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The Acute Effects of Whole Body Vibration on Isometric Mid-Thigh Pull Performance

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Introduction

Acute exposure to vibration has been suggested to produce transient increases in muscular strength (1,2,8), vertical jump displacement (4,8), and power output (2,6,7) recorded while performing various tasks. It has been hypothesized that the reported acute vibration induced increases in performance occur as a result of alterations in neuromuscular stimulation (1,3,4). Specifically, most studies have ascribed the observed improvements to the likeliness of Whole Body Vibration (WBV) in producing a "tonic vibration reflex" (TVR) in which the primary nerve endings of the Ia afferents of the muscle spindle are activated. This is thought to result in the excitation of the alpha-motor neurons and activation of the extrafusal fibers (4) which likely leads to a greater synchronization of motor units as a result of homonymous motor unit contraction. However, not all investigations report improvements in muscular strength (4), vertical jump (7), and power production in response to acute vibration (4).

While the current body of scientific knowledge offers conflicting evidence on the effectiveness of WBV in augmenting neuromuscular performance it is possible that WBV may result in alterations to specific aspects of the force-time curve during the performance of a maximal isometric contraction. Therefore, the primary purpose of this investigation was to examine the effects of WBV performed using 30 Hz frequency and 2-4 mm amplitude on the force-time curves of an isometric mid-thigh pull.

Methods

Subjects:

Eleven (4 women and 7 men) recreationally trained individuals served as subjects in the present investigation which was approved by the East Tennessee State University Institutional Review Board (IRB). All subjects read and signed informed consent documents in accordance with the East Tennessee State IRB.

The first testing session was used to perform all preliminary testing. This testing included the collection of the subject's physical characteristics. A summary of the subject characteristics is presented in Table 1. Additionally during this session each subject was familiarized with the WBV protocol (Figure 1) and the isometric mid-thigh pull testing procedures (Figure 2). Seven days after the completion of the familiarization session and 48 hours after their last exercise bout, the subjects performed one of the three randomly assigned treatment conditions. A summary of the testing protocol is presented in Figure 3.

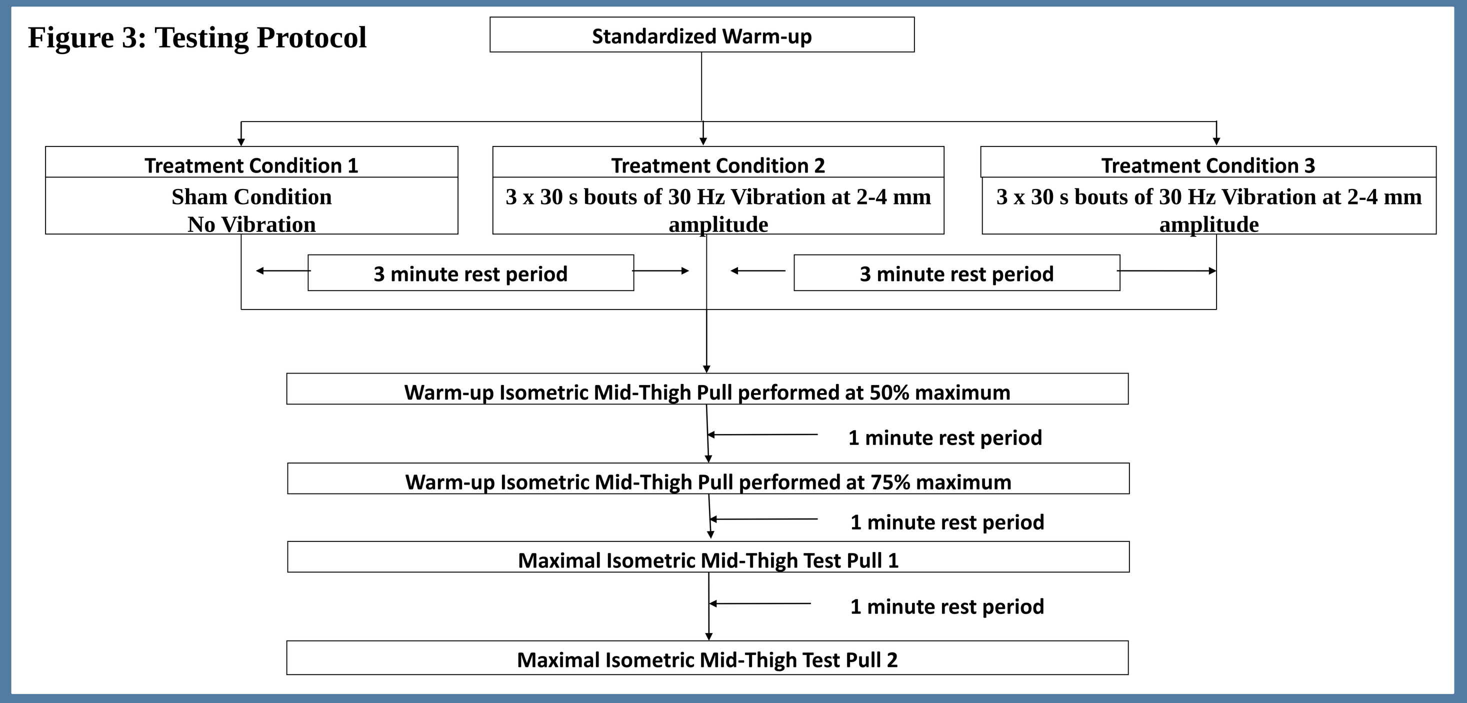
Table 1: Subject Physical Characteristics (n = 11).

	Males (n = 7)			Females (n = 4)			Combined (n = 11)		
	Mean	±	SD	Mean	±	SD	Mean	±	SD
Age (y)	24.7	±	1.8	23.5	±	1.0	24.3	±	1.6
Height (cm)	179.2	±	6.2	164.8	±	6.8	173.9	±	9.5
Weight (kg)	101.7	±	12.9	65.3	±	5.2	88.4	±	21.1

Figure 1: Standing on vibration platform

Figure 2: Isometric Mid-Thigh Pull

Figure 3: Testing Protocol



Results

- There were no statistically significant differences between any of the treatment groups for force-time curve parameters analyzed in the present investigation.
- There were no significant differences ($p \leq 0.05$) for the percent differences between the sham and vibration conditions for any of the force time curve variables analyzed in the present investigation.
- The results of the coefficient of variance, intraclass correlation, and interclass correlation analyses performed between the sham and vibration treatments (T1 vs. T2; T1 vs. T3) are presented in Table 2.
- The percent difference scores between the T1 vs. T2 and T1 vs. T3 are presented in Figures 4 and 5.
- There were only trivial to small correlations between body mass and the percent difference in potentiation for peak force at 50 ms (T1 vs. T2: r= -0.29; T1 vs. T3: r = 0.29), 90 ms (T1 vs. T2: r = -0.46; T1 vs. T3: r = 0.02), 200 ms (T1 vs. T2: r = -0.39; T1 vs. T3: r = -0.08), and 250 ms (T1 vs. T2: r = -0.48; T1 vs. T3: r = -0.11).
- Similar results were found when looking at the RFD results at 50 ms (T1 vs. T2: r= -0.33; T1 vs. T3: r = -0.23), 90 ms (T1 vs. T2: r = -0.36; T1 vs. T3: r = -0.40), 200 ms (T1 vs. T2: r = -0.04; T1 vs. T3: r = 0.14), and 250 ms (T1 vs. T2: r = -0.36; T1 vs. T3: r = -0.36).

Results

Table 2: Coefficient of Variance, Intraclass Correlations, and Interclass Correlations between Treatment Conditions

	T1 vs T2						T1 vs T3					
Variable	CV %	95% CI	ICCα	95% CI	R	95% CI	CV%	95% CI	ICCα	95% CI	R	95% CI
Peak Force @ 50 ms	11.7	8.0-21.4	0.93	0.75-0.98	0.92	0.71-0.98	7.4	5.1-13.3	0.97	0.90-0.99	0.97	0.89-0.99
Peak Force @ 90 ms	14.5	9.9-26.8	0.92	0.73-0.98	0.91	0.68-0.98	8.0	5.5-14.5	0.98	0.91-0.99	0.97	0.89-0.99
Peak Force @ 200 ms	10.8	7.5-19.8	0.93	0.77-0.98	0.93	0.75-0.98	3.9	2.7-7.0	0.99	0.97-1.00	0.99	0.96-1.00
Peak Force @ 250 ms	8.9	6.1-16.1	0.96	0.85-0.99	0.95	0.82-0.99	3.8	2.6-6.8	0.99	0.97-1.00	0.99	0.96-1.00
Maximal Peak Force	4.2	2.9-7.5	0.99	0.96-1.00	0.99	0.96-1.00	5.9	4.1-10.7	0.98	0.93-0.99	0.98	0.91-0.99
PRFD @ 0-50 ms	60.6	41.9-112.6	0.76	0.43-0.91	0.74	0.35-0.91	40.1	28.3-71.1	0.88	0.69-0.96	0.87	0.64-0.96
PRFD @ 0-90 ms	33.5	23.8-58.5	0.89	0.70-0.96	0.88	0.65-0.96	23.5	16.9-39.9	0.93	0.82-0.98	0.94	0.81-0.98
PRFD @ 0-200 ms	34.6	23.1-68.5	0.72	0.25-0.92	0.70	0.17-0.92	30.8	20.6-60.2	0.78	0.37-0.94	0.76	0.30-0.93
PRFD @ 0-250 ms	15.3	11.1-25.4	0.92	0.78-0.97	0.91	0.75-0.97	7.9	5.8-12.8	0.98	0.93-0.99	0.98	0.94-0.99

Note: CV = coefficient of variance; 95% CI = the 95% confidence interval; T1 = mid-thigh pull sham treatment; T2 = mid-thigh pull vibration treatment 1; T3 = mid-thigh pull vibration treatment 2.

Figure 4: Percent Change for Peak Force between Sham and Vibration Treatments

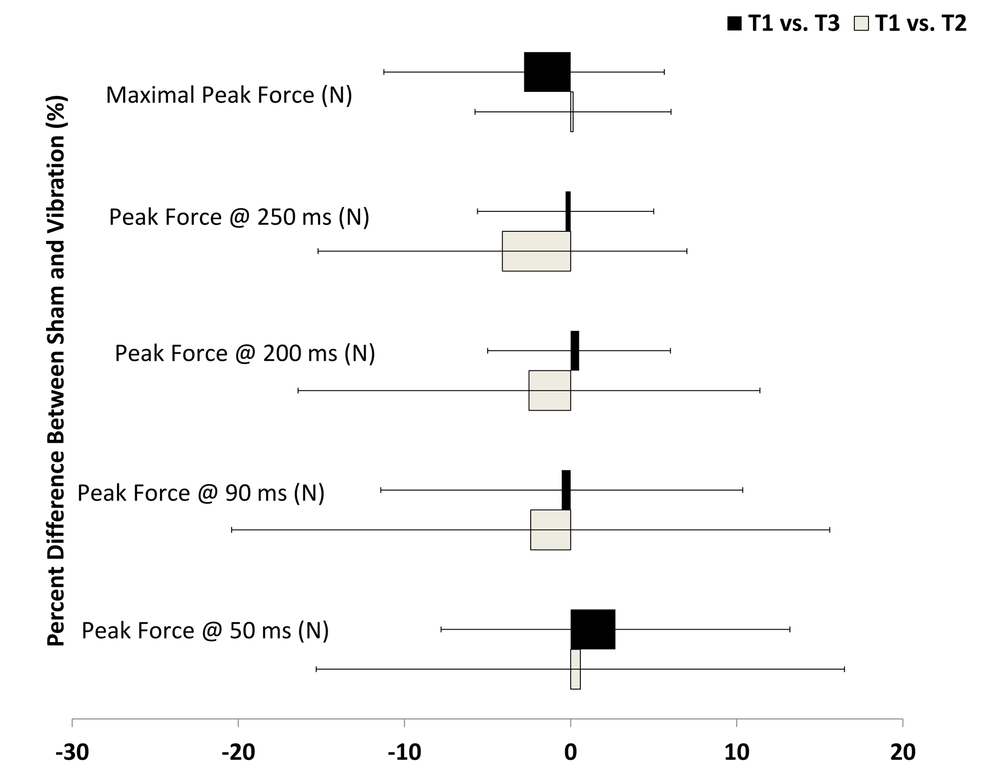
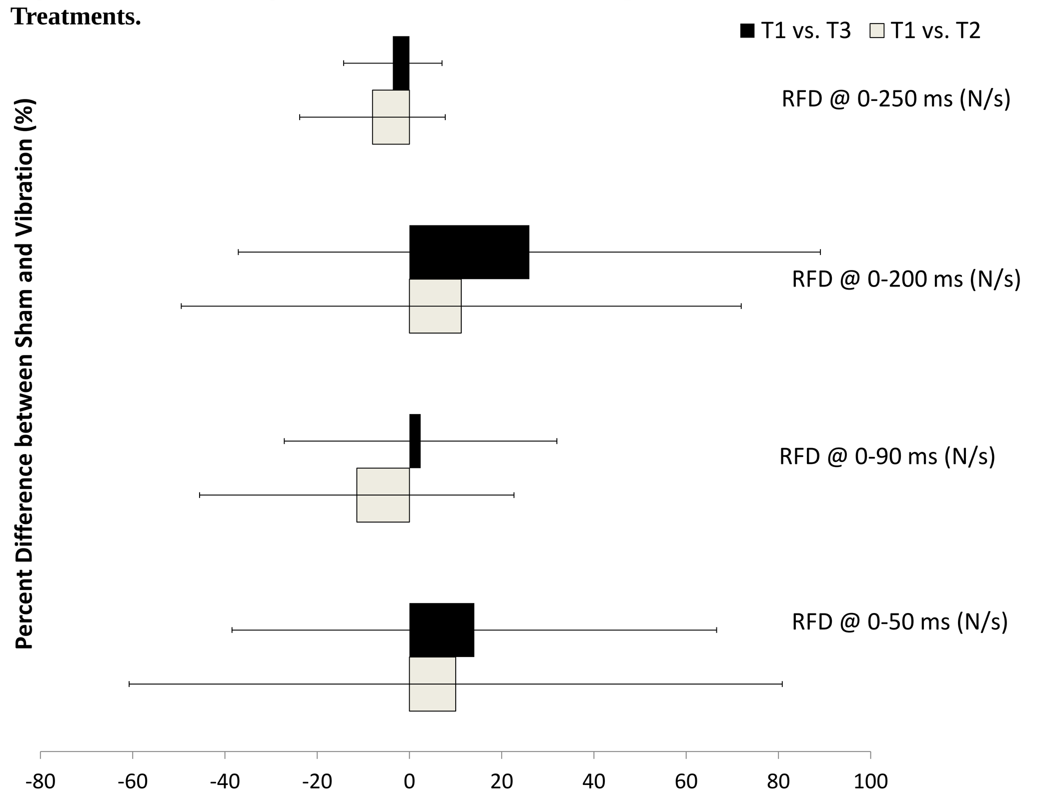


Figure 5: Percent Change for Peak Rate of Force Development between Sham and Vibration Treatments.



Summary & Conclusions

Based upon the current research the application of a 30 Hz 2-4 mm amplitude vibration does not result in any statistically significant alterations in isometric mid-thigh pull performance. Even though there are no significant differences in the outcome measures used in this study, it is still possible that the changes in performance noted by the coefficient of variance and the 95% confidence intervals suggest that there is a possible positive effect of WBV. This finding is somewhat in line with research that suggests the application of WBV can be used as a warm-up protocol for jumping activities. However, the positive benefits that may occur in response to a WBV protocol are likely related to the training status of the athlete and the activity which is performed after the warm-up protocol. More research is needed in order to determine the optimal application of WBV in field based settings.

Future Research

While there were no statistically significant increases in the variables measured in the present study, it is possible that there is still a positive effect in response to the vibration protocol. Hopkins et al. (5) suggest that an absolute increase of 10% should be considered as the minimum worthwhile increase in a treatment-induced alteration. Additionally, a coefficient of variance of 0.3-0.6% appears to be an important change for elite athletes. For example, increasing the coefficient of variance by 0.6% increases the chance of winning a competitive event by ≈9-19% . Therefore, based upon the changes in the coefficient of variance noted in this study, it is possible that the application of a WBV protocol may have a meaningful result when applied to an athletic population. In the present study the application of a WBV protocol resulted in increases in the coefficients of variance when compared to the sham protocol on the magnitude of 3.9-60.6% depending upon the variable analyzed (Table 2). With such high coefficients of variance it is likely that there is some acute ergogenic benefit of the WBV protocol, but more research, especially with high level athletes, and possibly with larger sample sizes is warranted to further investigate this hypothesis.

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