Bone Mineral Density of Lumbar Spine and Proximal Femur in Normal Thai Women

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Abstract

Objective : To find the reference data for age-specific normal bone mineral density in a Thai female population.

Study design : Cross-sectional, Descriptive study.

Material and Method : 1773 Thai women aged between 11-80 years were recruited, using multistage cluster sampling and stratifying from six represented provinces in the country, each strata was randomly selected. After recruiting, the women were interviewed by well-trained personnel using structured questionnaires. Bone mineral density of the lumbar spine 1-4 and nondominant hip were measured by Dual Energy Photon Absorptiometer. The scientists, X-rays technician were trained and standardized inter and intra observers variation. Quality control of examination was measured periodically. Every BMD outcome was re-examined by a specialist.

Results : The peak bone mineral density of both spines and hips was between the age of 30 to 34 years old. Mean Value for spine and femoral neck was 0.957 and 0.814 g/cm^2 respectively. The BMD of spine and hip was significantly decreased after the age of 35 and the loss was accelerated at age 50. Osteoporosis for spine and femoral neck is considered when BMD are below 0.682 and 0.569 g/cm^2 respectively.

Conclusion : The results are important data for public health policy, by maximizing bone mass during skeletal growth before menopause and minimizing bone loss throughout life as well as for detection of important risk factors.

Key word : Bone Mineral Density, Normal Value

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Increasing life expectancy and changes in life-style indicate that the problems of osteoporosis will markedly affect many more women in the years to come. The clinical consequences of osteoporosis are quite serious, both for individual and health-care agencies. The measurement of bone mineral density (BMD) of older women is most important for assessment of skeletal abnormality, especially in the area of osteoporotic fracture risk[1,2]. Diminution of BMD in women starts at the onset of menopause and estrogen withdrawal resulting in rapid bone loss during the early postmenopausal years (3-6) leading to increased risk of osteoporotic fracture[7-9]. As a result of advanced technology, such as dual-photon absorptiometry, the risk for osteoporotic fracture can be detected in the early stages of osteoporosis[1].

Osteoporosis is a major community health problem affecting up to half of the elderly population in most western countries. When bone tissue reduces, the likelihood of fracture increases. A low peak bone mass achieved in adulthood is a major determinant of bone density, which is in turn responsible for osteoporotic fracture in later life[10, 11].

The fact of impairment of quality of life for many years after fracture of the hip has to be taken into consideration by medical teams, such as Geriatric medicine, Orthopaedic surgeon and Gynaecologists. Although the incidence of hip fracture increases with age, the worst consequence of such a fracture may not be death. All women must live independently and happily, with good physical and mental health. Difference in peak bone density at skeletal maturity may account for ethic group, racial, regional and geographic difference[12]. For this reason the authors evaluated the pattern of bone mineral density of lumbar spine and proximal femur in normal Thai women, which can be used as the reference for health planning and clinical services.

Objective

The general objective was to obtain information on osteoporosis and osteopenia in terms of prevalence, trend and severity for prognosis and planning of prevention and treatment. The specific objective of this study was to find the reference data for age-specific normal bone mineral density in a Thai female population.

MATERIAL AND METHOD

Design : Cross-sectional, Descriptive Study

Target population : Thai female population aged 11-80 years.

Eligibility criteria

Inclusion criteria: Thai women who were born and living in the identified area for at least 5 years, without mental, hearing and speaking defects, could remember their birth date and whose BMI was within the 5^{th} to 95^{th} percentile.

Exclusion criteria: pregnant, delivery or abortion within 3 months, used hormonal contraception for more than 5 consecutive years, or used drugs that affect bone metabolism such as steroids.

Sample size

The sample size for estimating the population mean when the distance, in each direction from the true population mean was 0.018 and type I error, a is 0.05, σ could be estimated from a previous study as 0.09. As a result, a sample of 100 women was taken.

Since age specific bone mineral density was needed, age was divided into 5 year intervals from <15 to >75. The total sample size was 1400.

Sampling technique

The multistage cluster sampling was done in 3 stages. First stage, 6 out of the 76 provinces in Thailand namely Chiang Mai in the north, Nakorn-Sawan and Ratchaburi in the centre, Khon Kaen in the northeast, Yala in the south and Bangkok were purposively selected since the Hologic bone densitometer was located only in these six provinces. Except for Bangkok, which has no rural area, each province was stratified into "rural" and "urban" subdistricts. There were about 100-180 rural subdistricts and about 90-100 urban subdistricts in each province. One rural subdistrict and one urban subdistrict in each province were chosen by simple random sampling. In each subdistrict, there were about 10 villages. One village was randomly selected from those chosen subdistricts. All female inhabitants in those selected villages were approached for participation. The objective of the study was explained and written inform consent was obtained.

Operation definition : The European Foundations for Osteoporosis and bone disease, The National Osteoporosis Foundation of the United

States and the World Health Organization, 1994[13] recommended the following definitions :

1. Normal. A value of BMD greater than one standard deviation below the average value of the peak bone of healthy adults.

2. Osteopenia. A value of BMD more than 1.0 SD but less than 2.5 SDs below the average value of the peak bone of healthy adults.

3. Osteoporosis. A value of BMD more than 2.5 SDs below the average value of the peak bone of healthy adults.

Measurement and data collection

Eligible subjects received an appointment and were brought to the Health Promotion Center. Weight and height were measured with the subject wearing light clothing and no shoes. Standardized well-trained technicians measured the bone mineral density of the anterior lumbar spine at L_1-L_4 and the non dominant side hip at femoral neck and intertrochanteric area utilizing a Hologic QDR-4500 bone densitometer. The scans were standardized daily against phantom; the precision error was 1.5 per cent or better for hip and spine. Results were expressed in g/cm^2.

Analysis

Body Mass Index (BMI) analysis

BMI was calculated as Wt in kg/(Ht in meter)^2

Fifth and 95th percentile in each age group were calculated as shown in Table 1. Since under weight and obesity were defined as BMI under 5th and 95th percentile, women whose BMI was over the 95th or under the 5th percentile were excluded from this study.

Bone Mineral Density (BMD) analysis

The mean values of BMD at lumbar spine L_1-L_4 and hip in each age group were calculated in order to achieve the peak of BMD. The standard deviation of BMD at that peak was calculated in order to define osteoporosis and osteopenia. This research was approved by the Ethical Committee of both the Faculty of Medicine and Ministry of Public Health.

Table 1. Body Mass Index (BMI), 5th and 95th percentile by age group.

Age	5th percentile	95th percentile
<15	14.165	23.495
15-19	16.214	25.806
20-24	16.693	28.040
25-29	17.625	30.675
30-34	17.625	30.091
35-39	18.583	30.360
40-44	18.662	30.675
45-49	19.410	33.721
50-54	17.814	31.391
55-59	18.510	33.109
60-64	17.232	29.946
65-69	17.196	31.646
70-74	15.950	30.990
75+	15.347	27.488

RESULTS

Following the eligibility criteria, all subjects were neither pregnant nor breast feeding, had no history of gynecological operations, chronic disease, had never taken steroids, calcium, fluoride, diuretics and had never used hormonal contraception or used it for not more than 5 consecutive years. Ninety-nine per cent of Buddhists except in Yala, the most southern part of Thailand, where 51 per cent were Islam. The majority were farmers and housewives, 32 per cent and 30 per cent, respectively. However, 12 per cent were still in school or college. All of them were of average build and had normal blood pressure (Table 2). The maximum BMD was found at the age of 30-34 years for both spine and hip (Table 3). It started decreasing from the age of 35. The major fall in all sites could be seen from the age of 50 onward. The overall decrease in BMD from the peak value to those at age 70-74 years was 29 per cent, 30 per cent and 27 per cent in the lumbar spine, femoral neck and intertrochanteric, respectively. BMD of L_1, L_2, L_3 and L_4 were separately plotted against age group. (Fig. 1) L_4 had highest BMD in all age groups. For lumbar spine, the cut-off value of BMD for osteopenia and osteoporosis was 0.847 and 0.682 g/cm^2 respectively. BMD of the femoral neck and intertrochanteric were plotted against age

Table 2. Mean (Standard deviation) of body mass index and blood pressure of the subjects.

Age	Number of subjects	BMI(kg/m^2) Mean (SD)	Blood pressure (mmHg) Systolic Mean (SD)	Blood pressure (mmHg) Diastolic Mean (SD)
<15	110	18.2 (2.5)	101(12)	64(11)
15-19	134	20.4(2.0)	105(12)	66(9)
20-24	119	20.9(2.5)	108(13)	69(10)
25-29	123	21.9(3.0)	112(12)	72(10)
30-34	123	22.8(2.8)	111(12)	70(11)
35-39	127	23.7(2.8)	116(18)	75(13)
40-44	138	24.3(3.1)	119(19)	75(12)
45-49	123	24.9(3.3)	122(19)	78(13)
50-54	128	24.5(3.1)	127(22)	80(15)
55-59	116	24.8(3.7)	127(24)	76(13)
60-64	127	23.6(3.2)	132(21)	79(13)
65-69	122	23.3(3.4)	133(24)	79(16)
70-74	141	22.1(3.2)	139(25)	80(14)
75+	124	20.7(3.1)	138(24)	77(14)
Total	1773			

group. (Fig. 2) Using the same criterion, the cut-off value of osteopenia and osteoporosis for femoral neck was 0.716 and 0.569 g/cm^2 respectively. (Table 3)

DISCUSSION

Our study revealed that bone mineral density of lumbar spines and proximal femur of normal Thai women peaked at the age of 30-34 years. At peak, the average bone mineral density of Thai women at lumbar spines, femoral neck and intertrochanteric was 0.957, 0.814 and 1.053 g/cm^2 respectively. The bone mineral density started to decline after the age of 35 and the loss was accelerated at age 50 which corresponds to the average age at menopause of 49.5±3.6 years for Thai women[14].

We found the peak bone mass in the younger age group earlier than that reported by Poshyachinda and Chaiwatanarat, who reported a peak bone mass at age 35[15]. The average peak bone mass for lumbar spine in our study was slightly lower than the earlier report for Thai women[15] and lower than women in the United States and Japan[16].

Our study was community-based, covering rural and urban areas from all 4 regions of Thai-

Table 3. Bone mineral density (g/cm^2) of vertebra and proximal femur by age group.

Age group (yr)	Lumbar spine at L_1-L_4 Mean	X-1SD*	X-2.5SD**	Femoral Neck Mean	X-1SD*	X-2.5SD**	Intertrochanteric Mean	X-1SD*	X-2.5SD**
<15	0.739			0.702			0.855		
15-19	0.880			0.780			0.979		
20-24	0.924			0.771			0.994		
25-29	0.924			0.800			1.016		
30-34	**0.957**	**0.847**	**0.682**	**0.814**	**0.716**	**0.569**	1.043	**0.940**	**0.769**
35-39	0.952			0.794			1.031		
40-44	0.945			0.796			**1.053**		
45-49	0.908			0.773			1.026		
50-54	0.859			0.743			0.973		
55-59	0.783			0.683			0.920		
60-64	0.735			0.653			0.869		
65-69	0.718			0.605			0.810		
70-74	0.683			0.571			0.765		
75+	0.660			0.542			0.718		

*a value of BMD below this value define as Osteopenia
** a value of BMD below this value define as Osteoporosis

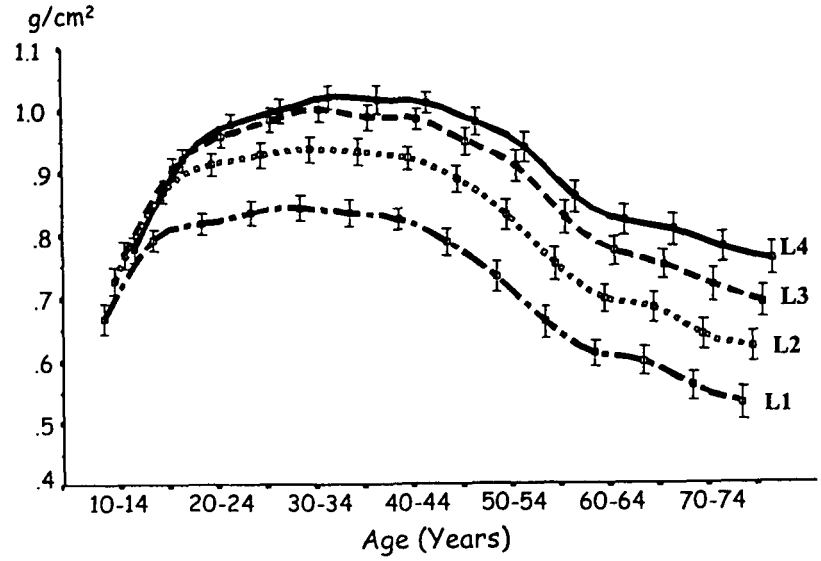

Fig. 1. Bone mineral density of L_1-L_4 of different age group.

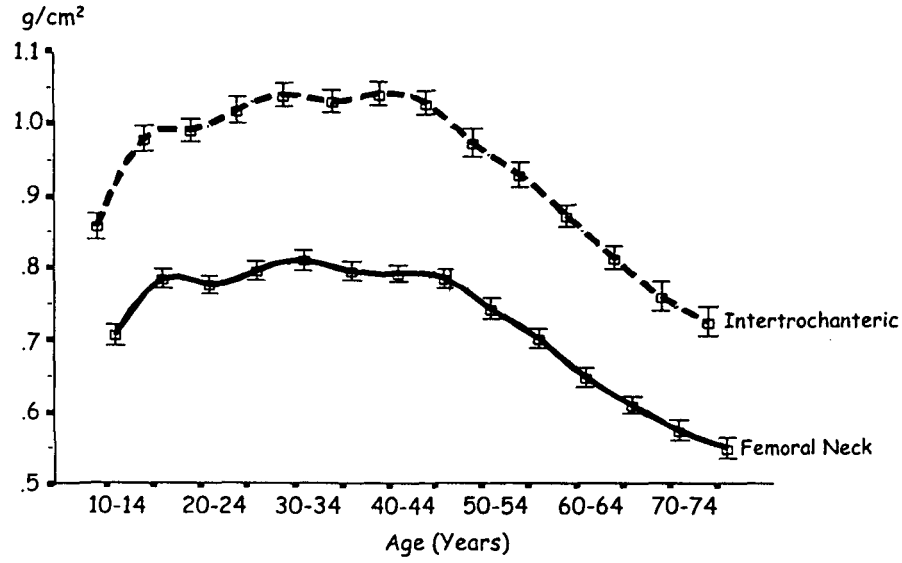

Fig. 2. Bone mineral density of femoral neck and interochanteric of different age group.

land. Appropriate sampling technique was used. Sample size was carefully calculated and adequate subjects from all age groups were obtained to ensure the precision of the data on bone mineral density. We do strongly believe that our study provides the most representative and precise bone mineral density for Thai women.

Bone mineral density is the most accurate diagnostic tool for the diagnosis of osteoporosis and determinant of bone fragility. Bone mineral density varies widely among different ethnic or geographical groups, dietary intake and life style[17]. It is obviously not appropriate to use the data from western populations as a standard for diagnosing

osteopenia or osteoporosis among Thai or other Southeast Asian women. To the best of our knowledge there are no studies reporting this type of information from any other Southeast Asian countries. The authors, therefore, strongly recommend that the data from this study be used as a reference for Thai women as well as for other Southeast Asian countries.

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ความหนาแน่นของเนื้อกระดูกสันหลังและข้อสะโพกของสตรีไทย

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วัตถุประสงค์ : เพื่อศึกษาหาค่ามาตรฐานความหนาแน่นของเนื้อกระดูกในสตรีไทย

รูปแบบการศึกษา : การวิจัยเชิงพรรณา แบบตัดขวาง

วิธีการศึกษา : สตรีไทยอายุ 11–80 ปี จำนวน 1,773 ราย ซึ่งมีภูมิลำเนาอยู่ในเขตพื้นที่ 6 จังหวัด ตามภาคต่าง ๆ ของประเทศไทย ได้รับการคัดเลือกเข้าสู่โครงการโดยวิธี multistage sampling และคัดเลือกเป็นกลุ่ม ๆ จากตำบลต่าง ๆ โดยวิธี random sampling และแบ่งเป็นจำนวนอย่างละกึ่ง จากทั้งในเขตเมืองและเขตชนบท สตรีเหล่านี้ได้รับคำอธิบายให้เข้าใจถึงวิธีการตรวจกระดูกแล้วจึงให้คำยินยอมเซ็นชื่ออนุญาต การตรวจความหนาแน่นของกระดูกตรวจที่กระดูกสันหลังข้อที่ 1 ถึง 4 และข้อสะโพกข้างที่ไม่ถนัด โดยใช้เครื่อง Dual Energy Photon Absorptiometer ทำการตรวจโดยผู้ตรวจที่ได้รับการปรับมาตรฐานการตรวจกระดูก ผลการตรวจความหนาแน่นของกระดูกได้รับการตรวจสอบโดยผู้เชี่ยวชาญด้านรังสีวิทยา

ผลการศึกษา : พบความหนาแน่นเนื้อกระดูกของสตรีไทยสูงสุดที่อายุ 30–34 ปี ค่ากลางของเนื้อกระดูกสันหลังและข้อสะโพก เป็น 0.957 และ 0.814 กรัม/ซม.^{2} ตามลำดับ เนื้อกระดูกของทั้งกระดูกสันหลังและกระดูกข้อสะโพกจะลดลงหลังสตรีอายุ 35 ปี และลดลงอย่างรวดเร็ว เมื่ออายุสตรีผ่าน 50 ปี จะอยู่ในภาวะกระดูกพรุนของทั้งกระดูกสันหลังและข้อสะโพกเมื่อความหนาแน่นน้อยกว่า 0.682 และ 0.569 กรัม/ซม.^{2} ตามลำดับ

สรุป : ผลการศึกษานี้ควรใช้เป็นข้อมูลเพื่อการวางแผนและการให้คำปรึกษาในการดูแลสตรีไทย ให้ความรู้และความเข้าใจ การดูแลตนเองเพื่อป้องกันกระดูกบางตั้งแต่ก่อนวัยหมดระดู

คำสำคัญ : ความหนาแน่นของเนื้อกระดูก, ค่าปกติ

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