PRE-MENOPOZAL KADINLARDA AEROBİK EGZERSİZİN KEMİK MİNERAL YOĞUNLUĞUNA ETKİSİ

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ÖZ

Amaç: Bu çalışmanın amacı, menopoz öncesi dönemdeki sedanter kadınlara uygulanan 12 haftalık aerobik egzersizin kemik mineral yoğunlukları (KMY) üzerine etkisini belirlemektir.
Yöntem: Çalışma grubu, düzenli olarak egzersiz yapmamış özel bir diyet programı uygulamayan, sağlık problemi olmayan kadınlardan oluşturuldu. Katılımcılara 12 hafta süre ile haftada 3 gün 30 dakikalık koş-yürü egzersiz programı uygulatıldı. Antrenmanın şiddeti Karvonen metoduna göre %70 olarak belirlendi. Egzersiz öncesi ve egzersiz sonrası lumbar spine bölgesinde T ve Z skorunda L1-L4, femur boynu bölgesinde T ve Z skorunda neck, trochanter, ve total KMY, kalsiyum, fosfor, alkalen fosfat, estradiol ve paratiroid hormonlarının ölçümleri yapıldı. Deneklerin ön ve son test değerlerinin karşılaştırılmaları ilişkili ölçümler için Wilcoxon işaretli sıralar testi kullanılarak yapıldı.
Bulgular: Katılımcıların (n=18) yaş, boy uzunluğu ve vücut ağırlığı ortalamaları, 44.33±2.08 yıl, 155.83±4.38 cm ve 75.44±7.76 kg olarak tespit edildi. Çalışma sonunda lumbar spine bölgesinde L1-L4 (T ve Z skorunda), kalsiyum ve fosfor değerlerinde anlamlı bir artış ($p<0.05$) tespit edilmiş, femur boynunda, alkalen fosfatta, estradiol ve parathormon değerlerinde anlamlı bir farklılık bulunamamıştır ($p>0.05$).
Sonuç olarak, menopoz öncesi dönemde yapılan düzenli ve uzun süreli orta şiddetteki aerobik egzersizlerin menopoz sonrasında daha sıklıkla görülen osteoporosis ve buna bağlı kırık oluşma riskini azaltacağı, KMY'nin korunmasında etkili olabileceği düşünülmektedir.

Anahtar kelimeler: Sedanter kadın; kemik mineral yoğunluğu; egzersiz.

THE EFFECT OF AEROBIC EXERCISE UPON BONE MINERAL DENSITY IN PRE-MENOPAUSAL FEMALES

ABSTRACT

Purpose: This study was carried out for determining the effect of 12-week aerobic exercise program upon bone mineral density (BMD) in pre-menopausal sedentary females.
Methods: The study group included females who did not do sports regularly, did not have a special diet program and had no health problem. The participants were asked to administer a 30-minute run-walk exercise program for 3 days a week during the 12-week period. The intensity of the training was determined to be 70% according to Karvonen method. Before and after the exercises, L1-L4 was measured at T and Z score in lumbar spine, and neck, trochanter, and total BMD, calcium, phosphor, alkaline phosphatase, estradiol and parathyroid hormones were measured at T and Z score in femur neck. Wilcoxon signed ranked test was performed for comparing the pre-test and post-test values of the participants.
Results: Age, height and weight averages of the participants (n=18) were determined to be 44.33±2.08 years, 155.83±4.38 cm and 75.44±7.76 kg, respectively. At the end of the study, a significant increase was determined at L1-L4 (T and Z score), calcium and phosphor values in lumbar spine ($p<0.05$); however, no significant difference was found at alkaline phosphatase, estradiol and parathormone values in femur neck ($p>0.05$).
Conclusion: In conclusion, it was possible to consider that pre-menopausal regular and long-term medium-severity aerobic exercises decreased the risk for post-menopausal osteoporosis and depending fracture formation, and were efficient on protecting BMD.

Keywords: Sedentary female, bone mineral density, exercise.

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INTRODUCTION

Because bones regenerate perpetually, they have a salient and complex tissue with high structural strength[14]. Bone is a special form of the connective tissue, and structured from a collagen mass saturated with calcium and phosphor in terms of minerals[9].

Bone mineral density (BMD) indicates the amount of mineral in the bone in grams. Bone fragility is proportional with the amount of mineral substance (Calcium, Phosphorus) and order in the structure of the bone[8]. Two main factors that determines BMD are peak bone mass forming until the adulthood and bone loss that accelerates in elderliness[6,18,20].

Because osteogenic cell activity decreases after the age of 35, most women have some bone loss every year. Osteoporosis is induced by microstructural impairment of bone and bone tissue, and this increases the risk for fractures[19].

Bodyweight is a significant part of the body mass. It has been known that weight has an effect protecting from osteoporosis. This effect is induced by a mechanical factor. Weight can cause the increase at density imposing more mechanical load on bone structure. Furthermore, fat tissue creates a hormonal effect transforming androgens into estrogens, and decreases the risk for fraction playing an absorbing role during the falling down[1,23].

Sedentary life style and insufficient exercise can cause the development of osteoporosis, and have negative effects upon BMD. Bone mineral density can decrease if no exercise is done for a long period. Bone density is protected with loading. It, physically, causes increase at mechanic stress density. Furthermore, exercising causes development in neuromuscular coordination and decreases the risk for falling and fraction. Therefore, if individuals start exercising at early ages, then they have high bone mass at advanced ages. Because exercising increases blood flow in body, nutritional flow to bones increases, as well. As result of this, nutrition of bones becomes healthy. One of the other results of this is the increase at the level of estrogen level[1,5,10,15,16].

Bone health can remarkably be protected doing exercises regularly. Peak bone mass developed during the childhood and early adulthood periods is the first determinant related to the risk for osteoporosis. Regular exercising during the adolescence period and early adulthood increases peak bone mass and causes osteoporosis to start at more advanced ages. The decrease at the level of exercising has been reported to cause an increase at osteoporotic fractures. The researchers who have reported a negative significant relationship between exercising and osteoporotic fractures have also mentioned that the individuals who have lived more actively have higher BMD[13,24].

In reference to this information, the purpose of this study was to investigate the effect of aerobic exercising upon bone mineral density in pre-menopausal sedentary females.

MATERIAL and METHOD

Research Group: The aim of this study was to determine the effects of 12-week aerobic exercise program on bone density of premenopausal women. This study was carried out with the participation of 18 healthy-volunteer women. The participants were asked to report a doctor's report that they did not have any problem about running and walking. Also, a questionnaire including health stories was applied. No diet program was given to the study group and they were asked to continue their normal diet.

Data Collection: Measurements of bone mineral densities of the study group at Gazi University Faculty of Medicine, hormone tests in the Nuclear Medicine laboratory of Gazi University School of Medicine, calcium, phosphorus and alkaline phosphatase levels were performed in the biochemistry laboratory of the Faculty of Medicine. All tests were performed twice before and after the 12-week exercise program.

Bone Mineral Density: The bone mineral density of the subjects was measured by Dual Energy X-ray Absorbtiometry (Hologic-DEXA). L1-L4 in T score, L1-L4 in Z score, neck in T score, neck in Z score, trochanter in T score, bone density in trochanter T total and Z total in Z score were examined.

Biochemistry and Hormone Analysis: A total of 10 cc of blood was collected from the participants for biochemical and hormone analyzes. The blood was kept at room temperature for 20 minutes until clotting was completed. The serum was then centrifuged at 3400 rpm. Aura-Set brand was used for calcium, phosphorus and alkaline phosphate values and ACL plus brand was used for estradiol and parathormone values.

Exercise Programe: The participants were asked to administer a 30-minute run-walk exercise program for 3 days a week during the 12-week period. The intensity of the training was determined to be 70% according to Karvonen method. Stretching and warming exercises that would increase the intramuscular heat were performed 10 minutes before the exercise and 5 minutes stretching exercises were performed at the end of the exercise.

Statistical Analysis: Nonparametric analyses can be used for dependent and independent variables under the conditions when the number of experiments is limited (30 individuals or less) or the variances are not homogenous[2]. Comparison of the pre-test and post-test values of the study group was administered using Wilcoxon signed ranks test for the relational measurements in 17.0 SPSS statistical software.

RESULTS

Table 1: Pre-post test body weight, BMI, bone mineral density, blood and hormone values of arithmetic mean and stantart aberration

Variables	Pre Test (n=18) x̄±SD	Post Test (n=18) x̄±SD
Body Weight (kg)	75,44±7,76	71,27±7,83
BMI (kg/m^2)	31,19±3,54	29,44±3,51
T L1-L4 (g/cm^2)	-0,73±1,07	-0,54±1,08
Z L1-L4 (g/cm^2)	-0,15±1,17	0,00±1,16
T Neck (g/cm^2)	-0,35±1,37	-0,22±1,37
Z Neck (g/cm^2)	0,52±1,44	0,49±1,46
T Troc. (g/cm^2)	-0,24±1,18	-0,21±1,13
Z Troc. (g/cm^2)	0,15±1,23	0,12±1,21
T Total (g/cm^2)	-0,09±1,13	-0,02±1,16
Z Total (g/cm^2)	0,32±1,19	0,38±1,25
Calcium (mg/dl)	9,12±,54	9,57±,52
Phosphorus (mg/dl)	3,34±,53	3,84±,46
Alkaline Phosphatase (U/L)	84,66±21,17	79,78±24,57
Estradiol (pg/ml)	105,88±99,15	106,34±101,90
Parathormone (pmol/L)	2,922±1,47	3,196±1,54

Table 2: Wilcoxon test results of bone mineral density pre-post test mean.

Variables	Pre Test-Post Test	n	Order Averages	Sequence Total	z	p
T L1-L4 (g/cm^2)	Negative sequence	2	1.50	3	3.43*	0.001
	Positive sequence	16	10.50	168		
	Equal	-				
Z L1-L4 (g/cm^2)	Negative sequence	2	7	14	3.11*	0.002
	Positive sequence	16	9.81	157		
	Equal	-				
T Neck (g/cm^2)	Negative sequence	6	8.25	49.50	1.57	0.11
	Positive sequence	12	10.13	121.50		
	Equal	-				
Z Neck (g/cm^2)	Negative sequence	10	8.15	81.50	0.23	0.81
	Positive sequence	7	10.21	71.50		
	Equal	1				
T Troc. (g/cm^2)	Negative sequence	8	10.13	81	0.19	0.84
	Positive sequence	10	9.00	90		
	Equal	-				
Z Troc. (g/cm^2)	Negative sequence	10	10.15	101.50	0.69	0.48
	Positive sequence	8	8.69	69.50		
	Equal	-				
T TOTAL (g/cm^2)	Negative sequence	7	8.14	57	1.24	0.21
	Positive sequence	11	10.36	114		
	Equal	-				
Z TOTAL (g/cm^2)	Negative sequence	7	9	72	0.59	0.55
	Positive sequence	11	9.90	99		
	Equal	-				

When bone mineral density was analyzed, it was noticed that there was a significant difference between pre- and post-exercise T L1-L4 and Z L1-L4 values (z=3.59, z=3.16, p<.05). No significant difference could be found in neck, trochanter and total areas at T and Z scores in femur neck (z=1.57, z=0.23, z=0.19, z=0.69, z=1.24, z=0.55, p>.05).

Table 3: Wilcoxon test results of Calcium, Phosphorus, Alkaline Phosphatase, Estradiol and Parathormone pre-post test mean.

Variables	Pre Test-Post Test	n	Order Averages	Sequence Total	z	p
Body Weight (kg)	Negative sequence	18	9.50	171	3.80*	0.00
	Positive sequence	-				
	Equal	-				
BMI (kg/m²)	Negative sequence	18	9.50	171	3.72*	0.00
	Positive sequence	-				
	Equal	-				
Calcium (mg/dl)	Negative sequence	4	7.13	28.50	2.49*	0.01
	Positive sequence	14	10.18	142.50		
	Equal	-				
Phosphorus (mg/dl)	Negative sequence	4	3.63	14.50	3.09*	0.02
	Positive sequence	14	11.18	156.50		
	Equal	-				
Alkaline Phosphatase (U/L)	Negative sequence	12	10	120	1.50	0.13
	Positive sequence	6	8.50	51		
	Equal	-				
Estradiol (pg/ml)	Negative sequence	10	10	100	0.63	0.52
	Positive sequence	8	8.88	71		
	Equal	-				
Parathormone (pmol/L)	Negative sequence	6	11.33	68	0.76	0.44
	Positive sequence	12	8.58	103		
	Equal	-				

*p<0.05

Whereas a significant increase was determined at calcium and phosphor values and a significant decrease at bodyweight and BMI values before and after the exercises (z=3.80, z=3.72, z=2.49, z=3.09, p<.05) no significant difference could be determined at alkaline phosphatase, estradiol and parathormone values (z=1.50, z=0.63, z=0.76, p>.05).

DISCUSSION

The previous studies indicated that the increase at variables related to the bones during the aging could be decreased with specific training programs. Strength, aerobic, high-intensity weight trainings and solo and multi-component exercising programs can help preventing the decrease at bone mass[11].

In this study; 18 premenopausal sedentary women with a mean age of 44.33 ± 2.08 years underwent 12 weeks, 3 days a week, 30 minutes of run-and-go exercise in 70% of the target heart rate. At the end of the program, a significant decrease in body weight and BMI values of the participants and a significant increase in calcium and phosphorus values were observed. There was no significant difference in alkaline phosphate, estradiol and parathormone values.

In a previous study, 12-week aerobic exercise was performed to the male and females with 41.6 age average and 27.3kg/m^2 BMI average, and at the end of the program it was reported that there was a significant decrease at BMI average at the end of the program[3]. Fat mass, which is an important component of body weight, is directly related to decreased bone mineral density and fracture risk. In a study carried out before, the relationship between bodyweight, BMI, abdominal fat and femur neck bone mineral density was investigated, and it was determined that bodyweight and BMI had a significant relationship with femur fracture in females; however, this relationship did not depend upon the bone mineral density of femur neck[17].

In another study, middle age women had 6-week endurance exercise, and at the end of the program, women's body weight, body fat and BMI decreases in the rate of 2.2%, 1.3% and 3.4%, respectively[22].

Asomaning et al. (2006) determined that 1 unit change in BMI (nearly 5-8 lb.) was more efficient rather than the other changeable risk factors for protecting and increasing the bone mineral density. As a result of this finding, in order to help reduce the risk of osteoporosis, it has been suggested that it should be recommended to maintain normal weight.

If BMD reaches to critical values, precautions to protect spine and hip should be taken. These are mentioned as regular physical exercising, avoiding from or decreasing smoking, alcohol, caffeine, sugar, salt, proteins, fats, phosphate and fibrous foods, and having ideal bodyweight appropriate to height stimulating the bone formation at a sufficient rate[12].

In our research, it was noticed that there was a significant difference at pre- and post-exercise T L1-L4 and Z L1-L4 values of the participants. This observed difference was determined to be in favor of positive ranks, namely of post-exercise values. According to these results, it can be said that aerobic exercise program increases bone density in L1-L4 regions in T and Z scores. No statistically significant difference could be found in neck, trochanter and total areas at T and Z scores in femur neck.

Combined exercises including the combination of aerobic, balance and coordination exercises were administered to the females over 45 years old for two days a week during a 12-month period, and it was emphasized at the end of the program that muscle strength and walking abilities besides the bone density increased, and the risk factors for the fractures decreased[7]. In another study, various dynamic loading exercises program was administered to distal forearm for three days a week during the 5-month period to post-menopausal osteoporotic females (n=14), and it was reported at the end of the study that there was a 1.9% decrease at average bone density of the control group and 3.8% increase in the exercising group[21].

In another study, 18 females who previously did gymnastics and 15 females who did no previous sportive activities were evaluated. In measurements, it was noticed that the females who did gymnastics before had higher BMD. At the end of this research, it was determined that gymnastics had a significant effect upon individuals' reaching to peak bone mineral density, and also had positive effect upon BMD at advanced ages[24].

CONCLUSION

When considering the results, it was determined that regular, medium-severity exercises performed during the pre-menopausal period caused a significant increase at bone mineral density. It was considered that, osteoporotic vertebra and femur fractures possible to appear during the post-menopausal period could be prevented with such exercising programs.

Accordingly, it will be possible to minimize social and economic loses that are likely to appear depending upon common bone pains and fractions induced by post-menopausal osteoporosis if the importance of regular, permanent easy-to-perform exercising is explained to the females in their premenopausal period in details, and these are started to be performed.

Life means acting and humankind has maintained development by acting as of the date they are born. During this development process, bone mineral density of human that starts to walk is possible to change depending upon nutrition, hormonal status and several other factors. The increase at density of the bones due to loading was also indicated in this study. It was possible to mention that supporting any kinds of medical treatments (hormone replacement therapy, medication regulating osteonecrosis and bone formation) to prevent osteoporotic fractures with regular, permanent and individual-specific exercising programs was more beneficial.

References

1. Aksu NT., Erman A., Düşük Kemik Mineral Yoğunluğu Olan Kadınlarda Kuramlar Üstü Modelin Egzersiz Yapma Alışkanlığı Kazandırma Üzerine Etkisinin İncelenmesi. Yüksek Lisans Tezi, Akdeniz Üniversitesi Sağlık Bilimleri Enstitüsü, Antalya, 2012.

2. Alpar R., Spor Bilimlerinde Uygulamalı İstatistik, Nobel Yayın Dağıtım, Ankara, 2001.

3. Amano M., Kanda T., Ue H., Maritani T., "Exercise Training and Autonomic Nervous System Activity in Obese Individuals", *Medicine Science in Sports Exercise*, 33(8), pp.1287-1291, 2001.

4. Asomaning K., Bertone-Johnson ER., Nasca PC., Hooven F., Pekow PS., "The Association Between Body Mass Index and Osteoporosis in Patients Referred for A Bone Mineral Density Examination", *J Womens Health (Larchmt).* 15(9), pp.1028-34, 2006.

5. De Laet C., Reeve J., "Epidemiology of Osteoporotic Fractures in Europe. Osteoporosis", *San Diego Academic Press*, pp.585-597, 2001.

6. Dilşen G., Göksoy T., Barden HS., Selim N., İşsever H., "Sağlıklı Türk Toplumunda Kemik Mineral Yoğunluğu Değerleri", *Aktüel Tıp Dergisi,* 6, pp. 96-108, 2001.

7. Englund U., Littbrand H., Sondell A., Pettersson U., "A 1-Year Combined Weight-Bearing Training Program is Beneficial For Bone Mineral Density and Neuromuscular Function in Older Women", *Osteoporosis International*, 16(9), pp.1117–1123, 2005.

8. Erselcan T., Özen A., Yüksel D., Durmuş Altun G., Öztürk E., Balcı TA., Karayalçın B., "Kemik Mineral Yoğunluğu Ölçümü Uygulama Kılavuzu", *Turk J Nucl Med*. 18(1), pp.31-40, 2009.

9. Ganong G., Tıbbi Fizyoloji, Doğan A(eds). Barış Kitabevi, İstanbul, 1994.

10. Gerend MA., Mindy JE., Aiken LS., Maner JK., "Reasons and Risk: Factors Underlying Womens Perceptions of Susceptibility to Osteoporosis", *Maturitas.* 55, pp.227-237, 2006.

11. Gómez-Cabello A., Ara I., González-Agüero A., Casajús JA., Vicente-Rodríguez G., "Effects of Training on Bone Mass in Older Adults", *Sports Medicine.* 42(4), pp.301–325, 2012.

12. Gürlek YS., Kalaycıoğlu A., Postmenopozal Kadınlarda Vücut Kitle İndeksinin Kemik Mineral Yoğunluğu Üzerindeki Etkisi. Yüksek Lisans Tezi, Karadeniz Teknik Üniversitesi Sağlık Bilimleri Enstitüsü, Trabzon, 2015.

13. Kohrt WM., Bloomfield SA., Little KD., Nelson ME., Yingling VR., "American College of Sports Medicine Position Stand: Physical Activity and Bone Health", *Medicine Science in Sports & Exercise*, 36, pp.1985-1996, 2004.

14. Kumar V., Cotran RS., Robbins LS., Temel Patoloji. 5th ed., Nobel Tıp Kitabevi, İstanbul, 1984.

15. Mallmin H., Ljunghall S., Persson I., Bergström R., "Risk Factors For Fractures Of The Distal Forearm: A Population-Based Case-Control Study", *Osteoporosis International.* 4(6), pp.298-304, 1994.

16. Marcus R., The Mechanism of Exercise Effects on Bone. Principles of Bone Biology, Academic Press, San Diego. 1435-45, 1996.

17. Nguyen ND., Pongchaiyakul C., Center JR., Eisman JA., Nguyen TV., "Abdominal Fat and Hip Fracture Risk in The Elderly: The Dubbo Osteoporosis Epidemiology Study", *BMC Musculoskelet Disord*. 23, 6:11, 2005.

18. Onat ŞŞ., Delialioğlu SÜ., Özel S., "Osteoporoz Risk Faktörlerinin Kemik Mineral Yoğunluğuyla İlişkisi", *Türk Osteoporoz Dergisi.* 75,19, pp.74-80, 2013.

19. Oral O., Hasdemır PS., Isık O., Yıldız M., Dınc N., Suza A., "Osteoporosis and Exercise", *TURAN-SAM Uluslararası Bilimsel Hakemli Dergisi.* 8(29), pp.1309-4033, 2016.

20. Raisz LG., "Pathogenesis of Osteoporosis: Concepts, Conflicts, and Prospects". *J Clin Invest.* 115, pp.3318-25, 2005.

21. Simkin A., Ayalon J., Leichter I., "Increased Trabecular Bone Density Due To Bone-Loading Exercises in Postmenopausal Osteoporotic Women", *Calcified Tissue International*. 40(2), pp.59-63, 1987.

22. Szmedra L., Lemura LM., Shearn WM., "Exercise Tolerance, Body Composition and Blood Lipids in Obese AfricanAmerican Woman Following ShortTerm Training", *The Journal of Sports Medicine and Physical Fitness.* 38(1), pp.59-65, 1998.

23. Yanık B., Atalar H., Külcü DG., Gökmen D., "Postmenopozal Kadınlarda Vücut Kitle İndeksinin Kemik Mineral Yoğunluğuna Etkisi", *Osteoporoz Dünyasından.* 13:569, 2007.

24. Yılmaz E., Bayan Sporcularda Egzersizin Kemik Mineral Yoğunluğu Üzerine Etkisinin Belirlenmesi. Yüksek Lisans Tezi. Selçuk Üniversitesi Sağlık Bilimleri Enstitüsü, Konya, 2013.