ASSESSMENT OF BONE MINERAL DENSITY IN NORMAL THAIS

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ABSTRACT

Bone mineral density (BMD) of anterior and lateral lumbar spine and femoral neck were studied in 301 normal healthy subjects (205 women and 96 men; age range, 20-84 years) utilizing dual energy x-ray absorptiometer (DEXA). In normal women, bone mass was increased with age and peaked around age 35 at all three scanning sites. Bone diminution began about the age of 40 and the loss was accelerated after age 50. The average rate of loss upto age 75 was 0.8% per year at all sites. In normal men, the pattern of bone diminution with age was different from women. Bone diminution from vertebrae and femoral neck began in young adulthood and were linear. The rate of decrease in BMD was two-thirds of that in women for femoral neck but was only one-fifth of that in women for anterior lumbar spine. Mean BMD in women was less than men at all three scanning sites.

Key Words : Bone mineral density, Bone mass, Bone densitometer, Dual energy x-ray absorbtiometer.

INTRODUCTION

Bone mineral density (BMD) and bone strength change throughout life. Density increases during growth, especially in adolescence, continue to increase in young adulthood and peaks around age 30. After skeletal maturity is reached, bone loss begins and persists until age 85 to 90 years. The loss is attributed to an imbalance in skeletal remodeling, in which the rate of bone formation is less than that of bone resorption. The influences of heredity, race and sex on incidence of osteoporosis appear to reflect their effects on peak bone density. Differences in peak bone density at skeletal maturity also may account for racial and sex differences in the incidence of osteoporosis. Therefore osteoporosis varies widely among ethnic groups, regions and nations (1).

Osteoporosis is a major community health problem affecting upto half of the elderly female population in most western countries (2-5). Osteoporosis reflects the inadequate accumulation of bone tissue during growth and maturation, excessive losses thereafter or both. When bone tissue is reduced in amount, the likelihood of fracture is increased.

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Currently the available data indicate a significant inverse relationship between bone mass and fracture incidence and it is no longer meaningful to require the presence of fracture to diagnose osteoporosis since an osteoporotic patient was at risk of fracture long before the fracture event, therefore measurement of bone mass provide the single best test for assessing the risk of subsequent fracture (6).

A variety of techniques have been developed to quantify bone density, among these, Quantitative digital radiography (QDR), also known as Dual-energy x-ray absorptiometry (DEXA) has the ideal properties of obtaining precise measurements in a short time with very low radiation exposure (5,7-10).

The objective of the present study is to establish a range of bone density from normal healthy Thais which will be served as normal reference for our clinical services.

MATERIALS AND METHODS

Subjects

Healthy volunteers with the age of 20 and above were studied. A detailed social history was obtained from all volunteers in order to analyse risk factors. The inclusion and exclusion criteria for selection of studied population were as follows:

Inclusion criteria

Thais who were born and live in Thailand, healthy and fully mobile. Body mass index (BMI) are between 18-28. Non smoking.

Exclusion criteria

History of prolonged bed rest (over 4 weeks).

Current medication including contraceptive pill or stop medication less than on month.

On calcium, vitamin D supplement.

On hormone replacement therapy at any time.

Presence of chronic illness including diabetes mellitus, hypertension, Thyroid disease, hyperparathyroidism.

History of steroid administration.

Daily alcohol intake.

History of x-ray contrast media administration or radionuclide study one week prior to present study.

In addition to the above criteria, pregnant, or lactating women, women with history of amenorrhea, premature ovarian failure, hysterectomy, oovarectomy or other ailment likely to affect bone metabolism were also excluded.

Method

Boty weight and height were recorded in all subjects and BMI were calculated.

Serum calcium, phosphate, haematocrit and MCV were determined whenever possible.

BMD of anterior lumbar spine at L_1 to L_4, lateral lumbar spine at L_2 to L_4 and left hip of all subjects were measured using a DEXA system (Hologic QDR-2000). The results of BMD at each site was expressed as $g/cm.^2$ For the hip, only BMD of femoral neck was analysed. The precision of these measurements in our laboratory is 0.41% for anterior lumbar, 0.76% for lateral lumbar and 0.89% for femoral neck.

Statistical analysis

The relation between BMD and age of male and female volunteers were separately analysed by using linear regression. The independent variables (height, weight) in relation to the dependent variable (BMD) was assessed by multiple linear regression analysis.

For establishing normal limits, the lower 5th percentile and upper 95th percential from appropriate regression equation was estimated.

The study was approved by the Chulalongkorn hospital Research ethics committee.

RESULTS

A total of 301 healthy volunteers, 205 women and 96 men, with the age range from 20-84 year-old were studied. The haematocrit, MCV, serum calcium and serum phosphate were determined in 140 subjects (84 women, 56 men) and they were within normal limits (Table 1).

The mean BMI for females and males was 22.5 and 23.2 respectively. There is significant effect of weight on BMD of anterior lumbar spine and femoral neck in both sexes but significant effect of height was only on femoral neck in both males and females (Table 2).

Table 1 Results of and blood examination

	Hct		MCV		Calcium		Phosphate	
	Female	Male	Female	Male	Female	Male	Female	Male
Mean	38.8	44.7	87.0	90.1	9.3	9.4	3.4	3.1
SD	2.7	2.8	7.2	6.5	0.6	1.1	0.5	0.5
Range	31-50	38-50	68-100	71-100	7.4-11	7.8-11	2.4-4.6	2.4-4.6

Table 2 Assessment of independent variable on BMD

	Women		Men	
	Lumbar	Femoral neck	Lumbar	Femoral neck
Weight	P<0.01	P<0.001	P<0.03	P<0.000
Height	P=0.056	P<0.005	P=0.056	P<0.000

The results of BMD determination at anterior and leteral lumbar spines and femoral neck in 205 women and 96 men are shown in Figs. 1-6. In normal women, BMD increase from age 20 and peaking around age 35 years at both anterior and lateral lumbar spines and femoral neck (Figs. 1-3). After age 40 years, bone diminution with aging occurred at all three scanning sites. Accelerated bone loss was observed between age 50 to 65 years, after that the diminution of bone mass wass less at all sites.

In normal men, bone diminution were observed at the age of 20 onward at all 3 scanning sites and the decline in BMD with aging was linear at all sites. The bone diminution was more rapid at the femoral neck (Fig. 4), less so at lateral lumbar spine (Fig. 5) and minimal at anterior lumbar spine (Fig. 6). There are certain different pattern of age regression of BMD between both sexes, bone loss in women was more accelerated than men at all sites (Fig. 7-9). The BMD of the femoral neck in women was lower than men throughout life but the BMD at the vertebrae in women during age 30-50 years was somewhat similar to men of the same age, after that bone loss in women was much more rapid. The mean of peak bone mass at each site for women and men is shown in Table 3.

Table 3 Peak BMD of lumbar spine and femoral neck

Site	BMD (g/cm^2)	
	Women (Mean + SD)	Men (Mean + SD)
Lumbar spine		
Anterior	0.987 + 0.089	1.030 + 0.081
Lateral	0.807 + 0.076	0.933 + 0.062
Femoral neck	0.810 + 0.087	0.973 + 0.097

In order to set a cutoff value for the purpose of diagnosis of osteoporosis, the value of BMD that is more than 2.5 SD below the young adult mean value was adopted (11) as shown in Table 4.

Table 4 Cutoff value for diagnosis of osteoporosis

	BMD (g/cm^2)	
	Women	Men
Lumbar spine		
Anterior	0.765	0.828
Lateral	0.617	0.778
Femoral neck	0.593	0.732

Comparison of BMD between our studied population, and Japanese population which was used as normal reference by the manufacture of our DEXA (Hologic) was attempted. We found slightly lower BMD in Thai women as compared to Japanese women at both lumbar spine and femoral neck and the bone mass was peaked earlier in Japanese women (Fig. 10-11). The BMD of Thai men was also slightly lower than Japanese men at lumbar spine (Fig. 12-13).

DISCUSSION

From our study, bone mass at axial and appendicular skeleton in normal women was similarly peaked at age 35 years, started to loss at age 40 years and the loss was accelerated at age 50 years which corresponded to the average menopausal age of 49.5 ± 3.6 years in Thai women (12). The age at peak bone mass and at the beginning of bone deminution in our study is somewhat similar to British women (13) but unlike Japanese population where the bone mass was peaked around 30 years old. The average peak bone mass in our study was 0.987 g/cm^2 which is slightly lower than the value of 1.06 g/cm^2 found in British women by Hall el al (13). The BMD of lumbar spine and femoral neck were also slightly lower than Japanese women.

A biphasic pattern of bone loss has been identified for both cortical and trabecular bone : a protracted slow phase that occur in both sexes and a transient accelerated phase that occurs in women after menopause (4). Our study also revealed similar pattern of bone loss for both cortical and trabecular bones in normal women. However data on trabecular bone loss from the axial skeleton are conflicting, some shows a linear decrease bone loss begining in young adulthood (14,15) and some have found evidence of an accelerated phase of bone loss following menopause (16,17).

For men, the peak BMD at anterior lumbar spine in our study is slightly less than Japanese populations. Bone diminution with aging at the femoral neck and the vertebrae was linear which is similar to Japanese men and other reports (18,19). However the BMD at the vertebrae fell much less rapid than the femoral neck which is in agreement to one report (18) but in contrast to other report (19).

By age 70 years, the age regression for BMD of anterior and lateral lumbar spine and femoral neck in women had decreased to a level below 2SD of peak bone mass. Similar findings were found in normal men except the anterior lumbar spine which had much less bone diminution with advancing age. The rate of decrease in BMD of anterior and lateral lumbar spine and femoral neck in women at age 75 years was 23%, 27% and 23% respectively or in average of 0.8% per year at all sites while in men the decrease rate at the same age was 8%, 21% and 26% or in average of 0.15% per year for anterior lumbar spine, 0.4% per year for lateral lumbar and 0.5% per year for femoral neck, Thus the rate of decrease in BMD for men was two-thirds of that in women for femoral neck, one-

half for lateral lumbar spine but was only one-fifth of that in women for anterior lumbar spine. These findings ar somewhat similar to other report which explained that why the female/male ratio is 2:1 for hip fractures but 8:1 for vertebral fractures (18).

In conclusion, the bone mass was peaked around age 35 years old for both trabecular and cortical bones in normal women and began tc loss bone mass at age 40 with accelerated loss after age 50 For normal men, the pattern of bone loss with age was different from women and the mean BMD was higher. Bone diminution with aging was linear for both vertebral and cortical bones and the rates of loss were less than women at all sites especially at lumbar spine where bone diminution with aging was minimal.

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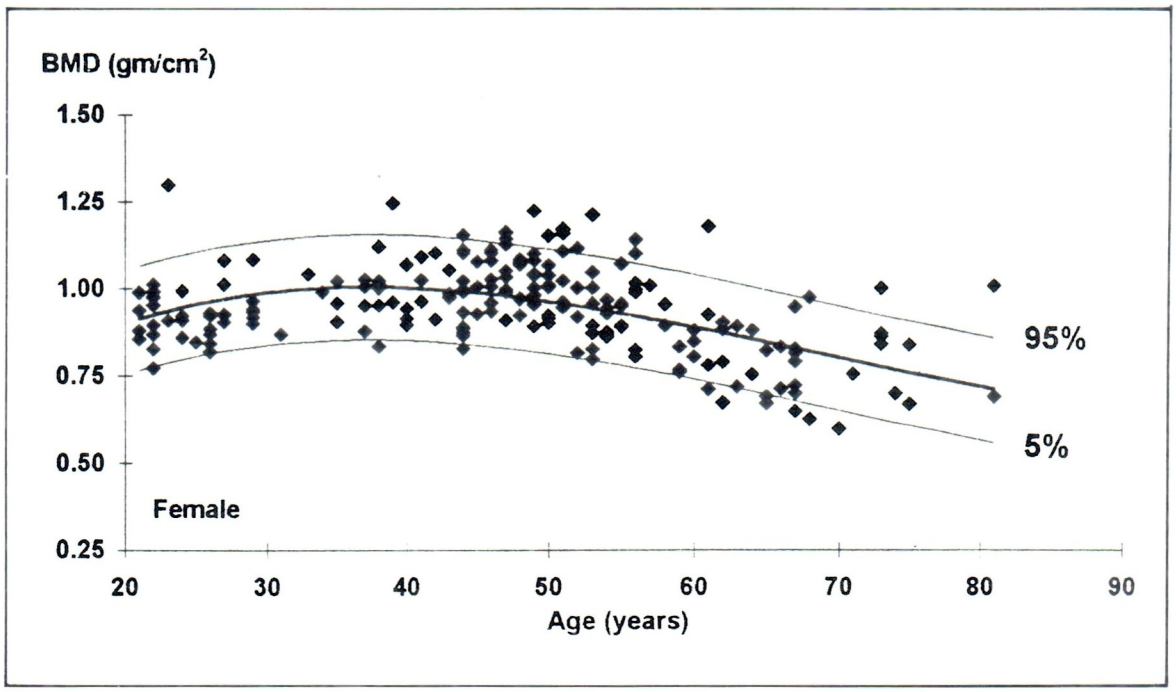

Fig. 1 Regression of BMD of anterior lumbar spine on age in 205 normal women (◆). The upper and lower lines represent 90% confidence limits.

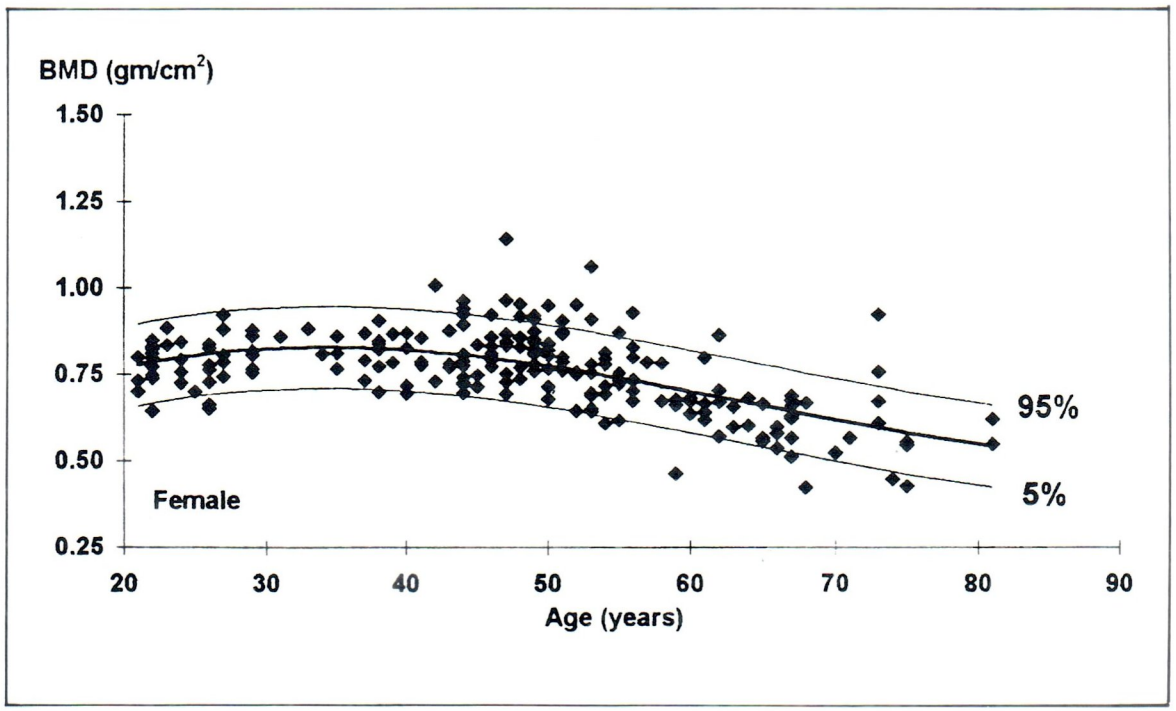

Fig. 2 Regression of BMD of lateral lumbar spine on age in 205 normal women (◆). The upper and lower lines represent 90% confidence limits.

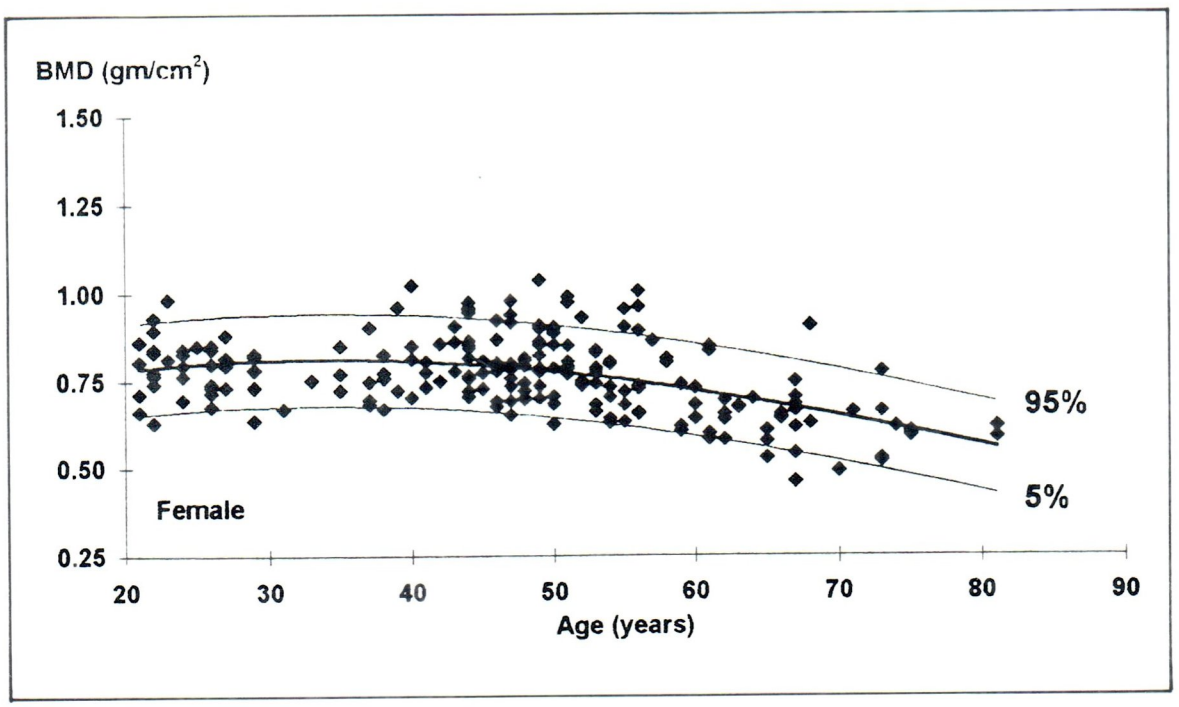

Fig. 3 Regression of BMD of femoral neck on age in 205 normal women (◆). The upper and lower lines represent 90% confidence limits.

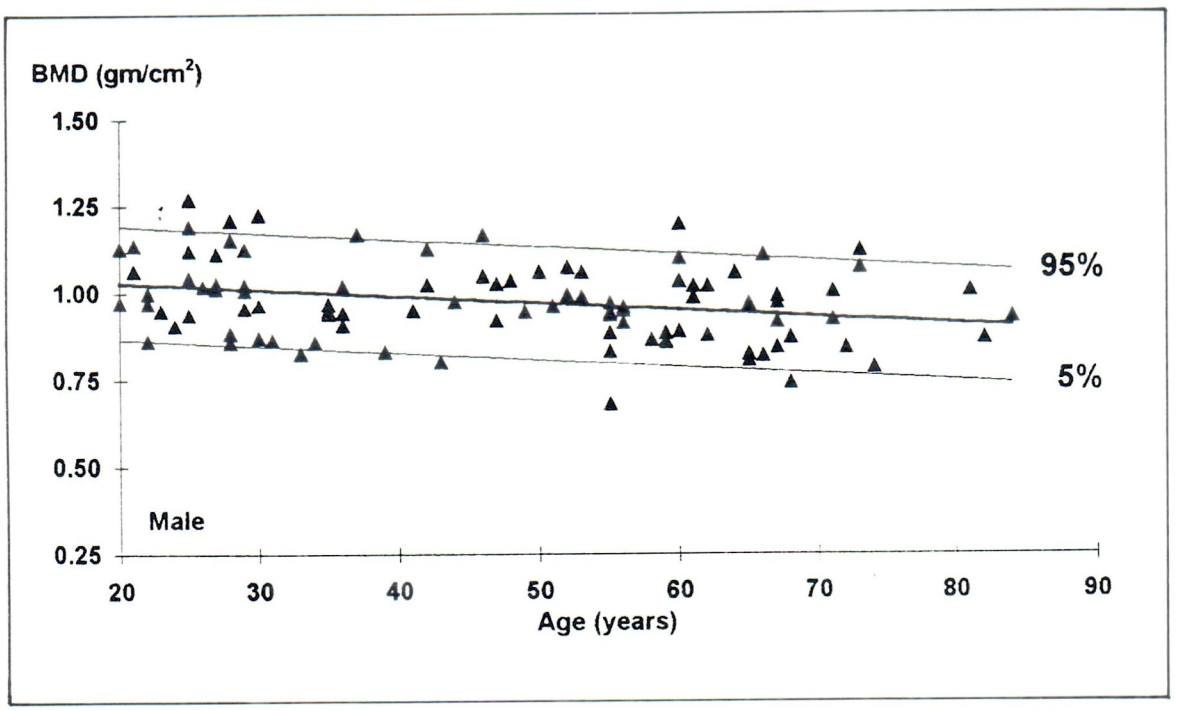

Fig. 4 Regression of BMD of anterior lumbar spine on age in 96 normal men (▲). The upper and lower lines represent 90% confidence limits.

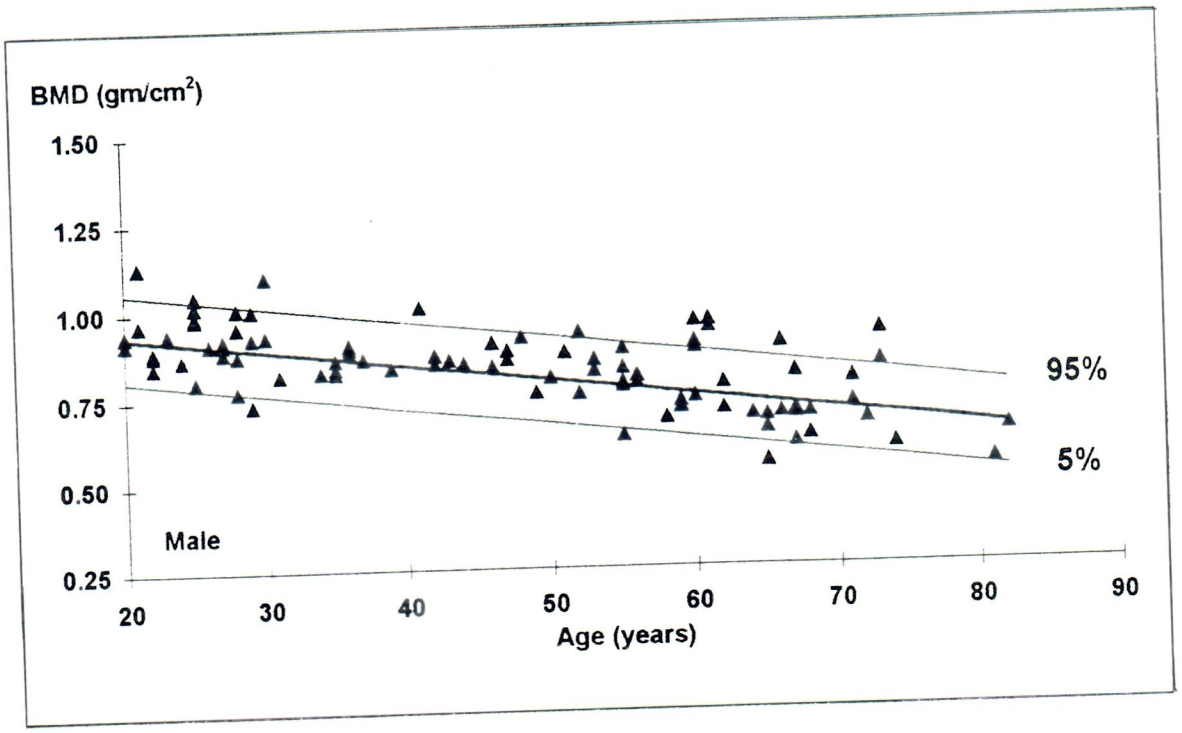

Fig. 5 Regression of BMD of lateral lumbar spine on age in 96 normal men (▲). The upper and lower lines represent 90% confidence limits.

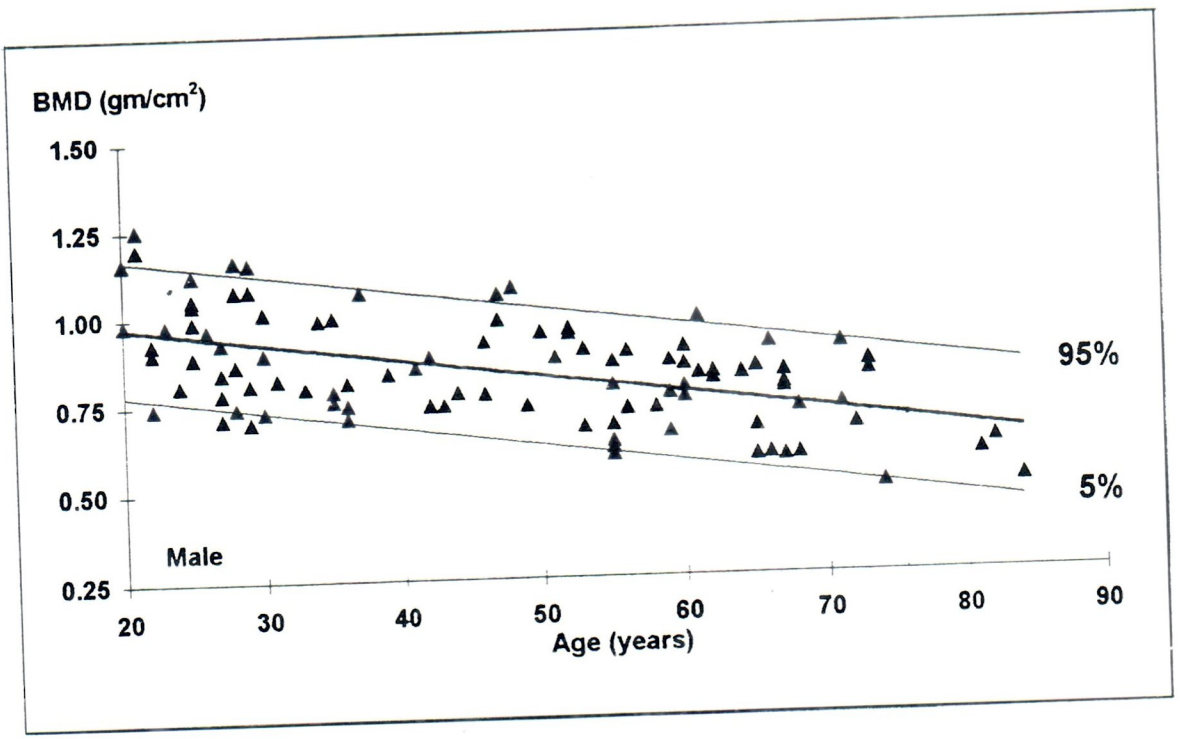

Fig. 6 Regression of BMD of femoral neck on age in 96 normal men (▲). The upper and lower lines represent 90% confidence limits.

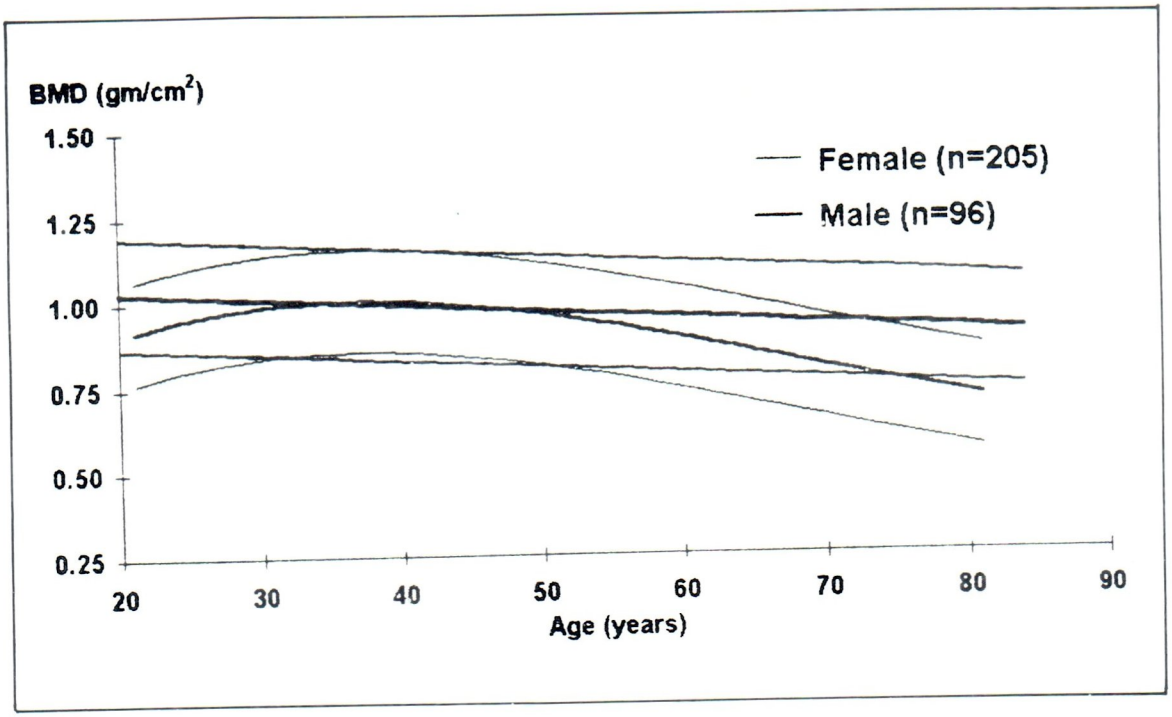

Fig. 7 Age regression of BMD of anterior lumbar spine in normal men and women. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.

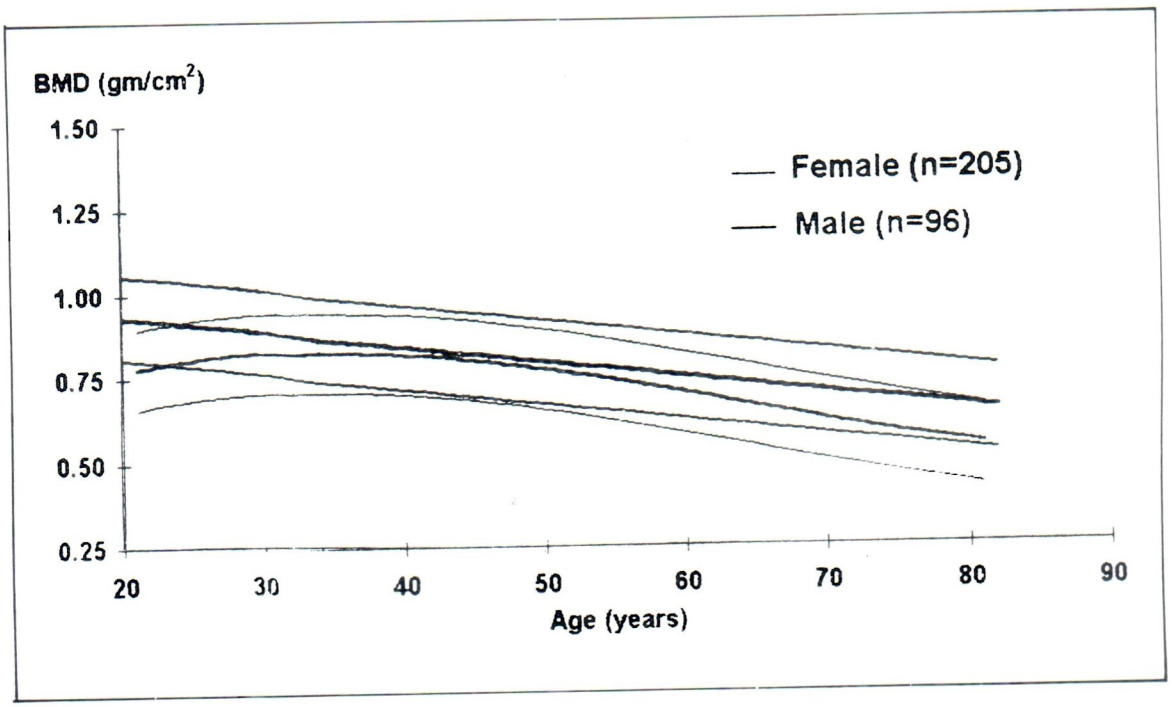

Fig. 8 Age regression of BMD of lateral lumbar spine in normal men and women. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.

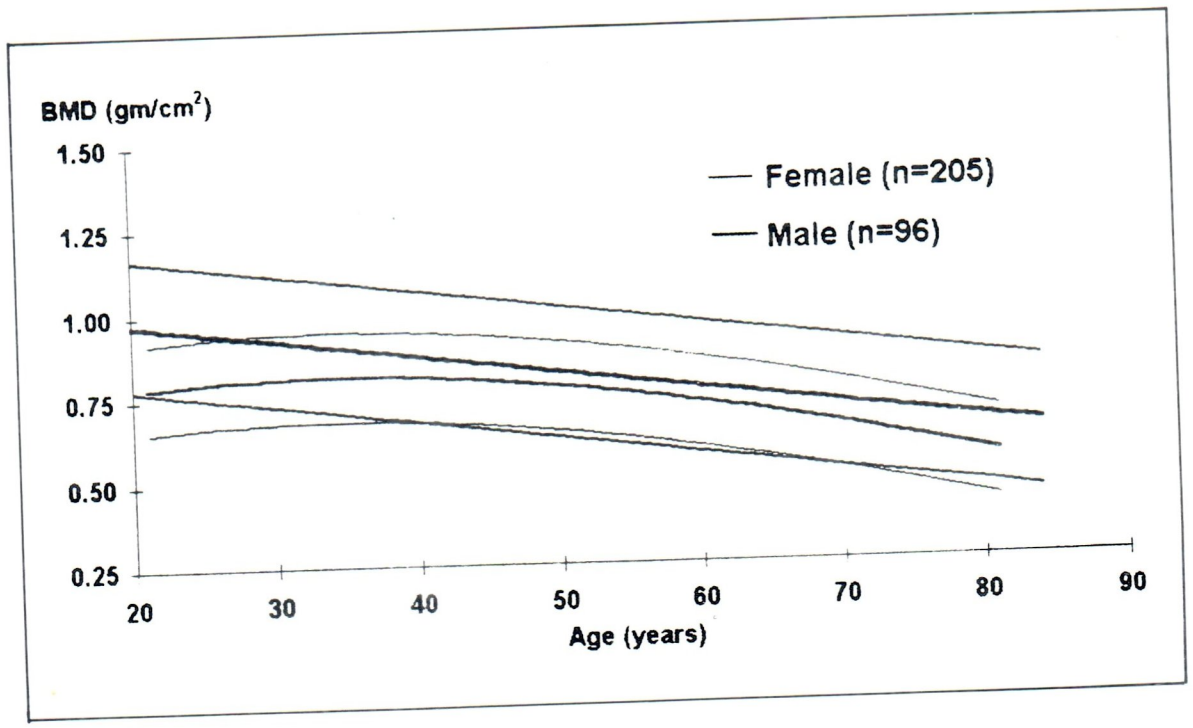

Fig. 9 Age regression of BMD of femoral neck in normal men and women. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.

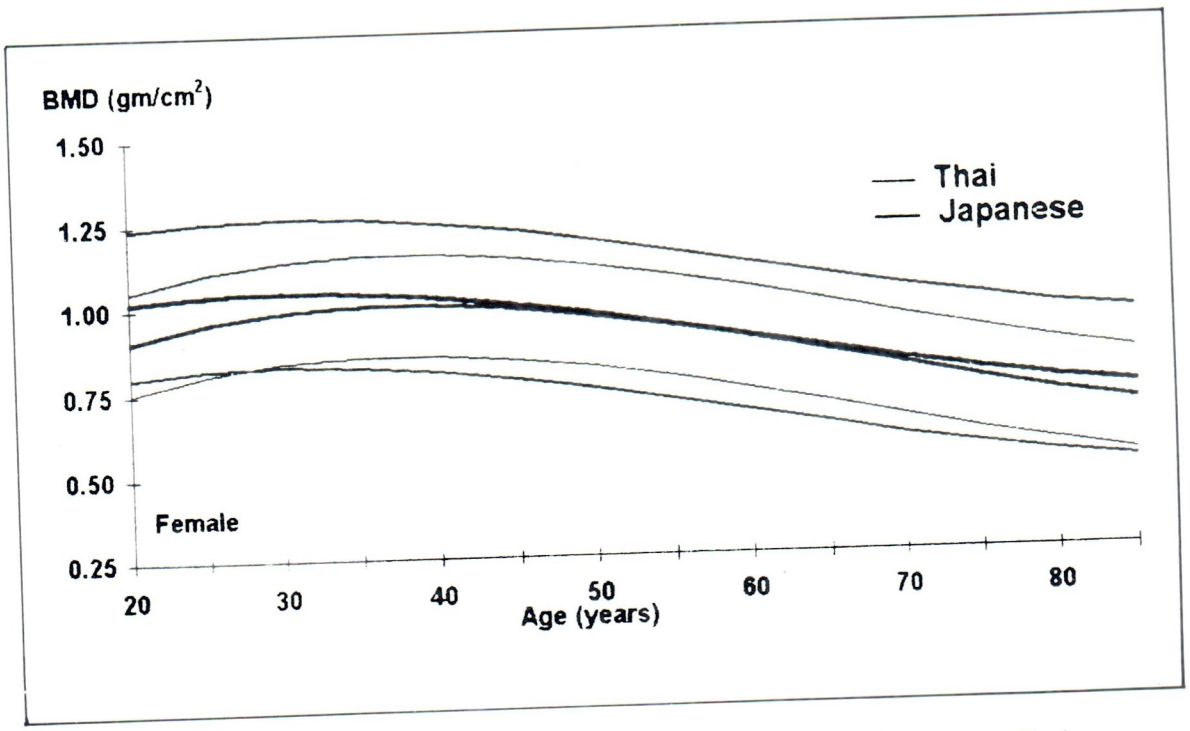

Fig. 10 Age regression of BMD of anterior lumbar spine in normal Thai and Japanese women. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.

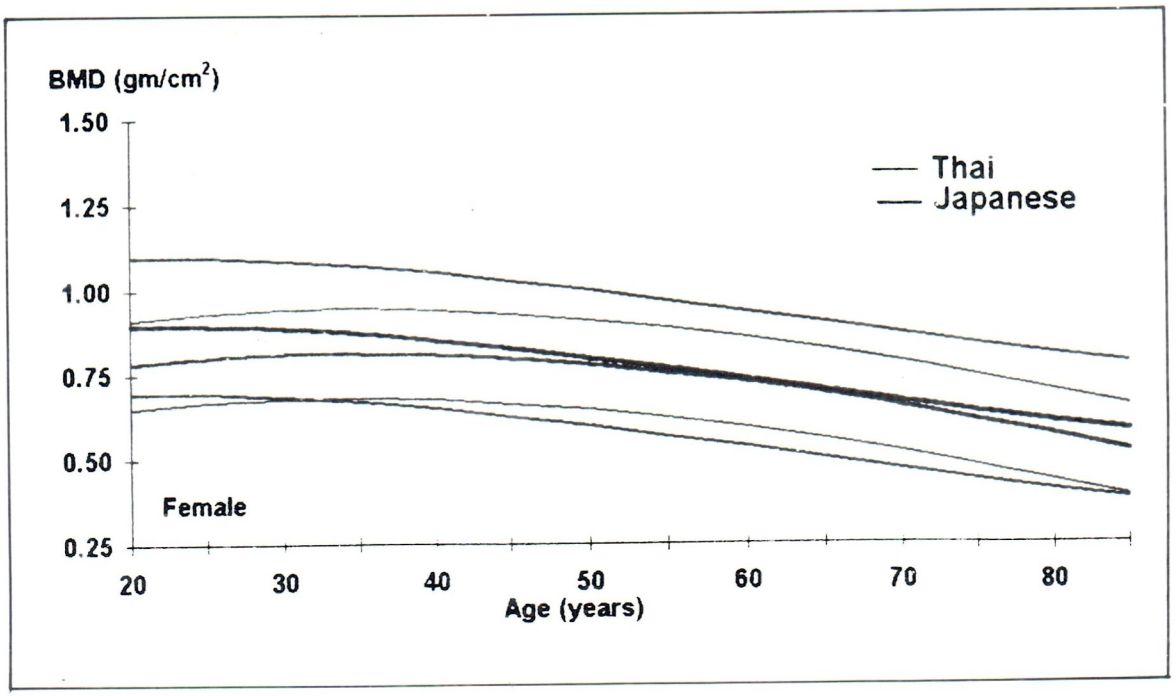

Fig. 11 Age regression of BMD of femoral neck in normal Thai and Japanese women. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.

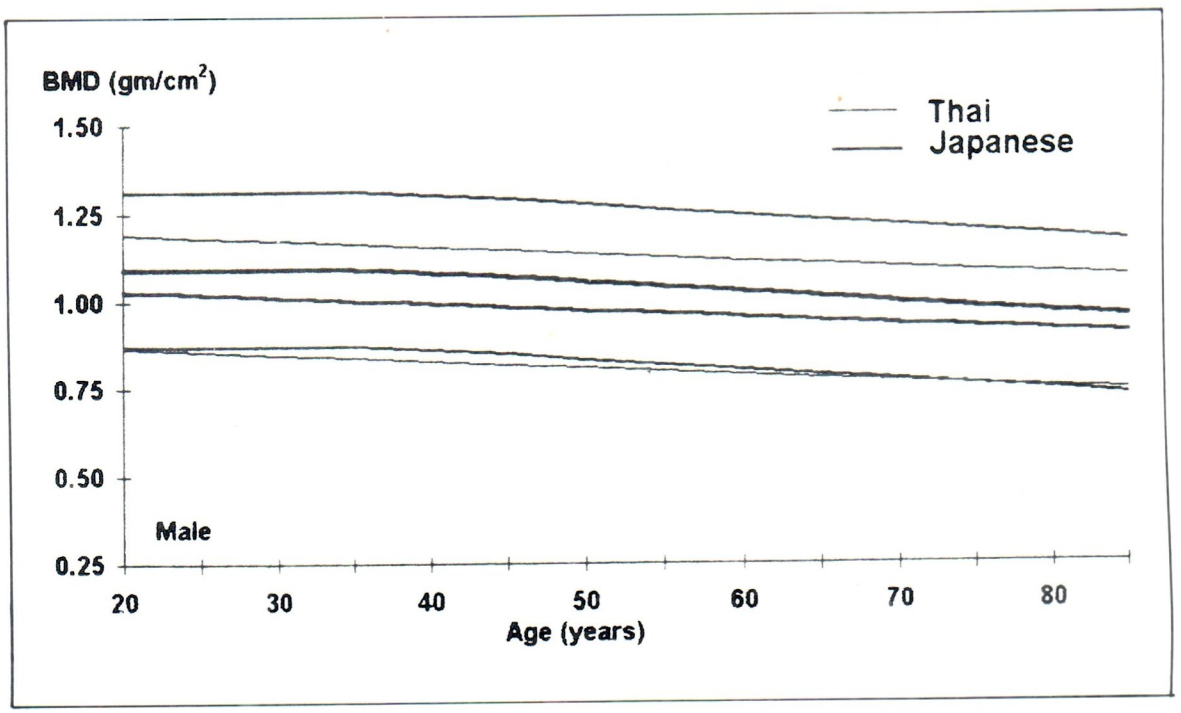

Fig. 12 Age regression of BMD of anterior lumbar spine in normal Thai and Japanese men. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.

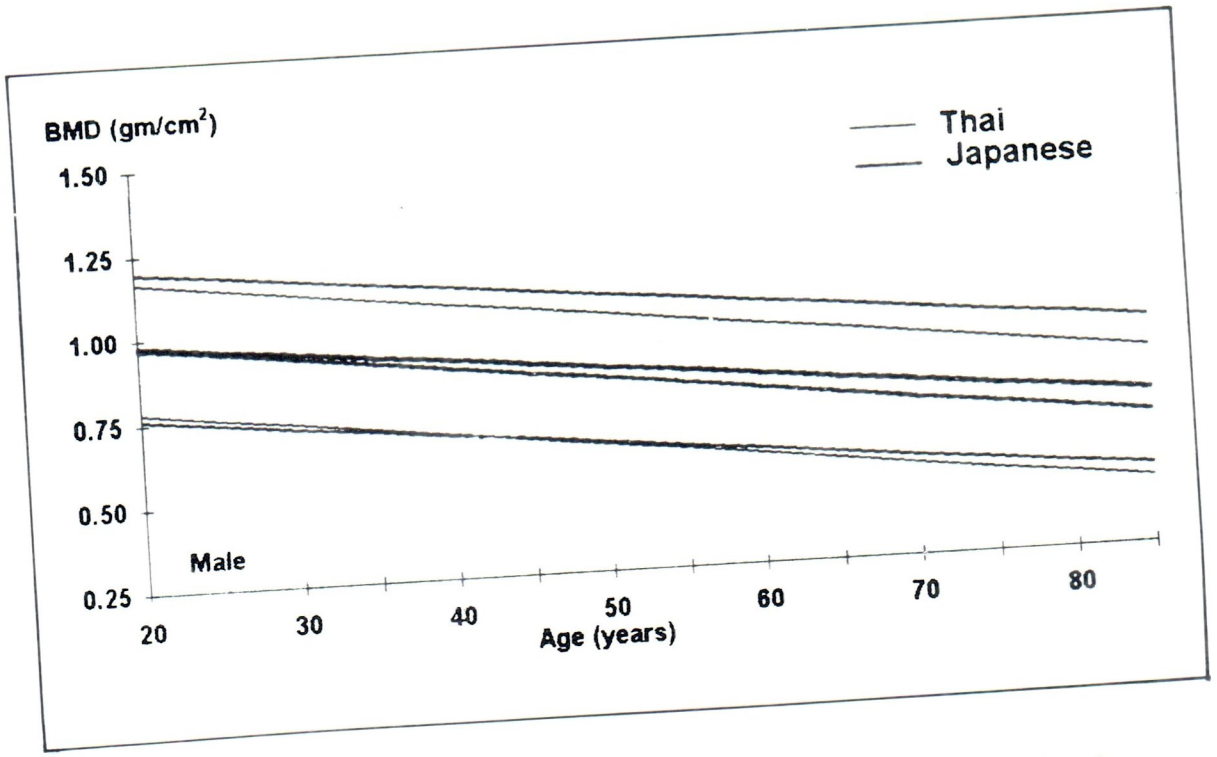

Fig. 13 Age regression of BMD of femoral neck in normal Thai and Japanese men. Central lines of each group is age regression and upper and lower lines represent 90% confidence limits.