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Does walking exercise improve BMD of young obese and thin women?

INTRODUCTION

Osteoporosis is a major public health problem that is characterized by low bone mass and increased susceptibility to fracture, primarily in the hip, spine and wrist (29, 31).Although symptoms of osteoporosis do not generally occur until after menopause, recent evidence suggests that bone loss starts much earlier in life and it may be associated with an increasingly sedentary lifestyle. That is why the world Health Organization (WHO) believes that we are heading for a major epidemic the years to come (15). In spite of development in diagnosis of osteoporosis, still the preventive measure of osteoporosis is neglected and the already staggering medical, social and economic costs can be expected to increase unless effective prophylactic and therapeutic regimens are developed (1).

Body weight impacts on bone density and is therefore an important risk factor for osteoporosis (11,19). It is well recognized that thin individuals have lower bone mass density than heavier individuals and there may be multiple reasons for this. In fact thinness is an important risk factor for bone loss and a reduction in bone mass is highly correlated with an increased of osteoporosis (10, 20).Obesity has been identified as a risk factor of many illnesses. The consequence of excessive weight can have a profound negative effect on bones and joints. An increased body mass index (BMI) has been associated with many orthopedic conditions, such as arthritis, osteoporosis, and joint immobility (9, 30).

The level of mechanical loading is one of the many factors that contribute to the homeostasis of the skeletal system (3). Bed rest or weightlessness result in bone loss whereas increased mechanical loading increase bone mineral content (25).Consequently, there may be a therapeutic role for exercise in the prevention and management of osteoporosis (32). There is, however continuing uncertainly concerning the amount of exercise that is likely to be effective.

In postmenopausal women, exercise has been suggested to be the most effective regimen, and it has been suggested that induced gain is maintained after intervention (12).A few meta-analyses have been published on the effectiveness of exercise on slowing premenopausal bone loss (2, 34).Evidence comes mainly from intervention studies in postmenopausal women aged 60 or older, and a few randomized controlled studies in women under 40 or younger have been conducted (26, 33). A recent Cochrane Review revealed that evidence about the long–term effect of exercise on postmenopausal bone loss is inadequate, because the follow–up times have been short and the reporting of outcomes has been poor (14). An overall conclusion from the meta-analyses is that after 1 year or longer, exercise may be effective for slowing bone loss from the lumbar spine and probably the neck of the hip and wrist. The lack of reporting on the exercise characteristics (type, intensity, frequency, duration and mode) of the exercise intervention in postmenopausal women limits the conclusions that can be drawn about the effect of exercise.

Walking is a weight-bearing of aerobic exercise that can be easily integrated into one's daily life and it is frequently recommended as a way to help protect against bone loss(13 ,23t). While various forms of weight-bearing activity may slow the loss of bone mass density (BMD) or possibly increase BMD through mechanical loading of bone, walking as an exercise intervention is of particular interest. It is known that the skeletal response to loading is characteristic of different age (28). However to our knowledge, no study has shown the effect of exercise program on BMD in obese and thin girls with a mean age 20 years simultaneously. Therefore the purpose of this study was to investigate whether 8-week program of closely supervised walking exercise would be beneficial for BMD of $L_2 - L_4$ and hip among healthy sedentary obese and thin women.

MATERIAL AND METHODS

SUBJECTS

Forty young physically untrained girls between the age of 20-25 years (obese n=20, BMI>30 and thin n=20, BMI <20) volunteered to participate in this study. Then the participants were pairwise BMI-matched and randomly assigned to two study (obese=10, thin=10) and two control (obese=10, thin=10) groups .Written informed consent for all procedures was obtained from all participants prior to entering the study. The criteria for the participation were being willing to participate, clinically healthy (no cardiovascular, musculoskeletal, respiratory, or other chronic diseases that might limit training or testing), no menstrual irregularities, not using medication that alert bone mass density and no beta-blockers, sedentary life style (no regular sports activities for at least 2 years), nondieting, nonsmoking, and no apparent occupational or leisure time responsibilities that impede their participation. The following measurements were made at baseline prior to the start of the exercise program and at after completion of the 2- month training program.

PROCEDURES

ANTHROPOMETRIC MEASUREMENT

Body weight and height were recorded and body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. Fat mass, percent body fat and lean mass were assessed with bioelectrical impedance equipment (BIA- 106, RJL Systems, USA). In addition, all subjects were weighed every week so that none of them gained or lost > 2.2 kg body weight over the entire study period.

BMD ASSESSMENT

The main endpoints of the study were the change in bone mass density of the hip and the lumbar spin ($L_2 - L_4$).BMD (g/cm²) was measured with the dual X-ray absorptiometry scans (DXA) (Norland XR-26, WI, USA).All the scanning and analyses were done by the same operator. The vivo day-to-day (coefficient of variation) of the BMD measurement in our laboratory range from 0.7 to 1.7%.The scanner was calibrated daily, and its performance was followed with our quality assurance protocol. There was no significant machine drift during the study period.

BLOOD ANALYSIS

Blood samples were collected after an overnight fast (>12 h) in a sitting position and centrifuged at 1500 rpm for 30 minutes at 4° C within 2 h. Serum samples from each participant were stored frozen at -20° C until analyzed. Serum estrogen level was assessed by radioimmunoassay (Amersham Biosciences, Piscataway, NJ, USA) in follicular stage in each subject's menstrual cycle and serum calcium, phosphorus levels were measured by standard automated laboratory techniques.

DIETARY INTAKE

Caloric expenditure was calculated based on the weight of the subject. To minimize any affect that dietary composition might have on the measured metabolic variables in experimental groups, the initiation of the study all subjects were instructed on the American Health Association (AHA) diet by registered dietitian. The composition of this diet was 50-55% carbohydrate, 15-20% protein, <30% fat (4, 27). The subjects were asked to maintain this diet composition throughout the study's duration (2mo).Compliance was monitored by review of 7-day food records taken every week.

EXERCISE PROGRAM

The program included warming-up phase for 5 minutes of stretching exercises, 30 minutes walking at 50-75% of maximum heart rat and cooling-down phase for 5 minutes of stretching, three times a week for 2 months. Stretching exercises were performed for the arms, leg, back and stomach. A target heart rate range between 50-75% of age adjusted maximum heart rate intensity was calculated by each walker from her age and walking supine resting heart rate (18). Heart rate was measured with an electronic heart rate meter (Sport Tester PE, Polar Electro, Oy, Finland). The exercise program was accompanied by music. All sessions were supervised by a professional exercise physiologist leader.

STATISTICAL ANALYSIS

The data were analyzed using the SPSS statistical package (SPSS 12 for Windows; SPSS, Chicago, IL, USA).Mean and standard deviation (SD) was used as descriptive statistic. Analysis of variance was used to compare baseline measures between groups. Repeated measures analysis of variance was used to detect significant change within groups and differences in response over time between groups. A significance level of set at $p<0.05$ was used for all comparisons.

RESULTS

Twenty subjects (100%) completed the training program. No major change in menstrual status was observed during the study. Table (1) shows the change in anthropometric data on both exercise and controls groups. There were no significant differences in mean age, height between the two groups. The notable differences between the groups were body weight, BMI and BMD. All subjects showed normal ranges of serum calcium, phosphorus, or estrogen levels at the baseline and analysis of data showed that the post-test differences between the groups were not significant ($p > 0.05$).

Percent body fat, fat mass and lean mass changes in response to training were significant in the two study groups compared with control groups. The lean mass in both study groups were significantly increased but the present body fat, fat mass were significantly decreased in them ($p = 0.000$).

No changes were seen in BMD of the spin ($L_2 - L_4$) and hip in either of study group ($p<0.05$). However study groups experienced slightly increased in BMD at both region, while the control groups did not. Table (2) shows the change in BMD and serum estrogen calcium and phosphorus levels in both study and controls groups.

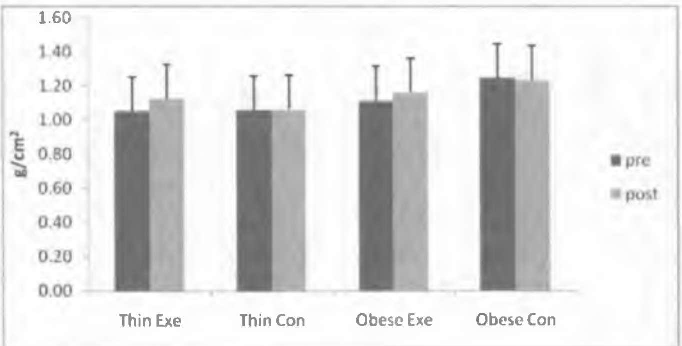

Fig1. Change from baseline in Spine ($L_2 - L_4$) BMD (g/cm²) during the study period (pre, poststudy) between the study and control groups.

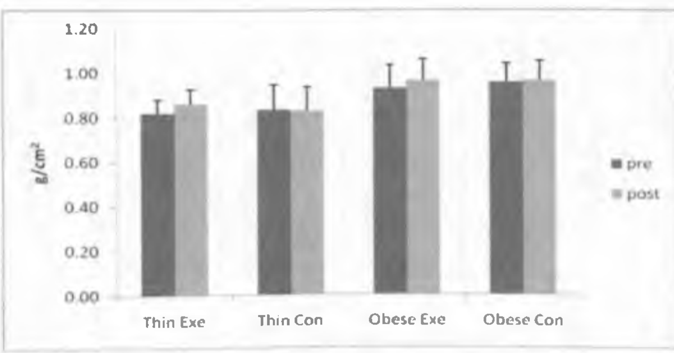

Fig2. Change from baseline in Hip BMD (g/cm²) during the study period (pre, poststudy) between the study and control groups.

Table1. Changes in Anthropometric variables in pre and post test exercise(X ±SD)

variable	**Obese**(Exe)		**Obese**(Con)		**Thin**(Exe)		**Thin**(Con)		**P value**
	pre	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	
Age (year)	22.22 ± 1.98	-	22.67±1.50	-	21.10± 1.73	-	21.90±1.29	-	
Height (cm)	157.78 ±5.11	-	159.11±1.50	-	159.90± 7.56	-	162.70 ±6.65	-	
Weight (kg)	74.98± 8.11	73.27±7.74	78.11±10.88	78.06 ±10.14	45.88 ± 5.33	46.43 ±5.18	46.49 ±5.70	46.31±5.21	0.000*
BMI (kg/m²)	30.20 ± 1.83	28.88 ±2.10	30.93 ±3.57	30.41±3.05	17.73 ± 1.05	17.89 ±1.49	17.51±1.05	17.24 ±0.98	0.000*
Lean mass (kg)	43.27±5.25	44.38 ±6.21	43.86 ± 6.03	43.25± 6.67	33.54 ± 3.72	34.53 ± 3.97	34.93 ±4.31	33.67 ± 4.57	0.000*
Fat mass (kg)	29.11±4.54	27.17±6.30	31.16 ± 6.28	30.42 ±7.13	9.86 ±1.85	9.21± 2.14	10.38± 1.92	10.51±1.90	0.000*
% Body fat	38.80 ± 3.97	36.35 ±6.84	39.97 ±3.51	39.00 ± 5.16	21.82 ± 3.13	20.13± 3.60	22.35 ± 2.86	22.43± 4.20	0.000*

*(*0.000) Significant at the 0.05 level by ANOVA among exercise and control groups.
*Exe=Exercise
*Con=Control

Table 2.Change in BMD and blood variables in pre and post test exercise (X ±SD)

variable	**Obese**(Exe)		**Obese**(Con)		**Thin**(Exe)		**Thin**(Con)		**P value**
	pre	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	
Hip BMD (g/cm^2)	.968± 0.106	.983± 0.095	.958± 0.085	0.945 ±0.092	.843 ± 0.059	0.863± 0.063	0.834 ±0.115	0.831 ±0.106	0.868
Spine (L_2–L_4) BMD (g/cm^2)	1.113± 0.167	1.147 ±0.155	1.137 ±0.173	1.128 ±.171	1.051±0.147	1.128± 0.216	1.057±0.120	1.056 ±0.134	0.562
Estrogen (pg/ml)	30.42 ±15.60	46.99 ±18.55	34.35± 24.17	39.51±17.24	25.55 ±8.93	42.15 ±18.80	38.00 ±10.57	30.42 ±15.60	0.967
Calcium (ml/dl)	9.47 ± 0.24	9.42 ±0.28	9.50 ±0.46	9.38 ±0.306	9.78 ±0.42	9.25 ± 0.50	9.67 ±0.30	9.28 ± 0.315	0.410
Phosphorous (ml/dl)	3.80 ± 0.39	3.65 ± 0.63	3.84 ± 0.46	3.53 ± 0.44	3.81 ±0.39	3.55 ± 0.36	3.96 ±0.53	3.80 ± 0.38	0.939

DISCUSSION

The aim of this study was to investigate the effects of walking exercise on BMD in young women. In our patient a simple 30 minutes of walking exercise at the range of 50-75% maximum heart rate was not enough to significant change the BMD in both obese and thin groups. The lack of a significant improvement in bone density in both study groups compared with the control groups was most likely due to the exercise being of insufficient intensity and/or duration of time or frequency. Several well-controlled studies similarly supported a positive effect of exercise on BMD, indicating either less reduction or more gain in BMD for the training group compared with the control group (6, 5).Several studies also have shown that exercise of relatively short duration did not enhance BMD, but decline in BMD were reported in non-exercise groups (21, 22).Result of the blood parameters also showed that neither estrogen nor calcium and phosphorous levels were significantly altered as a result of two-month training regimen, suggesting that estrogen, calcium and phosphorous did not mediate the observed skeletal changes in the both groups. The study finding revealed that 2 months walking exercise was of sufficient duration and intensity to result in significant improvements in the all components of body composition in young obese and thin girls. The decrease in body weight in the obese exercising and increase in the thin control group account for the responses of body weight to walking exercise compared with the control groups. Furthermore exercise program decreased fat mass and increased in lean mass in both study groups, making them healthier.

Exercise will be part of an effective strategy to reduce the incidence of osteoporosis only if the amount and type of physical activity needed to confer benefit is attainable for majority of women. The most easily accessible form of weight-bearing exercise is walking and the number of hours of walking per day has been found to be correlated with lumbar and hip densities (36).However, the degree and the extent of any exercise should be adapted to the age, the physical ability, the skeletal condition of the individual. The effect of exercise on preventing bone loss among women is controversial and comparisons among studies evaluating the effect of walking on bone density at various skeletal sites are limited by differences in methods to measure walking activity of the study population. For example Cavnaugh and Cann (7) reported that aerobic exercise such as walking program did not prevent bone loss. Hotori et al (16) also reported that walking for 30 minutes above the anaerobic threshold (AT) was effective in increasing BMD, whereas exercise below the AT was not. Martin and Notelovitz (24) similarly observed that walking speeds of less than 6.4 km/h did not increase BMD. Other studies have shown that physical exercise positively affected BMD in both young and elderly women. Among postmenopausal women, Yamazaki et al (35) demonstrated that the positive effect of 1 year of moderate walking exercise on the BMD was caused by a decrease in bone turnover in postmenopausal women. These findings confirm that exercise decreased bone turnover, which was elevated by estrogen deficiency, and resulted in positive effect to the skeleton. Chow et al (8) similarly reported an increase in bone mass as a result of treadmill exercise at 80% of the maximum heart rate during walking exercise. Iwamato et al (17) also found that walking exercise increased BMD. However continued exercise is required to maintain any gain.

In conclusion, this study demonstrated that walking exercise may reduce the risk of bone loss in young women .However further studies are needed to evaluate the efficacy of walking exercise on bone quality and the risk of bone loss as an exercise-related effect in different obese and thin groups.

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ABSTRACT

Objective: The purpose of the present study was to examine the effect of walking program on BMD in order to prevent bone loss among sedentary obese and thin women.

Material and methods: Forty untrained obese (n=20) and thin (n=20) women, 20-25 years, volunteered to participate in this study, then the participants were pairwise BMI-matched and randomly assigned to two study (obese=10, thin=10) and two control (obese=10, thin=10) groups.

Before and after the training program both groups had anthropometric measurements, blood analysis. Bone mass density was also evaluated by using dual-energy X-ray absorptiometry (DXA) . Each walking session was 30 min walking between 50-75% of maximal age adjusted heart rate, 3 days per week for 2 months.

RESULTS: After 2 months, exercise groups had no effect assignment on BMD at weight-bearing sites in the spin (L_2– L_4) and hip($p>0.05$).However exercise groups experienced slightly increased in BMD at both regions, while the control groups did not. Also no significant change was observed at blood samples in either group ($p>0.05$). Percent body fat, fat mass and lean mass were affected positively by exercise program compared with control groups (all $p = 0.000$).

CONCLUSION: This study demonstrated that walking exercise may have reduced the risk of bone loss in young women. However further studies are needed to evaluate the efficacy of walking exercise on bone quality and the risk of bone loss as an exercise-related effect in different obese and thin groups.

Key words: Bone mass density, bone loss, walking exercise, obese and thin women.