THE EFFECT OF WHOLE BODY VIBRATION ON THE DYNAMIC STABILITY OF WOMEN BASKETBALL PLAYERS

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This study investigated the effect whole body vibration (WBV) on the dynamic stability of NCAA Division I women basketball players. Eleven subjects were evaluated in two test conditions including one with and one without WBV. After each condition, subjects were tested for time to stabilization (TTS) on a force platform during bilateral, right leg, and left leg countermovement jumps (CMJ). Results of the statistical analysis revealed no significant difference in TTS between the vibration and non-vibration conditions for the bilateral (p = 0.24) and right leg (p = 0.48) CMJ. A significant difference was found between the conditions demonstrating a shorter TTS in the non-vibration condition for the left leg CMJ (p = 0.04, d = 0.57, η_p^2 = 0.36). Acute WBV has no effect on and in some cases impairs dynamic.

KEYWORDS: Time to stabilization, countermovement jump, landing, postural stability.

INTRODUCTION: Whole body vibration (WBV) has been used for rehabilitation, stimulating bone development, and enhancing physical performance. The acute enhancement of neuromuscular performance after vibration may be due to increased sensitivity of the stretch-reflex (Martin & Park, 1997). The vibration mediated deformation of soft tissues may activate muscle spindles, leading to an enhancement of a stretch-reflex loop. Cardinale & Bosco (2003) suggest that vibration could represent an effective exercise intervention for enhancing neuromuscular performance of athletes by increasing muscle activation via the stretch reflex.

Single and multiple exposures of short-term WBV training have been shown to improve power and strength (Bosco et al., 1999) and vertical jumping ability (Cardinale & Bosco, 2003). The acute application of WBV ranging from 30 seconds (Cormie et al., 2006) to 5 minutes (Bosco, 1999) has resulted in subsequent countermovement jump (CMJ) height increase. Similarly, training studies incorporating WBV ranging from eight weeks (Fagnani et al., 2006) to four months (Torvinen et al., 2002b), have resulted in increase subject strength, CMJ height, and flexibility. On the other hand, some evidence shows no positive acute effect of a four minute WBV session on strength and CMJ height (Torvinen et al., 2002a).

In addition to strength and power performance, the effect of WBV on balance has been studied. Results are equivocal with some studies demonstrating no improvements (Torvinen et al., 2002a; Torvinen et al., 2002b) while others found significant improvement in balance after acute WBV exposure (Moezy et al., 2008; Torvinen et al., 2002c). Previous studies that assessed balance used the Biodex Stability System (BSS) (Biodex Medical Systems, Shirley, NY, USA). The BSS measures the degree and time of tilt about unstable axes. Unfortunately, since foot stance in most sports does not occur on a surface with an unstable rotary axis, the BSS does not measure athletic activity (Wickstrom et al., 2005) and therefore may lack external validity.

Alternatively, time to stabilization (TTS) is a postural control measure that is used in conjunction with a functional jumping protocol. Time to stabilization is a measure of neuromuscular control and incorporates feedback from sensory and neuromotor systems during jump landings as the body transitions from a dynamic to static state (Wickstrom et al., 2005). Time to stabilization is also more reliable than other options such as center of pressure measurements (Wickstrom et al., 2006). The purpose of the present study was to examine the acute effect of WBV on bilateral and unilateral balance during jump landings of women basketball players, using TTS.

METHODS: Eleven current NCAA Division I women basketball players (age: 19.82 ± 2.18 years; height: 178.36 ± 10.64 cm; mass: 73.77 ± 15.29 kg) volunteered to serve as subjects. The study was conducted during the sport season and all subjects were participating in basketball practice, games, and strength and conditioning programs. Subjects gave informed consent before participating and human subject's research approval was obtained from the university office of research compliance before beginning the study.

Prior to the habituation and test sessions, subjects performed a warm-up, dynamic stretching, and vertical jumps of increasing intensity. The habituation session consisted of assessing CMJ height in order to provide subjects with an overhead target to use during the test sessions. Overhead targets were used since they have been shown to maximize CMJ height (Ford, et al., 2005). Subjects were taught and practiced the bilateral, right leg, and left leg CMJ and landings. This process included jumping to a maximum height, landing in an athletic position characterize by the shoulders over the knees, bringing arms down to a ninety-degree angle and "locking in" place upon landing, stabilizing as quickly as possible, facing straight ahead, and remaining motionless for a period of 5-7 seconds, consistent with methods previously used (Flanagan et al., 2008). Subjects also practiced the vibration protocol to be used during the test.

The order of the non-vibration and vibration test conditions was counterbalanced with each condition separated by 48 hours. Subjects then performed two trials of bilateral, right leg, and left leg CMJ, with the average of the two trials used for analysis. A one minute rest interval and randomization was provided between the bilateral, right let, and left leg CMJ to reduce order and fatigue effects.

A WBV platform (PowerPlate® Model PP040556129, PRO5 AIRDAPTIVE™ High Performance, Irving, CA, USA) was used as a vibration-loading device. The duration of the vibration stimulus was two minutes. During the first 30 seconds, subjects stood in an athletic position with slight knee joint flexion, shoulders over the knees, feet shoulder width apart, and a vibration frequency of 30 Hz was used. During the next 60 seconds subjects performed 10-12 slow continuous bodyweight squats at a vibration frequency of 40 Hz. For the final 30 second interval, subjects again stood in an athletic position, similar to that which was used during the first 30 seconds, but at a vibration frequency of 50 Hz. Vibration amplitude was 4 mm throughout.

After a minute, subjects performed two trials of bilateral, right leg, and left leg CMJ. Each CMJ was performed by taking off from and landing on a 60 x 120 cm force platform (BP60011200, Advanced Mechanical Technologies, Inc., Watertown, MA, USA). Kinetic data were collected at 1000 Hz, real-time displayed, and saved with the use of computer software (BioAnalysis 3.0, Advanced Mechanical Technologies, Inc., Watertown, MA, USA) for later analysis. Vertical ground reaction force data were collected for the sample period and used to calculate several variables from the vertical force components. Instants of initial foot contact, take-off, and landing were identified from the vertical ground-reaction force datasets. Vertical TTS was established as the time from the point of landing to when the vertical force component reached and stayed within 5% of the subject's body weight for one second.

All statistical analyses of the data were carried out in SPSS 16.0. A one-way ANOVA was conducted to assess differences in TTS between the vibration and non-vibration condition for the bilateral, right leg, and left leg CMJ. All data are expressed as means ± SD, with statistical effect size (d) and power (η_p^2) are reported. The *a priori* alpha level was set at $p \leq 0.05$.

RESULTS: Results of the statistical analysis revealed no significant difference in TTS between the vibration and non-vibration conditions for the bilateral (p = 0.24, d = 0.20, η_p^2 =

0.13) and right leg (p = 0.48, d = 0.10, η_p^2 = 0.05) CMJ. A significant difference in TTS was found between the vibration and non-vibration conditions for the left leg CMJ (p = 0.039, d = 0.57, η_p^2 = 0.36). Table 1 demonstrates the TTS data for vibration and non-vibration conditions.

Table 1. Time to stabilization (TTS) expressed as mean ± SD seconds (seconds) for the vibration and non-vibration conditions of each of the countermovement jump (CMJ) variations, and the difference between conditions.

	Vibration	Non-Vibration	Difference
Bilateral CMJ TTS (sec.)	1.00 ± 1.02	0.65 ± 0.15	35.0%
Right leg CMJ TTS (sec.)	0.90 ± 0.36	0.80 ± 0.30	11.2%
Left leg CMJ TTS (sec.)	1.25 ± 0.65	0.81 ± 0.29	35.2%*

*Significant difference ($p \leq 0.05$)

DISCUSSION: This study demonstrates that acute WBV, as performed in this study, offers no advantage and may impair dynamic stability. The TTS in this study was similar in some cases to the values of 0.97 seconds found by Flanagan et al. (2008). The TTS values found in the present study where shorter than the TTS values of 2.2 seconds demonstrated by Wickstrom et al. (2004) who studied a horizontal jump landing, compared to the vertical landings used in this study. In the present study, large TTS standard deviations in the vibration condition of the bilateral CMJ suggest that subject response to the vibration stimuli is highly variable, especially when compared the relatively small standard deviations found in the non-vibration condition.

Previous research has evaluated the nature of the vibration stimulus demonstrating potential optimal combinations of frequency and amplitude and it effects jump performance and power output. This research indicates that low frequency and amplitude or high frequency and amplitude combinations may be most effective (Adams et al., 2009). The present study used a range of low to high frequency stimuli and moderate displacement of 4 mm. Thus, it is possible that the vibration stimulus used in the present study may not have been optimal.

Vibration may enhance neuromuscular performance in athletes by increasing the muscle activity via muscle spindles (Cardinale & Bosco, 2003). Muscle spindles are the basis of the myotatic reflex, which is an important part of regulating posture. The myotatic reflex keeps length of a muscle constant (Robergs & Roberts, 1997). If muscles spindles are over-stimulated, the result is fatigue (Martin & Park, 1997). Torvinen et al. (2002a) showed that with a 4 min WBV session the surface electromyography (EMG) decreased in the vastus lateralis and gluteus medias during the vibration, which may indicate fatigue in those muscles. While some evidence indicates that the duration of the WBV session does not matter (Adams et al., 2009), it is also possible that the duration of the WBV stimulus in the present study may have been too long.

Time to stability provides researchers with a mechanism with which to assess dynamic stability during jump landings for basketball players, who demonstrate decreased proprioception, stability, and reaction time, particularly when recovery from ankle injuries (Fu & Hui-Chan, 2005). Overall, the above findings of this study indicate that some prescriptions of acute WBV training may impair dynamic stability.

CONCLUSION: Results of this study demonstrate that in some cases, WBV does not enhance and may acutely impair dynamic stability and balance in collegiate Division I female basketball players. Other combinations of frequency, amplitude, and duration of the vibration stimulus may be more effective.

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Acknowledgement

Travel to present this study was funded by a Green Bay Packers Foundation Grant