Bone mineral density of normal people by dual energy X-ray absorptiometry*

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Abstract   The bone mineral density (BMD) determination is performed for 210 selected Shanghai residents of both sexes across the age range 15-50 using Hologic QDR-2000 dual energy X-ray absorptiometry (DEXA). The results show that in female groups the peak value of L1-L4 BMD is $1.023 \pm 0.103 \, \text{g/cm}^2$ at the ages of 31~35, but in male groups it is $0.971 \pm 0.118 \text{g/cm}^2$ aged 26~30 and the peak period can last the ages 46-50. The similar conclusion is also obtained by further statistics.

Keywords   Bone mineral density, Dual energy X-ray absorptiometry, People, Age dependence

1 Introduction

In the past ten years new imaging techniques for quantifying skeletal integrity have got a rapid development. Dual Energy X-ray Absorptiometry (DEXA) was developed in 1987 and quickly superseded the dual photon absorptiometry (DPA)[1], it provides a powerful research tool to diagnose osteoporosis and prevent fracture. Since the beginning of 1995, our research group in cooperation with Shanghai 6th People's Hospital has carried out bone density measurements as a part of Co-ordinated Research Programme (CRP) organized by International Atomic Energy Agency (IAEA). The purpose of this study is to determine the age of peak bone mass in each study group of Shanghai residents and to quantify differences in bone density as functions of the age and sex of persons in the study groups. At the same time the normal human BMD (bone mineral density) reference database could be replenished especially for Shanghai residents. The roles of various types of life, exercise, diet and so on are also investigated.

2 Material and method

Normal healthy subjects of both sexes are selected from the residents living in Shanghai for more than 10 a. Most of selected subjects are students, employees, staff members and workers. An interviewer administers structured questionnaire, and measures certain physical characteristics (such as age, height and weight). Some criteria are adopted to prevent the interference for BMD, such as the types of disease and drug therapies. The studies of bone density are carried out in subjects of both sexes across the age range 15~50, 15 subjects are determined in each group with 5-age interval, total 210 subjects of both sexes.

We consulted the questionnaire of WHO osteoporosis project and made some necessary changes. Considering the characteristics of Shanghai residents, we worked out an English-Chinese bilingual form on IAEA CRP Questionnaire. Some useful information, such as (a)general information, (b) history of fractions, (c) reproductive history, (d) smoking history and physical activity, and (e) dietary history and tonic intake. For every selected subjects in study group, both of questionnaire form and BMD measurement report are well preserved for late statistics and evaluation.

Bone density is measured at Shanghai 6th People's Hospital using QDR-2000 DEXA imported from Hologic Co., USA. The Hologic QDR-2000 is the most sophisticated DEXA scanner. Fan beam scans of the spine and hip can be performed in 45 or 90s, respectively; measurement precision for lumbar spine and

femoral neck BMD is 0.8%.[2] Effective dose to the patient during a study including a spine and hip scan using the 45s fan beam mode is 1.2μSv, equivalent to about 4 h of natural background radiation.[3] The positions of bone density measurement in this study are: (a) the lumbar spine region (L1-L4, L1, L2, L3, L4) and (b) the femoral neck (neck, troch, inter, total, ward's). Measurement of BMD is performed according to the method recommended by Hologic. Quality control is accomplished by periodic and regular measurements of a spine phantom from Hologic Co. Up to now, the BMD measurements of to-

tal 210 subjects have been performed.

3 Results and discussion

First of all, calculate the mean and the standard deviation $(x \pm s)$ of the height, age, body weight and the BMD(g/cm^2) in each group with 5-age interval. The results of BMD measurements in 210 subjects of both sexes across the age range 15-50 are shown in Table 1. Some necessary information, such as height, weight, education, menarche is separately listed in Table 2 and Table 3 for later evaluation.

Table 1 BMD measurement results in 210 subjects across the age range 15-50 $(x \pm s)$

Group	L1	L1~L4	Neck	Troch
M-1	0.905±0.078	0.961±0.077	0.911±0.112	0.750±0.097
F-1	0.845±0.092	0.926±0.094	0.821±0.096	0.690±0.095
M-2	0.877±0.086	0.940±0.093	0.877±0.095	0.709±0.073
F-2	0.857±0.108	0.930±0.104	0.787±0.106	0.638±0.095
M-3	0.944±0.121	0.971±0.118	0.884±0.100	0.687±0.074
F-3	0.877±0.086	0.969±0.085	0.749±0.090	0.624±0.060
M-4	0.927±0.114	0.969±0.105	0.825±0.118	0.673±0.092
F-4	0.907±0.099	1.023±0.103	0.791±0.094	0.626±0.075
M-5	0.918±0.109	0.918±0.109	0.798±0.089	0.633±0.074
F-5	0.922±0.088	1.012±0.087	0.867±0.083	0.664±0.064
M-6	0.887±0.071	0.939±0.048	0.793±0.102	0.634±0.089
F-6	0.889±0.091	0.983±0.097	0.804±0.091	0.630±0.091
M-7	0.911±0.073	0.970±0.056	0.796±0.077	0.686±0.061
F-7	0.816±0.071	0.905±0.083	0.733±0.075	0.594±0.037

Table 2 Basic information about 105 male subjects in each group

Group	Age(years)		Height (cm)	Weight (kg)	Education (years)
	range	mean			
M-1	16~20	18.0±1.6	170±8	66.2±8.9	12.2±1.6
M-2	21~25	22.2±0.9	173±4	69.3±8.6	16.0±1.3
M-3	26~30	26.6±1.4	171±6	67.7±11.0	13.5±3.0
M-4	31~35	32.4±1.7	171±5	68.8±9.0	15.0±3.0
M-5	36~40	38.6±1.2	172±7	68.0±10.0	13.6±2.8
M-6	41~45	42.5±1.2	169±6	70.1±8.1	12.1±3.1
M-7	46~50	47.9±1.2	169±5	69.0±5.8	14.3±4.3

Table 3 Basic information about 105 female subjects in each group

Group	Age(years)		Height (cm)	Weight (kg)	Education (years)	Menarche (age)
	range	mean				
F-1	16~20	18.2±1.3	158±4	53.6±7.4	12.3±1.1	14.1±1.3
F-2	21~25	22.6±1.2	159±3	50.6±3.9	15.4±2.2	13.7±1.4
F-3	26~30	27.8±1.2	160±5	54.2±5.0	15.8±2.2	14.5±3.1
F-4	31~35	33.3±1.3	160±4	53.3±5.4	14.9±2.3	13.3±1.1
F-5	36~40	38.2±1.3	160±5	61.6±7.0	13.4±2.6	14.2±2.0
F-6	41~45	42.3±1.6	160±3	59.0±7.6	10.0±2.6	14.9±1.8
F-7	46~50	48.1±1.4	158±6	57.5±9.1	15.6±3.1	14.3±1.4

The results of L1~L4 BMD show that the BMD density of the male group aged 21-25 goes up, the highest is 0.971 g/cm^2 aged 26~30. There is no obvious difference among the other groups and then the groups aged 41~ 50 tend to rise, which indicates that the peak comes at

the age over 21 and the peak period lasts till the groups aged 41~50.

Table 4 The relative change rate of the bone density in female groups

Age range	n	L1-L4 BMD	Rate (%)
16~ 20	15	0.909	
			+ 0.44
21 ~ 25	15	0.922	
			+ 4.2
26 ~ 30	15	0.969	
			+ 5.6
31 ~ 35	15	1.023	
			- 1.1
36 ~ 40	15	1.012	
			- 2.9
41 ~ 45	15	0.983	
			- 8.7
46 ~ 50	15	0.905	

The values of the female groups aged 31~40 are remarkably higher than the other younger groups as well as the groups aged 41~50. Their bone density reaches the peak value 1.023 g/cm^2 at the ages of 31~35. Then their density begins declining. It is suggested that female peak comes 10 years later than that of the male and the peak declines at the ages of 41~50, 10 to 20 a earlier than the male.

Further the similar conclusion can be also got using mathematical statistics. The all data

of L1~L4 BMD for male groups and female groups are treated by means of polynomial regression and Gaussian fit separately. We can see that in female groups two curves have a common peak value, which is about 34 years old. But in male group it is not obvious.

Table 4 shows that bone density of the women at the age of 16 to 35 rises and begins to decline after the ages of 35. It can be seen that the female bone density declines rapidly after the age of 45, of which the relative change rate reaches 8.7%.

References

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