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Acute effects of loaded whole body vibration schemes on countermovement jump, speed and agility

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Abstract

The purpose of this study was to compare the effects of loaded whole body static squat exercise during whole body vibration and non-vibration schemes on countermovement jump (CMJ), speed and agility. Twenty-one healthy male college football players (age: 20.14 ± 1.65 years; body height: 179.9 ± 8.34 cm; body mass: 74.4 ± 13.0 kg; % body fat: 9.45 ± 4.8) participated in the study. They underwent a standardized general warm-up and dynamic stretching followed by randomized loaded protocols executed for 5 minutes with a rest interval of 30 seconds. These included static squat with 30% bodyweight external load (ST + 30%), ST + 30% on a vibration platform at 25 Hz and 2 mm (WBV25), and ST + 30% on a vibration platform at 50 Hz and 4mm. Measurement of CMJ, 15 m sprint and modified agility tests followed the warm-up protocol. One way repeated measures ANOVA revealed a significant difference on CMJ performance, $F(2,40) = 24.5$, partial $\eta 2 = .551$, $p < 0.01$. Bonferonni post hoc showed that ST+30% posted significantly lower CMJ than WBV25 and WBV50. CMJ at WBV50 was higher than WBV25. There was a significant difference on speed, $F_{(2, 40)} = 23.6$, partial $\eta 2 = .542$, $p < 0.01$. Post hoc determined that ST+30% was significantly slower than WBV25 and WBV50. WBV50 was faster than WBV25. There was a significant difference in the agility among interventions, $F_{(2, 40)} = 18.2$, partial $\eta 2 = .477$, $p < 0.01$. ST+30% agility time was significantly higher compared to WBV25 and WBV50. In conclusion, WBV50 posted the greatest benefits in CMJ, speed and agility.

Keywords: Football, warm-up, vibration training.

INTRODUCTION

Whole body vibration refers to the performance of exercise on a vibrating platform characterized by the interaction of the repetition rate of the cycles of oscillation and extent of the oscillatory motion (2). Recently, there has been an increasing interest in the utilization of high frequency WBV in warm-up settings to elicit favorable responses in training and competition. For example, Krol et al. (8) suggested that WBV at 60 Hz and 4 mm produced the highest vastus lateralis and vastus medials muscle activity. Rønnestad and Ellefsen (11) found out that 50 Hz WBV corresponded to enhanced 40-m sprinting in recreationally trained soccer players. Similarly, Rønnestad (10) identified increased lower body peak average power in trained and untrained individuals after WBV at 50 Hz frequency at 3 mm. If the quest of practitioners in WBV is aimed at increasing activation of the motor neuron pool, adding external load in WBV may be a potential stimulus to achieve this purpose. However, there seems to be a scarcity in literature in this field. Thus, the aim of this study was to determine the effects of loaded whole body warm-up schemes with or without vibration platform on CMJ, speed and agility.

MATERIALS AND METHODS

Twenty-one healthy male college football players (age: 20.14 ± 1.65 years; body height: 179.9 ± 8.34 cm; body mass: 74.4 ± 13.0 kg; % body fat: 9.45 ± 4.8) during the off-season training volunteered to participate in the study. The off-season training program consisted of 10-hour football training and 3-hour strength and conditioning training in a week. The participants signed a written informed consent prior to further experimentation. The athletes were requested to avoid strenuous training 48 hours prior to experimentation and were encouraged to sleep for at least 6-8 hours. Nutritional recommendations include avoidance of tobacco, alcohol and caffeine 48 hours before the experimentation, eating a light meal at least three hours prior to experimentation and fluid consumption in small amounts during testing sessions. The study was approved by the Ethical Committee of the Tuzla University.

Procedures

The participants in the study visited the Exercise Science Laboratory of Faculty of Physical Education and Sport, Tuzla University for four experimentation sessions between 08:00 hrs to 10:00 hrs. Height, weight, bodyweight and % body fat were acquired during the first visit. After 24 hours, the participants executed the first randomized experimental protocol. This was succeeded by 2 remaining sessions separated by 48 hours. Experimental protocols were performed after a standardized general warm-up and dynamic stretching. The general warm-up involved running 12 circles (1st 4 circles: 30 seconds; 2nd 4 circles: 25 seconds; 3rd 4 circles: 20 seconds) around an 86 m circumference area. After 1 minute, the participants proceeded with 7 dynamic stretching exercises in 7 minutes. Each exercise lasted 20 seconds for each of the two sets with an intra and inter exercise rest of 10 seconds. The dynamic stretching exercises were straight leg march, butt kicks, carioca, high knees, reverse lunge twist, power shuffle (step slide) and jogging with squats. A 1 minute rest commenced after dynamic stretching. This was succeeded by a loaded warm-protocol. The experimental protocols in the study were: 1. one minute standing in half squat position plus extra load of 30% of body weight for 5 minutes with 30 second rest interval in between repetitions (ST+30%); 2. ST+30% on a vibration platform with f =25 Hz and A = 2mm (WBV25); and, 3. ST+30% on a vibration platform with f =50 Hz and A =4mm (WBV50). Knee angle in the squat position was approximately 100 degrees. A commercial whole body vibration platform (POWRX® Vibration Plate Pro Evolution 2.7, Germany) was utilized in WBV25 and WBV50. Each loaded warm-up protocol was followed by a 2 minute rest. After 2 minutes, hands on waist CMJ were executed for two trials separated by 30 seconds. CMJ height was estimated using a commercial infrared technology (OptoJump System, Microgate, Bolzano, Italy). After CMJ test, a 1 minute rest occurred. This was succeeded by a 15 m sprint test in an indoor parquet floor. The starting position occurred 1 meter prior to 15 m distance mark. Speed was detected using an automated timer (Speedtrap II, Brower Timing Systems, Draper, UT, USA) which was adjusted approximately in line with an athlete's waist. This test is started upon subjective discretion of readiness from the athletes. Two trials separated by 30 seconds were completed in the speed test. A 1 minute rest period was conducted after this test. After 1 minute, a modified agility test was administered for two trials with a rest interval of 30 seconds in between trials. This test involves an athlete sprinting for 5 m then laterally shuffling to the left for 2.5 m. After, the athlete laterally shuffles to his right for 5 m then laterally shuffles back to his left for 2.5 m and back pedals for 5 m. Starting position for this test occurred 1 m behind the 5 m sprint mark. No verbal stimulus was used to start the test. Time was detected using the same technology during the speed test. The best performance in CMJ, speed and agility were kept for analyses. Figure 1 displays the experimental design in the study.

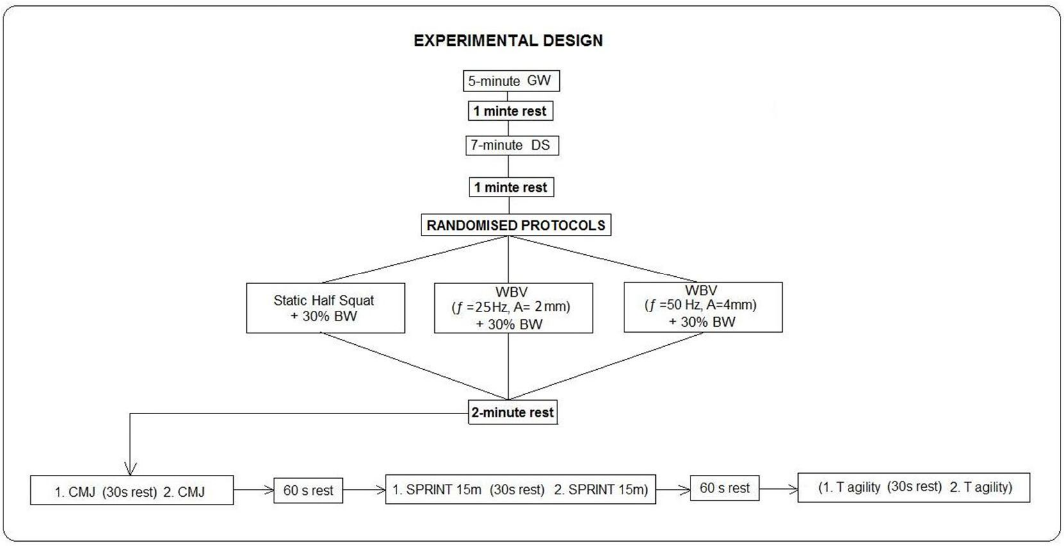

Figure 1. Experimental design.

Statistics

Means and standard deviations of data are displayed in the study. One way repeated measures ANOVA was utilized to determine any significant difference in loaded warm-up schemes. Estimation of effect size was established using partial eta squared. Bonferonni post hoc contrast was used to detect pairwise comparisons. All statistical analyses were utilized in a commercial statistical package (SPSS Inc., Chicago, IL; Version 14.0) with statistical significance set at $p < 0.05$.

RESULTS

One way repeated measures ANOVA showed a significant difference on CMJ performance at $F_{(2,40)} = 24.5$, partial $\eta 2 = .551$, $p < 0.01$. Bonferonni post hoc revealed that ST+30% posted significantly lower CMJ scores than WBV25 and WBV50. CMJ at WBV50 was significantly higher than WBV25. In a similar light, there was a significant difference on speed at $F_{(2, 40)} = 23.6$, partial $\eta 2 = .542$, $p < 0.01$. Post hoc identified ST+30% was significantly slower compared to WBV25 and WBV50. WBV50 was significantly faster than WBV25. There was a significant difference in the agility among interventions at $F_{(2, 40)} = 18.2$, partial $\eta 2 = .477$, $p < 0.01$. ST+30% agility time was significantly higher compared to WBV25 and WBV50. Table I shows CMJ, speed and agility performance in loaded warm-up schemes.

Table 1. CMJ, speed and agility in loaded warm-up schemes.

	CMJ (cm)	Speed (secs)	Agility (secs)
ST + 30%	37.2 ± 5.1	2.53 ± .10	6.38 ± .23
WBV25	38.4 ± 5.6	2.48 ± .08	6.19 ± .25
WBV50	39.3 ± 5.7	2.44 ± .08	6.12 ± .14

DISCUSSION

The purpose of this study was to identify the effect of various loaded warm-up schemes on vibration and non-vibration platforms. Results in the current study showed significant gains in CMJ and speed after WBV50 when compared to WBV25 and ST+30%. In agility, WBV50 posted significant faster performance only when compared to ST+30%. One possible mechanism for the highest gains in WBV50 than other schemes presented in this study may be related to increased reciprocal inhibition of the lower body antagonists which is also known as the tonic vibration reflex (TVR) (5). TVR response to WBV can be affected by location of vibration, excitability state of CNS, initial length of muscle, and vibration frequency and amplitude (1). The higher frequency and amplitude in WBV50 may have activated a larger number of muscle spindle endings that led to greater alpha motor neuron activation during submaximal isometric contractions (4,6). In a similar light, loaded exercise at high frequency with bent knee position attenuated mechanical signals in WBV which may also be a contributory factor to enhanced TVR (12). Another possible mechanism is the occurrence of higher post activation potentiation at WBV50. Post activation potentiation refers to improvement in muscle contractile function from myosin light chain physphorylation or H-reflex potentiation (7). The findings of current study was supported by Cochrane et al. (3) which discovered greater muscle twitch potentiation after an acute continuous bout of static squat WBV.

An interesting finding in this study is the non-significant difference in agility performance between WBV50 and WBV25. This may be explained by a similar motor unit activation pattern depicted by WBV50 and WBV25 during agility (9).

In conclusion, performing a static squat with a 30% bodyweight load on a vibration platform (50 Hz, 4mm) displayed better CMJ, speed and agility in college football players than completing the same exercise with a vibration platform at 20 Hz and 2mm settings and without a vibration platform. However, it should be noted that it was only in agility were WBV25 did not any show significant difference with WBV50.

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