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Original empirical article

THE EFFECT OF WHOLE BODY VIBRATION TRANING ON EXPLOSIVE POWER AND SPEED IN MALE NON ATHLETE STUDENTS

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Amir Sarshin[1], Sardar Mohammadi[2], Amir Reza Khadam[3], Khadijeh Sarshin[4]

[1]Department of Physical Education & Sport Sciences, Islamic Azad University Karaj Branch, Research Center of Physical Education of Islamic Azad University Karaj Branch, IRAN
[2]Kurdestan University(Ph.D) Department of Physical Education and Sport Science, University of Kurdistan-Sanandaj, IRAN
[3]Shahid Beheshti University (MA)- Shahid Beheshti University, Tehran, IRAN
[4]University of Medical Sciences of Semnan

Abstract. *Whole body vibration training (WBVT) as a new method of neuromuscular training has been considered and it has been vastly studied as a factor for strong mechanical stimulation in the neural system, bone tissue and muscles. The aim of this study was to investigate the effects of whole body vibration training on the explosive power and speed of male non-athlete students. For this purpose twenty students from the University of Kurdistan (Mean; age: 21/5 ± 1/4 yr, Weight: 71/5 ± 5/5 kg, Height: 174 ± 5/5 cm, BMI: 23/67 ± 1/30) were recruited and randomly divided into an experimental (EG) (n=10) and a control group (CG) (n=10). The EG were treated for four weeks, three session per week with 5 sets of 1 minute in a squat of 110◦ body position, for a total of five minutes per day. The subjects of the CG were asked to maintain their normal activity and avoid strength training. The subjects were tested at the beginning and the end of treatment with a specific functional test. The data were analyzed using SPSS and the Paired-t test statistical method. The results showed a remarkable and statistically significant enhancement in the EG with a 7.8% increase in explosive power (P≤0/002), and there was a significant difference in EG speed (5m: P≤ 0.001, 10m: P≤0.042 and 20m: P≤0.001) at the post-test. But no significant difference was found in the CG for this performance (P≥0.05, P≥0.05). Overall, we can conclude that whole body vibration probably can have an effect on explosive power and speed. Hence, WBVT can be used as a new method of training for athletes.*

Key words: *Whole body vibration, Vertical jump, Speed, Explosive Power*

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Corresponding author: Sardar Mohammadi
Department of Physical Education and Sport Science - University of Kurdistan-Sanandaj, IRAN
Tel: +09183737495 • E-mail: sardarmohammadii@gmail.com

INTRODUCTION

Whole Body Vibration Platform (WBVP) as the sender of mechanical stimulations pendulously throughout the body is an achievement of modern society used to offset immobility (Cochrane, Legg & Hooker, 2004). Today, WBVP is used as a device to improve athletic function and rehabilitation and has attracted many users in different scopes. Hence, it has attracted researchers toward examining short-term and long-term effects of such mechanical stimulations (Cochrane et al., 2004). WBVT has been studied as a relatively new neuromuscular training method and as a factor for mechanical and strong stimulation in the neuromuscular system, bone tissue and muscles extensively in medicine, ergonomics, and animal experiments (Bosco et al., 1998b; Delecluse, Roelants & Verschueren, 2003). The present knowledge regarding the physiological and neurological mechanism of WBVT is not so extensive, but the increase in stimulation of the central and peripheral neural system, coordination, stimulation and higher elicitation of motor units, decrease in the stimulation threshold, Golgi tendon organ and prevention of the activity of opposite muscles, increase and change in hormonal secretions, change in the amount and density of neural intermediaries (Dopamine and serotonin), and activation of Gama units and muscle spindles are the mechanisms that through which WBVT affects the body (Cochrane et al., 2004; Delecluse et al., 2003; Ronnestad, 2004). WBVT is carried out using different vibration systems and has its practical variables such as other training methods including frequency, meaning the fluctuation repeat rate at which the vibration system enters the body, measured in Hertz; amplitude, meaning the rate of transfer and the vertical movement of the vibration system measured in millimeters; duration, meaning the time devoted to vibration in each phase; and body position, which means how to stand or sit on the platform during training. WBVT can improve athletic performance, physical fitness, health levels, and even can accelerate healing of injuries (Delecluse et al., 2003).

Explosive power is a combination of power and speed and is defined as the application of maximum power in the minimum time. The power to perform athletic exercises such as jumping and throwing objects in the air is of great importance. But in addition to the fact that speed is a component of time, it is an important factor of physical form which enables the optimal performance of athletic proficiencies.

Gravity normally causes a great part of the mechanical stimulations responsible for the growth and development of muscular structure. Special strength training methods, explosive and speed power, are accompanied by a change in the rate and speed of gravitational acceleration changes leading to higher stimulations to improve the factors of physical form (Cardinale & Rittweger, 2006; Cardinale & Wakeling, 2005; Delecluse et al., 2003). Changes in gravitational conditions can be caused by mechanical systems and stimulators such as WBVP (Cardinale & Rittweger, 2006; Cardinale & Wakeling, 2005; Delecluse et al., 2003). This means that people with WBVT incur higher stimulations in terms of daily activities (Cardinale & Rittweger, 2006; Cardinale & Wakeling, 2005; Delecluse et al., 2003). The stimulation of the biological system by WBVT can be similar to other methods of explosive, speed and strength power training used to improve such factors (Bosco, Cardinale, & Tsarpela, 1999; Cardinale & Bosco, 2003). On the same basis, WBVT is used as a positive method to increase muscular power, vertical jumping, bone mechanical capability, Bone Mineral Density (BMD), body balance, explosive power and speed (Christiansen & Silva, 2006; Cochrane et al., 2004; Torvinen, Kannus,

& Sievinen, 2002). For example, Bosco et al. (1999) examined the effect of one session of 10-minute WBVT (10 bouts of each for 60 seconds with 60-second intervals) with a frequency of 26Hz, an amplitude of 10mm. They noticed a significant increase in strength and explosive power. Also, Bosco et al. (1998) noticed a 4% increase in explosive power in another study (vertical jumping) after one phase of WBVT. Torvinen (2002) reported a significant increase in vertical jumping after a 4-minute session. The results of Feland et al. (2006) did not show a significant change in the vertical jump after 60 seconds of WBVT in two 30-second repeats with a 2-minute interval and frequency of 26Hz. In another study, Coyle et al. (1981) examined one vibration practice on female members of the national Volleyball team. They reported a significant improvement of speed and explosive power. Marco Cardinal (2002) after 10 days of vibration exercise involving male athletes reported a considerable improvement in vertical jumping, speed and muscular strength. De Ruiter et al. (2003) after 6 exercise sessions during a period of two weeks did not notice any significant improvement in explosive power and speed.

In the present studie, the important point regarding WBNT is the lack of consensus regarding the application of a specific exercise protocol with specific frequencies, amplitudes and/or specific duration and whose frequency and amplitude can have maximal effects (Cardinale & Wakeling, 2005; Luo, McNamara & Moran, 2005). For example, it was seen that an exercise protocol with specific frequency, amplitude and position leads to a significant increase in speed and explosive power; however, in the same protocol with the same frequency and in the same body position in another study with an amplitude higher by 1mm, no significant change and increase was seen (Bosco et al., 1998a; Cochrane et al., 2004). The positive and negative results regarding the effects of this training method have motivated the researcher to conduct the present study and examine the possible effects of this new training method after 4 weeks of exercise on explosive power and speed.

METHODS

The participants of the study included non-athlete male students of the Kurdistan University. Twenty of them participated voluntarily as the statistical sample. These subjects were randomly divided into an experimental group (age: 21/3±1/44; weight 66/1±3/4, height 172.66±3/4) and control group (age: 21/1±1/03; weight 67/4±4/25, height 173±3.2). The subjects were not involved in any athletic side activities.

In the pre-test phase, one day before the exercises, the dependent variables of the subjects were measured. To measure explosive power, the Sergeant Test was used and to test speed, the 5-10-20 tests were used in three repeats and the best records of each subject in each test were registered separately. The vertical jump, using the digital system Sergeant Jump, was measured in a fixed vertical jump three times. Also the speed test was carried out in such a way that along the basketball field a 20-meter distance was marked, and then on the same distance, 5 and 10 meter intervals from the beginning line were marked. Three Assistants registered the time in 5, 10, and 20 meter intervals. The test was repeated thrice for each subject and the best records were specified and analyzed. The WBVT exercises of the experimental group training were done for 4 weeks and 3 times a week for 5 1-minute periods in each session. WBVT included standing on the vibration system model NEMES-LB Bosco System with a frequency of 30 Hz and ampli-

tude of 10 mm in a Squat 110° manner. The duration of the exercise in each stage was one minute done with 1-minute intervals (Issurin, 2005; Ruiter, Raak, Schilperoort, Hollander, & Haan, 2003). To determine the position of the Squat 110° among the subjects, the bevel was used. The subjects performed the Squat 110° with a frequency and amplitude of zero on the abovementioned system to get familiar with the vibration system before the main exercise. The EG warmed up for 10 minutes (running and stretching) and took 10 minute to cool down (stretching). Also, the subjects used gym sneackers during the exercise on the vibration system. During the study, the control group was asked to maintain their body activity and avoid strength exercises. One day after the last exercise session as the post-test stage, both the control and experimental groups were tested regarding the studied variables in the same conditions.

To determine the homogeneity of the groups in terms of performance variables, the independent t-test was used in the pre-test stage. The data were analyzed using SPSS (16) software and the associate t statistical method at the significance level $\alpha \leq 0/05$.

RESULTS

The independent t-test indicated no significant difference in any of the variables in the pre-test stage for the control and experimental groups, implying the physical and performance homogeneity of both groups ($P \geq 0.4333$ & $P \geq 0.221$).

Table 1 indicates the effects of vibration exercises on explosive power. The explosive power of the EG has a Significant difference in the pre- and post-test stages ($P \leq 0.001$). In general, a 9.7% change in the vertical jump changes (explosive power) has been seen for the EG, although for the control group no Significant difference was found ($P \geq 0.372$).

Table 1. The results of the effect of vibration on the explosive power of the studied groups

Group	Phase	Number	m** $_{(cm)}$ ± SD	P
Experimental	Pre-test	10	42.94 ± 2.86	0.001*
	Post-test	10	49.26 ± 3.33	
Control	Pre-test	10	41.99 ± 1.94	0.372
	Post-test	10	42.13 ± 1.81	

*P<0/05, **m(mean)

The results gained by the associate test regarding the effect of vibration exercises on the speed of the groups under study are indicated in Table 2. It is seen that vibration exercises had a significant effect in the sprint race of the 5, 10 and 20 meter run for the EG ($P \leq 0.001$ in the 5-meter run, $P \leq 0.042$ 10-meter run and $P \leq 0.001$ 20-meter run); however, no Significant change was seen in the control group ($P \geq 0.221$, $P \geq 0.472$, $P \geq 0.109$).

Table 2. The results of the effect of vibration on the speed of the 5, 10 and 20 meter run of the groups

Group			Number	$m_{(s)} \pm SD$	P
5m	Experimental	Pre-test	10	1.16 ± 0.11	0.001*
		Post-test	10	1.12 ± 0.08	
	Control	Pre-test	10	1.24 ± 0.23	0.221
		Post-test	10	1.23 ± 0.21	
10m	Experimental	Pre-test	10	2.09 ± 0.30	0.042*
		Post-test	10	1.95 ± 0.21	
	Control	Pre-test	10	2.06 ± 0.03	0.472
		Post-test	10	2.06 ± 0.05	
20m	Experimental	Pre-test	10	3.40 ± 0.10	0.001*
		Post-test	10	3.29 ± 0.10	
	Control	Pre-test	10	3/44 ± 0/15	0.109
		Post-test	10	3/32 ± 0/15	

*P<0/05

DISCUSSION AND CONCLUSION

The purpose of this study was to examine the presumable effect of 4 weeks of WBVT on explosive power and speed. The research results support both hypotheses based on the fact that vibration exercises increase explosive power and speed. The use of WBVT as a training method to improve athletic performance has received widespread use and more than 15 studies have reported an improvement in athletic performances using training methods of this kind from 1998 to 2005 (Cochrane et al., 2004; Issurin, 2005; Luo et al., 2005). However, offering clear theories regarding the usage of this system with a specific practice protocol and intensity is very difficult.

Explosive Power

The results of the studies conducted by some researchers (Bosco et al., 1998a; Cardinale, 2002; Mester, Spitzenfeil, Schwarzer & Seifriz, 1999) is consistent with the results of the our research regarding explosive power, and inconsistent with the findings of some studies (Cochrane et al., 2004). Inconsistent results regarding explosive power can be achieved by the use of different protocols with different practice variables. Consistencies raised by explosive power practices and the initial increase in muscular strength in strength exercises are mainly neural and without structural changes in size and mass of the muscle (Delecluse et al., 2003; Luo et al., 2005). Researchers have defined the following reasons as the presumable mechanisms of WBVT effects on explosive power:

The activation of muscular spindles raises the tonic vibration reflex located in the tensile reflex arch. This act has been seen when exerting vibration on muscles (Cardinale & Wakeling, 2005). The decrease in Electromechanical delay (EMD) of the muscular stimulation, can be a reason behind the increase in sensitivity of muscular spindles. A lower EMD indicates higher power generation speed and consequently explosive power (Issurin, 2005; Luo et al., 2005).

Another reason for power generation is the interface between actins and myosin linkages. It can be said that with an increase in the size of linkages the power can be increased (Cardinale & Bosco, 2003; Issurin, 2005; Luo et al., 2005). The increase in the contact between actins and myosin and also the calling and hyper activation of motor units raised by vibration exercises seen in different studies can be another probable reason and justification for the improvement of the athletic performance (Issurin, 2005; Luo et al., 2005).

The increase in power may be due to the simultaneous calling of motor units for a specific act, facilitating the traction and the increase in the ability of the muscles to increase power. Such an increase in the calling paradigm of different motor units can be due to the stoppage and the decrease of preventive momentums enabling the simultaneous activation of more motor units (Cardinale & Bosco, 2003; Issurin, 2005; Luo et al., 2005). Exercise can decrease the preventive momentums and let the muscle attain a higher level of power. Therefore, the increase in power can be gained through the decrease in neural control. These theories can indicate the increase in power in the lack of hypertrophy (Cardinale & Bosco, 2003; Delecluse et al., 2003).

Speed

The results of our study indicated that such findings are consistent with our results that reported a significant effect of WBVT on speed (Cardinale, 2002; Coyle et al., 1981) and are inconsistent with the findings of other authors (De Ruiter, Van Der Linden, Van der Zijden, Hollander & De Haan, 2003). The improvement in the speed of athletes is very difficult yet possible and running speed is related to power (Cardinale & Wakeling, 2005; Delecluse et al., 2003). The increase in the speed of muscular traction can increase speed in the same way (Cardinale & Wakeling, 2005; Delecluse et al., 2003). The decrease in muscular EMD in the studies can indicate the increase in the speed of muscular traction and subsequently the increase in speed (Cardinale & Wakeling, 2005; Delecluse et al., 2003). Tonic vibration reflection, higher activation of Motor neurons and muscular spindles and subsequently the increase in motor units, the decrease in EMD due to WBVT have been noticed (Cardinale & Wakeling, 2005; Torvinen, Kannus et al., 2002; Torvinen, Sievanen et al., 2002). Progress in amateurs who have not yet reached their peak performance is fast, so they could probably make progress with small effects of WBVT, but changes in elite athletes are more difficult (Cardinale & Wakeling, 2005; Luo et al., 2005; Torvinen, Kannus et al., 2002; Torvinen, Sievanen et al., 2002). Other neurological reasons for speed increase can include the following theories:

The theory of muscular coordination indicates the preparation of motor neurons in one practical group of muscles and joints. Also coordination and integration of motor units, co-contraction of synergist muscles, inhibition of antagonist muscles will be improved (Cardinale & Wakeling, 2005; Torvinen, Sievanen et al., 2002). Although evidence exists to prove the coordination of muscles with the help of WBVT, but which frequency and amplitude have the highest effect is yet unknown (Cardinale & Wakeling, 2005; Torvinen, Sievanen et al., 2002; Wakeling, Liphardt & Nigg, 2003). However, higher neural center activation, long loop reflex, hormonal secretions and higher coordination are the most important mechanisms of WBVT (Cardinale & Wakeling, 2005; Torvinen, Sievanen et al., 2002; Wakeling et al., 2003). Presumably, the reason behind the inconsistency between the studies is using different exercise protocols with various

training variables (Cardinale & Bosco, 2003; Cardinale & Lim, 2003; Cardinale & Wakeling, 2005). Most studies that have reported an increase explosive power and speed after WBVT have used a 30Hz frequency. The highest electrical activity of the muscles has been reported in the 30Hz frequency. If they had not used the 30Hz frequency, they would have used higher duration and amplitude of the vibration (Cardinale & Lim, 2003; Cardinale & Wakeling, 2005; Luo et al., 2005). For example Bosco et al. (1999) applied a 26 Hz frequency, 10mm amplitude, and 60-second duration with 10 repeats and 60-second intervals and reported an increase in explosive power. But in another study, 9 sessions of vibration with a frequency of 26 Hz, and 11mm amplitude had no significant effect on speed and explosive power (Cochrane et al., 2004). The fact that the training variables in the present study are identical with the consistent studies is the presumed reason for the consistency of the findings of such studies.

CONCLUSION

Generally, it can be concluded that vibration exercises presumably improve explosive power and speed. The use of WBVT can be a new method used to improve athletic performances which should be the focus of attention of coaches and researchers. However, due to the lack of exercise specificity principle in WBVT, it should not be replaced by other traditional exercises.

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UTICAJ TRENINGA VIBRACIJAMA PO CELOM TELU NA RAZVOJ EKSPLOZIVNE SNAGE I BRZINE KOD NESPORTISTA MUŠKOG POLA

**Amir Sarshin, Sardar Mohammadi,
Amir Reza Khadam, Khadijeh Sarshin**

Vibracije koje zahvataju celo telo (WBVT) su dosad proučavane kao metod neuromuskulatornog treninga, a dosta su istraživane kao faktor za jaku mehaničku stimulaciju nervnog sistema, kostiju i mišićnog tkiva. Cilj ovog istraživanja je da prouči uticaj treninga vibracijama koje zahvataju celo telo na eksplozivnu snagu i brzinu kod nesportista muškog pola. U istraživanju je učestvovalo 20 studenata sa Univerziteta u Kurdistanu (Srednja vrednost; starost: 21/5 ± 1/4 yr, težina: 71/5 ± 5/5 kg, visina: 174 ± 5/5 cm, BMI: 23/67 ± 1/30) koji su metodom slučajnog izbora podeljeni na eksperimentalnu (EG) (n=10) i kontrolnu grupu (CG) (n=10). EG bila je podvrgnuta ovakvom treningu u trajanju od četiri nedelje, sa po 3 treninga nedeljno od 5 seta u trajanju od 1 minuta u čučnju od 110◦, ukupno po 5 minuta u toku dana. Od CG se tražilo da ne menjaju svoje svakodnevne aktivnosti i da izbegavaju vežbe snage. Učesnici su mereni na početku i kraju tretmana uz pomoć posebnog testa. Podatke smo analizirali uz pomoć SPSS programa i t testa za zavisne uzorke. Rezultati su pokazali statistički značajno uvećanje kod EG sa povećanjem od 7.8% u eksplozivnoj snazi (P≤0/002), a javila se i značajna razlika u brzini EG (5m: P≤ 0.001, 10m: P≤0.042 i 20m: P≤0.001) u post testu. Ali statistički značajne razlike kod CG u ovom slučaju nije bilo (P≥0.05, P≥0.05). Na kraju, možemo zaključiti da vibracijama koje zahvataju čitavo telo verovatno možemo uticati na eksplozivnu snagu i brzinu. Zbog toga, WBVT se može koristiti kao novi metod za trening sportista.

Ključne reči: *vibracije koje zahvataju čitavo telo, skok u vis, brzina, eksplozivna snaga*