Normal Value of Bone Mineral Density of Lumbar Spine, Proximal Femur, and Distal Forearm of Women in Different Age Groups

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Abstract

The cross sectional, descriptive study was conducted to find the reference data for bone mineral density (BMD) in normal women in the area around Thammasat University Hospital. The study population consisted of 806 women aged 15-80 years. BMD of different parts of the body were measured by dual energy photon absorptiometer. The results showed that mean (± SD) BMD of the lumbar spine 2, 3, 4, neck of femur, Ward's triangle of femur, greater trochanter of femur, ultradistal part of radius, and distal ulnar averaged from all age groups were 0.954 ± 0.144, 1.027 ± 0.151, 1.059 ± 0.147, 0.898 ± 0.114, 0.774 ± 0.165, 0.777 ± 0.103, 0.412 ± 0.073, and 0.585 ± 0.096 g/cm^2 respectively. Overall, the peak BMD was between the age of 40-44 years old. It started decreasing from the age of 45 and decreased remarkably after the age of 50. The data is shown to be a database for our hospital's health policy, but the authors believe that it could also be used as reference data for future studies in Thailand. It is suggested that normal values in different areas should be available in the future in order to provide more specific and better health care according to demographic variation.

Key word : Bone Mineral Density, Normal Value

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Loss of bone mass with age is a universal phenomenon and is more pronounced in women than in men. Unexceptionable bone loss in elderly women especially after menopause leads to increasing risk of fracture even with minimal trauma[1,2]. The osteoporotic fracture often becomes a chronic process and the affected patients may suffer, lose their quality of life, and be bed-ridden[3]. Because of the trend in increased life expectancy leading to a larger number of elderly persons in the population, better bone status should be provided to improve their quality of life. Calcium replacement has been proved to benefit elderly women[4]. Knowledge of normal values of bone mineral density (BMD) by age can help determine the risk for osteoporotic fracture in the early stages[3]. There are many studies with data of BMD in women in other countries and also in Thailand, but there may be differences among areas according to geographic and demographic distribution. The present study evaluated the pattern of BMD of people in a particular area. This area-specific database will lead to more specific health care, knowledge, and the extension of future studies.

MATERIAL AND METHOD

The study was approved by the ethical committee of the Faculty of Medicine, Thammasat University. The study population consisted of 806 women aged 15-80 years. All samples were walk-in volunteers. These volunteers entered the program themselves after learning about the study from an announcement board in the public relations area of Thammasat Hospital. This study population was felt to be representative of people in this demographic area because they selected this hospital as their health care provider. Some volunteers with these criteria were excluded; 1) pregnancy, 2) delivery or abortion within 3 months, 3) using agents which could affect BMD such as steroids, hormonal contraceptives for more than 5 years, 4) having body mass index (BMI = weight in kg/height in square meter) below the 5th or above the 95th percentile of each age group, and 5) incomplete data record. Sample size calculated with type I error, a = 0.05 and s = 0.09 was 30 for each age group. The study population aged 15-80 years old was divided into groups by age in 5 year intervals, which therefore made the sample size 360 or more. After explaining the objective of study to each volunteer, informed written consent was obtained. Each volunteer was interviewed by a well-trained nurse at the gynecological outpatient department. Approximately 900 volunteers entered the program. After the initial interview, 806 volunteers were left from history exclusion. Of 806 volunteers, 61 (7.6%) were again excluded due to either abnormally low or high BMI (Table 1). BMD was then measured by dual energy photon absorptiometer at the lumbar spine 2-4, the neck of the femur, Ward's triangle of the femur, greater trochanter of the femur, ultradistal part of radius, and distal ulnar respectively. The instrument was standardized daily against phantom with the precision error of 1.5 per cent or

Table 1. BMI of study samples in each age group.

Age group (years)	Number of subjects (before exclusion)	BMI (kg/m^2) (mean ± SD) (before exclusion)	Number of subjects (after exclusion)	BMI (kg/m^2) (mean ± SD) (after exclusion)
15-19	34	19.48 ± 2.32	32	19.39 ± 1.79
20-24	54	19.73 ± 2.18	50	19.62 ± 1.68
25-29	50	20.44 ± 2.60	47	20.25 ± 2.22
30-34	163	21.62 ± 2.96	147	21.45 ± 2.14
35-39	75	22.99 ± 4.23	70	22.51 ± 2.54
40-44	73	23.56 ± 3.32	67	23.52 ± 2.93
45-49	88	23.82 ± 3.53	80	23.63 ± 2.69
50-54	78	24.01 ± 3.15	72	24.00 ± 2.75
55-59	68	24.89 ± 3.77	62	24.78 ± 3.06
60-64	58	24.94 ± 3.05	56	24.82 ± 2.53
65-69	34	23.72 ± 3.51	32	23.76 ± 3.02
≥70	31	23.63 ± 4.82	30	23.52 ± 4.08
Total	806	22.79 ± 3.69	745	22.64 ± 3.09

BMI = Body Mass Index

better. The measurements were performed by three well-trained X-ray technicians under the inspection of one radiologist from January 1999 to January 2001. Results were expressed in g/cm^2 and reported as mean ± SD in tables and graphs.

RESULTS

All of the study population was Thai. Twenty eight point four per cent of them were government officers, 27.4 per cent were employees, 26.0 per cent were housewives, and 8.4, 8.3, 1.3, and 0.6 per cent

Table 2. Number of parity, and age of menarche of study samples in different age groups.

Age group (years)	Number of subjects	Number of parity (median)	Age of menarche (mean ± SD)
15-19	32	0	12.79 ± 1.32
20-24	50	0	12.85 ± 2.22
25-29	47	0	13.04 ± 2.34
30-34	147	1	13.53 ± 2.74
35-39	70	1	13.31 ± 3.13
40-44	67	2	12.90 ± 3.73
45-49	80	2	14.35 ± 1.84
50-54	72	2	13.59 ± 4.07
55-59	62	3	13.68 ± 3.12
60-64	56	3	14.56 ± 2.61
65-69	32	5	14.50 ± 3.05
≥70	30	4	13.58 ± 5.86
Total	745	1	13.56 ± 3.10

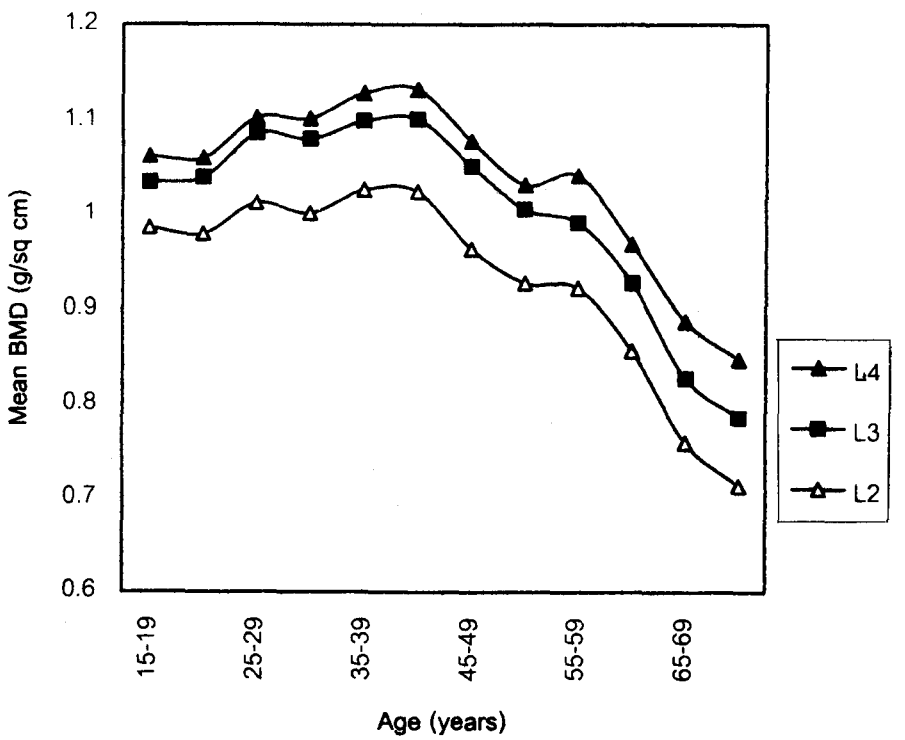

Fig. 1. BMD of Lumbar spine L2, L3, and L4 in different age groups.

were business women, students, seniors, and agriculturists respectively. Thirty five point three per cent of them graduated with a bachelors degree or higher, 29.8 per cent graduated with a vocational degree and/or high school level, 4.6 per cent were studying, and interestingly, 26.5 per cent had no further studies after primary school level. Basic information about number of parity and age of menarche of study samples are shown in Table 2. Mean onset of menarche of the entire population was 13.56 years. Means ± SD of BMD of different sites of bone divided by age groups are shown in Table 3. The peak BMD was between the age of 40-44 years old. It started decreasing from the age of 45 and decreased remarkably after the age of 50. BMD of spine L2, L3, and L4 are shown in the graph against age group in Fig. 1. It was found that L4 had the highest BMD in all age groups. Plotted graph of BMD of the neck of the femur, Ward's triangle of the femur, and greater trochanter of the femur are shown in Fig. 2. Plotted graph of ultradistal part of radius and distal ulnar are shown in Fig. 3.

Table 3. Mean ± SD of BMD of different sites of bones divided by age groups.

Age group (years)	Spine L2 (g/cm^2)	Spine L3 (g/cm^2)	Spine L4 (g/cm^2)	Neck of femur (g/cm^2)	Ward's triangle (g/cm^2)	Greater trochanter (g/cm^2)	Ultradistal radius (g/cm^2)	Distal part of ulnar (g/cm^2)
15-19	0.986 ± 0.116	1.034 ± 0.114	1.062 ± 0.107	0.910 ± 0.091	0.885 ± 0.190	0.761 ± 0.098	0.387 ± 0.059	0.527 ± 0.071
20-24	0.979 ± 0.101	1.039 ± 0.102	1.060 ± 0.101	0.896 ± 0.100	0.815 ± 0.164	0.750 ± 0.084	0.424 ± 0.056	0.584 ± 0.073
25-29	1.012 ± 0.102	1.086 ± 0.108	1.103 ± 0.125	0.920 ± 0.090	0.843 ± 0.156	0.769 ± 0.083	0.435 ± 0.055	0.602 ± 0.072
30-34	1.001 ± 0.118	1.080 ± 0.115	1.102 ± 0.120	0.909 ± 0.109	0.819 ± 0.152	0.773 ± 0.090	0.432 ± 0.063	0.606 ± 0.076
35-39	1.026 ± 0.116	1.099 ± 0.113	1.128 ± 0.115	0.921 ± 0.113	0.830 ± 0.139	0.781 ± 0.084	0.435 ± 0.059	0.613 ± 0.076
40-44	1.024 ± 0.113	1.101 ± 0.121	1.132 ± 0.113	0.935 ± 0.093	0.797 ± 0.112	0.823 ± 0.091	0.444 ± 0.067	0.621 ± 0.087
45-49	0.963 ± 0.121	1.051 ± 0.116	1.078 ± 0.130	0.916 ± 0.118	0.779 ± 0.151	0.801 ± 0.099	0.434 ± 0.072	0.612 ± 0.084
50-54	0.927 ± 0.126	1.005 ± 0.176	1.031 ± 0.143	0.901 ± 0.104	0.744 ± 0.142	0.788 ± 0.105	0.400 ± 0.075	0.583 ± 0.100
55-59	0.922 ± 0.143	0.991 ± 0.146	1.041 ± 0.186	0.910 ± 0.119	0.767 ± 0.167	0.808 ± 0.114	0.397 ± 0.074	0.570 ± 0.092
60-64	0.856 ± 0.137	0.927 ± 0.142	0.968 ± 0.136	0.880 ± 0.112	0.696 ± 0.147	0.780 ± 0.117	0.364 ± 0.074	0.516 ± 0.098
65-69	0.759 ± 0.138	0.827 ± 0.150	0.887 ± 0.122	0.787 ± 0.093	0.589 ± 0.087	0.706 ± 0.099	0.346 ± 0.054	0.496 ± 0.090
≥70	0.713 ± 0.102	0.785 ± 0.109	0.847 ± 0.116	0.741 ± 0.093	0.531 ± 0.123	0.659 ± 0.104	0.319 ± 0.064	0.434 ± 0.097
Total	0.954 ± 0.144	1.028 ± 0.151	1.059 ± 0.147	0.898 ± 0.114	0.774 ± 0.165	0.776 ± 0.102	0.412 ± 0.073	0.580 ± 0.096

DISCUSSION

Data from Table 2 shows that age at menarche of the entire population in the present study was 13.56 ± 3.10 years old. According to this recall type of question, the most acceptable value should be the result of women aged 15-19 years old (mean ± SD = 12.79 ± 1.32) because women in this age group had most recently passed the age of menarche. This data is consistent with results from a previous study in a large number of Thai women which reported that the mean age of menarche was 12.35 ± 1.41 years old[5].

Like other studies[6-10], curves of BMD ascended after adolescence until reaching the peak, and descended thereafter. In the present study, the peak BMD was between the age of 40-44 years old. It started decreasing from the age of 45 and decreased remarkably after the age of 50. Limpaphayom K reported a peak BMD of a Thai population at age 30-34. Results from studies in China[7], Mexico[9], and Canada[10], reported a peak BMD at the age of 35-39 years old. Poshyachinda M reported a peak BMD at age 35[11]. Interestingly, the age of peak BMD in the present study was later than the age of peak BMD from other studies, particularly later than that of Limpaphayom K which has presumed to be reference data of all Thai women[6]. Demographic

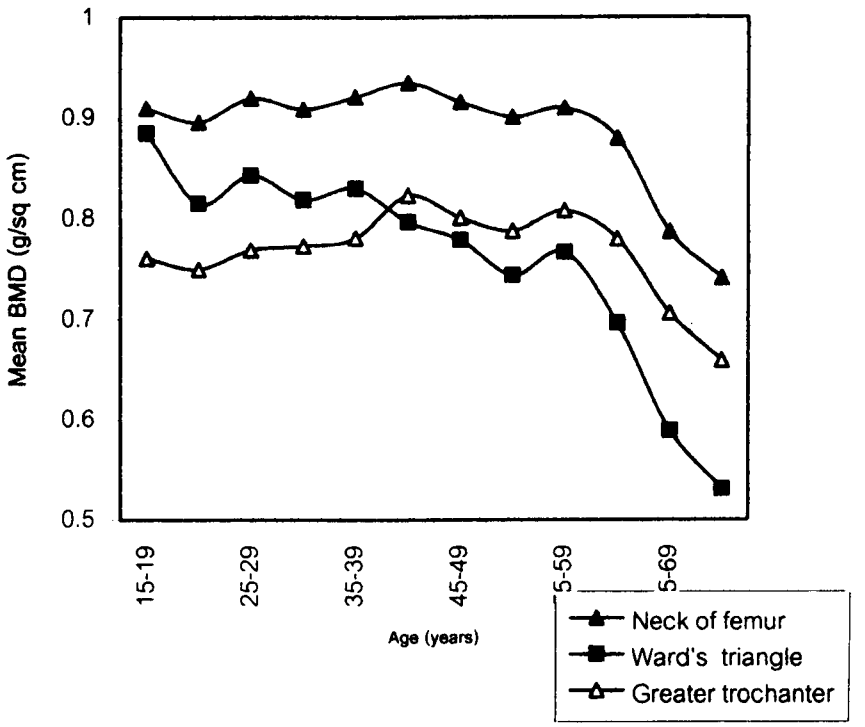

Fig. 2. BMD of neck, Ward's triangle, and greater trochanter of femur in different age groups.

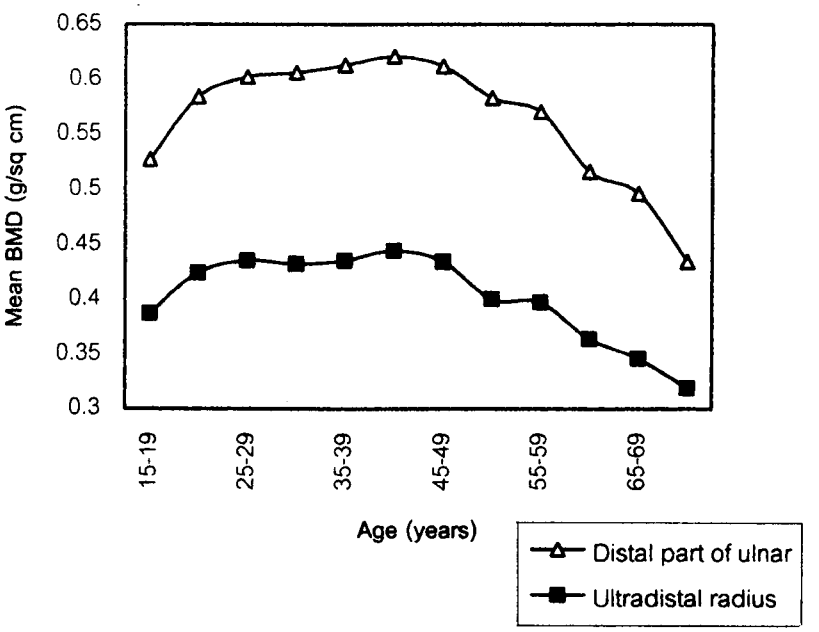

Fig. 3. BMD of ultradistal part of radius and distal ulnar in different age groups.

variation is supposed to be the best explainable factor. However, the BMD of women in the present study decreased remarkably after the age of 50, and is consistent with the findings of Limpaphayom K[6], and correlated well with the average age of menopause in Thai women of 49.5 ± 3.6 years[12].

Corresponding with other studies[6-10], lumbar spines have maximum BMD comparative to other parts of the body. L4 has the most density. The distal forearm BMD is of the least value in the present study. Interestingly, BMD of the distal forearm reached the peak later than other bones (Fig. 3), this finding is similar to the study of Berntsen GK which was recently reported in 2001[13]. The average BMD of all bone sites found from the present study is higher than the results from the study of Limpaphayom K in Thailand[6], but closer to average BMD found from studies in Mexico, Canada, and Japan[9,10,14].

The results have been used to form a new database for our hospital's health policy. The authors suggest that the normal value of different areas should be available in future in order to provide more specific and better health care according to demographic variation. It is believed that these measurements may be beneficial as database for other regions, and should also be one of the reference data for future studies in Thailand.

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ค่าปกติของความหนาแน่นของเนื้อกระดูกบริเวณกระดูกสันหลัง กระดูกต้นขา และส่วนปลายกระดูกแขน ในสตรีโดยแบ่งตามกลุ่มอายุ

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การศึกษาความหนาแน่นเนื้อกระดูกในสตรีปกติ โดยแบ่งตามกลุ่มอายุ เพื่อเป็นข้อมูลอ้างอิงสำหรับประชากรในบริเวณพื้นที่การดูแลของโรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ จังหวัดปทุมธานี ศึกษาจากกลุ่มตัวอย่างทั้งหมด 806 ราย อายุตั้งแต่ 15 ถึง 80 ปี ทำการวัดความหนาแน่นเนื้อกระดูกโดยเครื่องมือมาตรฐานชนิด dual energy photon absorptiometer ผลการวิจัยพบว่าค่าเฉลี่ย (± ค่าเบี่ยงเบนมาตรฐาน) ของความหนาแน่นเนื้อกระดูกบริเวณกระดูกสันหลังส่วนเอวที่ 2, 3, และ 4, กระดูกต้นขาส่วน neck of femur, Ward's triangle of femur, และ greater trochanter of femur, และส่วนปลายกระดูกแขนส่วน ultradistal part of radius, และ distal ulnar เท่ากับ 0.954 ± 0.144, 1.027 ± 0.151, 1.059 ± 0.147, 0.898 ± 0.114, 0.774 ± 0.165, 0.777 ± 0.103, 0.412 ± 0.073, และ 0.585 ± 0.096 กรัมต่อตารางเซนติเมตร ตามลำดับ ความหนาแน่นเนื้อกระดูกสูงที่สุดในกลุ่มอายุ 40–44 ปี โดยเริ่มลดลงเมื่ออายุ 45 ปี และลดลงมากเมื่ออายุ 50 ปี ผลการศึกษาครั้งนี้จะเป็นข้อมูลพื้นฐานสำหรับประชากรในบริเวณที่ศึกษา คณะวิจัยเสนอว่าควรมีการศึกษาเช่นนี้ในกลุ่มประชากรท้องถิ่นอื่น ๆ เนื่องจากอาจมีความแตกต่างกันจากผลของการกระจายของประชากร

คำสำคัญ : ความหนาแน่นเนื้อกระดูก, ค่าปกติ

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