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Effect of Different Whole Body Vibration Frequencies on Anaerobic Parameters During Ergometer Wingate Test

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Abstract

The aim of this study was to investigate the effect of different frequencies of whole body vibration (WBV) on anaerobic Wingate test. Eight recreational active participants (5 males, and 3 females) [33.6±4.5 years, 77.2±17.01 kg, and176.6±8.85 cm] volunteered to participate in this study. Each participant performed a Wingate test on Velotron Dynafit pro cycle Ergometer preceded by no treatment (CON), WBV at 30 Hz (30-Hz), and WBV at 60 Hz (60-Hz). WBV was consisted of 5 min, alternating every 30-sec from full standing to unloaded semi squat. None of WBV frequencies changed the total work done (P= 0.97), peak Watts (P= 0.99), and anaerobic power (P= 0.94). These data indicate that WBV either at high or low frequency was not able to improve the anaerobic performance of high intensity cycle ergometer in recreational active subjects. It is possible that the type of exercise is a crucial element for the WBV to affect performance.

Keywords: *Whole body vibration; Wingate test; anaerobic power; warm-up*

Introduction

The effects of Whole-body vibration (WBV) can be determined by different frequencies and amplitudes of vibration (Rittweger et al. 2002). Studies have investigated the acute (Rittweger et al. 2003), and chronic (Delecluse et al. 2003) effects of WBV on physiological responses and exercise performance. Acute WBV could induce physiological responses such as increasing heart rate (HR), blood pressure (BP), and blood lactate (Rittweger et al. 2000). Oxygen (VO2) and carbon dioxide kinetics (VCO2) were increased during exercise with vibration compared to exercise without vibration (Vissers et al. 2009). Furthermore, Acute WBV has been shown to increase blood flow velocity, muscle electromyographic (EMG) activity in a manner suggested to be dependent on the frequency of vibration (Herrero et al. 2011a; Herrero et al. 2011b).

The acute effect of WBV has been tried on a variety of exercise types, with mixed results. Low and high magnitude of vibration enhanced the total number of repetition and the average velocity of the whole set of exercise (Marín et al. 2010). Also, the one-repetition maximum was improved when preceded by WBV (Rønnestad 2009). In another study investigating the WBV on isometric muscle contraction, it was found that voluntary muscle activation and peak isometric torque were not altered; however, the decrease in those isometric components was reduced after WBV compared to control (Jordan et al. 2010). In contrast, maximal isometric contraction of knee extensors, and isometric squat were not improved after WBV (de Ruiter et al. 2003; Cormie et al. 2006). Furthermore, an ergometer warm-up and WBV induced similar results on peak torque at different isokinetic speeds (Kelly et al. 2010). Moreover, components of explosive strength, such as instantaneous forces, rate of force development, peak force, flight time, and jump height, were not affected by vibration pre-exercise treatments (Kinser et al. 2008). In the light of the previous results, it is plausible that the impact of WBV on performance might be depending on the type of exercise that follows WBV.

Measuring anaerobic power is highly related to sport performance (Surowiec et al. 2014). The Wingate test is considered one of the most used tests to measure anaerobic power, anaerobic fatigue, and total anaerobic capacity, and has been found correlated with cycling time trials performance (Davison et al. 2000). One study has shown an increased Wingate peak power after 10-weeks of WBV in cyclists (Oosthuyse et al. 2013). On the other hand, acute WBV at different frequencies did not change Wingate test parameters compared to no pre-treatment in competitive cyclists (Surowiec et al. 2014). The lack of WBV impact on anaerobic power test might be partially attributed to the fact that highly competitive cyclists might have muted the ergogenic effects of WBV; Had the study sample was less active subjects, this effect of WBV might have been more magnified.

In addition, the frequency of vibration might have a role in determining the change in post-intervention performance. In some studies who investigated the acute effect of WBV of different frequencies have shown that Higher frequencies only could increase blood flow and velocity (Herrero et al. 2011a; Herrero et al. 2011b). Furthermore, only the highest vibration frequency among three different frequencies was able to increase 1RM values (Rønnestad 2009). In contrast, Cardinale and Lim (2003) demonstrated an increase in vertical jump at the lower vibration frequency and a decrease at the higher one utilized during the pre-exercise interventions.

Therefore, the purpose of this study was to investigate the effect of WBV with different frequencies on Wingate test parameters within recreational active subjects. It was hypothesized that higher frequency WBV would enhance anaerobic performance relative to the lower frequency or no any vibration.

Methods

A total of 8 healthy and active participants (5 males, 3 females), volunteered to participate in this study [(mean ± STDEV) age 33.6 ± 4.5 years, weight 77.2 ± 17.01 kg, height 176.6 ± 8.85 cm]. Each participant filled a health history, and physical activity involvement questionnaires. All participants reported no cardiovascular, or metabolic diseases/symptoms, and were all non-smokers. In average, participants had declared participation in aerobic exercise for 2-3 days per week for 20-30 min per day. Before commencement of the study protocols, subjects signed a written informed consent that was approved by the local review board, and according to Helsinki declaration.

The study design was structured to perform Wingate test when preceded by no any warming up protocol, whole body vibration (WBV) at relatively low, and high frequencies. Wingate test was consisted of 20 sec pedaling at 25 Watts, 5 sec preparatory phase to start the real test, and 30 second in which the participant should perform this period by his/her maximum power output, in order to measure his maximum total work output, peak Watts, and anaerobic power that could be done within this short time of period.

Each participant had three separated visits to the human performance lab on three different days, separated by at least 72 h. On each visit, participants were asked to report to the laboratory after at least 3 h of fasting, but well hydrated. Moreover, Participants were instructed to avoid heavy exercise at 1 day prior to each trial, and abstain non-prescriptive drugs, caffeine, and alcohol during the entire study period. To assure adherence to the instructions, participants filled a 24-h history form once they reported to the laboratory on each visit. On the first visit, each participant just took about 2-3 min on the ergometer to adjust the seat, handles, and pedals positions according to their own perception. Thereafter, they performed a Wingate test on Velotron Dynafit pro cycle Ergometer (Racer Mate Inc. seattle, WA) with no prior warm-up, as a control trial (CON).

On the second visit, participants performed WBV at 30 Hz frequency (30-Hz) on horizontally vibrating plate (Pneumex Inc., Sandpoint, ID, USA), for 5 min, changing body position every 30 sec from full standing to unloaded semi squat. Following the WBV, participants were allowed for 1-2 min before the commencement of the ergometer Wingate test.

On the third visit, participants followed the same procedures of the 30-Hz trial, except the vibration was set at 60 Hz frequency (60-Hz). The vibration amplitude was fixed at 6 mm from baseline-to-peak for both frequencies, and during all body movement alterations.

Statistical method: All data were analyzed by the statistical package for the social sciences version 15 (SPSS, Illinois, USA). Each selected variable of Wingate test was analyzed using 2-ways repeated measures ANOVA. When appropriate, paired-t tests were used to select where were the exact differences. Significance was set at $\alpha = 0.05$.

Results

Total work: mean total works recorded for treatments were (14254 ± 4220; 14483.6 ± 4589.3; 15079 ± 4988.7 W) for CON, 30-Hz, and 60-Hz trials, respectively (Fig. 1). There were no main or interaction effects of treatment, and time ($P > 0.95$).

Peak Watts: the mean peak Watts values were (702.3 ± 317.4; 730.6 ± 264.8; 711 ± 212.04 W) for CON, 30-Hz, and 60-Hz trials, respectively (Fig. 2). There was no main effect, or interaction effect for treatment, and time ($P > 0.9$).

Anaerobic power: There was no effect of treatment, time, or interaction ($P > 0.9$) on the mean anaerobic power (8.8

± 2.06; 9.3 ± 1.73; 9.13 ± 1.5 W/kg, for CON, 30-Hz, and 60-Hz trials, respectively) (Fig. 3).

Discussion

The results of this present study have shown that whole body vibration (WBV), either with low (30-Hz), or high frequency (60-Hz), was not effective in improving the anaerobic capacity during Wingate test. The majority of previous studies have been conducted to investigate the effect of WBV on isometric (de Ruiter et al. 2003; Cormie et al. 2006), maximum strength (Rønnestad 2009), or other types of exercises composed of single trials, such as high jump (Kinser et al. 2008). The effect of WBV on anaerobic power has been minimally investigated (Surowiec et al. 2014).

Previously, Surowiec et al. (2014) have used a 30-Hz vibration frequency and an individualized frequency, that resulted in a maximum muscle activity on the dominant leg. The Study sample was selected and verified as highly trained cyclists. None of the vibration modes could change anaerobic performance on Wingate test compared to no intervention prior to the test. The present study has used two levels of vibration frequency (30 and 60 Hz), instead of individualized frequency, and used recreational active subjects in place of elite cyclists. Given those procedures differences, the results of both, this, and of Surowiec et al. (2014), studies were similar in not affecting Wingate performance. One interpretation of the lack of WBV effect on performance in Surowiec et al. (2014), was that the high level of training of subjects minimized the ergogenic effect. It was suggested before, that elite athletes can show only small improvements during laboratory and field tests (Kearney 1999). On the other hand, it was suggested that subjects with less fitness levels could show greater effects of pre-exercise treatments, possibly because of higher level of fatigue and muscle soreness, relative to higher elite athletes (Poppendieck et al. 2013). Nonetheless, using less active subjects resulted in no change in anaerobic performance following high and low vibration frequencies.

Oxygen kinetics (VO2) was increased proportionately with increasing vibration frequency in WBV protocol, as well as with increasing vibration amplitude. Hence, it was proposed that vibration exercise could enhance metabolic power and muscle activity (Rittweger et al. 2002). Consequently, WBV is a potential intervention to enhance anaerobic performance, such as Wingate test, through increasing oxygen availability prior to anaerobic exercise (Suchý et al. 2010). However, performance was not improved with both WBV frequencies in the present protocol.

The vibration exercise was consisted of 5-min, alternating between 30-sec standing and 30-sec unloaded semi squat. It has been shown that vibration exercise combined with loaded squat increased blood lactate to ~ 3.5 mM, and reduced knee extension voluntary force (Rittweger et al. 2000). Moreover, muscle activity was increased similarly during WBV with loaded and unloaded squats (Hazell et al. 2010). It is plausible, therefore, that WBV protocol that was used in the present study was sufficient to induce an increase in muscle activity, but without elevating muscles acidity.

The effect of vibration frequency on performance has been unsettled. It has been found that the higher vibration frequencies (20 and 30 Hz), and not the lower (10 Hz), increased blood flow and velocity (Herrero et al. 2011a; Herrero et al. 2011b). Whereas, muscular circulation was increased after low vibration frequency (27 Hz), suggesting that low frequency does not induce negative systematic consequences (Kerschan-Schindl et al. 2001). However, none of the vibration frequencies (30-Hz and 60-Hz) elicited an improved Wingate test.

The type of exercise may have a role in determining the effect of vibration exercise. Marín et al. (2010) examined a high and low frequency on the elbow flexion exercise repetitions and velocity, and found that higher frequency facilitate more neuromuscular activity associated with higher velocity. In 1RM test, only the higher vibration frequency could improve performance (Rønnestad 2009). In contrast, vertical jump height enhanced by low vibration frequency and impaired by high frequency (Cardinale and Lim 2003). The Wingate test used in this study and the study of Surowiec et al. (2014) was not improved by low, high, and individualized frequency, in elite cyclists or recreational active subjects.

In conclusion, WBV, at low and high frequency, was found not effective in eliciting an enhancement in anaerobic power during Wingate test in recreational active subjects. It is possible that WBV can only impact certain types of exercise.

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Figures Legends

Fig.1 Mean ± Standard deviation of total work done (W) during ergometer cycling Wingate test when preceded by no treatment (CON), WBV at 30 Hz (30-Hz), and WBV at 60 Hz (60-Hz).

Fig.2 Mean ± Standard deviation of peak Watts (Watts) achieved during ergometer cycling Wingate test when preceded by no treatment (CON), WBV at 30 Hz (30-Hz), and WBV at 60 Hz (60-Hz).

Fig.3 Mean ± Standard deviation of anaerobic power (W/kg) during ergometer cycling Wingate test when preceded by no treatment (control), WBV at 30 Hz (30-Hz), and WBV at 60 Hz (60-Hz).

Figure (1)

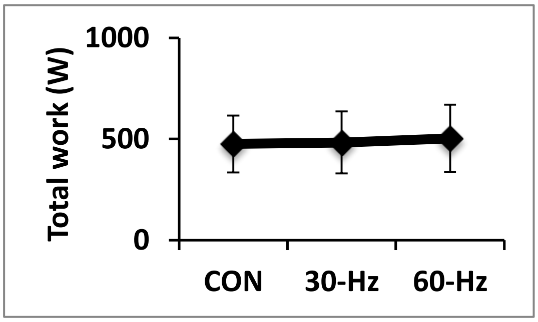

Figure (2)

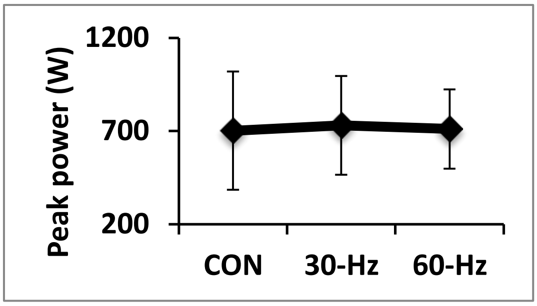

Figure (3)