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The Short-Term Effect of Whole Body Vibration Training on Sprint Start Performance in Collegiate Athletes

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ABSTRACT

Int J Exerc Sci 2(4): 264-268, 2009. Whole body vibration (WBV) is characterized by a vibratory stimulus emitted throughout the body through the use of a vibrating platform on which the subject stands. Studies have shown over 30% increases in maximal explosive strength such as maximal speed biceps curl as well as increases in maximum dynamic force such as maximal sitting bench pull as the result of vibration. The purpose of this study was to investigate the effects of short term whole-body vibration on sprint starts among collegiate track athletes. On the first day eleven subjects were randomly assigned to either a non-vibration or vibration group for initial testing. The vibration group used whole body vibration along with their normal warm-up routine while the non-vibration group did not. Force measurements were taken where the starting blocks were placed using a force plate embedded under the track surface following the warm up. One week later the groups alternated. The results were then compared between vibration and non-vibration groups for individual athletes. The vibration protocol occurred for 60 s at 26 Hz with an amplitude of 4mm on a Galileo 2000 platform. Repeated measures analysis of the variance showed peak resultant force was 6% greater when the vibration platform was utilized prior to the start (p=0.013). Further research is needed to determine whether any meaningful differences exist in sprint start velocity as a result of WBV. There were no observed differences in the 30m sprint times.

KEY WORDS: Whole Body Vibration, Sprint Starts, Maximal Explosive Strength

INTRODUCTION

The use of whole body vibration (WBV) has become an increasingly popular method of training for enhancing performance in sport. Significant improvements in performance have been demonstrated across a wide spectrum of sporting activities with the use of WBV training. The most common improvements are seen in explosive activities such as weightlifting or vertical jump tests (2). A review of vibration studies by Issurin shows a clear trend of performance enhancement towards that of explosive strength and maximum dynamic force production with decreases being seen in endurance activities (8).

It appears that the effects of WBV are short lived and improvements are best seen immediately following vibration. It has also been shown that prolonged duration vibration can be damaging to health such as that seen in hand-arm vibration syndrome commonly seen in occupational health clinics as well as damaging to athletic performance (12, 14). Short duration WBV (1 minute or less) however, demonstrates significant improvement (1, 7, 9, 10). WBV has been described to produce gravitational acceleration changes similar to those of power and strength training and has been reported to improve muscular power of the upper and lower musculature, changes to hormonal profile, such as increases in testosterone and growth hormone levels (2), and increases in cardiovascular responses (4).

There are several theories for how the WBV exerts its effect. One of the theories is that muscles have a particular resonant frequency that, when excited, stimulates the gamma motor neurons to cause muscle spindle contraction. This resonant frequency has been shown in animals (11). It is also theorized that muscles are dynamically tuned to match the resonant properties of the entire musculoskeletal system (11). Muscle spindle contraction may cause an increase in the responsiveness of the extrafusal alpha fibers of the muscle which would allow for a stronger and quicker reflexive response. The muscle spindle’s connections provide a means for rapidly executed reflex adjustments in muscle length following any stretching or change in muscle load. Since the neural pathways for the muscle spindle are relatively short, the change in motor neuron firing and ultimately muscle adjustments can be made more rapidly than if intervention by the central nervous system of the brain were needed. If this theory is indeed the case, it would be expected to be a short-term effect as the muscle would rapidly return to a state of relaxation following stimulation.

Five weeks of WBV training in addition to conventional training of sprint-trained athletes showed no surplus value upon the conventional training program to improve speed-strength performance in sprint-trained athletes (5). Although several studies have analyzed the long term cumulative effects of WBV, very few studies have been aimed at WBV’s immediate, acute effects in sport, especially on sprint starts in a sprint trained population. This study analyzed the effects of WBV on trained sprint athletes and specifically looked at force production off of the sprint blocks immediately following WBV.

METHOD

Participants

This study was approved by the university Internal Review Board for use of human subjects. Participation in the study was voluntary and, following an explanation of the study, each subject gave informed consent. Eleven male sprinters were selected from a Division I NCAA track team. All subjects were tested for the maximum resultant force they could produce during a sprint starts on two testing days one week apart. Subjects were randomly assigned to groups that performed whole body vibration (WBV) on the first or second days of testing. Subjects mean height was 18.0 ± 0.04 m, mean mass was 66.6 ± 6.3 kg and mean age was 21.9±2.5 years.

Protocol

On each testing day three trials were performed. On the vibration testing trials, WBV occurred within 60 seconds of each trial. The WBV protocol included 60 seconds of vibration at 26 Hz at an amplitude of 4 mm on a Powerplate (Galileo 2000, Orthometrix, White Plains, NY). The vibration protocol replicated Bosco et al. (3). Subjects stood on the platform with the heels slightly off the ground and 45 degrees of knee flexion. Subjects completed their traditional warm-up on both testing days and were asked not to vary their warm-up between days. A typical warm-up for these subjects included about 10 minutes of jogging, followed by static and dynamic stretching, then four 80 m strides. Measurements were taken during the teams' preseason training.

A Kistler force plate (9287BA, Amherst, NY) was under the surface of an indoor track and measured peak ground reaction forces at a vibration frequency of 1000 Hz. Subjects completed a start and ran 30m at maximum effort. In order to replicate a normal sprint start a starter's pistol signaled the start for each athlete. Peak ground reaction force was recorded for each start after normalizing by body weight. A wireless timing light system (Brower, Draper, UT) with sensors placed at head height were interfaced with starting blocks were used to determine 30-m sprint time.

Statistical Analysis

A repeated measures analysis of the variance (ANOVA) was completed to compare conditions with the alpha-level set at 0.05.

RESULTS

Acute effects of WBV showed an increased peak ground reaction force 6% greater than the control condition (table 1, p=0.013). No significant differences in 30-m sprint time were found.

Condition	Peak Force (N/kg)	30-m Sprint Time (s)
Vibration	2.41 ± 0.20	4.56 ± 0.04
Control	2.28 ± 0.19	4.56 ± 0.05

Table 1. Peak ground reaction force and 30-m sprint time under WBV and control conditions (mean ± SD). Differences between conditions in peak ground reaction force, normalized by body weight (p=0.013) and 30-m sprint time (p=0.992).

DISCUSSION

Whole body vibration is effective for aiding sprinters in producing slightly greater peak forces during sprint starts. Previous studies show mixed results in the benefits of short-term WBV in vertical jump performance (2, 15). Short-term training effects on sprinting speed were non-significant in this and other studies (4). Other studies have shown 10% or greater improvements in explosive strength (8, 18). While an increase in peak resultant force is encouraging, there are other factors to consider. Studies have not concluded an optimal direction of the resultant force during the sprint start. There may be no benefit to increased force production if the direction of the increased force is not optimized.

The goal of a sprint start is to increase momentum as rapidly as possible. Increases in momentum can only be attained by increases in impulse, which is a combination of force and time of force application. Since the hands were not on the force plate at any point of the start, impulse could not be calculated accurately. So, there may not be increased running speed or an improved start just because of increased peak ground reaction forces. However, increased peak force typically leads to increased impulse and greater changes in momentum in human movement. Thus, further research looking into the above issues should finish answering the question of whether acute WBV has a benefit on improved performance in the sprint start. The above listed limitations to determining an increase in performance based upon greater peak ground reaction force were supported by the lack of any decrease in 30-m sprint time.

The 30-m sprint times were so similar that it is unlikely that vibration platforms will make it to the warm-up area at track meets. Furthermore, the cost and the necessity to travel with the large and heavy platform make it unlikely that WBV will be used in competitive track meets. There is also the possibility of the increases being due to other variables such as health on the day of testing or psychological impacts resulting in a placebo effect.

This study looked at the acute effects of WBV on trained collegiate sprinters. None of the studies to date have looked at collegiate sprinters, and data for the acute effects of WBV on any trained athletes is limited to one study testing vertical jump on trained handball players (3). Significant increases have only been shown with the use of acute WBV for recreational athletes in leg press power and counter-movement jump (8). Furthermore, many of the previous studies on acute WBV examine the effects that long term (more than a minute) WBV has while the subject is on the plate (6, 13, 15-17). This study examined an immediate response following short term (one minute) WBV. Long term WBV is likely to have a fatiguing effect due to excessive contraction of the extrafusal fibers caused by constant muscle spindle firing. This fatiguing effect may be the reason that a decrease in actual race time is not observed. Short term (acute) WBV may stimulate the gamma motor neurons just enough for an increase in spindle sensitivity resulting in an increase in peak force. Further research is needed to determine the optimal duration and frequency of the WBV training protocol.

Acute WBV increases peak ground reaction force in sprint starts. However, improvements in 30-m sprinting time do not exist in this or previous studies. Athletic performance is affected by WBV, yet it is still unknown the method by which this is happening. Further investigations of vibration training should answer at least three major questions: How is the response occurring? What are the most efficient training protocols and how can the health risks associated with whole body vibration be eliminated?

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