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Peak Bone Mass Measurement in Iranian Healthy Population

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Abstract

Background: Osteoporosis is a disabling disease characterized by compromised bone strength, which predisposes a patient to increased risk of fracture. The aim of this study was evaluation the pattern of bone mass in Iranian healthy population.

Methods: The study was performed between December 2000 and May 2001 on one thousand three healthy Iranian subjects who currently live in Tehran. They were selected randomly by cluster random sampling among men and women of 10-76 yr from 50 clusters. The volunteer people were referred to the Bone Mineral Density BMD unit of EMRC. The participants were recalled for three times and the response rate was 83%. BMD was measured by DXA using Lunar DPX-MD device.

Results: Females achieved maximum lumbar BMD up to 25-35. Femur BMD maximized in 30 to 35 and after 45 the intensity of bone loss increased. Female peak bone mass in lumbar region was 1.19 ± 0.12 g/cm2and in femur was 1.02±0.12 g/cm2. Male peak bone mass in lumbar region occurred between ages 25-40 yr, Male's femur BMD maximized in 20-30. In male peak lumbar bone mass was 1.22±0.16 g/cm2 and femur was 1.08±0.15 g/cm2. Osteopenia was recognized in 50% and 48.8% of women above 50 in spine and total femur, respectively, however these percentages were 37.1% and 34.8% among male subjects.

Conclusion: Iranian BMD values sufficiently different from other countries to warrant a separate reference sample with which to compare individuals for the purpose of diagnosing osteoporosis and osteopenia according to the WHO criteria.

Keywords: *Bone mineral density, Life style, Nutrition, Osteoporosis, Iran*

Introduction

Peak bone mass (PBM) is defined as the amount of bony tissue present at the end of skeletal maturation (1). Bone strength is mainly determined by volumetric density, i.e., the amount of bony tissue per unit of volume, by outer bone dimensions, by intraosseous microarchitecture, and by intrinsic bone quality (2). It is generally accepted that fractures result from low bone mass. Bone mass accounts for 75%-85% of the variance in the ultimate strength of bone tissue, and such measurements also provide an accurate indication of whole bone strength (3). The probable importance of achieved peak bone mass for late life bone strength was first suggested by the cross-sectional observation of Newton-John and Morgan that the dispersion of bone mass values was not widened by age (4). Similarly, Matkovic et al., in their study of bone mass in Croatia, noted that older age cohorts had lower bone mass than younger cohorts and that the degree of difference between old and young was proportionately the same for individuals with high and low starting bone mass (5). Both observations suggested that, other things being equal, bone mass tracks throughout life, i.e., if an individual is on the high end at the age of 30, he or she will likely be on the high end at the age of 70.

In the study was done in Iranian population, in women peak lumbar BMD (1.182+/-0.127 g/cm2) occurred in the 29- to 33-yr age group, whereas peak total femur BMD (1.006+/-0.126 g/cm2) occurred in the 32- to 36-yr age group. In men,

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peak lumbar BMD (1.181+/-0.153 g/cm2) and femoral BMD (1.096+/-0.159 g/cm2) both occurred in the 20- to 24-yr age group, when standardized to mg/cm2 units using established formulas (6). Osteoporosis is a disabling disease characterized by compromised bone strength, which predisposes a patient to increased risk of fracture.

An estimated 1.7 million hip fractures occurred throughout the world in 1990. By 2050, the worldwide incidence of hip fracture in men is projected to increase by 310% and 240% in women (7). Currently, the majority of hip fractures occurs in North America and Europe but demographic shifts over the next 50 yr; however, will lead to huge increases in the number of elderly in Asia, South-America and Africa. They also should be involved in the research and treatment of osteoporosis to decrease the burden. 75% of hip fractures are expected to occur in the developing world by the year 2050. In the study in Iranian population the incidence rates of hip fracture increased exponentially after the age of 60 yr in both genders and nearly tripled with each successive decade. The Iranian age-standardized incidence rates as 127.3 (men) and 164.6 (women) per 100,000 person-years (8). Therefore, it will be necessary to develop and disseminate prevention strategies which can be used in these regions (9). Although genotype is believed to be one of the most important determinants of skeletal development and bone mineral accretion, diet and lifestyle may modify the genetic potential for achievement of optimum peak bone mass (10). Accordingly, because of the importance of osteoporosis and its consequent disabilities, it was crucial for us to evaluate the pattern of bone mass in Iranian healthy population.

This investigation aimed to offer Iranian healthy population reference data and normative curve using dual X-ray absorptiometry, which provides satisfactory precision. By means of this curve we have a clear image of the amount of bone mass in the society which is helpful for designing some prevention strategies about osteoporosis in order to reduce the risk of fractures and the burden of this disease on society in the future. Also diagnosis of osteoporosis can be determined by using this reference data. Furthermore, with the help of the normative curve we are able to estimate the amount of bone loss in patient monitoring.

Materials and Methods

The study was performed between December 2000 and May 2001 on one thousand three healthy Iranian subjects who lived in Tehran. They were selected randomly among men and women of 10-76 yr from 50 clusters.

Acceptance into this study was based on the following exclusion criteria. All diseases or drugs that may affect bone or vitamin D metabolism were among exclusion criteria. The criteria for exclusion were as follows: 1) metabolic diseases include: hypothyroidism, hyperthyroidism, hypoparathyroidism, hyperparathyroidism, adrenal disorders, diabetes mellitus, renal insufficiency, end stage hepatic failure, 2) any kind of cancer, 3) gynecology disorders such as disorder of menstruation after 18, permanent cease of menstruation either over the past 3 mo in those who were under 40 or those who had menstruation less than 6 months over the past 1 year in those who were under 40, oophorectomy before menopausal age , 4) infertility, 5) pregnancy and 6) breast-feeding during the study, 7) smoking more than 10 cigarettes in a day and 8) alcohol consumption of more than one glass for more than 5 yr, 9) drug abuse, 10) professional sport, 11) spinal column deformity or fracture or any other minor fractures, 12) full bed-rest for three consecutive months and finally 13) taking drugs such as estrogen, progesterone and primarine among women with menopause, taking one calcium pill a day at least, taking multivitamin and vitamin D over the past two weeks and getting parental vitamin D3 over the past six months were all among the exclusion criteria.

For cluster random sampling, 50 blocks were selected according to population distribution in

Tehran. From every block 24 participants were selected. Afterwards some invitation letters were sent to the concerned people, and the volunteer people were referred to the BMD unit of EMRC. The participants were recalled for three times and the response rate was 83%. All participants had their standing height measured using a portable stadiometer to the nearest 0.1 cm, weight was measured on a weight scale with a precision of 0.1 kg. Body mass index (BMI) was calculated as weight (kg) divided by height (ms). In case, the subject took radio opaque or radioactive materials or kind of drugs consisting calcium, BMD assessment was postponed to at least five days later. BMD was measured by DXA using Lunar DPX-MD device (Lunar Corporation, Madison, Wisconsin, 53713. USA). The instrument was calibrated weekly by using appropriate phantoms. The precision error for bone mineral density measurements was 1-1.5 in the lumbar and 2-3 in the femoral regions. Bone density was calculated based on gr/cm2. The study protocol was approved by the research ethic committee of Endocrine and Metabolism Research Centre (EMRC). All participants provided written consent after being fully informed of the nature of the study.

SPSS (version 11.5) was used for data analysis. To compare the mean BMD values, Student,s t test and ANOVA were applied. All statistical tests were two-sided, and comparisons were considered significant at a *P* value of 0.05 or less. Frequency of variables compared with the help of chi-square. Finally, multiple regression analysis used for evaluating the relation between variables. Scatter plot chart with Lowess fitness used for evaluating relation between age and BMD.

Results

A total of 1003 healthy participants of 10 to 76 were selected (600 female and 403 male). Mean age was 32.11±17.79 yr in the male group, and 38.93±15.26 yr in the female group ($P< 0.001$). Mean body mass index was 24.85±6.18 kg/m2 vs. 26.55±5.78 kg/m2 in the male and female, respectively ($P< 0.06$).

Females achieved maximum lumbar BMD up to 25-35. After the age of 40 yr, bone loss gradually started then this decrease aggravated till 55 and after this age the intensity of bone loss decreased (Fig. 1). Femur BMD maximized in 30 to 35 and after 45 the intensity of bone loss increased (Fig. 2). Female peak bone mass in lumbar region was 1.19±0.12 g/cm2 and in femur was 1.02±0.12 g/cm2 ,these estimation of peak bone mass considered as reference data. Male peak bone mass in lumbar region occurred between ages 25-40, and after 40 bone loss gradually started while after 50 this decrease became intense (Fig. 1). Male's femur BMD maximized in 20-30 and after 50 the pace of bone loss increased (Fig. 2). In male Peak lumbar bone mass was 1.22±0.16 g/cm2 and femur was 1.08±0.15 g/cm2. Based on these references, for female subjects above 50, 27.8% and 8.4% were osteoporotic in spine and total femur, respectively. Also this prevalence in men was 2.3% in both areas. Osteopenia was recognized in 50% and 48.8% of women above 50 in spine and total femur, respectively, however these percentages were 37.1% and 34.8% among male subjects. Regression analysis showed a significant correlation between lumbar and femur BMD and BMI in both genders.

Female's bone mass reduction in lumbar region in comparison with its proceeding decade were 2.7% in 35-44, 9.6% in 45-54, and 8.64% in 55-64 and lastly 6.4% decline in 65-74. In femur region this decline had been 2.96% in 35-44, 4.46% in 45-54, 7.8% in 55-64 and 5.89% in 65-74. Finally bone mass in 65-74 in comparison with young age showed 24.52% decrease in lumbar and 20.37% in femur region. In males, bone loss in every decade in comparison with its previous decade had been 5% in 40-49 and 7% in 50-59 in lumbar region. Also 5.5% decline in 30-49, 5.8% in 50-59, and 4.5% in 60-69 in hip region had been recorded.

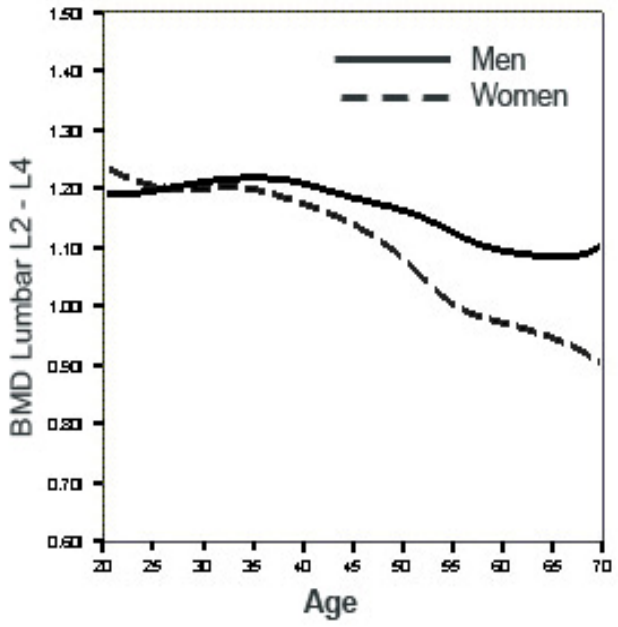

Fig. 1: Relation between bone mineral density in lumbar spine and age

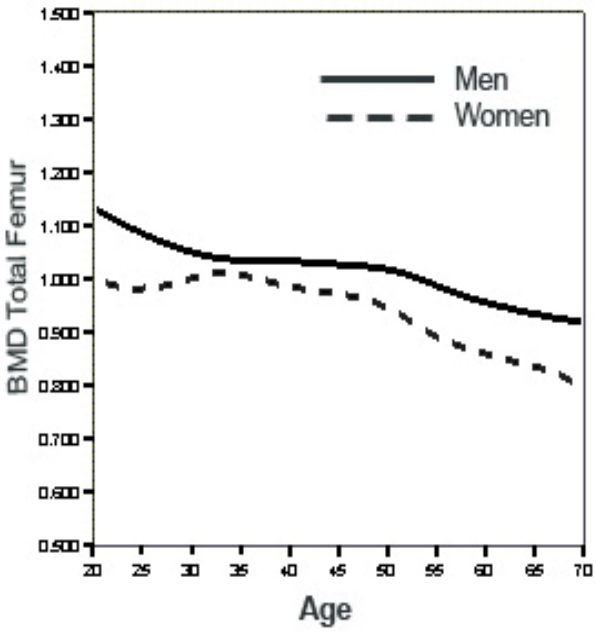

Fig. 2: Relation between bone mineral density in total femur and age

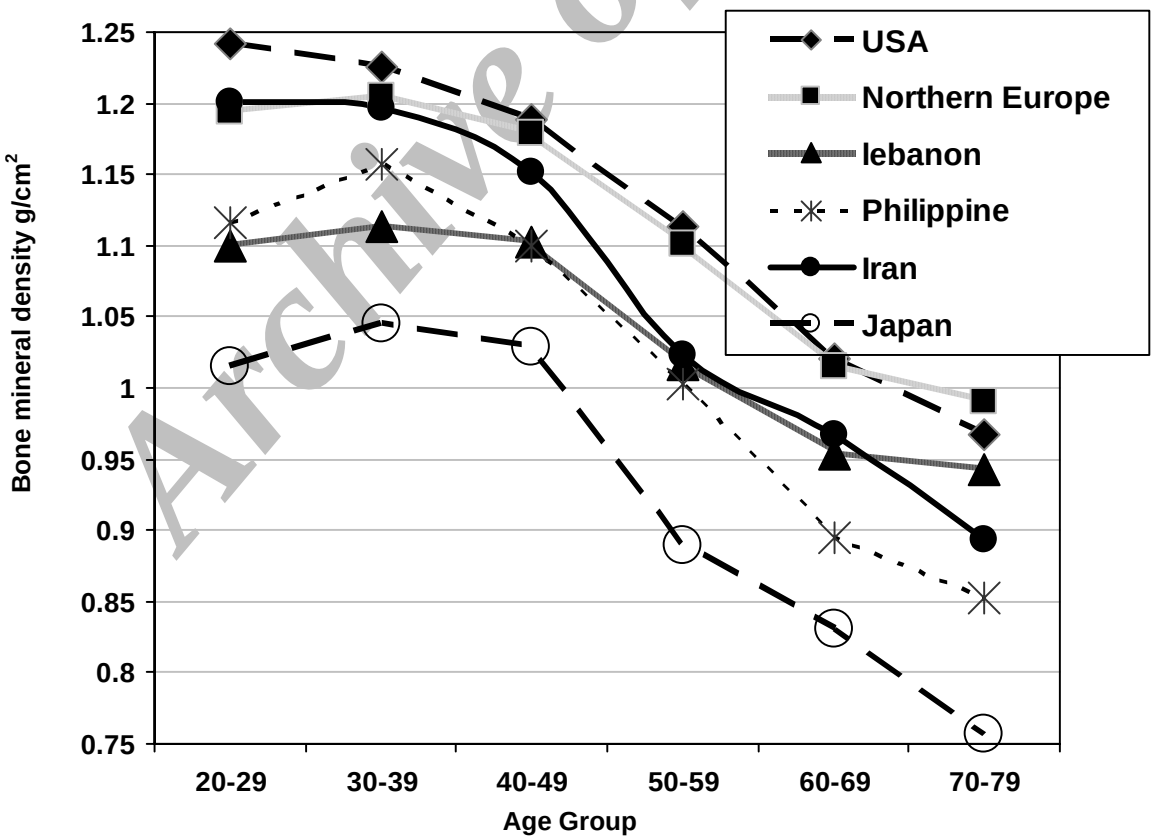

Fig. 3: Comparison of Female Lumbar BMD in Different Countries

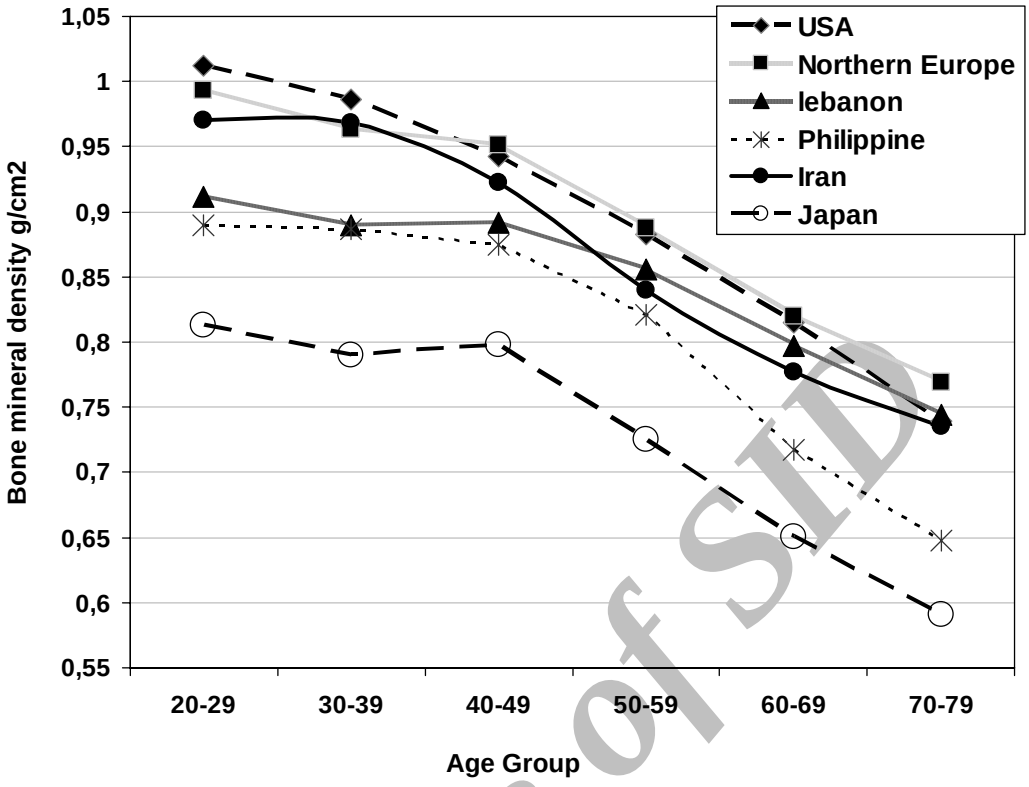

Fig. 4: Comparison of Female Femoral neck BMD in Different Countries

Discussion

There are several factors, such as gender, age, ethnicity, anthropometric parameters, menopause age, medical history, nutrition habits, and physical activity that may affect the bone mineral density (BMD). The BMD results obtained by DEXA are evaluated depending on the amount of standard deviation in t-scores settled by World Health Organization (WHO); however, the individual value of BMD has to be compared with a reference value. Considering that manufacturers of DEXA systems provide their own reference database of bone mineral density, which usually is derived from a population in other countries necessarily with a different geographical and genetic background (11-15), we determined bone mineral density and peak bone mass in a healthy Iranian population to set up our reference data.

These data were compared with recently reported lumbar and hip reference data for male and female BMD in different countries supplied by the manufacturer (Lunar). Changes in bone mass with age in our study generally mirrored the pattern established for others (Fig..3, 4), although mean BMD in Iranian were lower than US and Northern European population and higher than Japanese, Filipino and Lebanese people (16-18). The mean of spinal column BMD among Iranian women 30-39 was 2.36% lower than the American women, 14.6% higher than Japanese and 7.5% more than Lebanese (16-18). Many studies have indicated that alteration in BMD depends on the type of bone, menstrual condition, nutrition, genetics effects, physical activity and age (11-15). Accordingly, BMD results which achieved in other countries demonstrate different means and amounts; however our obtained data through this study show a similar BMD pattern with others. Also, the present study suggests that the maximum BMD of femur bone compared with spinal column

occur later. This is justifiable considering the fact that the maximum BMD in cortical bone compared with trabecular bone occurs later (19-21). In comparison with countries in our nearby geographical region, Lebanese females and males lumbar peak bone mass was slightly less than our finding (17). Despite the fact that, Iranian BMD was almost higher than Lebanese, the prevalence of spine osteoporosis and osteopenia was lower among Lebanese (17). Some explanation can be given for this finding, first of all Iranian peak bone mass was higher than Lebanese, which results in a higher reference value, on the other side we found higher rate of bone loss among Iranian, which both of them caused a higher rate of osteoporosis in Iranian population. This high rate of bone loss could be explained by racial differences, vitamin D deficiency (22), nutritional habits, life style and war.

In this study, we observed decreases in the pace of BMD decline in both genders or even increase of BMD in male's lumbar after age 65. This could be due to osteophytes, joint space narrowing and osteosclerosis as typical features of osteoarthritis, which are prevalent in the elderly population, strongly affect DEXA measurement (23).

At last, this study still has some limitations. The present study is cross-sectional, which is relatively quick and inexpensive for bone mass studies and may provide a similar result for the prediction of fracture as a longitudinal study (24), and one of the most important limitations is the secular effect because the age range of the subjects in the present study was wide (from 10 to 76), the age-related change could actually reflect the life experiences of people during those time. People 40 yr old and over, whose adolescence occurred during or shortly after Iraq-Iran war probably consumed less dairy and had less recreational physical activity than those under 40. These different nutritional conditions and lifestyle may cause this older group attained less BMD than younger cohorts when they reached the same age. Another limitation was that our healthy population was chosen based on their awareness about their diseases which was obtained by a questionnaire survey and our physical examination. As a result, there was a probability that few non healthy people had entered to the study, although its existence was small.

In conclusion, an Iranian reference BMD for men and women has been established for the lumbar and femur regions on a sample of adequate size. Results suggest that Iranian BMD values sufficiently different from other countries to warrant a separate reference sample with which to compare individuals for the purpose of diagnosing osteoporosis and osteopenia according to the WHO criteria.

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