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European Journal of Experimental Biology, 2014, 4(5):72-75

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Effect of resistance training and intake of calcium and phosphorous on bone density of the nonathletic adolescents

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ABSTRACT

The aim of this research was to investigate effect of resistance training and intake of calcium and phosphorous on bone density of the nonathletic adolescents. For this purpose, 30 volunteer nonathletic adolescents with mean age of 17.60 ±0.3, weight of 61.31±5.95, height of 162.7±6.21 cm , BMI of 23.37±1.96 kg/m^2 were randomly divided in three groups each including 10 people i.e. resistance exercise , resistance exercise and intake of calcium and phosphor and control group. The resistance exercise programs with intensity of 60 to 80% of a maximum repetition were performed for 8 weeks and 3 days per week. The blood samples of each group of subjects were taken separately before and after completion of the resistance exercise protocol and resistance exercise with intake of supplement for measurement of indices of bone density , Osteocalcin, parathyroid , Alkaline phosphatase, calcium and phosphor in specialized laboratory. Statistical analysis was done with dependent t-test for intragroup changes and one-way ANOVA test was performed to study difference between groups in alpha level of 0.05. Results of this research in the resistance exercise group and resistance exercise group with supplement intake showed significant increase in levels of osteocalcin, parathyroid, alkaline phosphatase, calcium and phosphor and this increase in the resistance exercise group with calcium and phosphor supplement intake was higher than that in resistance exercise group. Therefore, based on results of this research, it can be mentioned that intake of calcium and phosphor supplement along with resistance exercise led to more increase of osteocalcin, parathyroid, alkaline phosphatase, calcium and phosphor of the body compared with the resistance exercise alone.

Key words: osteocalcin, parathyroid, alkaline phosphatase, resistance exercise, calcium and phosphor supplement

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INTRODUCTION

Osteoporosis is accompanied by reduction of bone density and destruction of bone microstructures leading to increase of bone fracture. This complication as spread disease leads to reduction of mineral bone density and transformation of bone microstructures[1]. Today, some of the food and therapeutic diets can be absolutely executed through the extensive studies relating to role of some factors in creation and progress of osteoporosis[1, 2]. Among the environmental effective factors, eating habits and physical inactivity and sport play 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[3, 4]. Today, some of the food and therapeutic diets can be absolutely executed through the extensive studies relating to role of some factors in creation and progress of osteoporosis. For example, physical activity has been considered as a factor affecting change of bone markers considering role of calcium and phosphor regarding bone density[5]. In this regard, findings show that continual physical activities particularly the sports which put pressure on bone or have

high bone load cause bone density and increase formation of bone which probably results from increase of calcium ion postruminal absorption and reduction of calcium urinary excretion and increase of parathyroid levels[6, 7]. On the contrary, immobility and complete bed rest increase osteoporosis during which parathyroid level is also reduced. As a result, continual physical exercises can prevent osteoporosis and reduction of density and bone density[1, 8].
In the conducted researches on effect of exercise on bone density and its markers, there is increase in serum level of osteocalcin and alkaline phosphatase along with execution of resistance activity[9-13]. In a research, concurrent effect of calcium and resistance training on bone density of healthy children aged 7-16 years was studied and increase of bone density due to this exercise protocol was observed [10]. Therefore, considering that combination of physical activity with other nutritional and pharmaceutical strategies may increase strategic effect of prevention and treatment of osteoporosis, therefore, goal of this research is to study effect of 8-week resistance exercise along with calcium and phosphor supplement intake on bone markers of Alkaline phosphatase, osteocalcin, parathyroid , phosphor and calcium in nonathletic adolescents.

MATERIALS AND METHODS

Subjects

the statistical population of the research included inactive healthy adolescents aged 17-18 years in Qom city. The subjects included the healthy adolescents who didn't participate in any physical activity. All participants first received the written information about the research and after the study, they were asked to sign letter of consent. The present research was conducted under supervision of specialist and exercise physiologists and all subjects didn't have any cardiovascular diseases, hypertension, diabetes and renal diseases by completing PARQ questionnaire and medical history questionnaire. Then, 30 inactive healthy adolescents were selected among the qualified volunteers participating in the research. The subjects became familiar with physical activity in a session. Then, the subjects were randomly divided in three groups each including 10 people i.e. resistance trainig, resistance training and intake of calcium and phosphor and control group.

Table 1: General specifications of subjects of three groups

Variable groups	Age (year)	Height (cm)	Weight (kg)	BMI (kg/m^2)
Resistance training	17.6±0.38	161.1±5.98	60.35±6.21	23.15±2.16
Resistance training and intake Supplements	17.55±0.48	161.3±6.00	62.45±4.97	23.99±1.75
Control	17.65±0.40	166.4±5.85	63.15±7.47	23.99±1.75

Resistance training protocol

This resistance exercise protocol includes 8-week exercise along with front leg extension, hamstring extension, back squat, biceps, triceps, halter, deadlift and sit-up exercise in steep or flat surface. Front leg extension with intensity of 50% IRM in two sets with 8 movements when the subject feels to be ready for another movement and 70% IRM in two sets with 8 movements and 80% in two sets with 8 movements. Hamstring extension is performed with the same intensity of front leg extension and the same intensities. These exercises are performed within 2 weeks. In the third week, back squat with intensity of 5%, 70% and 80% is performed with the same number of front leg extension. Biceps movement with halter was performed with intensity of 50% with one set of 10 movements and 60% with one set of 10 movements and 70% with one set of 10 movements with the same number and percent as that in triceps exercise with halter. Deadlift exercise was performed in the first movement (50% in two sets with 3 movements and 60% in one set with 3 movements, 70% in one set with 3 movements and 80% in two sets with 3 movements). At the end, sit-up movement was performed in four sets with 15 movements of hands beside body or on the ears or neck.

Supplement and its intake

After determination of the research groups, one calcium tablet which contains 1000 mg of calcium under brand of Health burst made in America along with phosphorus effervesnt Tab under brand of Health Burst which contains 500 mg of phosphor were given to the subjects of supplement group and exercise group every day. The intake rate was selected based on the information in history of the researches and views of the nutritionists based on the Iranian population (15).

Blood measurement

All dependent variables were measured in two pretest and posttest stages. 5 mm of the blood samples were taken from Antecubital vein by laboratory sciences specialists and temperature of blood sampling place was recorded 22 ˚C in both stages. Serum levels of calcium (mmol/L), parathormon (pmol/ml), phosphor (mmol/L) and alkaline phosphatase (international unit in liter) were measured in base state (before start of exercise plan) at the end of the eighth week. To prevent acute effects of the participation in the exercise plan and intake of supplement on results of

the research, all measurements were done in the posttest stage after completion of exercises (with time interval of 24 hours after the last stage of exercise with intake of supplement). Serum level of calcium and phosphor was determined with analyzer (Bayer USA), serum levels of parathormon and osteocalcin were determined with Immulite, Diagnostic products corporation and with Diagnostic products corporation,USA and serum levels of Alkaline phosphatase were measured with photometry method.

Statistical research method

After ensuring normality of the data distribution with Kolmogorov–Smirnov test, independent t-test and One-way ANOVA were used to study effect of independent variables on dependent variable and in case of significance, Tukey post hoc test was used to determine difference between groups. All statistical research operations were considered with SPSS software, version 16 and significance level of $P<0.05$.

RESULTS

Results of this research showed that there was significant difference between resistance exercise group and resistance exercise group with intake of osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor from pretest to posttest stage. So, rate of these variables significantly increased after 8-week exercise in both experimental groups while no intragroup difference was found in the research variables (Table 2).

Table 2- Within group difference of the research variables in three groups

Groups	Stages	Calcium (mg/dl)	Phosphor (mg/dl)	Alkaline phosphates (U/L)	Parathyroid (pg/ml)	Osteocalcin (ng/ml)
Resistance training	Pre test	9.78±0.73	3.7±0.47	207.3±11.72	86.59±6.9	23.53±2.8
	Post test	10.14±0.62	4.13±0.34	224.4±13.22	108.5±13.9	32.48±2.3
	P within group	0.061	0.032	0.007	0.001	0.001
Resistance training and intake Supplements	Pre test	9.48±0.43	4.14±0.52	168.5±26.21	68.8±21.04	23±2.01
	Post test	9.95±0.6	4.64±0.38	199.3±30.05	92.7±20.4	27.51±1.01
	P within group	0.251	0.028	0.017	0.020	0.001
Control	Pre test	9.67±0.62	3.81±0.44	191.75±23.7	70.69±21.43	23.41±4.72
	Post test	9.54±0.52	3.85±0.40	181.1±22.7	69.68±22.1	22.84±2.5
	P within group	0.362	0.59	0.48	0.94	0.32

Results of within group analysis of the research data showed that there was significant difference in levels of osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor between the resistance group and supplement – resistance group in the posttest stage so that more increase was found in levels of osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor than the resistance group. In the resistance group and supplement – resistance group, there was significant difference in levels of osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor than the control group (Table 3).

Table 3- Tukey test results to determine difference between groups

Groups	difference between groups	Calcium (mg/dl)	Phosphor (mg/dl)	Alkaline (U/L)phosphates	Parathyroid (pg/ml)	Osteocalcin (ng/ml)
Resistance training and intake Supplements	Resistance training	0.981	0.004	0.001	0.021	0.045
	Control	1.2	0.58	0.53	0.46	0.41
Resistance training	Resistance training and intake Supplements	0.981	0.004	0.001	0.021	0.045
	Control	1.07	0.55	0.51	0.48	0.40

DISCUSSION

The present research showed that participation in resistance physical activities and intake of supplement had significant effect on indices of bone density such as osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor and didn't have significant effect on index of bone density of calcium. Results of research by Rei, fujimura et al. (1996), Vincent et al. (2002), Lestermi et al. (2009) showed that performance of resistance physical activity significantly increased blood osteocalcin. Results of the present research are in line with findings of these researchers. It seems that resistance training increase pressure on muscles and bones, stimulate osteoblasts and increase osteocalcin considering that the osteoblasts make osteocalcin[7, 10, 14].

Results of researches by Bouassida et al. (2006), Chilibeck (2013) showed that performance of resistance sport significantly increased parathyroid hormone[6, 15]. The present results are in line with findings of these researchers. Considering the conducted researches in this regard, it seems that resistance exercise increases bone density which

results from periodical absorption of calcium and reduction of Urinary calcium excretion and increase of PTH levels. On the contrary, immobility and immobility and complete bed rest increase osteoporosis during which PTH level is also reduced. As a result, continual resistance training can prevent osteoporosis and reduction of bone density[16, 17]. Results of researches by Ruiz, jc.et al. (1995), Maïmoun et al. (2008), Prentice (2005) showed that performance of resistance training significantly increased ca of blood after resistance exercises[3, 18, 19]. Considering the conducted studies, resistance training have considerable effect on strength of bones and strengthen bones and increase bone density. Resistance training strengthen muscles against gravity and with high pressure on bones and joints and help make and protect bone in addition to bone strengthening. Daily intake of calcium with rate of 800 mg from 20 to 30 years and 1200 mg from 10 to 20 years and participation in resistance training in which feet tolerate weight help the person increase bone density. Calcium in bone skeleton stabilizes them and also acts as a reservoir which sometimes should regulate concentration of extracellular liquid calcium. Calcium along with vitamin D is more absorbed and reaches bone through blood flow and increases bone density[5]. Results of researches by Maïmoun et al. (2008) showed that performance of resistance training significantly increased blood phosphor after the resistance exercise[3]. Considering the conducted researches, the resistance physical training increase bone density and intake of enough phosphor with rate of 100-500 mg/day helps person increase bone density[20].

CONCLUSION

Generally, results of this research showed that performance of resistance exercise and resistance exercise with calcium and phosphor supplement intake increases levels of osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor and finally increases bone density while this increase in level of the mentioned variables due to performance of resistance exercise with calcium and phosphor supplement intake is higher than that of resistance exercise.

Hence, based on the research results, it can be mentioned that calcium and phosphor supplement intake along with resistance exercise leads to more increase in levels of osteocalcin, alkaline phosphatase, parathyroid hormone and phosphor of the body compared with performance of exercises alone.

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