.295	4.332	0.000
	No of child	–0.003	0.005	–0.036	–0.505	0.614
	Menopause	0.000	0.001	0.078	0.776	0.439
a	Dependent Variable: Femur Neck BMD					

In our study, weight was 56.6 ± 7.10 kg in women under 30 years of age and over 60 kg after 30 years of age. Women with weight under 57 kg had significantly lower BMD values at lumbar spine, femur neck, total femur, and total body. Our results show correlation with the other studies [18]. Weight had no effect on ultradistal radius BMD values. This shows the useful effects of weight on weight bearing skeletal regions. No correlation was found between body mass index and bone loss.

In healthy women who had 3 or more children, BMD values of radius, total body, spine and femur neck were lower than those with 2 or less children ($p < 0.05$ all). In previous studies it was reported that as the number of children and lactation increase, BMD decreases [24, 25]. The amount of daily tea consumption had no negative effect on BMD.

Conclusion

We conclude that forearm, femur, and spine BMD values of healthy Turkish women enrolled in our study are lower than the values reported for American and European women. However, total body BMD values of our study group were higher than those reported from the western countries.

Among the measurement sites BMD was lower at ultradistal radius than spine and femur. These results showed us the importance of appendicular measurements in addition to axial measurements.

The identified risk factors for bone loss were low body weight, ageing, and having three or more children.

We suggest that for each population, localized reference values for DXA equipment should be used. As life styles may change in time, it is prudent to periodically evaluate new healthy generations for database verification.

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