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ORIGINAL ARTICLE

BONE MINERAL DENSITY(BMD) MEASUREMENT USING CENTRAL DUAL ENERGY X-RAY ABSORPTIOMETRY (DEXA) IN ADULT ETHIOPIANS

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ABSTRACT

Introduction**:** *Bone mineral density is the amount of inorganic mineral in bone tissue. Its' measurement is an important screening investigation done to diagnose patients with osteoporosis. Osteoporosis is a metabolic disorder characterized by low Bone mineral density resulting in increased incidence of fragility fractures.*
Objectives*: This study is an attempt to establish a normative Bone mineral density data for the Ethiopian population*
Methods*: This is a uni-center-based retrospective study. We reviewed the Bone mineral density of 345 Ethiopian individuals measured with a Dual-energy X-ray absorptiometry.*
Results*: The peak bone density in males was reached at the age of 20-29 years. The age-related decline in bone mineral density was about 0.62%per year at the lumbar spine and 1.01% per year at the femur neck from the age 30 to 70 years. The peak bone density in females was reached at the age of 20-39 years, the age r-related decrease in bone density was about 0.465% at the lumbar region and 1.41% at the femur neck region .*
Conclusion*: Although this study has outstanding draw backs we found that the Bone mineral density values of Ethiopian individual was higher than those established for Caucasian individuals. Its significance is in highlighting the importance of establishing a normative data so as to accurately diagnose, treat and follow osteoporosis.*
Key words: *Bone mineral density, osteoporosis, Ethiopian, DEXA scan, BMI*

INTRODUCTION

Bone mineral density measurement is an important screening investigation done to diagnose, treat and follow patients with osteoporosis. It is also used to calculate the fracture risk in established osteoporosis cases. Although there are different methods of determining bone mineral density, the standard is using central dual energy X-ray absorptiometry as per the world health organization recommendation. Bone mineral density is essentially the amount of inorganic matter/ mineral in bone tissue. It is clinically measured by proxy according to optical density per square centimeter of bone surface upon imaging.

Osteoporosis is an endocrine/metabolic disorder characterized by low Bone mineral density (BMD) resulting in increased incidence of fragility fractures. Osteoporosis is becoming a serious public health concern as the world aging population is on the rise. However, the actual value obtained from the dual energy X-ray absorptiometry(DEXA) scan do not define osteoporosis and osteopenia. According to World Health organization WHO guidelines, the T-score, which is the difference between the measured BMD and the mean value of young adults expressed in standard deviation for a normative population of the same ethnicity is used to define the above mentioned conditions.

An individual is diagnosed with osteopenia is -2.5<T-score< -1 and osteoporotic if the T-score is < -2.5. (1)

However, there are limitations to using the DEXA scan and T-score results produced because most manufactures use the Caucasian adult population as a reference data. Multiple studies have shown, however, that BMD values differ between races and different ethnicities. Therefore, using a reference data established for a population other than our population of interest introduces a systematic error in defining osteoporosis.

The aim of this study was to measure the BMD of the proximal femur and lumbar spine of Ethiopian individuals in an attempt to establish a reference data for the Ethiopian population. In this retrospective study, we examined the results of 219 female and 126 male Ethiopian individuals aged from 20 to 102 years who had a DEXA scan done at a private wellness clinic in Addis Ababa. This study describes the first attempt to provide a guideline for distribution of normal BMD values in a sample of Ethiopian individuals.

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PATIENTS AND METHODS

For this retrospective study, the DEXA scan results of 345(219 female and 126 male) Ethiopian individuals was examined. All the subjects were of Ethiopian origin and within the age range of 20-102 years. The DEXA scan was done at a private wellness clinic in Addis Ababa over the last 03 years (2017-2020). The BMD of all the subjects were determined from the femur neck and lumbar spine by using DEXA scan using the fast scan mode. The manufacturer's instructions were followed. Subjects with known/ documented comorbidities like endocrine disorders and subjects with incomplete data were excluded from the study.

Verbal informed consent was obtained from each individual prior to scanning and their identity was concealed .SPSS VERSION 20 was used to analyze the data.

RESULTS

The 345 individuals (219 females, 126 males) were stratified by age and divided into five subgroups for cross-sectional analyses. Mean values of height, weight and BMI, according to age, are given in Table 1.

Table 1: mean values of height, weight and Body mass index of the study population

male		Height		Weight		BMI	
	N0	Mean	SD	Mean	SD	Mean	SD
<20	0						
20-29	71	173.07	7.098	59.94	7.77	19.98	2.09
30-39	35	173.23	7.373	65.51	9.057	21.819	2.68
40-49	15	169.87	6.163	72.33	11.902	25.173	4.62
50-59	2	164.0	.000	51	.000	18.961	0E-7
60-69	0	0		0			
>70	3	165.0	.000	70	.000	25.711	0E-7

Female			Height	Weight		BMI	
	No	Mean	SD	Mean	SD	Mean	SD
<20	2	160	.000	40	.000	15.625	0E-7
20-29	68	162	5.356	52.85	7.971	20.132	2.829
30-39	28	163.5	6.155	61.86	29.834	23.452	12.835
40-49	25	164.08	10.255	69.28	14.424	25.485	2.613
50-59	33	160.48	7.467	73.42	25.809	28.419	9.598
60-69	48	162.23	5.744	68.35	12.012	25.973	4.427
>70	15	156.33	4.186	67.47	18.578	27.492	7.097

Table-2: correlation of sex, age and bone mineral density

Male		L2-L4		Neck of femur		Female		L2-L4		Neck of femur	
AGE	N0	MEAN	SD	MEAN	SD	AGE	No	Mean	SD	Mean	SD
20-29	71	2.013000	1.2527	1.995	0.2198	20-29	68	1.1157	.154	1.398	0.3166
30-39	35	1.306810	.243	1.508	0.3588	30-39	28	1.0073	.1876	1.808	0.388
40-49	15	1.057750	.1016	0.972	0.322	40-49	25	1.041	.1679	1.003	0.68
50-59	2	1.088500	.0502	1.124	0.397	50-59	33	1.063	.462	1.167	0.669
60-69	0					60-69	48	.9856	.4478	0.9788	0.852
>70	3	0.98930	0.5768	0.898	1.083	>70	15	.814	.1833	0.7815	0.702

The peak bone mass in males at the lumbar spine and the neck of the left femur was reached at the age range of 20-29 years and was about 2.013 ±1.2527g/ cm2 and 1.995±0.2198 g/cm2, respectively. An age-related decrease in bone density began after the age of 30 in males. The average age-related decrease in bone density was about 0.62% per year at the lumbar spine and 1.01% per year at the neck of the femur from the age of 30 to 70.

The peak bone mass in females at the lumbar spine and the neck of the left femur was reached at the age of about 25±5 and 35±5 years and was about 1.1157±0.154 g/cm2 and 1.808±0.388 g/cm2, respectively. In this group, the age-related decrease in bone density was about 0.465% and 1.41% per year at the lumbar spine and the neck of the femur, respectively from 30 to 70 years.

Table 3:- Mean bone mineral density and standard deviation in women based on menopausal status

	L2-L4		Neck of Femur	
	Mean	**SD**	**Mean**	**SD**
Premenopausal	.851136	.1305652	1.001565217	.1391038938
Postmenopausal	.780911	.1655008	.9897236842	.4557849376

As shown in table 3, The BMD of the lumbar spine and the femoral neck declines in perimenopausal women as compared to women in their 30s and there is a statistically significant decline in BMD after menopause.

Table 4: Prevalence of osteopenia and osteoporosis in adults aged 50 and older

		Normal	**Osteopenia**	**Osteoporosis**
Neck of femur	F	40%	54.5%	5.5%
	M	75%	25%	-
L2-L4	F	18%	40%	42%
	M	66.69%	22.22%	11%

Table 4 shows the prevalence of osteoporosis and osteopenia in our sample population. WHO guideline reference data for T-score was used for definition. Standard WHO definitions of osteoporosis and osteopenia were used.

DISCUSSION

This report is the first ever attempt to establish spine (lumbar vertebra) and hip (femur) BMD normative values using standard DEXA scan for a large group of adult Ethiopian males and females. The objective of the study was to determine normal BMD and establish age at peak bone mass for Ethiopian population in addition, to compare BMD values established for Caucasians with our findings. This study is meant to highlight the importance of establishing a separate Ethiopian reference data. Multiple studies have demonstrated that there are racial and ethnic differences in BMD values. Reference values for different Caucasian populations were found to be identical; however (2-6).

The BMD values in black subjects were found to be about 8-12% higher than in Caucasians. Whereas;Asian women have lower BMDs than both Caucasians and black subjects (7).

The peak BMD was established and the age related decrease in bone density was determined for our subjects. These values were then compared with multiple reference data's established for Caucasian women (2-6,8-10). Our results were consistent with the established findings although the rate of decrease in BMD was higher in Ethiopian females compared to American and Iranian females. This could be attributed to the lower mean BMI in Ethiopian women since low weight has been shown to be a predictor of rapid bone loss potentially due to the lack of peripheral estrogen production. Mean BMD values in our subjects were generally higher than those found in the American and Iranian data (1, 8, and 10). This can be attributed to differences in race as there are multiple studies showing black men and women have higher BMDs. (7, 11, and 12)

We also tried to see the decrease in BMD following menopause in our subjects. There was a decrease in mean BMD in our menopausal subjects which is consistent with findings in other studies (13, 14).

We also examined our BMD data with regard to the prevalence of osteoporosis and osteopenia. Although WHO's diagnostic criteria for definition of osteoporosis and osteopenia was established for Caucasian women, we applied it to our subjects (1). Peak BMD and standard deviation are the two determining factors in calculating T-scores. The standard deviation and BMD values for both the femur neck and the lumbar spine in Ethiopian women was found to be larger than the American database. When the subjects' BMD and the standard deviation of the peak BMD remain constant, the Peak BMD increases with a decreasing T-score. This indicates that the threshold to diagnose osteoporosis increases.

When the American database is used, the prevalence of osteoporosis is lower. This point further emphasizes the relevance of establishing a national reference database.

There are several limitations to this study, it's a retrospective study done from data collected at a single center with multiple variables unaccounted for. It's also a cross-sectional study in nature and doesn't provide actual BMD changes over time. It is meant as an indicator towards the importance of establishing a national reference data with regards of diagnosis and treatment of osteoporosis for a country with an ever increasing life expectancy and a growing aged population.

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