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Effect of Light Activities on Bone Mass in Postmenopausal Women

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The aim of this research was to investigate the preventive role of light activity and to determine effectiveness of weight-bearing activity or specific strengthening exercise on bone mass in postmenopausal women. Twenty-five postmenopausal women participated in this study. They had been diagnosed clinically and also their lumbar spine bone density was measured by Dual Energy X-ray Absorbtiometry (DEXA) as normal, osteopenic or osteoporotic. Twelve women received 30 min walking as a weight-bearing activity and 13 women performed specific strengthening exercise for back extensors and postural exercise twice a day for 6 months. Bone density of both groups were measured before and after the treatment. Considering the post-treatment T values, it was found that Bone Mineral Density (BMD) was increased in 50% of women from the walking group and 53.8% of women from the exercise group; nevertheless this was not statistically significant. Although BMD values showed similar changes in both groups, they were significantly decreased in the exercise group ($p<0.05$). This study reveals that walking and specific strengthening exercise have no effect in the prevention of bone mass in postmenopausal women if they are applied as light activities (1-3 MET). Although there is similar decrease in both walking and specific strengthening exercise groups after treatment, the decrease in exercise group was found significant.

Key words: Bone mass, weight-bearing activity, walking, strengthening exercise, postmenopausal women

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INTRODUCTION

Bone mass decreases with age and hormonal changes, increasing the risk of osteoporosis especially among women. Osteoporosis (OP) is a bone disease associated with reduced bone mineral density and a disruption in the micro architecture of the skeleton resulting in debilitating bone fractures[1-3]. The treatment and prevention of OP which is a major public health problem include calcium supplementation, estrogen replacement and physical activity. Physical activity has been proposed as a strategy for improving or maintaining the structural competence of bones. Physical activity transmits the load to the skeleton by at least two mechanisms: direct impact from weight-bearing activity and muscle pull[4]. Benefits of exercise include increased muscular strength, coordination, and balance which could decrease risk for falling down and subsequent fractures[5-7].

As postmenopausal women are exposed to high level of risk for osteoporosis and because the most disfiguring effect of postmenopausal osteoporosis is on the spine, most of the prospective studies on physical activity and bone mass have been applied on this group of women[8-11]. It is known that the most suitable exercise program to increase bone mass are weight-bearing and muscle strengthening exercises. The studies have reported conflicting results because of the differences of frequency, intensity, duration and type of exercises[9-16].

The aim of this study was to investigate the preventive role of light activity and to determine effectiveness of weight-bearing activity or specific strengthening exercise on bone mass in postmenopausal women.

MATERIALS AND METHODS

Thirty postmenopausal women were recruited from the Physical Medicine and Rehabilitation Department at Istanbul Medical Faculty. Eligible subjects for the study were healthy postmenopausal women who had no history of fractures; metabolic bone diseases; renal, liver or thyroid disorders, gastrectomy; alcoholism; or of taking estrogen or other drugs that might affect bone metabolism. Subjects were randomly divided into two groups. Fifteen women walked as a weight-bearing activity and other fifteen women performed posture and back extension strengthening exercises. One subject had hysterectomy in walking group. Two subjects had had hysterectomy and 1 subject had ophorectomy in exercise group.

Baseline age, menopause age, years past from menopause, physical characteristics, daily calcium intake and physical activity assessments were evaluated for women in both groups. Inspired by the questionnaire which is used in Mayo Clinic; daily calcium intake questionnaire which was composed by taking nutrients into consideration as well as dietary habituation and food most frequently consumed by Turkish population. As for the evaluation of women's daily physical activities and sleeping habits, a questionnaire which is composed by Sallis *et al.*[17] was used. BMD of the lumbar spine (L1-4) was assessed by dual energy x-ray absorptiometry (DEXA-Hologic 1000) at baseline and after 6 months.

Walking group performed brisk walking as a weight bearing activity during 30 min a day. They were contacted by telephone about once a week during the study. Exercise group performed posture and resistance back extension exercises using backpack of 2 kg. The exercise was conducted at home for the convenience of the patient, generally in the morning and in the evening, twice a day and one day per week at the hospital under physical therapist's supervision, for 5 days a week. Each exercise was repeated 15 times. Seance durations were approximately 15 min. Therapy duration was 6 months. All participants also agreed to maintain their baseline level of physical activity and dietary practices during the study.

The results were expressed as the mean±SD, and differences were considered significant at the level of $p<0.05$. The comparability of two groups at baseline was tested by Student's t test. Changes from baseline in bone density were compared by paired-samples t test.

RESULTS AND DISCUSSION

Five women dropped out of the study because of low adherence and compliance problems. Twenty-five women, 12 of them in the walking group and 13 of them in the exercise group, completed the study.

Baseline age, age of menopause, years past from menopause, physical characteristics, daily calcium intake and physical activity assessments for both groups are given in Table 1. There were no statistically significant differences between two groups except that age of menopause ($p<0.05$). Mean age was 56.83±4.42 years (52-67) in walking group and 52.07±8.58 years (42-68) in exercise group.

The changes in BMD are given in Table 2 and 3. Results obtained by the comparison of BMD measurement values which belong to walking and exercise groups are shown in Table 4. There was similar percentage of improvement in T score in walking and

Table 1: Results of the comparison of baseline values of walking and exercise groups

	Walking group (N=12) X±SD	Exercise group (N=13) X±SD
Age (year)	56.83±4.42	52.07±8.58
Age of menopause (year)	49.08±3.39	43.46±6.16*
Year after menopause	8.58±4.71	7.53±7.14
Height (cm)	160.75±6.22	160.76±5.61
Weight (kg)	64.08±8.11	67.76±5.70
Body mass index (kg m^{-2})	24.75±2.36	26.78±1.51
Daily calcium intake (mg)	1076.91±336.72	1049.53±474.00
Physical activity (kcal/kg/day)	33.28±1.54	33.58±1.93

* $p<0.05$, SD: Standard Deviation

Table 2: T and Z scores, bone mineral density and bone mineral content values of walking group before and after the treatment

Patient No.	BTT	ATT	BTZ	ATZ	BTBMD	ATBMD	BTBMC	ATBMC
1	-1.78	-1.89	-0.66	-0.73	0.852	0.839	40.58	39.13
2	-2.03	-1.91	-1.19	-1.01	0.837	0.828	45.48	42.04
3	-2.26	-2.21	-0.42	-0.32	0.798	0.803	33.12	34.27
4	-2.76	-2.84	-1.95	-1.97	0.744	0.735	36.13	36.49
5	-1.95	-1.71	-0.91	-0.61	0.832	0.859	45.43	46.18
6	-2.40	-2.52	-0.82	-0.90	0.783	0.770	42.33	42.61
7	-1.40	-1.46	-0.37	-0.35	0.893	0.887	50.78	50.83
8	-2.13	-2.24	-1.01	-1.05	0.813	0.801	43.89	43.48
9	-2.70	-2.53	-1.83	-1.63	0.750	0.768	36.85	38.29
10	-2.63	-2.37	-1.59	-1.29	0.758	0.786	35.23	36.56
11	-1.17	-1.13	0.09	0.20	0.918	0.922	44.64	45.32
12	-2.39	-3.05	-1.08	-1.65	0.784	0.712	34.24	32.55

Table 3: T and Z scores, bone mineral density and bone mineral content values of exercise group before and after the treatment

Patient No.	BTT	ATT	BTZ	ATZ	BTBMD	ATBMD	BTBMC	ATBMC
1	-0.95	-0.67	-0.09	0.23	0.943	0.861	51.04	49.18
2	-2.29	-2.15	-0.37	-0.17	0.795	0.811	41.37	42.26
3	-1.54	-1.44	-0.79	-0.66	0.877	0.888	45.47	44.74
4	-0.15	-0.83	-0.47	-0.17	1.031	0.955	55.20	46.94
5	-1.78	-1.59	-0.65	-0.42	0.872	0.851	46.76	45.75
6	-2.46	-2.55	-2.16	-2.23	0.777	0.766	44.62	44.36
7	-0.22	-0.49	-0.02	-0.26	1.023	0.994	52.83	49.83
8	-0.52	-0.8	1.11	0.87	0.990	0.959	44.63	43.07
9	-0.50	-0.76	0.10	-0.11	0.992	0.964	47.24	46.78
10	-1.63	-1.55	-0.31	-0.26	0.868	0.876	42.98	42.90
11	-1.26	-1.14	-0.21	-0.29	0.908	0.921	49.22	50.00
12	-1.69	-1.74	-0.75	-0.73	0.861	0.855	40.04	40.92
13	-1.50	-1.33	-0.54	-0.33	0.882	0.901	48.51	48.68

BTT = Before treatment T score, ATT = After treatment T score,
BTZ= Before treatment Z score, ATZ= After treatment T score,
BTBMD= Before treatment bone mineral density,
ATBMD= After treatment bone mineral density,
BTBMC= Before treatment bone mineral content,
ATBMC= After treatment bone mineral content,
T Score= The comparison to normal young adult mean bone density,
Z Score= The comparison to age-matched normal subject mean bone density

exercise groups, respectively 50% and 53.8%. This result was not statistically significant ($p>0.05$). Although bone density seems to have similar changes in both of the groups, statistically significant decrease was observed in exercise group ($p<0.05$). After treatment, exercise group showed significant decrease in bone density.

Although many researches which investigated the effect of physical activity on BMD reported that there is increase in BMD, some studies have reported conflicting

Table 4: Comparison of T and Z scores, bone mineral density and bone mineral content values of walking and exercise groups before and after the treatment (Mean±SD)

	Walking group		Exercise group	
	Before treatment	After treatment	Before treatment	After treatment
T score	-1.83±1.23	-2.13±0.56	-1.26±0.93	-1.31±0.72
Z score	-0.97± 0.60	-1.04±0.63	-0.32±0.95	-0.34±0.85
BMD	0.813±0.55	0.809±0.61	0.909±0.09	0.892±0.07*
BMC	40.72±5.56	40.64±5.97	46.91±4.45	42.01±2.57

* $p<0.05$, T Score= The comparison to normal young adult mean bone density, Z Score= The comparison to age-matched normal subject mean bone density, BMD = Bone mineral density,
BMC = Bone mineral content

results[10,11]. In some studies, it had been shown that BMD increases in women performing weight-bearing exercise program[14-16].

Therapeutic exercises must be done long-term or lifelong to prevent or relieve the bone loss in postmenopausal women. Flexion exercises are not recommended. These can increase the vertical compression forces on the body of vertebral bones and may increase the possibility of occurrence of compression fractures[18]. For this reason, we composed our exercise and walking programs in order to be applied as daily living activities and can easily be performed. Present study duration was 6 months and was parallel with the literature[11,19-21]. Twenty-five women completed the study; the number of subjects was similar to literature[10,21-23].

The most active bone tissue is the corpus of the vertebrae that consists of trabecular bone in postmenopausal stage. Fractures because of postmenopausal osteoporosis are frequently seen in this area. For this reason, it is very important to assess the effect of physical activity on bone mineral density of spine. Sinaki *et al.*[24] reported that levels of physical activity and back extensor strength may be contributors of lumbar spine BMD. Limburg *et al.*[25] reported that moderate reduction of back extensor strength may occur with increasing age in healthy women. Weakness in back extensor musculature increases the possibility of compressing vertebrae in the fragile osteoporotic spine. Reducing bone loss with maintenance of back extensor strength can be accomplished.

Dilsen *et al.*[21] studied participating back extension, breathing and posture exercises at home on exercise group for one hour, and on walking group for half an hour twice per week for a period of 6 months and control group was assessed. After the exercise period, BMC values have shown 4.76 % increase. A reason for this result may be the combination of exercise and walking programs. Sinaki *et al.*[26] conducted exercise study which consists of back extension and posture exercise using a backpack that contained weights equivalent to 30% of the maximal

isometric back muscle strength, 10 repetitions, twice daily, 5 days a week for 2 years. Researchers showed that this exercise program has no effect on age related bone loss in healthy, ambulatory postmenopausal women. In present study, exercise program consists of resistance back extension exercise. Back extension against resistance induce tension in the vertebral bones by contraction of anatomically related muscles. In our study, in the exercise group it is found significant decrease in bone mineral density of lumbar spine after treatment.

Sinaki *et al.*[26] suggested that not every type of exercise is effective for decreasing bone loss or increasing bone mass in healthy, ambulatory postmenopausal women, even when a positive effect of exercise on muscle strength is substantiated. Present results showed significant decrease in lumbar spine BMD in exercise group after a 6-month treatment. In exercise program designed by Sinaki *et al.*[26] a backpack that contained weight equivalent to 30% of the maximal isometric back muscle strength in pounds is used. We aimed to increase back extensor strength to 5 value according to manual muscle test assessment in the first place, later our aim was to do against resistance with 2 kg. In the present study, significant decrease in bone mass in exercise group can be explained by the differences in therapy duration and resistance when compared with the study done by Sinaki *et al.*[26].

It had been found that progressive strengthening program for 2 years is effective in increase hip BMD[27]. Zlystra *et al.*[18] reported benefits to the spine and femoral neck densities with increased hours of walking in total, also including the walking activity during the course of daily living. Krall *et al.*[29] showed that healthy postmenopausal women who walk approximately more than 12 km per week have higher whole body bone density than women who walk shorter distances. Walking is also effective in slowing the rate of bone loss from the legs. These results strongly support the widely held belief of walking being a beneficial form of physical activity for maintaining skeletal integrity.

In a study which attempted to increase the mechanical loading during walking, Nelson *et al.*[30] studied the effect of walking with leaded belts for approximately 50 min four times per week for a year. They have also reported varying results by skeletal site. The experimental group showed a slight increase in lumbar spine BMD compared to a significant decrease in controls. There were no significant changes in femoral neck BMD or radial BMC. By contrast, Cavanaugh and Cann[10] have conducted a 1-year study of 2 h per week brisk walking and have observed a decrease in lumbar spine BMD in both control and exercise women groups. Supporting the results of Cavanaugh and Cann[10], White *et al.*[11] showed that the ratio of radius loss BMC is similar with control group in women who walk 12 km per week.

Sandler *et al.*[31] reported results somewhat similar to those of White *et al.*[11], but also found a relationship to grip strength. Although both exercisers and controls lost comparable amounts of bone over the-3 year study, women exercisers who had high grip strength exhibited a significant increase in bone cross-sectional area compared to controls. They concluded that walking in synergism with adequate muscle strength, as indicated by grip strength greater than 25 kg. contribute to beneficial changes in radial geometry. Since the radius is not directly loaded by walking, the results suggest a generalized effect of exercise.

Krolner *et al.*[14] compared the bone mineral content of the lumbar spine, in a controlled trial involving healthy women of 50-73 years old who were assigned either to the control or exercise group. The second group exercised for one hour twice a week for eight months. The lumbar spine bone mineral content of the exercise group increased by 3.5%; on the other hand it decreased by 2.7% in the control group. This study shows that physical activity can decrease involutional bone loss from axial skeleton in postmenopausal women. Thirty min. a day, 3 days per week, 7 month trial by Hatori *et al.*[12] showed that postmenopausal women increased significantly in bone mass doing exercise with intensity above the anaerobic threshold. Chien *et al.*[13] reported that high-impact aerobic exercise for 6 months is effective in relieving BMD loss in osteopenic postmenopausal women.

Dalsky *et al.*[15] have shown that postmenopausal women, doing weight-bearing exercise designed to load the axial skeleton, had significant increase above baseline in lumbar bone mass for as long as 22 months. With reduced training, bone mass diminished towards baseline. Investigators have reported that weight-bearing exercise seems effective for the treatment of postmenopausal women with low bone mass.

In the study by Cavanaugh and Cann[10], walking duration was similar to our study, 3 times per week for 1 year. In the study by White *et al.*[11], patients walked 4 times per week, walking and therapy duration were the same as ours. In the study by Nelson *et al.*[30], walking duration was 50 min., 4 days per week and it was done by weighted belts. Therapy duration was 1 year. In this study walking has no significant effect on femoral neck and radius BMC. In most of the studies, exercise program consists of walking activity [11,14,15,21]. In this study, we didn't add any other exercise in order to assess the effect

of walking activity solely as a weight-bearing exercise on BMD. For this reason, it is expected that increase in BMD may be higher in studies which are composed of both walking and exercise programs.

The results of Smith *et al.*[32] and Dalsky *et al.*[15] which investigate the effects of exercise with calcium supplement on BMD are contradictory. Smith *et al.*[32] showed that there is no benefit of calcium supplement, but Dalsky *et al.*[15] found that there is significant increase in BMC in exercise group taking calcium supplement. Nelson *et al.*[30] reported that there is no significant effect of calcium on spine or femoral neck BMD in walking and control groups whose calcium intakes are similar. In this study, we didn't give any calcium supplement in order to assess the effect of only exercise program or walking on bone mass. We conclude that there is no change in our groups during the study, considering risk factors, daily calcium intake and physical activity level.

Several possible explanations could be offered for the decrease in BMD of lumbar spine in walking and exercise groups: (1) in postmenopausal of physically active women, bone mass may not increase or involutional bone loss may not decrease in response to additional light exercise; (2) the walking and exercise program may have been at a subthreshold level for influencing bone mass because of the duration, intensity, or type. The progressive increase may not be provided to weight-bearing to the skeleton; (3) the subjects may not have complied with their exercise programs. (4) 30 min walking may not be sufficient to stimulate the bone.

We suppose that it is more useful when exercise program is planned as moderate level activities [(3-5 MET; 1 MET is the metabolic oxygen requirement under basal conditions, which is equal to the metabolic rate (1 kcal/kg/h)] such as 1.5 km. walking in 15-20 min or 5-6.5 km brisk walking per hour. It is concluded that if walking and strengthening exercise of back extensors are applied as light activities (1-3 MET) have no effect in the prevention and treatment of osteoporosis.

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