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Original Article

The effects of milk intake and whole-body vibration exercise on bone mineral density in elderly women in nursing homes

So Min Lee[1)], Sungchul Kim, PhD[1)], Chae-gil Lim, PT, PhD[2)*]

[1)] *Department of Radiological Science, College of Health Science, Gachon University, Republic of Korea*
[2)] *Department of Physical Therapy, College of Health Science, Gachon University: 191 Hambangmoe-ro, Yeonsu-gu, Incheon 21936, Republic of Korea*

Abstract. [Purpose] This study was designed to investigate the effects of lactose-free milk intake and whole-body vibration exercises on bone density in elderly female nursing home residents who had difficulty exercising outdoors and had not consumed milk. [Subjects and Methods] Twenty seven elderly women aged 70 or older from 3 nursing homes located in Incheon, Korea participated in the study. The experimental group (n=13) carried out whole-body vibration exercises and drank lactose-free milk, while the control group (n=14) continued to live their ordinary nursing home lives. Weight, BMI, T-scores, and Z-scores were compared between the experimental and control groups after 12 weeks. [Results] The comparison of changes in weight and BMI in the control group before and after the 12-week experiment found no statistically significant differences. However, bone mineral density was significantly different, with the T-score significantly decreasing from −2.99 to −3.48 and the Z-score decreasing from −1.87 to −2.58. The other comparisons of physical changes in the control group before and after the 12-week experiment found no statistical significance. [Conclusion] The results indicate that regular consumption of lactose-free milk and performing whole-body vibration exercises can delay the progression of bone density loss in older adults in nursing homes; adequate exercise and calcium intake could eventually help prevent fractures.

Key words: Lactose-free milk, Bone density, Whole-body vibration

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INTRODUCTION

Developments in medical technology and the improvement of economic conditions have resulted in increased life expectancy around the world, with the percentage of people aged 65 or older also increasing in every country[1)].

Such changes—the rise in the relative size of the elderly population, the improvement in income levels, living conditions, and medical technology—have led to an increased interest in osteoporosis, one of the leading conditions affecting elderly women. Osteoporosis is a condition involving low bone mass and weak bone structure that makes bones more likely to break, which decreases quality of life and increases mortality among elderly women. In this context, osteoporosis has become one of the main healthcare issues faced by an ageing population[2)].

Aging causes the gradual loss of such bone tissues, and increases the risk of fractures[3)]. The risk of fractures is higher in women than in men, as 13% men aged 50 or older are likely to break bones, but 40% of women in the same age bracket are at risk of fractures[4)].

Many studies have found that bone mineral density (BMD) is correlated with calcium intake levels[5, 6)], but calcium deficiency is actually caused when there is an increase in the amount of serum calcium, such as through intestinal calcium ab-

*Corresponding author. Chae-gil Lim (E-mail: jgyim@gachon.ac.kr)

Table 1. General characteristics of participants (N=27)

Variables	Group	Mean	SD	p-value
Age (yrs)	Control	85.79	8.09	0.828
	Experimental	85.08	8.72	
Height (cm)	Control	148.21	7.87	0.174
	Experimental	144.50	5.65	
Weight (kg)	Control	44.08	12.44	0.801
	Experimental	45.14	8.73	
BMI	Control	20.12	5.89	0.446
	Experimental	21.67	4.28	
T-score	Control	–2.99	0.63	0.556
	Experimental	–3.12	0.56	
Z-score	Control	–1.87	0.94	0.502
	Experimental	–2.11	0.86	

sorption, and there are insufficient levels of osteolysis for bone regeneration or compensation for a loss of calcium. Therefore, calcium absorption and excretion amounts as well as the amount of calcium intake are considered to be important because each of them can cause bone loss. Likewise, it cannot be stated that calcium intake is the sole factor that is correlated with bone mineral density. However, to prevent further bone loss, regular calcium intake is required[7].

There have been a number of studies that have demonstrated that calcium intake delays bone loss, therefore preventing osteoporosis. However, many elderly Koreans are reluctant to consume milk, as some of them have lactose intolerance, while others are not accustomed to drinking milk[8]. Another way to treat osteoporosis among elderly citizens is to alter their lifestyle so that there will be a decrease in the reduction of bone mass, such as through an increase in exercise. At present, it is unclear how effective exercise is in improving bone health, but exercise is known to stimulate bone loading, build muscles, provide the skeleton with mechanical stress, and promote osteoblast activity[9].

The present study was conducted to examine the effects of lactose-free milk intake and whole-body vibration exercises on bone density in elderly female nursing home residents who had difficulty exercising outdoors and did not regularly consumed milk.

SUBJECTS AND METHODS

The subjects in the study were thirty elderly women aged 70 or older living in 3 nursing homes located in Incheon, Korea. The subjects were explained and agreed on the research ethics and signed a written consent form approved by the local ethics committee. The experimental group carried out whole-body vibration exercises and drank milk, while the control group continued to live their ordinary lives in their nursing homes.

Lactose-free milk (Maeil Co., Ltd.) was given to all subjects in the experimental group in case any were lactose intolerant. The subjects in the experimental group consumed 190 ml of milk (400 mg of calcium) per day and carried out in a standing position on a whole-body vibration exercises using a whole-body vibrator (Model 1310, Egojin Co., Gyeonggi-do, South Korea) that generated vibration at a speed of up to 3,200 rpm for 5 minute. To prevent any accidents while exercising, the subjects used walking aids and were accompanied by researchers at all times. The experiment lasted for 12 weeks, and, of the 30 subjects who started the experiment, 3 subjects were discharged from their nursing homes during the experiment period or failed to continuously consume milk and were excluded from the study. Therefore, the data of 27 subjects (14 in the control group; 13 in the experimental group) were used.

First, each participant's height was measured. Then, their weight and body mass index (BMI) were measured with the InBody H20B (InBody Co., Ltd., Seoul, South Korea). To assess BMD, both T-scores and Z-scores were measured with the SONOST 3000 (OsteoSys, Seoul, South Korea), which uses quantitative ultrasound. To minimize the influence of measured values, correction was conducted using a QC phantom before each measurement, and each BMD measurement was made at the patient's right calcaneus. All statistical analyses were performed with SPSS (version 21.0, IBM Corp., Armonk, NY, USA). For a non-parametric test to compare the differences between two independent groups (control and experimental) before the experiment, the Mann-Whitney U test was used. For comparisons of the two groups before and after milk intake and whole-body vibration exercises, the Wilcoxon signed-rank test was used. The significance level was set at 0.05 or less.

RESULTS

Table 1 shows the age, height, weight, BMI, T-scores, and Z-scores measured before the experiment. We found no statistically significant differences between the experimental group (13 subjects) and the control group (14 subjects).

The age of the subjects ranged from 70 to 103 years with a mean age of 85.44 years. Their height ranged from 135 to 161 cm (mean, 146.43 cm); weight from 29.2 to 65.8 kg (mean, 44.59 kg); BMI from 9.93 to 35.22 (mean, 20.86); T-score

Table 2. Wilcoxon signed-rank test results of the control group after 12 weeks (n=14)

Variables		Mean	SD	Z	p
Weight (kg)	pre	44.08	12.44	–1.021	0.307
	post	44.04	14.25		
BMI	pre	20.12	5.89	–1.020	0.308
	post	20.06	6.63		
T-score	pre	–2.99	0.63	–2.425	0.015*
	post	–3.48	0.71		
Z-score	pre	–1.87	0.94	–2.388	0.017*
	post	–2.58	1.13		

*p> 0.05

Table 3. Wilcoxon signed-rank test results of the experimental group after 12 weeks (n=13)

Variables		Mean	SD	Z	p
Weight (kg)	pre	45.14	8.73	–1.571	0.116
	post	46.50	8.65		
BMI	pre	21.67	4.28	–1.727	0.084
	post	22.35	4.49		
T-score	pre	–3.12	0.56	–1.651	0.099
	post	–3.32	0.90		
Z-score	pre	–2.11	0.86	–1.603	0.109
	post	–2.39	1.26		

from −3.80 to −1.70 (mean, −3.05); and Z-score from −3.3 to −0.1 (mean, −1.99). Two subjects in the control group and one in the experimental group had osteopenia, and the remaining 24 subjects had osteoporosis.

Table 2 shows the changes in physical characteristics in the control group before and after the 12-week experiment. We found no statistically significant differences, with their weight dropping after the experiment by 0.04 kg on average, and their BMI by 0.06 on average. However, their BMD significantly changed, with the T-score significantly dropping from −2.99 to −3.48 and the Z-score from −1.87 to −2.58.

Table 3 shows the changes in physical characteristics in the experimental group before and after the 12-week experiment and shows increases in weight (from 45.14 to 46.50 kg) and BMI (from 21.67 to 22.35). However, those changes were not statistically significant. The T-score dropped from −3.12 to −3.32, and the Z-score decreased from −2.11 to −2.39, but these decreases were also not statistically significant.

DISCUSSION

Due to the fact that the relative size of the elderly population is rapidly increasing, Korea introduced long-term care insurance for the elderly in 2008. With the number of elderly nursing home residents also going up, maintaining their health is quickly becoming a major healthcare issue[10]. Nursing home residents are generally at advanced ages, and more than 50% of them suffer from chronic diseases including hypertension, diabetes, and arthritis. The living conditions of nursing homes tend to cause them to engage in fewer physical activities, meaning their physical strength weakens and their osteoporosis worsens. For these reasons, elderly people in nursing homes can be classified as those at a high risk of experiencing injuries from a fall[11, 12]. Falls in the elderly result in fractures, and low bone density increases the risk of fractures[13]. Therefore, the continuous management of osteoporosis for the elderly in nursing homes is necessary[14]. The present study tracked changes in BMI and BMD in an experimental group (elderly women in nursing homes who consumed milk and performed indoor whole-body vibration exercises) and a control group (elderly women in the same facilities who followed ordinary daily nursing home programs).

In a study by Kim et al.[8], elderly women who were provided with milk for 4 months showed significantly higher BMD than elderly women who were provided with no milk. In the present study, both the experimental group and the control group saw their T-score and Z-score decrease after the 12-week experiment in which the experimental group drank milk and performed whole-body vibration exercises. The BMD values of the control group decreased significantly, but the decrease in the BMD of the experiment group was not statistically significant. The findings of the present study, which examined elderly female nursing home residents who experienced less physical activity than non-elderly women, are consistent with the previous study that demonstrated the effect of milk intake on changes in BMD.

According to a study by Gil et al.[15], outdoor exercise has more positive effects on the increase in bone density than indoor exercise, as exposure to the sun helps skin cells create vitamin D. The subjects of the present study were nursing home residents aged 70 or older, however, so they underwent whole-body vibration exercises indoors. The drop in the BMD in the experimental group, which performed whole-body vibration exercises, was significantly minor compared to the control group.

Both the experimental group and the control group showed no significant changes in weight and BMI after the 12-week-long experiment. However, the experimental group increased an average of 1.36 kg and the control group lost 0.04 kg, indicating that the consumption of milk, a source of protein and calcium, delays age-driven weight loss. This is consistent with the findings of other studies that have demonstrated correlations between weight/BMI and BMD[16, 17].

The limitations of the present study are that only one region's nursing facilities were used, and the number of subjects in the experimental and control groups was small because only those who had no problem performing their daily activities could participate. Furthermore, among multiple variables that may affect bone density, only calcium intake from milk and full-body exercise were analyzed. In addition, bone density was measured through quantitative ultrasonography; although this method is relatively simple compared to quantitative computed tomography or dual-energy X-ray absorptiometry (DEXA),

the results are controversial, with some studies supporting their significance[18, 19], and others arguing that the results may be insignificant, depending on gender and age[20, 21]. Hence, additional studies using DEXA are needed to ensure accuracy of the experiment. However, considering the growing elderly population and increased use of nursing homes, the findings of this study are expected to provide comprehensive guidance for measures to delay the progression of bone density loss among older adults in nursing homes.

The present study investigated the effects of milk intake and whole-body vibration exercises on the BMD and BMI in female nursing home residents aged 70 or older. The group that drank milk and performed whole-body vibration exercised was not significantly different from the control group considering body weight and BMI ($p>0.05$). However, bone density (T-score and Z-score) remained unchanged in the experimental group, but significantly decreased in the control group ($p<0.05$).

In conclusion, the continuous consumption of lactose-free milk and performing whole-body vibration exercises can delay the progression of bone density loss in older adults in nursing homes; adequate exercise and calcium intake could eventually help prevent fractures.

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