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Bone Mineral Density and Health-Related Physical Fitness of Middle-Aged Women

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Abstract

Objectives: *The purpose of this study was to examine the relationship between the level of bone mineral density (BMD) and health-related physical fitness (HRPF) of middle-aged women.*

Methods: *The participants in this study were composed of 47 menopausal women in their 45-55years, who were selected by convenience sampling. BMD was measured by using Dual Energy X-ray Absorptiometry. HRPF was measured by muscular strength, muscular endurance, cardiorespiratory endurance, flexibility, and body composition. The level of BMD was classified into two groups: T-score of –1 and above was sorted into the normal group, and T-score of –1 and below was sorted into the osteopenia group. The level of HRPF was also classified into two groups to analyze the odd ratio of osteopenia risk depending on the level of physical fitness.*

Findings: *The group with normal BMD had significantly higher muscular strength, muscular endurance, and lean mass than the osteopenia group. Also, the group with the low level of HRPF had higher risk of osteopenia, which was 4 to 8 higher odds ratio of osteopenia than the group with a high physical fitness level.*

Applications: *HRPF is critical for middle-aged women to reduce the risk of osteopenia and for promotion of health. Future studies are required to approach more comprehensively by examining the effects of amount of physical activities and eating habits on BMD.*

Key Words: *Bone mineral density, Osteopenia, Health-related physical fitness, Menopausal, Middle-aged women*

1. INTRODUCTION

Osteoporosis easily causes bone fractures even by minor shocks that are common in daily lives. Bone mineral density(BMD) significantly decreases with age, which is reported to be due to changes in bone metabolism, changes in calcium and phosphorus-regulating hormones, decreased physical activities, and dietary deficiency as getting older [1, 2]. Osteoporosis increases the likelihood of fractures and falls, restricting mobility and independence, and is closely associated with adverse health conditions such as hospitalization and death [3, 4]. Therefore, it is important to block a vicious circle through active health management, so it is also important to manage osteopenia in advance before going to osteoporosis.

Health-related physical fitness management in everyday life can promote healthy lifestyles and reduce the risk of many health problems. Health-related physical fitness improvement through exercise is known to increase BMD and reduce bone loss by applying gravity to bones [5]. BMD in premenopausal women decreases by about 0.3 per year, and the rate of bone loss in early menopause (less than 10 years after menopause) is accelerated by about three times [6]. Health-related physical fitness management in middle-aged women may help to prevent stress fractures and decreased bone density by increasing bone density and lean body mass.

However, most studies have targeted the elderly [7, 8] or former athletes [9-11], and only a few studies directly compared the relationship between BMD levels and health-related physical fitness in menopausal middle-aged women. It is also known that weight is associated with BMD in middle-aged women, but whether it is related to body fat mass or lean body mass has been controversial.

Therefore, the purpose of this study is to analyze the relationship between BMD levels and health-related physical fitness in postmenopausal middle-aged women to provide basic data for promoting bone health in middle-aged women.

2. METHODS

2.1. *Participants*

The participants in this study were composed of 47 females aged 45-55years, among menopausal middle-aged women attending the cultural center located in Y city were selected as participants. According to the criteria for selecting participants, the research plan (experiment purpose, contents, and method) was explained in detail, and those who voluntarily agreed to participate in the study and those who did not have any problems in physical examination were selected. According to the exclusion criteria, those who have already been diagnosed with osteoporosis, those who are taking drugs due to illness, those who have had a fracture in the past six months, or those who do not want voluntary participation were excluded. The characteristics of the participants was listed in [Table 1].

Table 1. Characteristic of the study participants

	Total	Normal BMD Group	Osteopenia Group	p-values
n	47	34	13	N/A
Age(years)	47.33±4.15	47.43±3.39	47.07±5.86	.839
Height(cm)	156.81±4.81	157.15±5.22	155.94±3.56	.371
Weight(kg)	57.53±6.05	58.31±6.17	55.46±5.39	.150
BMI(kg/m^2)	23.40±2.27	23.61±2.15	22.86±2.56	.316
BMD $g \cdot cm^{-2}$	1.101±0.079	1.128±0.65	1.030±0.070	<.001

BMI: body mass index, BMD: total body bone mineral density

2.2. Measurements

2.2.1. Characteristics and BMD test

Height was recorded with 0.1cm unit by using an extensimeter (Seca 213, Seca, Germany). BMD (□), body weight (kg), percent body fat (%) and lean mass (kg) was measured using Dual Energy X-ray Absorptiometry (GE Medical system Lunar, USA). Body mass index (BMI) was calculated using the formula 「weight (kg)/height (m^2)」.

All participants were asked to maintain an empty stomach for at least 4 hours when measuring physical characteristics and bone mineral density. In order to prevent the measurement error due to the subject's clothes or belongings, the measurement was made only with the top and bottom of cotton and metal materials removed. All bone mineral density and body composition measurements were performed by one expert.

2.2.2. Health-related physical fitness test

The specific measuring method for each item is as follows:

1) Muscular strength (grip strength): A hand dynamometer was used to conduct the test two times each at left and right, and the maximum value was recorded in the 0.1 kg unit

2) Muscular endurance (sit-ups): The participants were asked to lie on their back, and then take a ready posture by bending their knees to 90 degrees, sitting on the mat with their feet 50 cm from their hips and crossing their arms in front of their chest. According to the start command, sit-ups were performed for 1 minute and the number of times was measured.

3) Cardiorespiratory endurance (20M shuttle run): The participants wait for the start signal at the starting point and perform according to the start signal. After arriving at the opposite starting point before the next signal, they wait for the next signal without running back immediately. When the beep sounds, they move back to the opposite starting position. They repeat the above process until they are able to carry it out within their capacity.

4) Flexibility (sit and reach): With both knees extended, the participants were asked to stretch out their knees and sat on the floor, and push the measuring plate as far as possible with both fingertips with the soles close to measuring instrument. The maximum value of the two measurements was recorded in the 0.1 cm unit.

2.3. Date analysis

All data collected in this study was analyzed via the SPSS ver. 22.0 program. T-score was used to diagnose osteopenia according to the criteria of World Health Organization [12]. T-score -1 or more was classified into the normal range bone mineral density group, while T-score -1 or less into the osteopenia group. The differences in health-related physical fitness depending on the level of BMD (normal group vs. osteopenia) was tested by independent t-test.

Health-related physical fitness levels were divided into two quartiles to analyze the odd ratio of osteopenia according to the physical fitness level. The risk of osteopenia (odd ratio) depending on the level of physical fitness was analyzed based on binominal logistic regression. The significance level of all data was set to α= .05.

3. RESULTS

3.1. Differences in health-related physical fitness according to BMD levels

[Table 2] and [Figure 1] show the results of the independent sample t-test to verify the difference in health-related physical fitness according to the presence or absence of Sarcopenia.

The group with normal-range BMD had significantly higher muscular strength (t-value=3.547, p=.001), muscular endurance (t-value=3.685, p=.001), and lean mass (t-value=3.311, p=.005). There was no significant difference regarding flexibility (t-value=-.157, p=.876), cardiorespiratory endurance (t-value=1.125, p=.269), and % body fat (t-value=1.929, p=.060).

Table 2. Difference in physical fitness depending on osteopenia

Fitness item	Group classification	M±SD	t	p-values
Strength (Hand grip strength, kg)	Normal BMD	29.47±4.73	3.547	.001
	Osteopenia	25.72±2.40		
Muscular endurance (Sit-ups, rep/min)	Normal BMD	21.91±9.06	3.684	.001
	Osteopenia	10.99±9.15		
Cardiorespiratory endurance (Shuttle run test, mL/kg/min)	Normal BMD	32.63±2.67	1.125	.269
	Osteopenia	31.40±2.06		
Flexibility (Sit-and-reach test, cm)	Normal BMD	15.88±5.27	-.157	.876
	Osteopenia	16.20±7.70		

Body composition 1 (Lean mass, kg)	Normal BMD	29.86±8.53	3.311	.005
	Osteopenia	24.47±8.69		
Body composition 2 (Percent body fat, %)	Normal BMD	39.86±4.16	1.929	.060
	Osteopenia	30.50±9.87		

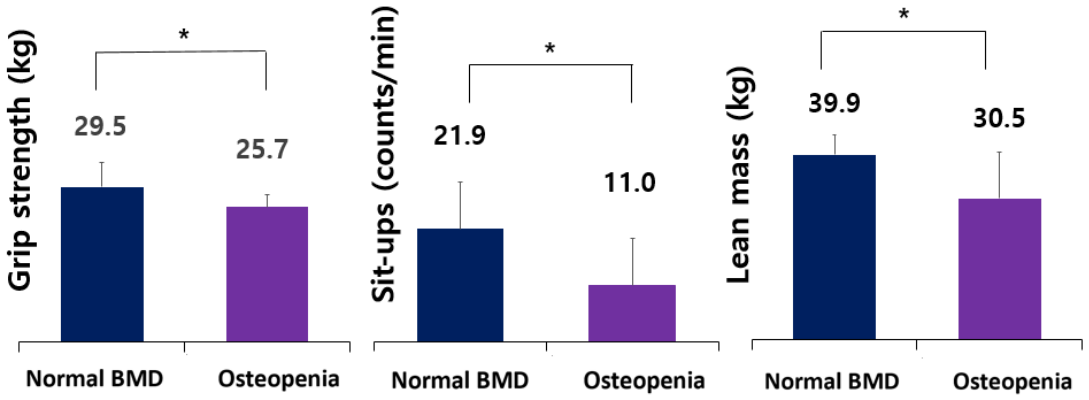

Figure 1. Difference in health-related physical fitness depending on BMD

3.2. Risk of osteopenia according to health-related physical fitness levels

[Table 3] shows the results of the logistic regression analysis to find out the risk of osteopenia according to health-related physical fitness levels. Based on the odd ratio of osteopenia according to health-related physical fitness levels (second quartile), the low physical fitness group was found to have a higher muscular strength odd ratio of 5.128 (p = .029), muscular endurance odd ratio of 4.762 (p = .036), and lean body mass odd ratio of 8.890 (p = .010) than the high physical fitness group.

Table 3. Odd ratio of osteopenia depending on health-related physical fitness level

		OR(95%CI)	p-value
Strength (Hand grip strength, kg)	Normal BMD Group	1(Reference)	0.29
	Osteopenia Group	5.128(1.18-22.24)	
Muscular endurance (Sit-ups, rep/min)	Normal BMD Group	1(Reference)	.036
	Osteopenia Group	4.762(1.10-20.50)	
Cardiorespiratory endurance (Shuttle run test, mL/kg/min)	Normal BMD Group	1(Reference)	.247
	Osteopenia Group	2.917(0.48-17.86)	
Flexibility (Sit-and-reach test, cm)	Normal BMD Group	1(Reference)	.186
	Osteopenia Group	0.395(0.10-1.57)	
Body composition 1 (Lean mass, kg)	Normal BMD Group	1(Reference)	.010
	Osteopenia Group	8.89(1.69-46.63)	

Body composition 2 (Percent of body fat, %)	Normal BMD Group	1(Reference)	.093
	Osteopenia Group	3.21(0.82-12.54)	

4. DISCUSSION

This is the first study to identify the relationship between bone mineral density levels and health-related physical fitness in menopausal middle-aged women. Physical activity and lowered fitness are connected by a vicious cycle, and the lowering of physical activity leads to lowered fitness and, in turn, lowered fitness to the lowering of physical activity. In particular, the practice of physical activity and fitness management in menopausal middle-aged women are known to be major factors in the prevention and management of osteoporosis [7-9]. This study aimed to identify which factors among health-related physical fitness items are related to bone mineral density levels in menopausal middle-aged women.

Menopausal middle-aged women were classified into the normal group and osteopenia group according to their bone mineral density levels to compare health-related physical fitness. As a result, the osteopenia group showed significantly higher muscular strength and muscular endurance than the normal group. These results were partially consistent with previous findings that fitness management delayed the occurrence of osteoporosis and reduced the risk of fracture [7, 13]. After the publication of the Physical Activity Guidelines for Health Promotion [14], moderate or highly intensive muscular strengthening activities twice a week have been steadily recommended. However, the practice rate of muscular strength exercise is reported to be more insignificant than that of aerobic exercise [15]. Previous studies showed that walking exercise has a limited effect on bone mineral density, while resistance training and impact action have an effect on bone formation [7]. It has also been reported that an increase in muscular strength of 5 kg reduces mortality by 16% [16]. This means that resistance training and shock-loading activities for muscular strength improvement should be considered as strategies for preventing osteoporosis in the middle-aged and the elderly. Eventually, physical fitness management should be continuously recommended because it is considered as the primary non-drug treatment for the prevention of osteoporosis.

A previous study that examined the relationship between bone mineral density and cardiopulmonary fitness in women (20-75 years old, 84 people) reported that the improvement of cardiopulmonary fitness could increase the femoral and lumbar spine bone density [17]. It was partly consistent with the results of this study in that health-related physical fitness had a positive correlation with bone mineral density. In this study, the cardiopulmonary fitness was higher in the normal group than in the osteopenia group, but there was no significant difference. These results may be due to differences in age group or measurement site of the participants.

According to the bone mineral density levels, the participants were classified into the normal group and osteopenia group to compare the body composition. As a result, the osteopenia group showed significantly higher lean body mass than the normal group. This was consistent with the results of a study [9] that examined the association between body composition and bone mineral density in 52 female marathon runners (18 to 44 years old). According to the result, the higher the weight, the higher the bone mineral density, and the higher the fat mass, the lower the bone mineral density.

This study focused on the comparison of health related physical fitness according to the osteopenia group and normal group in postmenopausal middle-aged women. As a result, it was found that the management of muscular strength, muscular endurance and lean body mass is important for prevention of osteoporosis. For today's middle-aged women who are experiencing rapid physical, mental, and social changes, regular and sufficient exercise is essential for a healthy and energetic life. In the future, studies that consider physical activity and dietary habits affecting bone mineral density of middle-aged women will be needed.

5. CONCLUSION

The purpose of this study was to suggest the relationship between bone mineral density levels and health-related physical fitness in menopausal middle-aged women, and the following conclusions were drawn: The normal bone mineral density group had significantly higher muscular strength, muscular endurance, and lean body mass than the osteopenia group. In addition, the group with low fitness was found to have a higher muscular strength odd ratio of 5, muscular endurance odd ratio of 4, and lean body mass odd ratio of 8 than the group with high fitness. The relationship between muscular strength, muscular endurance, and lean body mass according to bone mineral density levels of menopausal middle-aged women revealed in this study could be used as a primary non-drug treatment for the prevention of osteoporosis and could be also useful for health promotion and exercise prescription site of middle-aged women.

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