The Effect of Weight Bearing Exercise on Bone Mineral Density of Premenopausal Women

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Abstract

Introduction: Maintaining optimal level of bone mineral density during Premenopause plays an important role in reducing the risk (relative risk of 1.5-3 times mire) of osteoporosis and the subsequent fractures in post-menopausal , therefore aim of this study was to explore the effect of weight-bearing exercise on bone mineral density of premenopausal women. **Materials and Methods:** In this semi-experimental pretest-posttest with control group design, 20 premenopausal women in the 40 to 45 age range were randomly selected and distributed in two experimental and control groups. Experimental group completed 12 weeks of training, three times a week and 70 minutes per session. Before and after the period of 12 weeks, femoral bone mineral density in all samples were measured by DEXA bone mineral densitometry. We used K-S test for normality assumption, independent sample t-test in within-subject design and paired t-test, ANCOVA for between-subject design. Significance level was 0.05 SPSS-21 was used. **Results:** The results revealed that 12 week weight bearing exercise resulted in an increase in femoral bone mineral density among participants in experimental group with the significant decrease in control group. Bone mineral density of femoral neck and total hip among the subjects distributed in experimental group, was significantly different from corresponding areas in control group. **Discussion:** It should be emphasized that exercise is the harmless and appropriate approach to prevent any decrease in bone mineral density in menopausal period which can prevent decrease in bone mineral density due to aging in this period.

Key words: Bone Density, Premenopausal, Weight-Bearing Exercise

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Introduction

Osteoporosis is considered to be a global health problem defined as the loss of bone density and changes in the bone structure which increases the risk of bone fractures (1). It should be noted that osteoporosis is not common only among old people. According to the evidence the percentage of its outbreak as well as of bone density loss is 5% and 15% respectively among premenopausal women (2). It has been also reported annually that the percentage of bone mineral density in this group of people is between 0.25% and 1% (1). As some studies have shown maintaining the optimal level of bone mineral density during Premenopause stage will reduce the risk of osteoporosis and its subsequent bone fractures during post-menopause stage in which this risk becomes 1.5 to 3 times more (2). In a meta-analytic study maximum and minimum values of osteoporosis outbreak in femoral artery among Iranian women were reported to be 1.5% and 43% respectively. In the same study the value of osteoporosis outbreak in thigh was estimated to be 18.9% with confidence interval of 15-22.7 among Iranian women based on stochastic modeling (3). Loss of bone density process depends on age factor, in other words, both genders, male and female start losing about 1-5% of the bone density annually at the age of 40 which lasts until the end of life (4). There are some factors including, body mass index, smoking, using alcohol and sedentary lifestyle which speed up this process. However, some

measures can be taken to maintain the bone density in different age stages. One of the effective, available, economical and non-pharmacological way to achieve this purpose is doing physical activities, which as environmental moderator plays a main role in maintaining and increasing the bone mineral density among children and adults. Kelley *et al.* in a meta-analytic study supported the positive effects of physical activity on BMD among premenopausal women (5).

Many studies have been conducted to examine the effect of doing sports on bone density among Postmenopausal women suffering from Osteoporosis (6, 7). Since Osteoporosis is not a health issue only among Postmenopausal women it means that unfortunately even young women due to several reasons are exposed to this serious health problem; thus, having it prevented at young age is of great importance. The findings of some studies on the one hand, have already approved the positive effect of doing exercise on BMD, on the other hand, some other studies have not supported that effectiveness. A striking illustration of this is the study by Habibzadeh in which the effect of walk on preventing the Osteoporosis among healthy girls in the age range of 20 to 36 was examined (8). According to its findings, there was no significant effect on their thigh and waist BMD. However, based on the study conducted by Borer *et al.*, 30-minut walk with 88% VO2max intensity, four times a week for three successive months brought about a considerable increase in the bone density of thigh and spinal cord among thin Postmenopausal women (9). Korpelainen *et al.* examined the effect of 35-minute walk, three times a week for three continual months on the thigh and spinal cord bone density of the thin middle-aged women and noticed no significant change in the bone density (10). Gusi *et al.* carried out a study to survey the effect of 30-minute walk, three times a week for two succeeding months on the thigh and spinal cord bone density of fat Postmenopausal women, at the end of the study, although the participants lost weight, no significant difference in the bone density was witnessed (11). Mulhim et *al.* observed that 30-minute fast walk with the speed of 1/5 kilometer per hour, three times a week for three months led to an increase in the bone density among fat but active women in the age range of 25 to 50 (12). In the study by Kun *et al.* bone mineral density was reported to be higher in the organs bearing the body weight (13). Bravo *et al.* also studied the effect of one-year Weight-bearing exercise on the bone density of 124 Postmenopausal women diagnosed with Osteoporosis, the results supported the fact that this type of exercise could decelerate the process of bone density loss (14). Nichols *et al.*, examined 34 Postmenopausal women who had the experience of physical activities and took 12 months of Weight-bearing exercise, they could not notice any marked difference between participants of study in experimental and control groups regarding the bone density (15). In another study by Bassey and Ramsdale observed the effect of Weight-bearing exercise with low and high intensity for one year among 44 Postmenopausal women, but they did not spot a significant difference in the bone density of the subjects (16). Finally, Lau *et al.*, studied the effect of 10-month Weight-bearing exercise among 50 Postmenopausal women, but then again they could not see any significant effect on their bone density (17). These apparent contradictions observed in the literature review relating to Osteoporosis necessitated the effort to conduct further research on this subject; consequently, in the current study the effect of 12-month Weight- bearing exercise on the bone density of the Postmenopausal women was surveyed.

Materials and Methods

The current semi-experimental pretest-posttest with control group design study was conducted in 1394 on Postmenopausal women living in Hamedan in the range age of 40 t0 45. The research protocol with acronym ID of IR.UMSHA.REC.1394.421 was approved by the ethics in research committee and the intentional consent was signed by all the participants in the study. To begin with, a questionnaire including questions on age, weight, height, bone fractures record, medication use, calcium use, physical activity, times of baby delivery, menstrual cycle age, pregnancy and disease record, was distributed, then twenty volunteers enjoying inclusion criteria checked by the doctor using GPower3.1 software were selected to take part in the study. Inclusion criteria included, not being diagnosed with Rheumatoid Arthritis, Hypothyroidism and hyperthyroidism, Parathyroid and Adrenal, diabetes, Kidney failure, Hepatic Insufficiency, Cardio and respiratory disease, Neurological disorders, Concussion, lower limb damages, Menopause symptoms, bone fractures, cancers, Menstrual disorders after 18, Permanent cessation of menstruation, temporary cessation of menstruation during last three months, menstruation of less than six months during the last year, not undergoing Oophorectomy under age of Menopause,not experiencing Infertility, pregnancy or breast feeding during the study, smoking, alcohol use, drug addiction, spinal cord deformity, not being hospitalized two weeks before the participation in the study, not being on Bed rest for about three successive months, not using Estrogen and progesterone drugs, not having T-score lower than 2.5, not using calcium, multi vitamin and vitamin D and not having vitamin D3

Table 1. Demographic features of participants

	Experimental group (n=10)	Control group (n=10)	T	*P*-value
Age (Year)	42.20±2.20	43.50±1.84	-1.43	0.169
Height (Cm)	158.10±7.87	160.53±6.46	-0.75	0.460
Weight(Kg)	72.68±6.83	71.07±11.60	0.38	0.710
BMI (Kg/M)	29.24±3.74	27.68±4.73	0.82	0.425
Total Hip Density (G/Cm)	1.00±0.22	1.14±0.17	-1.55	0.139
Femoral Neck Density(G/Cm)	0.88±0.20	0.99±0.14	-1.42	0.174

Table 2. Paired T-test results of bone density in the experimental and control groups (* significant difference in *P*≤0/05)

Group	Area	Pre-test	Post-test	Mean difference	T	*P*-value
Experimental	Total hip	1.00±0.22	1.02±0.23	0.02	-1.28	0.232
	Femoral neck	0.88±0.20	0.92±0.23	0.04	-2.22	0.053
Control	Total Hip	1.14±0.17	1.05±0.15	-0.09	3.89	0.004*
	Femoral neck	0.99±0.14	0.93±0.15	-0.06	2.251	0.033*

Table 3. Covariance test results relating to the thigh density before and after 12 weeks of treatment in experimental and control groups

Area	Sources	Total squares of type III	Freedom degree	F	*P*-value
Total hip (cm)	Fixed	0.00	1	0.07	0.790
	Pre-test	0.63	1	140.92	0.000
	Group	0.05	1	11.23	0.004*
Femoral neck (G/CM)	Fixed	0.00	1	0.35	0.560
	Pre-test	0.60	1	128.75	0.000
	Group	0.05	1	10.65	0.005*

injection. The participants were distributed into two groups of control and experimental each with 10 members. The subjects in the experimental group were asked to do sport three times a week seventy minutes for twelve weeks; however, those in the control group had no physical activities during the study (18). The participants were also asked to complete the food questionnaire as well as not to take food supplementary or calcium and vitamin D pills. They were also required not to alter their diet and not to take any medicine without referring to a doctor.

The training protocol including 12 weeks of training which contained three seventy-minute sessions a week was based on the training program by Elsisi *et al.*, Liang *et al.* and Kisner *et al.* (19-21). That daily training program encompassed warming up (10 minutes), strength training (35 minutes), Endurance training including 15-minute walk with Maximum heart rate of 60-65% on treadmill and Colling (10 minutes). Warming up contained walking, running slowly, stretching and Kinetic movements. Strength training comprised 50% Open kinetic chain and 50% Closed kinetic chain and eight different movements including; Latissimus dorsi muscle stretch, Knee flexion, Standing Calf Press, Trunk extension, Sitting knee presses, knee extension, Seated leg press and Sit-ups. During the first four weeks the participants were asked to do 1 to two sets of exercises including 10 movements with 60-651RM, then, in the second four weeks they were required to do the three sets of 8 movements with the intensity of 70-75 1RM, finally in the last four weeks they did three sets of 10 movements with the intensity of 75-80 1RM. There was a minute interval between the sets. The 1RM was not only determined at the beginning of the training, it was also repeated at the beginning of every month. Endurance training included 20-minute walk with Maximum heart rate of 60-65% on treadmill and Colling (10 minutes) comprised relaxation and stretching movements (19-21).

The instruments used to collect necessary data were a Standing stadiometer with the accuracy of one millimeter and digital balance with accuracy of 0/01 kilogram. The weight was measured after normal exhalation and with the minimum amount of cloths on. The bone density in two Femoral and hip areas was evaluated by using Dexa e=X-ray. Mode Dexxum-T

made in South Korea by Osteosys Company. In order to have the bone density measured by central device, after measuring the weight, the participants were asked to lie on their back and the device was placed on the area to be measured, it is worth mentioning that the direction of the x-ray was toward thigh bone. This is considered to be a simple, fast, non-aggressive and painless without Anesthesia. This method succeeded in measuring the bone density in almost no time (10 to 20 minutes). Prior to the participation of the subjects, they were briefed on the potential dangers of the device used to measure the bone density. Bone mineral density based on G/CM was measured in the total hip and femoral neck and the results were prepared via the computer.

The bone density test relating to before and after training was examined carefully. Then, several statistical procedures were adopted to analyze the data collected. The mean and the standard deviation were used to describe the data, K-S test was used to examine the possibility if the variables measured were normal, the levene test was utilized to match the groups, the paired T-test was taken to study the variables before and after the intervention, the independent T-test was employed to examine the difference between two groups, and finally to have the significant difference between two groups observed Covariance test was applied. All statistical tests were employed at Significance level of 0.05 through SPSS version 21.

Results

Considering the data relating to mean and standard deviation of the demographic features of the participants presented in the table 1, the independent T-test showed that the subjects were homogeneous in term of age, height, weight, BMI and bone density when they participated in the study.

The mean and the standard deviation of thigh density (hip density and femoral neck density) among the participants distributed in the experimental group and the control group before and after the 12 weeks of treatment are illustrated in table 2. As can be clearly seen, there was an increase regarding the mean of the total hip and femoral neck density in the subjects of the experimental group after 12 weeks, it should be noted though, the increase mentioned was not a significant one. On the other hand, there was a significant decrease in the density of the total hip and the femoral neck after 12 weeks of experiment (P=0.033 and P=0.004).

According to the results of *Covariance* test relating to total hip and femoral neck density which are presented in table 3 for both experimental and control groups after 12 weeks there was a difference in the amount of these variables by adjusting the pre-test variables (P=0.005 and P=0.004).

Discussion

The purpose of the current study was to examine the effect of the weight-bearing exercise during twelve weeks on the bone density among the Postmenopausal women. Taking the results of the study into consideration, it can be concluded that on the one hand, there was an increase in the thigh density after the twelve weeks of treatment (doing weight-bearing exercise) which could not be considered as the significant one; On the other hand, there was a decrease in the thigh density among the individuals in the control group (P<0,05) , so the thigh density of the subjects in the experimental group was significantly different from those in control group (P<0,05) . Regarding the results obtained, a marked increase has been observed among the participants in the experimental group in density of total hip and femoral neck areas which are in line with results of the study by Kun *et al.* where they reported higher density in the organs bearing the body weight (13). In the current study, it is assumed that physical activity led into the increase in the bone density by imposing mechanical pressure on the bone. This results are also compatible with the results of the study carried out by Mulhim *et al.* (12). In their study, similarly participants in the range age of 25 to 50 were engaged in a period of physical activity. In another similar research by Chein *et al.* approximately parallel results were obtained, the only difference was related to the period of the physical activity which was two times more than the time allocated to physical activity in the present study, another important difference to be mentioned is that the results of the current study indicated the positive effects of the shorter period of physical activity on the younger group of participants (22). In the study done by Mousavian *et al.* the effects of doing Pilates during the similar period (12 weeks) among female partisipants with age range of 60 to 65 were studied which demonstrated the compatibility with the results of the present study (23). The results of the current study approved the positive effects of doing physical activity on the total hip and femoral neck and the similar results of the study by Martyn and Carroll showed that doing impact exercise, such as walking could bring about an increase in the thigh of the Postmenopausal women (24). Correspondingly, Gusi *et al.*, studied the effects of the vibration exercises on the bone density of Postmenopausal women, according to the results of the study this type of exercise with low frequency, compared to walking, had more major effect on thigh bone density (11). In contrast the results of the current

study did not match the results of the one conducted by Smidt *et al.* and Bassey and Ramsdale in which the period allocated to doing exercise was considered to be a year (16, 25). This incompatibility can be explained by taking the intensity of the training as well as the age of the participants into account. Some other studies carried out to study the positive effect of the weight-bearing exercises and Resistance exercises on bone density correspond with the current study (22, 26), as an example the study by Rhodes *et al.* can be referred to. They reported that doing Resistance exercises for a year resulted in the increase in thigh bone density (27). By the same token, using a questionnaire to examine the level of physical activity among Postmenopausal women, Krall *et al.* reported that bone density in the body of the women who walked more than 7,5 miles a week was significantly more that those who walked only a mile during a week (28). According to the mechanical status theory suggested by Frost, the bone structure is protected by a feedback system so that increase in dynamical or mechanical pressure stimulates the bone to grow. The extent of mechanical pressure should be considered in a way that it encourages the bone reabsorption to be overtaken by bone formation and regeneration. This mechanical pressure is called minimum Pressure threshold. Taking all these into consideration, it can be concluded that probably in the current study, the intensity and the pressure of the exercise had the minimum amount in bony areas, so that it failed to decrease the bone density loss (29). As it has been already mentioned the results of the current study was either compatible or incompatible with the results of the previously conducted studies which can be explained if the importance of training session number, training period and training intensity which are important factors in bone response to mechanical and dynamical pressures are considered (30).

According to Snow *et al.*, low resistance training and high load could improve the bone density more that repeated resistance training and low load. Intensity and the period of the training should stimulate factors facilitating the process of bone regeneration (26). The lowest intensity and the shortest period which can result in the bone regeneration are respectively called the least effective intensity and time (31) . A noticeable difference observed between the results of the current study and other studies can be related to the lack of control group in some of them. When doing exercise increases the mechanical and dynamical pressure on body, it can have positive effect on the bone density (32). It should also be mentioned that different bones response differently to the mechanical and dynamical pressure to be regenerated for example, the amount of bone regeneration in thigh cortical bone is large, but this process is done slowly in the formless bone like those shaping the spinal cord. In the present study it seems that doing sport increased the bone density by imposing mechanical pressure.

Conclusion

Considering the results of this study it can be concluded that weight-bearing exercises have positive effect on the bone density. A comprehensive review of literature indicated that although there were some studies conducted on Postmenopausal women suffering from Osteoporosis, there were few researches done to survey the effect of doing exercise prior to Menopause. In accordance with the results of the this study or similar studies, doing exercise is a suitable and harmless approach to prevent bone density loss at old age, in other words, its least effect is to prevent bone density loss caused due to aging. One of the limitations of current study was that the daily Calorie intake of the participants was not controlled. Further studies are suggested to be conducted in order to examine the bone density in spines and thigh at the same time on larger number of participants during the longer period to investigate the potential effect.

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All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

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