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Original Article

Normative Bone Mineral Density values in Isfahani women

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ABSTRACT

Background: The correct interpretation of bone mineral density (BMD)measurement by dual energy x ray absorptiometry(DEXA) requires a population specific reference range. We collected data on age 20-35 years to obtain reference values of BMD for Isfahani women in order to make a population specific diagnosis of osteoporosis.

Methods: In 660 healthy Isfahani women Volunteers (20-35 years) without illness, use of drugs or predisposing conditions to osteoporosis, the BMD (gr/cm²) of lumbar spine and non-dominant femur was measured by lunar DPX –IQ machine.

Results: The mean BMD and its standard deviations at each site were calculated and compared with normative data from Caucasian US/North European women. No significant differences were detected between them.

Conclusions: Bone mineral density measurements of these 660 healthy Isfahani women can serve as a reference guide for the diagnosis of osteoporosis in Isfahani women.

Key words: Bone Mineral Density, Osteoporosis, Normative data, DEXA

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Osteoporosis is the most common metabolic bone disease, characterized by decrease in bone mass and deterioration of bony micro architecture, resulting in an increased susceptibility to fracture[1]. Its pathogenesis consists of genetic and environmental factors. Genetic factor account for about 46-62% of inter individual variation in peak bone mass in both sex. Environmental factors, especially diet and mechanical loading also play a role in determining peak bone mass (38-54%)[2]. In some studies, 20-30% of postmenopausal woman [3] and more than 50% of men [4,5,6] with osteoporosis had a secondary cause. Secondary causes of bone loss are drugs, endocrine abnormalities, gastrointestinal and kidney diseases, immobilization, marrow-related disorders, cancer and eating disorders.

Now, osteoporosis is recognized as a silent epidemic disorder and affects an estimated 75 million people in Europe, USA and Japan [7]. In the United States, 54% of postmenopausal women are osteopenic and 30% osteoprotic [8].

In Canada, approximately 1 in 4 women and 1 in 8 men have osteoporosis [9].

The public health and clinical importance of osteoporosis lies in the fractures associated with disease. There is an inverse relationship between bone density and gradient of risk for fracture[10], but 10-12% decrement in the bone density is associated with 2-fold increase risk of fracture11. At age 50, the lifetime risk of having a hip, wrist, or clinical vertebral fracture is about 40% in white women and 13% in white men. Hip fractures are associated with 20% mortality rate within the first year of fracture, and 50% of patients are unable to ambulate independently[12].

The Cost of osteoporotic fractures in USA is estimated at $ 7-10 billion annually for a population of 250 million. In England, the total cost of osteoporosis is estimated to be £ 614 million annually for a population of 50 million 1.

Osteodensitometry by dual energy X-ray absoroptiometry (DEXA) is a widely used method to determine bone mineral density (BMD) at different skeletal sites. For reliable interpretation of individual BMD data, however, they should be expressed in relation to established normative data. Comparison can be made either in terms of the age-matched standard deviation score, commonly referred to Z score, or by T Score, which indicates deviation from the mean BMD of a young

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normal population. For this reason, comparison of T Scores yields the best available information on the extent of osteoprotic bone loss and the associated fracture risk. WHO defines osteopenia and osteoporosis as T score between -1 and -2.5 and T score ≤ -2.5 respectively [13,14]. Severe osteoporosis is defined as additional presence of one or more fragility fractures.

Although BMD data provide an important basis for lifestyle counseling to prevent osteoprosis, and are of paramount importance for planning and monitoring of antiresorptive therapies, a reliable interpretation of individual BMD data as assessed by DEXA methods is hampered by two facts: first, there is an apparent discrepancy between normative data used by different manufacturers (Hologic or Lunar system); Second, as all manufacturers use normative data derived from an adult population in USA, they can be applied only for studying similar large population in, for example the UK and Northern Europe[16],but might not be an appropriate reference for local or selected populations with a different genetic , geographic and socio-economic background. Recently, the necessity for using regional reference values rather than those supplied by the manufacturers of DEXA systems has been emphasized [17- 20].

Because of no DEXA reference ranges for Iran, we initiated the present study to generate an appropriate database for DEXA measurements in adult Isfahani women.

Subjects and Methods

Six hundreds and sixty healthy Isfahani females aged 20-35 years were sampled clustery and systematically by selected household listings, from 25 regions across Isfahan equally. All subjects were screened by a detailed questionnaire, history and physical examination. Exclusive criteria were conditions affecting bone metabolism Such as chronic renal failure, urolithiasis, cirrhosis, malabsorption syndromes, gastrectomy, intestinal bypass, thyroid or parathyroid diseases, hypogonadism, diabetes mellitus, menstrual abnormality, rheumatoid arthritis, lupus erythematous, ankylosing spondylitis, malignancy, hematologic diseases, previous pathologic fractures, pregnancy, lactation, immobilization, smoking and drugs (steroid, estrogen, anticonvulsants, sodium fluorides, anticoagulants, prolonged or excessive thyroid replacement therapy, vitamin D or calcium).

Bone mineral density of anteroposterior lumbar spine (L1-L4) and non-dominant femur was done for all subjects at supine position. In vivo reproducibility for lumbar spine and femur was 1%. Machine calibration using the phantom spine was done daily prior to doing any scan to ensure precision of the machine. The BMD (gr/cm^2) was measured by lunar DPX-IQ densitometry.

SPSS (version11.5) Statistically analyzed the mean and standard deviation (SD) of BMD at various skeletal regions.

Results

The basic characters were Age (20-35 year), Height (158.5±5.820cm), Weight (62.2 ±11.507kg) and BMI (24.7±4.5 kg/m^2).

The mean BMD, corresponding standard deviations (SD) and minimum and maximum BMD at each site are shown in Table 1. Table 2 provides detailed mean BMD at each site with corresponding +1, +2.5, -1 and -2.5 SDs. The mean BMD and corresponding values for a Caucasian US/North European population at the lumbar spine and femur are shown in Table 3.

Table 1: BMD reference values (gr/cm^2) with min/max at all sites in Isfahani women

Site	Mean (SD)	Minimum	Maximum
Neck Femur	0.94093(0.11932)	0.674	1.426
Total Femur	1.00019(0.12487)	0.708	1.449
L_1	1.09872(0.13804)	0.740	1.552
L_2	1.18786(0.14335)	0.807	1.699
L_3	1.23785(0.14335)	0.889	1.853
L_4	1.20008(014296)	0789	1.716
L_2 - L_4	1.20849(0.13504)	0.857	1.731

BMD = bone mineral density SD =standard deviation

Table 2: The mean BMD (gr/cm²) and corresponding +1,+2.5,–1, -2.5 SDs at each site in Isfahani women

Site	Mean	Mean-1SD	Mean+1SD	Mean-2-5 SD	Mean+2.5 SD
Neck Femur	0.94093	0.82161	1.06025	0.64263	1.23923
Total Femur	1.0099	0.87532	1.12506	0.689725	1.312365
L_1	1.09872	0.96068	1.23676	0.75362	1.44382
L_2	1.18786	1.04451	1.33121	0.829495	1.546235
L_3	1.23785	1.09353	1.38217	0.87705	1.59865
L_4	1.20008	1.05712	1.34304	0.84268	1.55743
$L_2 - L_4$	1.20849	1.07345	1.34353	0.87089	1.54609

BMD = bone mineral density SD = standard deviation

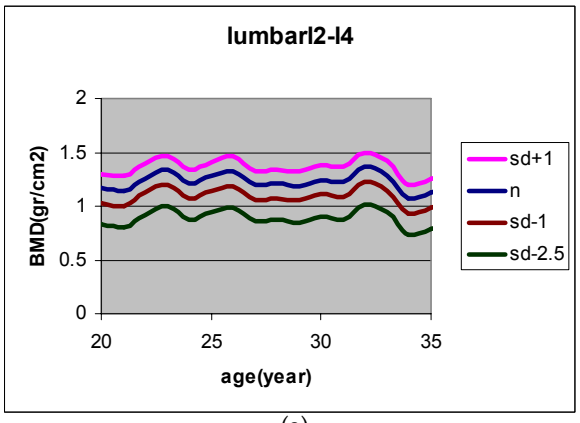
Table 3: Comparative mean BMD between Isfahani and Caucasian women.

Site	BMD (Isfahani)	BMD (Caucasians)
Neck Femur	0.94093	0.97952
Total Femur	1.00019	1.00124
L_1	1.09872	1.13015
L_2	1.18786	1.20008
L_3	1.23785	1.20050
L_4	1.20008	1.20094
L_2- L_4	1.20849	1.20047

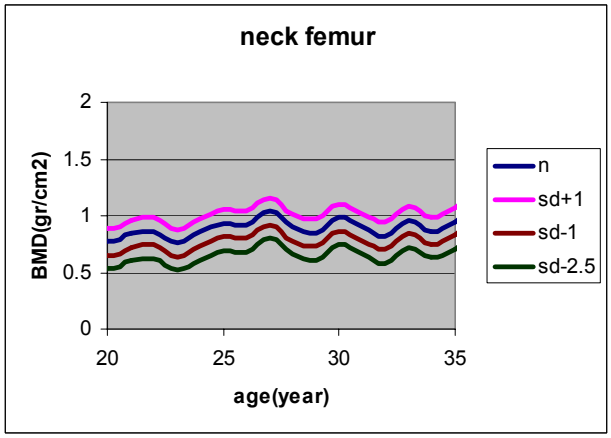
BMD = bone mineral density SD =standard deviation

The relation between BMD at the various sites and age variations were analyzed by cubic regression models.

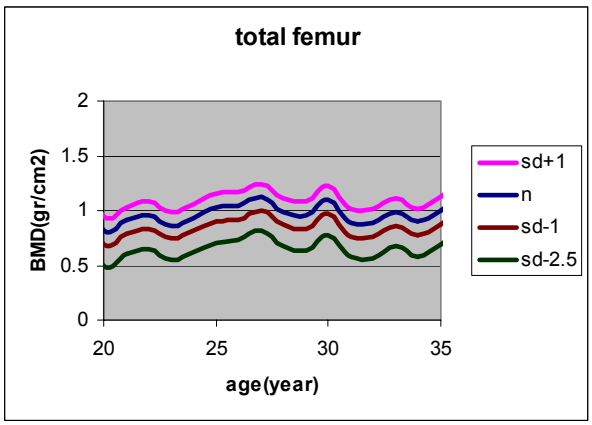
Figure 1 presents the fitting curves and the distribution of age related changes of BMD at different skeletal sites.



(a)



(b)



(c)

Figure 1. Curves (a, b, c) and distribution of age related BMD at femoral neck, total femur, lumbar l2-l4 and corresponding +1, normal, -1,-2.5 SDs at each site.

Discussion

Because of heterogeneity in genetic determinants, differences in sunlight exposure geographically, and variations in dietary habits, height or weight, BMD accrual is different among races. Hence it is essential to establish reference values for bone mineral density for every race and country.

Bachrach was found that black females and males had consistently greater mean values than non-blacks for all BMD measurements[21]. BMD values in black were about 8-12% higher than in Caucasians [22, 23].

He also found that Caucasians had greater mean total hip BMD and whole body BMD, while Hispanics had lower spine BMD than Caucasian or Asian men[21], Hence he advocated the use of gender-specific and ethnic specific norms for interpreting BMD data.

Most studies would state differences in BMD and mass between ethnic groups; however other studies point out that when weight and height adjustments have been added to the computation, BMD among ethnic groups does not largely differ. Russell-Aulet concluded that although Asian women and men have lower BMD in all regions when multiple regression was done with body weight, height and age, no significant differences found between Asians and Caucasians for bone measurements [24] .

In this study, we assessed BMD by DEXA in 20-35 years old which is in keeping with most studies stating the peak bone mass is attained between the age of 20-35 years [25,26]. We found that the BMD values taken at the femoral neck were 4% lower than US/North European values, and similar at the total femur.

Lumbar spine BMD values were 3% and 1% lower at L_1 and L_2, respectively and 3% higher at L3 and not significantly different at L_4 .The BMD values at L_2- L_4. were similar to US /North European values.

Despite the different ethnicity, dietary habits, and lifestyles between our subjects and Caucasian US/North European females, their BMD values are not statistically different at total femur or lumbar spine (L_2 - L_4).

Recently, BMD values have been studied on Arab populations:

In normal Lebanese subjects, BMD values at lumbar spine were around 8% lower than US/North European for ages 20-59 years, 5-6% lower for older subjects and at femoral neck and 8% lower in young adults (20-39 years) [27].

In healthy Saudi women, BMD values were about 5% lower than in US/North European, despite higher average body weight and body mass index than their Caucasian counterparts [28,29].

In Kuwait, Dougherty compared bone mass of healthy women with Caucasian normative data and found similarity between them [30].

In healthy Filipino women, the mean BMD was closely approximates that of mean BMD in Asians than those of Caucasians [31].

Table 4 illustrates further comparison of BMD at lumbar and femur for age 30 among different countries. Therefore it is important to use a population specific reference range for DEXA measurements.

Based on our study, the mean values for BMD of healthy Isfahani women can serve as a guide for diagnosis of osteoporosis.

Table 4: Comparative BMD (gr/cm²) at Lumbar and Femur for age 30 among Isfahani, Kuwaiti, Filipino, Austrian, Asian, Caucasian

Site	Isfahani Mean (SD)	Kuwaiti Mean (SD)	Filipino Mean (SD)	Austrian Mean (SD)	Asian Mean (SD)	Caucasian Mean (SD)
Lumbar	1.208(.135)	1.210(.13)	1.132(0.12)	1.076(0.13)	1.110(0.12)	1.18(0.12)
Femur	1.000(.125)	1.022(.11)	0.919(0.10)	0.972(0.15)	0.934(0.15)	1.00(0.12)

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