INTRODUCTION

The ability to generate high force in the shortest time possible, also referred to as the rate of force development, is a quality possessed and optimized by elite athletes. Power development has become a primary focus of athletic performance enhancement training programs [1]. Whole-body vibration (WBV) has been proposed as a potential alternative or adjuvant to exercise for power development [2]. More recently individualized frequency (I-Freq) has been introduced with the notion that individuals may elicit a greater reflex response to different levels (Hz) of vibration [3]. As such, the aim of the study was to evaluate acute WBV as a feasible intervention to increase power in trained cyclists. Additionally, we sought to evaluate the efficacy of utilizing I-Freq as an alternative to 30 Hz, a common WBV frequency seen in the literature.

METHODS

Twelve highly-trained, competitive male cyclists (age= 29.9 yrs ± SD 10.0; body height=175.4 cm ± SD 7.8; body mass=77.3 kg ± SD 13.9) participated in the IRB approved study. One subject was excluded due to adherence to the Wingate procedure. The subject’s I-Freq was determined by recording the EMG activity of the vastus lateralis of the dominant leg (DelSys, Boston, MA). The adapted I-Freq protocol included vibrations ranging from 20-55Hz administered randomly in 5Hz increments [3]. Muscle activity was recorded for 10s of no vibration followed by 10s of vibration with four minutes of seated rest between trials. A band-stop filter set at ± 2Hz of the frequency of interest was utilized and averaged root mean square muscular activity was graphed to determine which frequency most exited the muscle of interest resulting in the subject’s I-Freq (Figure 1).

![Figure 1: EMGrms of the vastus lateralis for Subject A. The black bar indicates the highest neuromuscular response recorded indicating the participants’ I-Freq.](image)

The testing protocol included three conditions; the subject's I-Freq, a fixed frequency of 30 Hz, and a control of no vibration. Each condition was immediately followed by a 30-second Wingate test for anaerobic power where measures of peak power (PP), average power (AP), and rate of fatigue were determined.

The control condition of no vibration was administered on day one of testing. The two vibration conditions, performed on day two, were administered in random order. All vibration conditions were executed on a vibration platform (Pneumex, Sandpoint, ID) (peak to peak amplitude: 2mm) and consisted of 10 series of one minute WBV followed by a one minute pause of no vibration. Immediately following vibration, the Wingate test was administered using a Monark Cycle Ergometer (Monark Exercise, Vansbro, Sweden). The flywheel force was kept at a constant 0.085 kp/kg bodymass within a 0.1-kg resolution of
resistance range with the load reflecting the trained nature of the cyclists. PP, AP, and rate of fatigue were calculated by Monark software throughout the 30s test. Immediately following the test the subject pedaled at slow pace (25-100W) for 2-5 minutes as an active recovery phase. To ensure recovery prior to the next test, 20 minutes of passive rest was achieved by the subject in the seated or supine position.

RESULTS AND DISCUSSION

The means and standard deviations of all test variables (PP, AP, and rate of fatigue) are displayed in Table 1. Test variables from the Wingate (i.e., PP, AP, and rate of fatigue) were not impacted differently by the three interventions (control, 30 Hz, and I-Freq). For the measure of PP, no significant effect of vibration (F=2.54, p=0.104, partial eta²=0.202, observed power=0.358) was observed which indicates that no significant differences between the control, 30 Hz, and I-Freq. Similarly, in response to the vibration treatments, no significant effect was observed for the measure of AP (F=0.534, p=0.589, partial eta²=0.052, observed power=0.127). Likewise, as a result of vibration, there was no significant effect in the rate of fatigue (F=1.966, p=0.166, partial eta²=0.164, observed power=0.358) as the subjects did not fatigue differently across the three testing conditions regardless of vibration intervention.

Based on the results of the present study, acute WBV did not significantly increase PP, AP or improve rate of fatigue in the trained cyclists. It was also noted that I-Freq was not superior to 30 Hz in that neither vibration intervention was able to elicit an effect on power in the athletes. The literature regarding WBV has been equivocal thus the findings support previous acute WBV data suggesting that WBV may not increase power in highly trained individuals. Up until now WBV studies, specifically ones using I-Freq, have not been tested with a sport specific power measurement such as the Wingate test.

The capacity for improvement for elite athletes in laboratory or field tests is typically small. Although previous vibration studies have elicited a significant increase in power in elite and amateur athletes in other sports (typically measured by the vertical jump), the combination of elite athlete and the sport specific nature of the Wingate test proved to show no significance. This could be due to the stimulus used in the present study as the amount of vibration and length of the protocol prescribed to an athlete remains ambiguous in the literature. Similar findings were reported by Ronnestad et al. supporting recommendations for evaluating greater stimuli for trained individuals [4]. Prospective research endeavors may choose to look at this protocol utilizing greater intensity in vibration amplitude and duration in the event that training status may be a limiting factor for eliciting increases in power following acute WBV.

REFERENCES


<table>
<thead>
<tr>
<th></th>
<th>PP (W)</th>
<th>PP (W/kg⁻¹)</th>
<th>AP (W)</th>
<th>AP (W/kg⁻¹)</th>
<th>RF (%)</th>
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<tbody>
<tr>
<td>Subjects (n=11)</td>
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<tr>
<td>Control</td>
<td>945.8 ± 173.8</td>
<td>12.8 ± 2.1</td>
<td>674.7 ± 125.5</td>
<td>9.1 ± 1.2</td>
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<td>30HZ</td>
<td>907.6 ± 214.9</td>
<td>12.1 ± 1.5</td>
<td>661.8 ± 105.6</td>
<td>8.9 ± 0.7</td>
<td>49.8 ± 5.4</td>
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<td>I-Freq</td>
<td>891.2 ± 206.7</td>
<td>11.9 ± 1.5</td>
<td>660.8 ± 117.2</td>
<td>8.8 ± 0.5</td>
<td>49.3 ± 5.2</td>
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PP= peak power; AV= average power; RF= rate of fatigue; I-Freq= individualized frequency