

# The Diet of Women's College Students (part 7)

## Bone Mineral Density and Food Intake

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### SUMMARY

This paper is to study the relationship between the diet and bone mineral density (BMD). The research of variable sources of Calcium is important for the prevention of osteoporosis. As Japan is increasingly becoming an aged society, this is more important. The most significant findings in this study are the high rates of BMD increase, Calcium intake and body weight.

The results are as follows :

- (1) The average of the subjects' body height and weight was slightly higher than the national average.
- (2) The overall average of BMI evaluation was  $20.7 \pm 2.57$ , which means normal, but those subjects who seem to have slender physique occupy 50%.
- (3) As for the overall average of BMD evaluation, there is no problem. However, 13% of them have low value and so have to take care in their diet.
- (4) Nutrient intakes of Energy and Calcium were less than the required value.
- (5) As for food group intakes, fats and oils, sugars, fishes and meals were taken enough (more than 100%), while milk was not taken enough (89%).
- (6) The exercise add test and the physical strength measurement show that they were as a whole on low level compared with the national average.

### INTRODUCTION

The purpose of this study was to investigate the relationship between bone mineral density and Food intake, body structure and exercise in adolescents. Nowadays the situations of dietary life have changed remarkably in Japan. Profound influences, therefore, were exerted upon our food style, dietary pattern, dietary behavior and nutrient intakes.

Under this circumstance, there is an increasing tendency toward taking such kinds of food as fat, animal protein, and sugar, but there is, on the other hand, a decreasing tendency toward taking the starch and plant protein.<sup>1)</sup> With the advent of an aging society, people suffering from osteoporosis

and at the same time old invalid people will necessarily increase in number.

For the prevention of osteoporosis it is important for us to build a maximizing peak bone mass at an early age and pay attention to life style and nutrition control while in our youth.

A number of studies have so far reported on BMD and meals, and especially Hirota *et al.* (1992) found a positive correlation among young women's body weight and the quantity of their in-taking Calcium and their exercise.<sup>2)</sup> Nieves *et al.* (1995) reported Calcium intake during teen age may have a greater impact on BMD in women between 30 and 39 in age.<sup>3)</sup> Gunnes *et al.* (1995) noted that dietary Calcium and Vitamin C is a predictor of BMD in healthy children and adolescents.<sup>4)</sup> Alamiel *et al.* (1995) reported that BMD in young women have relations with smoking.<sup>5)</sup> Cundy *et al.* (1995) investigated interracial variation in BMD and suggested that the heavier body weight is, the higher BMD values is.<sup>6)</sup>

In most of these reports BMD was measured by X-ray, DIP (a kind of digital image processing method), MD (microdensitometry method), or DEXA (dual energy X-ray absorptiometry method). But so far no report has been delivered on the BMD measured for female college students by using ultrasonic wave. The writer has been engaged in the research of the physique element, nutrient intake, and dietary behavior of female college students from the viewpoint of health control of nutrition education. In one of the reports, the writer pointed out that the students had a problem such as physique ; a third of them belong to the group of which physical type is slender, with the value of BMI (body mass index) being less than 20%.<sup>7)</sup>

In this paper the writer measured the students' BMD using ultrasonic wave and examined the relationship among the BMD and their physique, exercise, strength, nutrient intake and food groups.

## METHOD

The survey was conducted in the following manners :

- (1) Subjects and term : The subjects consisted of 81 students of the Nutrition Course at Tezukayama College. The term was from October 1994 through February 1995.
- (2) Substance and item : The diets they ate for three consecutive days in a week were filled in the form of self writing questionnaire. At the same time they were asked to submit the picture of each meal so that the survey might be as precise as possible. They were assigned to record all their actions in any one day during the term in accordance with Time Study of Living in order to get consumption energy index. BMD was measured by ultrasound bone densitometer (Lunar Company Manufacture ACHLLES). And the exercise add test and the physical strength measurement were conducted concerning the following items : intake of the maximum oxygen (ml/kg/sec), momentary reaction power (cm), quick movement ability (sec), keeping balance (sec), and flexibility (cm) in corporation with the Nara Foundation of Longevity.

(3) Statistical analysis : Nutrition and food group intake per day were calculated from the data collected, depending on *Food Element Data* (the 4th edition). As a result of the data processing, the mean with standard deviation of nutrition and foodstuff intake per day were gained. The results were confirmed with a t-test ; the differences among the groups being significant at the 0.01 level. BMD was examined based on the Stiffness Index which is said to be equal to DEXA method in high sensitiveness, by reference to Yamasaki *et al.* (1993) in which the basic efficiency and utility of ACHLLES are reported in detail.<sup>8)</sup>

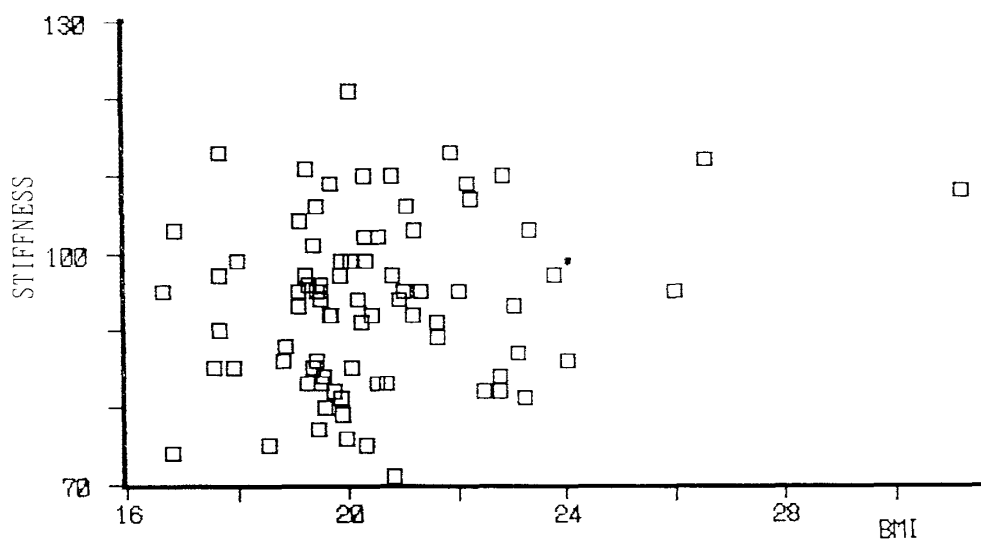
## RESULT

1. Anthropometric measurements and BMD : Table 1 shows the subjects' height, weight, BMI, waist-to-hip ratio, and stiffness index. Height and weight are slightly over those reported in the National Nutrient Research.<sup>9)</sup> While the BMI overall average  $20.7 \pm 2.57$  shows that it is within a normal range (20~24), more than 50% of the subjects are slightly slender. That BMI ranges from minimum 16.7 to maximum 31.3 indicates a wide distribution, that is, slender to obese. Waist-to-hip ratio is within a normal range , and its correlation with BMI cannot be found. AS for stiffness

**Table 1** Measured Value of Physical Biometry Mean Value, Standard Deviation and Coefficient of Variation (n=81)

Variable	Mean	(SD)	CV	Range
Height (cm)	158.6	( 5.17)	3	147-172
Weight (kg)	51.7	( 6.73)	13	38-80
BMI (kg/m <sup>2</sup> )	20.5	( 2.21)	11	16.7-31.3
Waist-to-hip	0.7	( 0.02)	3	0.68-0.75
Stiffnes*	93.6	(10.78)	12	71-121

\*Stiffness Index



**Figure 1** Distribution of BMI and Stiffness

index average  $93.6 \pm 10.78$ , there is no problem. BMI and Stiffness Variables are shown in Fig 1, 13% of them have to take care of their health, for they have low stiffness index, though their BMI is within a normal range.

Subjects can be divided into two groups in accordance with their value of stiffness ; one has the values above the mean and the other has the values below the mean (Table 2). The group with the value above the mean has some correlation with height, weight and BMI. But there is no sta-

**Table 2** Body height and Weight divided into two groups of higher and lower levels of bone density stiffness

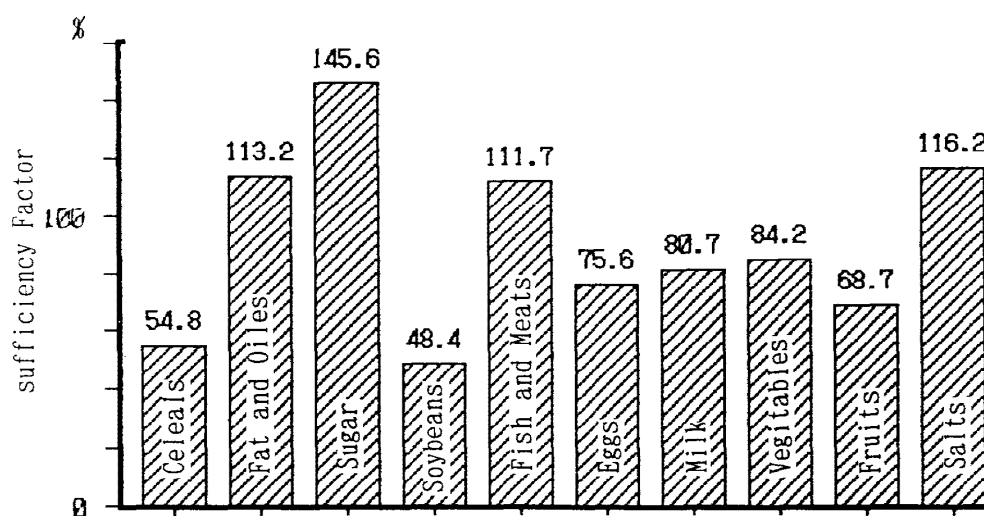
Variable	Higher (n=43)				Lower (n=38)			
	Mean	(SD)	CV	Range	Mean	(SD)	CV	Range
Height (cm)	159.1	(4.86)	3	149–168	158.1	(5.45)	3	147–172
Weight (kg)	52.6	(7.69)	15	38–80	50.6	(5.25)	10	42–59
BMI (kg/m <sup>2</sup> )	20.7	(2.57)	12	16.7–31.3	20.3	(1.68)	8	16.8–24.0
Stiffnes*	101.8	(6.80)	7	94–121	84.3	(5.70)	7	71–93

\*Stiffness index

**Table 3** Nutrient intakes

Variable	Mean	(SD)	CV	Range	SF (%)
Energy (kJ/d)	7298	(1174)	16	5300–10144	83.1
Protein (g/d)	70.6	(11.45)	16	48.5–90.4	117.6
fat energy (%)	29.6				118.4
Calcium (mg/d)	544	(132.2)	24	382–807	90.8
Na (mg/d)	3218	(551)	17	2509–4301	82.0
Vit. A (IU/d)	2154	(1288)	60	756–2154	119.6
Vit. B <sub>1</sub> (mg/d)	0.85	(0.52)	61	0.44–2.93	106.2
Vit. B <sub>2</sub> (mg/d)	1.00	(0.17)	17	0.71–1.43	90.9
Vit. C (mg/d)	58	(31.7)	55	21–179	116.0

Vitamin A, B<sub>1</sub>, B<sub>2</sub> and C represent the values subtracting the cooking loses  
SF: Sufficiency Factor



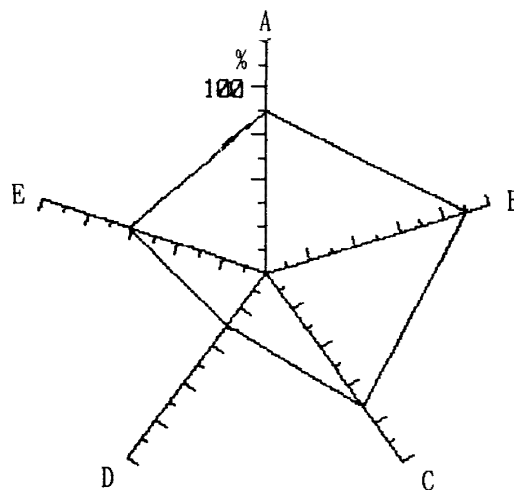
**Figure 2** Results of Food Group Intakes

tistical significance found.

2. Nutrient intake : The average intakes of nutritive elements and their sufficient percentage are shown in Table 3. Energy (83%) is not taken sufficiently. Calcium (89%) which is needed for high BMD is taken 544mg per day (the national average is 600mg), which indicates it is not taken as sufficiently as it should be.<sup>9)</sup> The average intake of Fat energy (29.6%) shows it is taken above the uppermost bound (normal range 20~25). This is due to having a lot of food with protein and fat.

3. Food group intake : Sufficient amount of Fats and oils, sugar, fishes and meats are taken daily (Figure 2). On the other hand, cereals and potatoes, milk, pulses, and vegetables are not taken sufficiently (less than 90%).

4. Exercise add test and physical strength measurement : The results are shown in Figure 3. Compared with the national average, all the items except momentary reaction power are in low level. The power of keeping balance (average 40.2/sec) is extraordinarily low.



**Figure 3** Effect of Exercise Add and Physical Measurement  
A : Maximum Oxygen  
B : Momentary React Power  
C : Quickly Ability  
D : Keep Balance  
E : Flexibility

## DISCUSSION

The BMD of healthy adolescents is profoundly influenced by their environment, nutrition, and internal secretin. Tuji *et al.* (1993) reported that important factors are body weight, calcium intake, menstruation, and usefulness of exercise.<sup>10)</sup>

Bones are formed and BMD increases at the physiologically growing age. Generally bone mass attains the peak value at the age of 25–30. Therefore it is no doubt very important for adolescents to make peak bone mass at this period. It is a matter of grave significance that about 50% of the subjects have the BMI value below 20. And the fact found by this survey that the group with high BMD has a good physique in comparison with the group with low BMD provides valuable suggestions as to their weight control and health management.

Calcium is a main nutritious factor for increasing bone density, and also a main mineral component of bone. As Calcium metabolism is about 30~40%, and 200mg is wasted out of our body per day, at least 600mg should be supplied daily. Insufficient intake of Calcium during adolescence leads without fail to low BMD.

The chief source of supply of Calcium is milk and dairy products, which we can get easily, but

its metabolism varies in accordance with the kind of food we take.

The problem that comes up next is about protein intake. There is an increasing tendency to take high protein meals including meats. Though the average protein intake (140 g/prot/day) is not necessarily abnormal, it must not be forgotten that the rate of sufficient intake of protein(117%) is fairly high. Food with high protein causes a lot of Calcium to be passed with urine, which brings about minus balance of Calcium. In this sense, a way of a proper intake of the food having animal protein should be examined and taken in nutrition education.

In order to make improvement on bone mineral density and other items, most careful attention should be paid to nutrition, especially intake of Calcium, moderate exercise, and life style.

To sum up, three main guidelines for nutrition education will be : (1) proper guidance on health and nutrition (2) knowledge of cooking, handling food (3) necessity and continuity of exercise.

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