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A Study of Correlation among Bone Mineral Density, Body Composition and Body Circumference on 20's Women

The aim of this study was to investigate the correlation among bone mineral density(BMD), body composition and body circumference on 20's college women in Hwaseong. A total of 86 subjects were measured with BMD and body composition and body circumference. To evaluate the correlation between BMD and body composition, bone density and body weight, body mass index(BMI), lean body mass, muscle mass, fat mass and body fat mass were compared. The results of this study, weight was considered the strong correlation with BMD than the height and BMI seems to be greater significance rather than the lumbar spine and femur BMD. In addition, the relationship between body composition and BMD, lean body mass, muscle mass, body fat mass were the most relevant factors and BMD. The relationship between BMD and body circumference that have been difficult because of not enough previous studies but somewhat the study showed that association.

Key words: *Bone Mineral Density; Body Composition; Body Circumference; 20's Women*

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INTRODUCTION

Recently, under weight population is increasing in young women by a social atmosphere to like thin body type. The body weight loss is causing the chronic degenerative diseases such as osteoporosis, low back pain and that is a health threat in women(1). University student has a physical health critical elements such as drinking, smoking, irregular meal habit and lack of sleep(2). Especially, female university students overestimate and dissatisfaction their body weight so that they choose taking a drug and insufficient dietary methods to control body weight(3). In fact, the 20's women occurrence rate of osteoporosis has been reported that it is increased more than doubled in five years from 2006(4), Kim & Koo reported that it appeared to have greater risk on bone mineral density(BMD) in 20-30 aged women from a study of BMD and causal factors in 20-50 aged female so further study may need to investigate(5). BMD is define as the proportion of BMD per bone mass unit area, it has formed the peak bone mass in mid 20's or early 30's since then the progress of bone loss is increasing due to aging(6, 7). Especially, decrease of BMD in postmenopausal women, it is known to be associated with the peak bone mass in young adult(8). Thus, it is important that the formation of peak bone mass and BMD in women. Osteoporosis caused by reduction of bone density have several risk factors for example genetic factors by about 80% and environmental factors such as age, menarche age, menopause age, postmenopausal period, body mass index(BMI), weight, parity, education level, exercise, calcium intake, alcohol, caffeine intake and smoking(9). Meanwhile, the weight is the highest correlation factor to affect on BMD and it is divided into body fat mass and fat free mass(8). Many studies show that a higher BMD with increasing body weight and it reduces the risk

of osteoporosis(1, 10, 11, 12, 13, 14, 15), it has been reported that there are a significant correlation between body fat mass and fat free mass(11). However, even if someone have the same weight, they have a different skeletal muscle development and fat deposition in many cases so how these factors impact on BMD are needed. Furthermore, recent BMD studies suggest that it may have correlation among waist circumference(13, 16, 17), hip circumference(15, 18) and thigh circumference(15, 19). BMD of the existing research on domestic mostly elderly and middle aged women after menopause, only a few studies analysis to target young women(8). Therefore, the purpose of this study is to investigate the correlation among BMD, body composition and body circumference on 20's women.

METHODS

Subjects

86 students who are S college in Hwaseong-si were recruited as a subject for this study and someone who takes a medication or have surgical history excluded from this study.

Bone Mineral Density Measurement

The lumbar spine(L1-L4) and femur neck were used to measure the BMD by dual energy x-ray absorptiometry(DEXA)(Fig. 1).

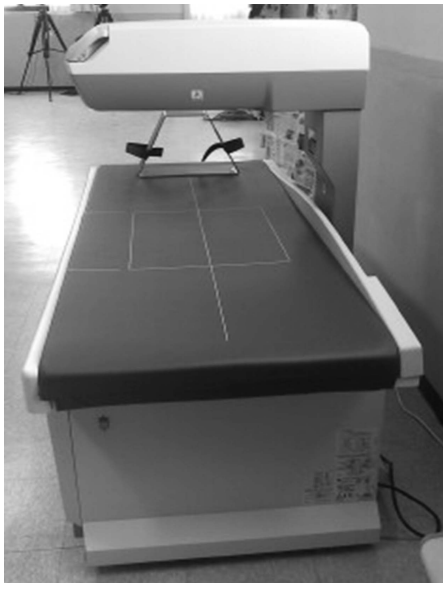

Fig. 1. Dual energy x-ray absorptiometry(Lunar, USA)

Body Circumference Measurement

Inspectors have enough experience for the body circumference measurement and the average value was used to measure the same area twice by width 1.5cm, length 152cm tape. Subjects were easy dress and measure waist circumference, hip circumference and thigh circumference. There are performed circumference of each site in order to reduce measurement errors by the same inspectors.

Waist circumference

Waist circumference was measured by international society for the advancement of kinanthropometry (ISAK) and measured between below the 10th rib and the iliac crest which is the most concave part horizontally in order to reduce the error range. If the subjects are overweight, we measured midway between the rib and the iliac crest area.

Hip circumference

Hip circumference was measured by international society for the advancement of kinanthropometry (ISAK) and measured the most prominent part of the hip horizontally in a standing position when observed from the side.

Thigh circumference

Thigh circumference was measured by international society for the advancement of kinanthropometry (ISAK) and measured half of the upper femur and the knee in a standing position when observed from the front.

Fig. 2. Inbody 720 body composition analysis (Biospace, Korea)

Body Composition Measurement

Body composition was measured by Inbody 720 body composition analysis(Biospace) and measured intracellular proteins, minerals, fat, weight, BMI, muscle mass, lean body mass, fat mass, percent body fat, body balance. Subjects were easy dress and measure body composition(Fig. 2).

Body mass index

BMD is define as the proportion of BMD per bone mass. BMI(kg/㎡) = Weight(kg) / Height(m) × Height(m). According to WHO Asia-Pacific Area criteria for obesity define as under weight 〈 18.5kg/㎡, normal weight 18.5-22.9kg/㎡, overweight 23.0-24.9kg/㎡, obesity ≦ 25.0kg/㎡(20).

Data Analysis

Collected data were statically analyzed by SPSS win 12.0/PC. The pearson's correlation coefficient for correlation among BMD, body circumference and body composition. One way ANOVA was performed to analysis the difference of BMD and performed Bonferroni method for post-hoc. The significant level was set at .05.

RESULTS

General Characteristics

The general characteristics of subjects follows as Table 1.

Table 1. General characteristics

General characteristics		Frequency(%)	M±SD
Height(cm)	≦ 160	32(37.2)	161.30±5.50
	160-169	49(57)	
	Over 170	5(5.8)	
Weight(kg)	≦ 50	17(19.8)	57.63±8.85
	50-59	45(53.3)	
	60-69	16(18.6)	
	Over 70	8(9.3)	
BMI(kg/㎡)	Underweight	4(4.7)	22.14±3.13
	Normal weight	55(64)	
	Overweight	15(17.4)	
	Mild obesity	10(11.6)	
	Moderate obesity	2(2.3)	

Table 2. Bone mineral density, body circumference and body composition

Item	M±SD
BMD of lumbar spine (g/㎠, T-score)	-.07±.93
BMD of femur neck (g/㎠, T-score)	.06±.96
Waist circumference(㎝)	68.51±7.81
Hip circumference(㎝)	94.46±5.50
Thigh circumference(㎝)	53.27±4.30
Lean body mass(㎏)	39.08±4.06
Muscle mass(㎏)	36.72±3.82
Fat mass(㎏)	18.54±5.91
Percent body fat(%)	31.52±5.76

Bone Mineral Density, Body Circumference and Body Composition

The BMD, body circumference and body composition of subjects follows as Table 2.

The Differences of Bone Mineral Density

The differences of lumbar spine BMD according to general characteristics

There were no significant differences according to height and BMI but there were significant differences lumbar spine BMD by weight(Table 3). It appeared that the over 70kg was higher T-score than under 50kg($p<.05$).

Table 3. Differences of lumbar spine BMD(according to general characteristics)

General characteristics		M±SD	F(p)	Bonferroni
Height(cm)	Under 160	−.37±.83	2.702(.073)	
	160−169	.11±.95		
	Over 170	.00±1.01		
Weight(kg)	Under 50(a)	−.65±.74	3.433(.021*)	d>a
	50−59(b)	−.01±.87		
	60−69(c)	.12±1.12		
	Over 70(d)	.40±.86		
BMI(kg/m^2)	Underweight(a)	−.75±.96	1.820(.133)	
	Normal weight(b)	−.18±.95		
	Overweight(c)	.04±.61		
	Mild obesity(d)	.42±.96		
	Moderate obesity(e)	.65±1.48		

*: p<.05

The differences of femur neck BMD according to general characteristics

There were no significant differences according to height but there were significant differences femur neck BMD by weight and BMI(Table 4). The difference of femur neck BMD due to weight, it appeared that the over 70kg was higher T-score than under 50kg and 60-69kg(p<.05) moreover, 60-69kg was higher T-score than under 50kg(p<.01). The difference of femur neck BMD due to BMI, it appeared that the mild obesity was higher T-score than underweight and normal weight(p<.05)

Table 4. Differences of femur neck BMD(according to general characteristics)

General characteristics		M±SD	F(p)	Bonferroni
Height(cm)	Under 160	−.12±.76	1.104(.336)	
	160−169	.20±1.09		
	Over 170	−.06±.69		
Weight(kg)	Under 50(a)	−.52±.58	7.741(.000**)	d>a, b, c c>a
	50−59(b)	−.05±.88		
	60−69(c)	.55±.93		
	Over 70(d)	1.01±1.12		
BMI(kg/m^2)	Underweight(a)	−.62±.92	6.443(.000**)	d>a, b
	Normal weight(b)	−.18±.83		
	Overweight(c)	.43±.91		
	Mild obesity(d)	1.14±.95		
	Moderate obesity(e)	.30±.42		

**: p<.01

The Correlation between BMD and Body Composition

The analysis of the correlation between BMD and body composition, there were significant results that lumbar spine BMD has been increased with BMI, lean body mass, muscle mass, fat mass, percent body fat increases furthermore, there were significant results that femur neck BMD has been increased with BMI, lean body mass, muscle mass, fat mass, percent body fat increases(Table 5).

Table 5. Correlation between BMD and body composition

Item	Lumbar spine BMD r(p)	Femur neck BMD r(p)	BMI	Lean body mass	Muscle mass	Percent body fat
Femur neck BMD	.673 (.000**)					
BMI	.283 (.008**)	.455 (.000**)				
Lean body mass	.306 (.004**)	.389 (.000**)	.622 (.000**)			
Muscle mass	.313 (.003**)	.393 (.000**)	.619 (.000**)	1.000 (.000**)		
Fat mass	.280 (.009**)	.416 (.000**)	.939 (.000**)	.558 (.000**)	.551 (.000**)	
Percent body fat	.198 (.068)	.328 (.002**)	.835 (.000**)	.249 (.021*)	.241 (.025*)	.932 (.000**)

*: p<.05, **: p<.01

The Correlation between BMD and Body Circumference

The analysis of the correlation between BMD and body circumference, the lumbar spine BMD has been increased with waist circumference, hip circumference and thigh circumference. There were significant correlation between lumbar spine BMD and hip circumference and thigh circumference but there were not significant correlation between lumbar spine BMD and waist circumference. Furthermore, there were significant results that femur neck BMD has been increased with waist circumference, hip circumference and thigh circumference(Table 6).

Table 6. Correlation between BMD and body circumference

Item	Lumbar spine BMD r(p)	Femur neck BMD r(p)	Waist circumference	Hip circumference
Femur neck BMD	.673(.000**)			
Waist circumference	.182(.094)	.401(.000**)		
Hip circumference	.313(.003**)	.389(.000**)	.853(.000**)	
Thigh circumference	.276(.010*)	.399(.000**)	.805(.000**)	.847(.000**)

*: p<.05, **: p<.01

DISCUSSION

The factors that affect BMD such as age, race, weight, exercise, smoking, caffeine, dietary calcium intake, genetic factors, the use of female hormones, excessive acid intake, which include long term use of heparin moreover, caused by drugs or other diseases as a secondary osteoporosis such as hypogonadotrophic hypogonadism, Cushing's syndrome, long-term steroid use, hyperparathyroidism, hyperthyroidism, malabsorption, rheumatoid arthritis, metabolic disorders(21, 22). The most important factors is the weight among them to predict osteoporosis and fracture because obese people have larger body and BMD than lean people and excessive weight given mechanical load on bone to stimulate remodeling so they have been proven to lower the risk of osteoporosis(23, 24). However, many studies has been reported different results about the correlation between BMD and body composition according to the researchers differently and also body composition has been changed by aging so the relationship between BMD and body composition should be considered in

age and menopause status(25).

The studies of association with BMD, height, weight and BMI report that lumbar spine and femur BMD have increased significantly with hight increases(8, 17, 25, 26) but there are no significant correlation between BMD and height(6). Thus, the results of previous studies, it may have a high correlation between BMD and height.

The studies of association with BMD and weight report that lumbar spine and femur BMD have a significant correlation with weight(6, 13, 17, 18, 24, 25, 27, 28, 29) but there are no significant correlation between BMD and weight(13). Therefore, the results of previous studies, it may have a high correlation between BMD and weight.

The studies of association with BMD and BMI report that lumbar spine and femur BMD have a significant correlation with BMI(6, 11, 18, 25, 26, 30) but there are no significant correlation between BMD and BMI(31, 32). The results of previous studies, the correlation between BMI and BMD is not clear yet, therefore it may show different results depending on the components such as the age of subjects, measurement methods and BMI.

The results of the differences of BMD according to height, there were no significant difference lumbar spine and femur BMD so these findings were consistent with Kim & Kim research(6). however, there were significant results that lumbar spine and femur BMD have been increased with weight increases so these findings were consistent with Kim & Kim(6), Chung et al.(17), Sung et al.(18), Orozco et al.(24), Kim(28) researches. The results of the differences of BMD according to BMI, there were significant results that femur BMD have been increased with BMI increases so these findings were consistent with Kim & Kim(6), Sung et al.(18), Choi et al.(26) researches partially and there were no significant difference lumbar spine BMD by BMI so these findings were consistent with Lee et al.(31), Park et al.(32) researches. Each of these results were affected by statistical analysis method and BMD measurement area but usually weight has more significant effects on BMD than height. On the relationship between BMI and BMD, the researchers reported relatively large differences because there are different components of BMI such as age, measurement method, body fat mass and lean body mass.

When the larger size of force exerted on skeletal, it should give benefits on BMD but it is not clear which body composition is acting more effective as a work forc(6). Reid et al. reported that there are positive relationship with high levels of fat mass in premenopausal women BMD(33) but Cadogan et al. reported that lean body mass is the most important elements of body composition to increase BMD(34). Therefore, in order to improve the bone density, it may be need that normal weight and balanced body composition with the acquisition of muscle mass and lean body mass rather than obesity and high body fat mass(6).

The results of previous studies about the correlation between BMD and body composition, there were significant correlation among lumbar spine BMD, fat mass, lean body mass(25) but Kim & Kim reported that there were significant correlation between percent body fat and femur BMD therefore, there were more meaningful an increase in lean body mass rather than an increase in fat mass(6). Chung et al. reported that there were strong correlation between lumbar spine and femur BMD and muscle mass thus body fat mass showed positive correlation with lumbar spine BMD(17).

However, lean body mass and body fat mass showed negative correlation with lumbar spine BMD and femur BMD(17, 18). Although the difference results were reported by previous studies, it proposed the most affecting factors to increase BMD such as lean body mass, body fat mass and muscle mass.

The results of the correlation between BMD and body composition, there were significant results that lumbar spine BMD has been increased with BMI, lean body mass, muscle mass, fat mass increases but there was no significant correlation with percent body fat. Thus, there were significant results that femur BMD has been increased with BMI, lean body mass, muscle mass, fat mass, percent body fat increases.

The results of the correlation between BMD and body circumference, Moon et al. reported that there are positive correlation between lumbar spine BMD and waist circumference(13) but Choi et al. reported that there are negative correlation between femur BMD and waist circumference(26) and Chung et al. reported that there are negative correlation between lumbar spine BMD and femur BMD and waist circumference(17).

The analysis of the correlation between BMD and body circumference in this study, there were significant correlation between lumbar spine BMD and waist circumference and thigh circumference but there was not significant correlation between lumbar spine BMD and hip circumference. Furthermore, there were significant correlation between femur BMD and waist circumference, hip circumference and thigh circumference. These findings are unlike previous

studies, it may reduce the lumbar spine movements as a result of an increase in circumference of the body on the other hand, it may give weight-bearing on proximal femur.

CONCLUSION

The results of this study, the weight may have more correlation with BMD than the height and BMI may have more signifiant effects on femur BMD rather than lumbar spine BMD. Also, the results of relationship between BMD and body composition, there are the most correlation with lean body mass, muscle mass, percent body fat furthermore, the results of relationship between BMD and body circumference, it have been difficult to discuss because of the lack of previous studies, but the exact extent of this study showed that association. Therefore, it is important that young women have a normal body shape and weight in order to maintain normal BMD. As a results, increase lean body mass seems to be helpful for preventing osteoporosis when entering menopause or old age. This study was not able to control exercise frequency, dietary habbits and lifestyle so future study need to concern about enough numerical population for reflect difference factors due to age.

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