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Is whole body vibration and plyometric training with creatine supplementation effect on fitness factors in healthy males?

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Key words: Whole body vibration training, Plyometric training, Creatine supplementation, Fitness, Muscular Power.

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Abstract

The purpose of this study was to investigate the effect of whole body vibration training (WBVT) and plyometric training (PT) with creatine supplementation on some fitness factors in healthy males. 70 healthy male students were selected randomly and were assigned in seven groups: 1: WBVT with creatine supplementation (WBVT+Cr) 2: WBVT with placebo consumption (WBVT+P) 3: WBVT without supplementation consumption (WBVT) 4: plyometric with creatine supplementation (PLY+Cr) 5: plyometric with placebo consumption (PLY+P) 6: plyometric without supplementation (PLY) And 7: Control. The leg press test, the Sargent jump test, and the 60-meter sprint were used for measuring the maximum strength and muscular power in lower extremity, and speed respectively. The results of one-way ANOVA with Tukey's Post Hoc Test showed that there is a significant difference between the data related to lower extremity muscular strength and power and the 60-meter sprint of the six training groups' subjects in the post-test period, which illustrates the improvement of the measured factors after the exercises and creatine supplementation consumption. Considering the research's findings, it is suggested that in designing the exercise plans for athletic fields which need speed performance similar to 60-meter sprint, the WBVT and PT and creatine supplementation feeding can be used.

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Introduction

Considering the importance of athletes' performance enhancement in competitive sports and records' proximity in national and international competitions, consuming the permitted athletic supplementation has become an important part of athletes' preparation for participating in the competition (Chrusch, *et al.* 2001). From the viewpoint of competition holders, managers, trainers and many athletes, two points in supplementation are of importance: 1. using the permitted supplementation 2. using the substance with maximum efficiency and least side effects (Clark, 1996). Considering the mentioned points, using the monohydrate creatine supplementation as a permitted athletic supplementation is included in the plans of many athletes in different levels of professionals, semi-amateurs and amateurs. Hence, along with the increase of creatine supplementation use, the researchers' attention is attracted to it, and many studies have been done in this field. Creatine (Methyl guanidine acetic acid) is found in skeletal muscles in two forms of Free (Fcr) and Phosphocreatine (Pcr). Theoretically, the energizing effects of creatine is related to the creatine and Pcr's roles in the muscle's energy reconstruction. Although the creatine supplementation may have energizing effect on intense and short-term sports performance which are dependent to phosphagen system (ATP-Pcr), it may also be helpful for long-term activities with low intensity (Greenhaff, 2001). The maximum decomposition speed of Pcr inside the body is near to the maximum speed of ATP hydrolysis by the contractive proteins. So the Pcr availability may be a limiting factor in potential activities, even before the complete evacuation of muscle's phosphocreatine (Gualano *et al.,* 2008). This can explain why the running speed decreases at the end of 100-meter sprint although the Pcr is not completely evacuated. Theoretically, creatine supplementation can increase the total creatine (Tcr) of the muscle and probably it can facilitate the Pcr production inside the muscle, especially in the fast twitch muscle fibers, which increases the performance capacity with high intensity (van Loon *et al.,* 2004). Some of the researches have shown that the creatine supplementation, expedites the reconstruction of ATP from ADP up to 30% or more in intense activities (Gallo *et al.,* 2006a). Recent studies show that in different conditions, muscular fatigue is related to the increase of adenine nucleotide catabolism to inosine monophosphate (IMP) and ammonia and they support the hypothesis that the fatigue is due to the imbalance between the production and consumption of ATP (Chilibeck, *et al.,* 2004).

Doing power training has an ancient history, but in the last 20 years, with some power athletes' consistency and with improving the athletic records by using this method, these trainings have gained a great share of the training plans of many athletes (Spurrs, *et al.,* 2003). The power trainings historically, have had a concept of increasing the power and the size of the muscles. Recently, various people use the power training for enhancing the power, the speed, the stiffness and the tone of the muscle, to help the empowering process, to protect from injuries and to preserve the muscular performance in old age (Stane & Powers, 2005). The plyometric exercises, has been a common method of power training in the eastern bloc countries in the last 30 years (Hewett, *et al.,* 1996). The trainers and the athletes claim that the plyometric exercises create a bridge between power and potency and directly increase the competitive performance. They often regard the power training as the sources for increasing the general power and the plyometric exercises as the method to use this power (the increased general power as a result of power training). This kind of interpretation is endorsed in the scientific works and it is reported in many studies that plyometric exercises in comparison with the traditional power training can help achieving the highest performances (Grosset, *et al.,* 2009; Matavulj, *et al.,* 2001).

Gravity causes most of the mechanical stimuli that is responsible for development in muscle structures in everyday life; on the other hand, the strength and power training are along with changes in magnitude and speed of gravity, that this leads to greater stimulation of gravity to improve physical fitness (Cardinale & Wakeling, 2005; Delecluse, *et al.,* 2005; B. R. Ronnestad, 2009). Gravitational conditions can change by mechanical stimuli such as whole body vibration platform (WBVP) (Cardinale & Wakeling, 2005; Delecluse *et al.,* 2005; B. R. Ronnestad, 2009), that means subjects with help of WBVT can suffer more stimuli than daily activities (Cardinale & Wakeling, 2005; Delecluse *et al.,* 2005; B. R. Ronnestad, 2009). Vibration as a factor for powerful mechanical stimuli in neuromuscular system, skeletal and muscular tissue has been studied widely in medicine, ergonomic and animal studies (Rittweger, 2010) and the use of WBVT has been considered as a new method in neuromuscular training (Bosco *et al.,* 1998; Rittweger, 2010). In WBVT subjects stand and take different physical conditions on WBVP that produce Sinusoidal vibrations and they maintain this position until the end the practice. The WBVT device is adjustable in different frequency and severity (Bosco *et al.,* 1998; Rittweger, 2010). Recent increases of different audiences and fans in different areas to WBVT have caused researchers to consider the short and long-term effects of this practice more than before. The different effects of WBVT that have been published in numerous journal articles can be mentioned as the shorter of training time, increase in muscle strength, flexibility enhancement, neuromuscular enhancement, and increase in skeletal density (Delecluse, *et al.,* 2003; Punakallio, 2005; B.R. Ronnestad, 2004). The studies have shown that sport performance, fitness, health level can be accelerating by WBVT (Cardinale & Bosco, 2003; Delecluse *et al.,* 2005). Although the physiological effects of WBVT are anonymous, researchers have expressed somatosensory activation theory, vibration tonic reflex, decrease in electromechanical delay, increase in motor unit recruitment, muscle activation and neuromuscular coordination (Cardinale & Wakeling, 2005; Delecluse *et al.,* 2003; Issurin, 2005; Luo, *et al.,* 2005; Torvinen *et al.,* 2002).

Despite the positive effects of creatine supplementation on body mass increasing, after studying the previous studies it was observed that some of the uses of this supplementation does not improve the athletes' performance. Considering the importance of improving the performance without increasing the muscular mass or with low increase of the mass, and also considering the importance of plyometric training and WBVT, especially in potential sports, the purpose of this study was to investigate the effect of WBVT and PT with creatine supplementation on some fitness factors in healthy males.

Materials and methods

In order to operate the research, 70 healthy male students were selected randomly and were assigned in seven groups: 1: WBVT with creatine supplementation (WBVT+Cr) 2: WBVT with placebo consumption (WBVT+P) 3: WBVT without supplementation consumption (WBVT) 4: plyometric with creatine supplementation (PLY+Cr) 5: plyometric with placebo consumption (PLY+P) 6: plyometric without supplementation (PLY) And 7: Control (n = 10 per groups). The leg press test, the Sargent Jump Test, and the 60-meter sprint were used for measuring the maximum strength of lower extremity, the muscular power in lower extremity, and speed respectively. After getting the subjects' records in the pre-test stage, the subjects of the three experimental groups did the WBVT with a similar plan, for 6 weeks. With this difference that the first group subjects received creatine supplementation, the second group was given placebo; the third group subjects did not receive any supplementation. This training protocol contain the standing on the WBVP with 20-35 Hz of frequency and the amplitude of 5-10 mm. subjects did training in 6 position: standing with semi locked knee, 120 degree squat, 90 degree squat on right leg, 90 degree squat on left leg, and slowly ascending and descending on WBVP. Training and relaxation time had set up with the overload principle. The subjects of the three experimental groups did the PT with a similar plan, for 6 weeks. With this difference that the first group subjects received creatine supplementation, the second group was given placebo; the third group subjects did not receive any supplementation. The plyometric exercises group participated in 6-week training plan in which the subjects perform the plyometric exercises designed for lower body organs. This training protocol included two sessions of trainings in a week with volume domain of 9 to 140 floor touch with foot, for each session. The plyometric exercise's performances were as follows: hopping to both sides on one foot, standing long jump, lateral jump over the hurdle, hopping with both foots, lateral jump over a cone, diagonal jump over a cone, standing long jump with lateral sprint, jumping up and down on one foot, lateral jump with one foot. The training intensity increased until the fifth week and would decrease highly in the sixth week to prevent the fatigue effect during the post-test period (Stane & Powers, 2005).

The creatine supplementation groups subjects were given 20 grams of supplementation per day at the beginning of the exercises for five days and afterwards until the end of the trainings, consumed 10 grams of creatine (5 grams before the training and 5 grams after the training) every day. The placebo supplementation groups' subjects in a similar plan used the glucose instead of creatine and the trainings control groups only did the WBVT and PT without taking creatine and placebo. The control group continued their daily activities. After the end of the training period, the subjects were assessed similar to the pretest period. To describe the subjects' individual characteristics the descriptive statistics and for investigating the difference among the seven groups' data in pretest and post-test periods the statistical test of one-way ANOVA with Tukey's Post Hoc Test in SPSS version 16 environment were used ($\alpha \leq 0.05$).

Results

By using the ANOVA test, it became clear that there is no significant difference among the individual characteristics of the seven groups' subjects, which shows the homogeneousness of the groups in the pretest period. Also, using the ANOVA test did not show any significant difference among the data of the lower extremity maximum power, lower extremity muscular potency and 60-meter sprint speed among the seven groups' subjects in the pretest period (table 1).

Table 1. The average and the standard deviation of maximum strength, muscular power and 60-meter sprint time of seven groups' in pretest period.

Variable	Group	Average	SD	F	P
Maximum Strength (kg)	WBVT + Cr	87.12	4.97	0.346	0.291
	WBVT + P	85.45	5.23		
	WBVT	82.54	3.65		
	PT + Cr	83.61	4.63		
	PT + P	84.14	5.37		
	PT	81.25	5.38		
	Control	80.80	4.76		
Muscular Power (cm)	WBVT + Cr	54.4	2.48	0.293	0.253
	WBVT + P	53.2	3.52		
	WBVT	52.7	2.83		
	PT + Cr	55.1	4.12		
	PT + P	52.6	3.81		
	PT	50.4	4.36		
	Control	49.03	4.29		
60-meter Sprint time (second)	WBVT + Cr	7.36	1.48	0.393	0.288
	WBVT + P	7.85	1.88		
	WBVT	7.12	1.25		
	PT + Cr	7.56	1.91		
	PT + P	7.59	1.81		
	PT	7.48	1.76		
	Control	7.51	1.26		

After including the training period, ANOVA test showed a significant difference among the seven groups' data. By using the Tukey's Post-hoc test it became clear that there is a significant difference among the lower extremity maximum strength of the control group's subjects and WBVT + Cr (F=15.85, P=0.001), WBVT + P (F=12.43, P=0.012), WBVT (F=9.45, P=0.023), PT + Cr (F=13.45, P=0.001), PT + P (F=11.76, P=0.011), PT (F=10.95, P=0.013) groups. The difference between the data related to the six groups of training was not significant (P>0.05). In case of the muscular power of lower extremity, a significant difference was observed among the jump level of control group's subjects and WBVT + Cr (F=10.45, P=0.001), WBVT + P (F=11.47, P=0.022), WBVT (F=9.82, P=0.034), PT + Cr (F=10.40, P=0.001), PT + P (F=11.55, P=0.015), PT (F=12.32, P=0.043) groups. In case of the mentioned factor, no significant differences were observed among the six training groups (P>0.05).

In case of the 60-meter sprint time, a significant difference was observed among the control group's subjects and WBVT + Cr (F=7.75, P=0.011), WBVT + P (F=8.29, P=0.032), WBVT (F=6.52, P=0.033), PT + Cr (F=8.40, P=0.001), PT + P (F=6.85, P=0.014), PT (F=5.82, P=0.023) groups. In case of the mentioned factor, no significant differences were observed among the six training groups (P>0.05) (table 2).

Table 2. The average and the standard deviation of maximum power, muscular power and 60-meter sprint time of seven groups' in post-test period, * Differences with control.

Variable	Group	Average	SD	F	P
Maximum Strength (kg)	WBVT + Cr	109.02*	5.35	0.732	0.533
	WBVT + P	106.20*	6.19		
	WBVT	105.17*	4.75		
	PT + Cr	108.31*	5.37		
	PT + P	104.54*	5.67		
	PT	108.25*	5.92		
	Control	91.82	4.16		
Muscular Power (cm)	WBVT + Cr	69.42*	3.83	0.861	0.614
	WBVT + P	68.61*	3.65		
	WBVT	65.53*	2.91		
	PT + Cr	65.19*	4.42		
	PT + P	66.63*	3.31		
	PT	64.25*	4.64		
	Control	50.03	4.88		
60-meter Sprint time (second)	WBVT + Cr	6.2	1.32	0.890	0.424
	WBVT + P	6.55	1.73		
	WBVT	6.32	1.29		
	PT + Cr	6.16	1.76		
	PT + P	6.73	1.72		
	PT	6.47	1.75		
	Control	7.49	1.72		

All three measured factors for the supplementation group's subjects, showed improvement in post-test period compared to the pretest condition. In case of placebo group and training group without supplementation, the observed difference for the muscular strength and lower extremity's power was meaningful. For the control group's subjects none of the measured factors in post-test and pretest showed any difference.

Discussion

The purpose of this study was to investigate the effect of WBVT and PT along with creatine supplementation on some fitness factors of healthy males. The results of this research, in accordance with the previous studies' findings, which reported performance improvement after creatine supplementation, showed the performance enhancement of subjects after the supplementation period (Bemben *et al.,* 2010; Castell, *et al.,* 2010; Gallo *et al.,* 2006a, 2006b; Hickner, Dyck, Sklar, Hatley, & Byrd, 2010). Creatine is an active osmotic substance, so increasing the density of

intracellular total creatine (Tcr), free creatine (Fcr) and phosphocreatine, stimulates the water stream to get into the cell. The increase in body water causes the increase in body mass. In addition, the intracellular water increase may be a sign of cellular anabolic development. We can conclude that the intracellular water increase done by creatine supplementation, may increase the synthesis of protein and decrease its analysis. Hence, the body mass and the fat-free mass increase (Bemben *et al.,* 2010). Some of the researchers have observed the decrease in urination during the supplementation period, which helps to prove the aforementioned hypothesis (Castell *et al.,* 2010). However, the creatine-caused increase in intramuscular osmolality cannot be the probable cause of this amount of water. In a study, it is suggested that the simultaneous consumption of creatine and carbohydrates leads to increase in insulin level of blood, which can increase the glycogen production and consequently it can increase the muscle's water (Castell *et al.,* 2010). Also in some studies it is recommended that increasing Pcr in muscular cell can stimulate the protein, like the sport's or insulin's stimulation (Hickner *et al.,* 2010).
Several mechanisms that can cause the creatine supplementation act as energizer for intense activities are suggested, as follows:
Increasing the muscle's Pcr amount in relaxation state which can be as urgent transporter of phosphate for reconstructing ATP during the activity.

Increasing the muscle's free creatine (Fcr) in relaxation state can increase the Pcr reconstruction during and after the activity and can facilitate the energy transportation from mitochondria to places ATP is consumed.

Increasing the buffering state for hydrogen ion which can prevent from muscular cells' acidity.

The training increaser: increasing the creatine or Pcr in athletes can cause reaching to higher training load, can decrease the training fatigue and it makes possible that the muscle's hypertrophy accelerate which can improve the performance.

Body mass increase: the increase in fat-free mass or muscular mass in sports which need high potentiality for overcoming a resistance or an external thing, can be helpful (Bemben *et al.,* 2010; Castell *et al.,* 2010; Chrusch *et al.,* 2001; Clark, 1996; Gallo *et al.,* 2006a; Hickner *et al.,* 2010).

Also, the results of this study in case of performance improvement after doing plyometric exercises was in agreement with the previous studies' findings (Christiansen & Silva, 2006; Cochrane, *et al.,* 2004; Torvinen *et al.,* 2002). The effect of WBVT and PT in improving the performance can be summarized as follows: Considering the sensory receptors' activation by the WBVT and PT, it is obvious that these exercises can directly affect the brain's activity. This issue expresses the kinetic neurons' preparation in a group of muscles and joints for doing a motion and its compatibility to environmental background and also increasing the harmony and integrity of kinetic units, the cooperative muscles' twitch, the reverse muscles' resistance increase which can finally cause the improvement of neuromuscular responses, leading to the athletic performance improvement (Petit *et al.,* 2010; B. R. Ronnestad, 2009).

Conclusion

Considering the findings of this study, it is suggested that in designing the training plans for power sport, whose best performance depends on the proper jump, the WBVT and PT be used. In addition, it can be said that for athletic training whose purpose is to increase the muscular power, doing exercises without creatine supplementation is also effective. Therefore, it is suggested that in these trainings, the creatine supplementation not be used. However, for training courses which aim to increase the speed, the creatine supplementation can be used.

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