

Effect of Pilates Exercise Training on Serum Osteocalcin and Parathormone levels in inactive and overweight women

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Abstract

Introduction: Experimental evidence suggests positive effects of physical activity on skeletal mass. Biochemical markers determine the response rate of bone metabolism to physical activity. Therefore, the aim of this study was to investigate the effect of Pilates exercise training on serum osteocalcin and parathormone levels in inactive and overweight women.

Methods: 28 healthy overweight women participated in this quasi-experimental study. They were randomly divided into two groups: exercise group (n=14) and control group (n=14). Pilates exercise training was performed during 12 weeks (3 sessions per week, 60 min per session). Blood samples of osteocalcin and parathormone were collected in two stages of fasting, 48 hours before and after exercise. The serum levels of osteocalcin and parathormone was measured by the ELISA method. For analyzing within-group data and between-group data paired t-test and ANCOVA test were performed, respectively.

Results: Post-test data showed a significant increase in osteocalcin (P=0.017) and parathormone levels (P=0.015) compared to pre-test data. But in between group comparison, only a significant increase in the amount of osteocalcin in exercise training compare to control group was observed (P=0.03).

Conclusion: Based on the results, three months of Pilates exercise training program can change some biochemical markers levels of bone metabolism in inactive and overweight women. In this regard, Pilates exercise may reflect some mechanisms involved in the positive effect of physical activity on bone mass.

Key words: Osteocalcin, Parathyroid Hormone, Overweight

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Introduction:

Based on the researches results about 40 percent of a woman's life is threatening by the risk of bone fracture (1). Bone is an alive tissue. With an imbalance between the markers of bone metabolism it becomes osteoporosis.

Osteoporosis is defined as a reduction in bone mass and an impairment of bone architecture resulting in thinning and increased cortical porosity, bone fragility and fracture risk. Analysis of the fine structure of bone and decreased bone

density leading to the loss of mechanical strength, bone fragility and at the end resulting bone fractures. Now this disease is one of the numerous public health problems in the world. The rate of bone fractures due to low bone density is over than incidents of cancer and stroke (2-5). Among the environmental effective factors, eating habits and physical inactivity, exercise plays the main role in development of this disease. Exercise and sport are regarded as non-pharmaceutical method to obtain the highest

bone density during youth for improvement of bone density and prevention of bone density loss during old age. In this regard, findings show that continual physical activities particularly the exercises which put pressure on bone or have high bone load cause bone density and increase formation of bone. While the increase in bone formation due to exercise is considered responsible for increasing the structural-level mechanical properties of bone, the coinciding increase in tissue-level mechanical properties and fracture toughness have been attributed to changes in both the mineral and matrix composition (6, 7).

Biochemical markers assesses dynamic changes in bone function. One of them is osteocalcin that plays an important role in calcium absorption, and other one is parathormone hormone (PTH) (8).

Osteocalcin is a special marker of osteoblasts' function, major part is placed in the bone extracellular matrix after the synthesis and a little part enters the blood flow (9). Osteocalcin is the major non-collagenous protein in bone matrix produced by osteoblasts and dentin cells (10). PTH is the major hormone regulating calcium metabolism and is involved in both catabolic and anabolic actions on bone. Intermittent PTH exposure can stimulate bone formation and bone mass when PTH has been injected. In contrast, continuous infusion of PTH stimulates bone resorption (11). PTH hormone plays a role in regulating organic hemotacetic phosphate and plasma calcium ions by stimulating the activity of osteoclasts, stimulating the reabsorption of calcium in kidney cells, and unexpectedly increasing calcium intake in the intestine by stimulating the production of active form of vitamin D. Limited studies indicate that this hormone increases insulin sensitivity and improves glucose metabolism (12, 13). Recent studies have shown that physical activity can affect biochemical markers and bone metabolism, including osteocalcin and PTH, and thus help maintain bone density in men and women, as well as in energy metabolism (14, 15).

Physical activity seems to affect the structure of bones through three mechanisms: The first mechanism has a direct effect on bone, thus transmitting biological signals through

mechanical receptors, the second mechanism is the indirect effect of muscle mass: The secondary mechanism affects mechanical receptors, and the last mechanism is the indirect effect of hormonal changes (19). The third mechanism examines the effects of hormones which one of the most important of them is PTH hormone. On the one hand, studies have shown that there are contradictions in the results of bone regeneration and metabolism, and that the best type of exercise activity is not specified for bone optimization, and on the other hand Pilates exercise training is one of the methods of motion therapy that has recently been developed. Therefore, considering the importance of these two markers of bone metabolism, the limitation and contradiction in the results of the researches with the aim of the effect of training on bone metabolism, as well as the lack of studies in the field of long-term Pilates exercise training, more researches are required to evaluate the effect of long term Pilates exercise training on health. In light of these evidences, the aim of the current study was to investigate the effect of Pilates exercise training on osteocalcin and parathormone levels in inactive and overweight women.

Methods:

The present study is a semi-experimental design with pretest-posttest design which was conducted at Ahvaz sport club. The statistical population was inactive overweight women in Ahvaz city with the age of 25 to 35 years old and BMI between 25 and 29 kg/m². Volunteers were recruited by using local advertisements. Among them, 28 people were selected. By completing the consent form for collaborative research work, the subjects expressed their readiness to participate in the study. The exclusion criteria for the exercise intervention were: no smoking and no drinking alcohol, lack of thyroid disorders, any functional limitation or chronic disease that might have limited training and testing of the cardiovascular, musculoskeletal, or respiratory systems; any disease or medication known to affect bone metabolism; pregnancy or breast feeding; and current or previous participation in impact-type exercise. In addition, the lack of regular exercise during the past 6 months and the ability to perform exercise activities were

conditions for entering the research. The women were divided randomly into two groups (training group and control group) of 14 persons. The training program consisted of 12 weeks Pilates exercise training (20) 3 sessions per week and 60 minutes each session. Each training session included three steps: 1) warming up (15 minutes); 2) Pilates exercise training (35 minutes); 3) returning to the initial state (10 minutes). These exercises were divided into the first part of the training on the mattresses (the first 6 weeks) and the second part of the exercises using rubber band and ball (the second 6 weeks) (Table 1). The movements began to be simple, and their intensity and complexity were continued to increase. Exercise intensity was measured by the Borg index. The intensity of exercise in the warming up and cooling down was 10-8 RPE, and during the main exercises from the first week to the last week (18-10 RPE) was gradually increased. The exercises were initially steady, then continued sat and slept. The control group did not have activity during this period and were asked to continue their normal daily lives. Before starting the exercise, height, weight, WHR (waist circumference [cm]/hip circumference [cm]) and BMI were measured and using body composition measuring device for all participants. Blood samples were taken 48 hours before and after the last session of exercise training. After 12 hours fasting, 5 ml of blood from each person's vein was taken between "8-9" o'clock in the morning. Centrifugation was performed at 3000 rpm for 10 min, the serum was isolated and stored at -70 C. The serum level of osteocalcin (Elisa kit manufactured by Zellbio, Germany), and the serum level of PTH was

measured by the ELISA method (Elisa kit manufactured by Zellbio, Germany). For all data, the mean and standard deviation for each group were calculated. Descriptive statistics were used to show the mean and standard deviation.

The normal distribution of data was studied by using Shapiro Wilkes test. After assuring the normality and homogeneity of the groups, paired t-test and ANCOVA test were used to examine for within-group changes from pre-data to post-data and between-group differences, respectively. All data are expressed as $\text{mean} \pm \text{standard deviation}$. The significance level of statistical tests was defined at $P \leq 0.05$. Data were analyzed by SPSS version 23 software.

Results:

All the participants completed the three months Pilates exercise training. The anthropometrics and some bone biochemical characteristics information are presented in tables 1 and 2. Prior to commencement of the program, the results of this study showed that, after 12 weeks of Pilates exercise training, serum levels of osteocalcin were significantly increased in within-group changes ($P=0.017$) and in between-groups changes ($P=0.015$). This changes were significantly higher than those in control group. But serum levels of PTH were significantly increased only in within-group comparisons ($P=0.036$), while there was no significant difference in between-groups changes ($P=0.052$). With regard to the changes in bone metabolism markers after the 12-week exercise program, weight, BMI and waist-hip ratio were decreased significantly ($P \leq 0.05$) in training group compare to control group (Page number; 14).

Table 1. Anthropometric indicators of the subjects, before and after exercise

Index	Group	Pre-data	Post-data	Within group P	Between group P
Age (year)	Control	29.6±3.6	29.6±3.6		
	Training	30.1±4.0	30.1±4.0		
Height	Control	165.7± 3.3	165.7±3.3		
	Training	165.7±3.3	165.7±3.3		
Weight	Control	77.1±3.2	75.7±3.2	*0.003	#0.005
	Training	73.5±4.1	72.5±3.2	0.093	
BMI (kg/m ²)	Control	28.0±0.8	27.5±1.1	*0.002	#0.008
	Training	26.5±0.9	26.8±1.1	0.096	
WHR	Control	0.95±0.05	0.92±0.04	*0.011	#0.001
	Training	0.96±0.02	0.97±0.01	0.094	

Table 2. Serum level of PTH and osteocalcin before and after exercise

Index	Groups	Before	After	Within-group		Between-group	
		(M±SD)	(M±SD)	T	P	F	P
Osteocalcin (pg/l)	Training	10.07±0.74	11.64±0.90	-2.75	#0.017	6.83	*0.015
	Control	8.42±0.54	8.28±0.60	0.273	0.789		
Parathormone (ng/l)	Training	22.21±1.04	24.50±1.27	-2.332	#0.036	4.14	0.052
	Control	18.28±0.94	18.35±1.09	-1.130	0.912		

#Significant difference (P<0.05) between before and after 12 weeks of exercise training; *significant difference (P<0.05) between training group (n = 14) and control group (n = 14).

Conclusion:

Exercise performance reportedly has great effects on bone formation. The aim of this study was to investigate changes of serum osteocalcin and PTH levels in inactive overweight women after three months of Pilates exercise training. The main purpose of these exercises is to increase muscle strength, flexibility, balance and physical condition. In fact, Pilates exercise is a useful method for practicing mind, body, and position control (21). In Pilates, a person first takes complete control of his body and then, through repetition of movements in a gradual but in a progressive manner, achieves a natural kind of coordination (22). Only a few controlled prospective trials on the long term effect of impact exercise on bone metabolism have been conducted. Recent findings showed a significant increase in osteocalcin hormones after 3 months of Pilate's fitness exercises compared to the control group. Based on the result of the current study, increasing in osteocalcin levels is consistent with some other studies such as Ghorbanian and Barani (2017) (23), and Kim et al (2015) (24). In the study conducted by Ghorbanian and Barani (2017), a correlation between osteocalcin and PTH serum with glycemic, lipid and adipocyte parameters after 10 weeks of aerobic training in women with type 2 diabetes was showed, Based on the results of their study, the amount of osteocalcin was significantly increased after 10 weeks of aerobic training. It seems that one of the main mechanisms that exercises increase the levels of osteocalcin is: activity of bone cells and its response to exercise mechanical stress that causes secretion of osteocalcin from the bone cells and the latter is discontinuation of energy metabolism during physical activity (25, 26). The changes in osteocalcin is not consistent with Nowak et al (2008) (27) and Wiczorek-

Baranowska et al (2012) (28). In general, the contradictory findings of the studies that are being investigated show that the effects of exercise training on bone metabolism affected by many factors, such as the type of exercise activity (e.g. weight bearing), age and sex of subjects may respond bone metabolism indices which affected by the exercise training. In addition, other factors like genetic characteristics, nutrition and hormonal status of subjects seem to be influenced exercise responses. (29, 30). Another aim of the current research was to measure the serum level of PTH variable, which showed a significant increase only in within group comparisons and did not show a significant difference in comparison between groups (P<0.05). PTH is one of the hormones involved in stimulating, forming and absorbing of bone and is one of the most important bone regulators. The most important physiological role of this hormone is to preserve hemostatic calcium ions and inorganic phosphate via the receptor associated with kidney, bone and bowel proteins (31). Various exercises such as running on treadmill, jumping, and resistance exercises have various mechanisms for activating bone cells. Some dynamic activity studies have been considered as the best exercise for young people and adolescents because of their effect on bone mineral. Scott et al (2010) have shown that short-term and exhausting exercises on treadmill have significantly increased their parathyroid hormone levels, while their values 1 to 2 hours after exercise is reduced to baseline values (32).

In some studies, the increase in the level of PTH was followed by exercise activities: Barry et al (2007) (33), Bouassida et al (2003) (34) in young subjects, Hassanzadeh et al (2013) (35) which were disagree with the results of this research. Some reasons for contradiction in the results of various research are differences in the

type, intensity, duration and repetition of activity as well as the amount physical fitness and age of different people. The intensity and amount of exercise pressure are the main cause of the contradiction of the response Parathyroid hormone which has been investigated. So that, in most researches that exercise causes increase parathyroid hormone levels, adequate exercise intensity has been known as an important reason for increasing in the amount of hormone changes Parathyroidism (Parathormone) (23). It has been said that one of the reasons for the increase in the PTH after exercise is metabolic acid (32). It has been pointed out that acidosis has a direct effect on the increase of parathormones, which is independent of calcium. The proposed mechanisms for reducing calcium and increasing the pituitary hormone interactions due to exercise activity are increased calcium excretion by sweating, increased concentration of hydrolysate released phosphate and muscle creatine phosphate which attaches to ionizing calcium (36). The results of this study is the same with Evans et al (2008) (37), in male athletes and Lester et al (2009) (38). Based on research results of Evans et al (2008) (38) levels of PTH did not change significantly in young athletes after exercises. In addition, Maimoun et al (2011) suggested that an increased stimulation threshold for increasing PTH levels in exercise should be considered as an anabolic agent in bone turnover (39). So it seems that the intensity of exercise in the present study was not enough to stimulate this effect.

In summary, there were some limitations such as low numbers of subjects, dietary control, hereditary and psychological factors that may affect the findings of the research. Therefore, with all the limitations, it seems that the results of the present study program is argued an increase in some biochemical markers of bone after 12 weeks Pilates exercise training. Our results emphasize the necessity of continuous training to achieve bone benefits.

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تأثیر تمرین ورزشی پیلاتس بر سطوح سرمی استئوکلسین و پاراتورمون در زنان غیرفعال دارای اضافه وزن

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چکیده

مقدمه: شواهد تجربی نشان‌دهنده آثار مثبت فعالیت بدنی بر توده‌ی اسکلتی است. مارکرهای بیوشیمیایی میزان پاسخ متابولیسم استخوان به فعالیت بدنی را تعیین می‌کنند. از این رو، هدف از مطالعه حاضر تأثیر تمرین ورزشی پیلاتس بر سطوح سرمی استئوکلسین و پاراتورمون در زنان غیرفعال دارای اضافه وزن بود.

روش کار: در این مطالعه نیمه تجربی، ۲۸ زن دارای اضافه وزن شرکت کردند و به طور تصادفی به دو گروه تمرین پیلاتس (۱۴ نفر) و گروه کنترل (۱۴ نفر) تقسیم شدند. برنامه تمرینی (شامل ۳ جلسه در هفته، با زمان ۶۰ دقیقه در هر جلسه) تمرین ورزشی پیلاتس به مدت نوازده هفته بود. نمونه خونی در حالت ناشتا طی دو مرحله، ۴۸ ساعت قبل و پس از تمرینات گرفته شد. از روش اندازه‌گیری الایزا برای سنجش سطوح استئوکلسین و پاراتورمون استفاده گردید. آزمون آماری تی وابسته و آزمون تحلیل کوواریانس به ترتیب برای بررسی اختلاف درون گروهی و اختلاف بین گروهی داده‌ها استفاده گردید.

نتایج: نتایج پس‌آزمون نشان‌دهنده افزایش معنی‌دار در سطوح استئوکلسین ($P=0/017$) و پاراتورمون ($P=0/015$) در مقایسه با پیش‌آزمون بود. اما در مقایسه بین گروهی فقط افزایش معنی‌دار در میزان استئوکلسین گروه تمرین نسبت به گروه کنترل مشاهده گردید ($P=0/03$).

نتیجه‌گیری: از نتایج چنین استنتاج می‌گردد که سه ماه برنامه تمرین ورزشی پیلاتس می‌تواند باعث تغییر برخی از مارکرهای بیوشیمیایی متابولیسم استخوان در زنان غیرفعال دارای اضافه وزن گردد. در این راستا، ورزش پیلاتس منعکس‌کننده مکانیسم‌هایی است که بیان‌کننده تأثیر مثبت فعالیت بدنی بر توده‌ی استخوانی است.

کلیدواژه‌ها: استئوکلسین، هورمون پاراتیروئید، اضافه وزن

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