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SHORT REPORT

Differential effects of whole body vibration durations on knee extensor strength

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Summary The effectiveness and optimality of whole body vibration (WBV) duration on muscular strength is yet to be determined. Hence the aim of this study was to investigate the effects of three different durations of continuous WBV exposure on isometric right knee extensor strength measured pre and post exposure. The study involved 12 trained male subjects (age 23.7 ± 4.2 years, height 1.82 ± 0.06 m, weight 81.8 ± 15.5 kg). Pre and post knee extensor strength was measured using the Biodex™ System 3. Peak and mean torques were recorded over three maximal 2 s contractions with 10 s intervals. All subjects completed three interventions of WBV lasting 2, 4, or 6 min, in a balanced randomized order. Whole body vibration was performed on the Galileo™ machine set at 26 Hz with peak-to-peak amplitude of 4 mm. We found significant interaction (duration × pre—post) effects for both peak and mean torque. Two minutes of WBV provided a significantly different ($p < 0.05$) effect (peak torque +3.8%, mean torque +3.6%) compared to 4 min (−2.7% and −0.8%, respectively), and compared to 6 min (−6.0% and −5.2%, respectively), while 4 min produced significantly different results compared to 6 min for peak torque measurements only. Two minutes of WBV produced an improvement in isometric right knee extension strength compared to 4 and 6 min, both of which produced strength decreases. Nevertheless, the mechanisms and optimal dose—response character of vibration exposure remain unclear.

Introduction

Whole body vibration (WBV) has become increasingly popular with many coaches, trainers, and athletes for conditioning, rehabilitation, and general fitness. Whole body vibration has been reported to give both performance and health benefits, including increases in muscle power,[1] and a reduction in the occurrence of falls in the elderly.[2] The likely explanation for such effects is that the vibration causes a neurogenic and muscle response known as tonic vibration reflex, which activates the

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muscle spindles thereby enhancing the excitatory drive reflex of the alpha motoneurons.[3] However other investigators have reported no change in muscular performance,[4,5] and it is known that lengthy vibration exposure is a precursor to inhibiting motor unit recruitment.[6] These discrepancies may be attributable to different devices, body positions, frequencies, amplitudes, and durations.

Currently, there are no prescriptive guidelines for vibration exercise and a lack of consensus on an appropriate, safe, and effective duration exposure. For example de Ruiter et al.[5] used a 5 min × 1 min exposure with 2 min rest (frequency 30 Hz, amplitude 8 mm); Cochrane and Stannard[1] employed a 4 min × 1 min and 2 s × 30 s protocol with no rest (frequency 26 Hz, amplitude 6 mm); and Torvinen et al.[4] used 4 min continuous exposure (frequency 15—30 Hz, amplitude 8 mm).

Clearly, the effectiveness and optimality of WBV duration on muscular strength is yet to be determined. Therefore the aim of this study was to investigate the effect of 2, 4, and 6 min of continuous WBV exposure on isometric knee extensor strength.

Materials and methods

Twelve trained male subjects, (age 23.7 ± 4.2 years, 1.82 ± 0.1 m, 81.8 ± 15.5 kg) having no prior experience of WBV gave their informed consent and volunteered to participate in the study, as approved by the University Human Ethics Committee.

All subjects attended a familiarisation session prior to the main study, gaining experience of both WBV and knee extension strength measuring equipment. WBV utilised the Galileo™ SPORT Professional (Novotec, Pforzheim, Germany) vibration platform. Right knee maximal voluntary isometric contractions were performed on the Biodex™ System 3 (Biodex Medical Systems, Inc., New York, USA) muscle dynamometer. Testing sessions were conducted in a thermally neutral environment (temperature 21 °C, relative humidity 40%) at the same time of day. Subjects did not engage in any strenuous activity within 24 h of testing.

In the main study each subject experienced three WBV exposure durations (2, 4, and 6 min) in balanced and randomized order allowing at least 24 h recovery between each session. These durations were selected based on the Torvinen et al. study[7] in which 4 min of continuous WBV increased leg extension strength. Subjects stood in shoes on the platform, knees flexed at approximately 5°, with feet positioned equidistant from the central oscillating axis, and with weight evenly distributed between the legs. Vibration frequency was set at 26 Hz with peak-to-peak amplitude 4 mm, similar to a previous study.[1]

Strength testing entailed three maximal 2 s contractions separated by 10 s rest. Pre and post testing were completed within 90 s either side of vibration exposure. Peak torque was recorded as the maximum, while mean torque was calculated from all three contractions. The range of movement was set at 110° knee flexion and 5° extension. Isometric contractions were performed in extension at 75° from horizontal. No warm-up was allowed prior to testing.

Peak and mean torques were analysed by repeat measures analyses of variance using standard software (Minitab Inc., State College, PA). Duration effects were assessed within subjects, and pre—post differences and their interaction with duration were assessed within durations. Scheffe's post-hoc test was applied to ascertain specific differences. The level of statistical significance was set at $p \leq 0.05$.

Results

Mean baseline (pre) peak and mean torque values were not significantly different. Both post sets of torque values showed similar patterns of linear decline with exposure duration ($p \leq 0.05$). The mean (S.D.) pre—post knee extensor strength differences (% changes) after 2 min of WBV exposure were +3.8% (1.7) peak torque, +3.6% (1.2) mean torque; 4 min −2.7% (1.4) peak torque, −0.8% (1.0) mean torque; 6 min −6.0% (2.2) peak torque, −5.19% (1.7) mean torque.

Detailed ANOVA revealed significant interactions between pre—post differences and exposure dura-

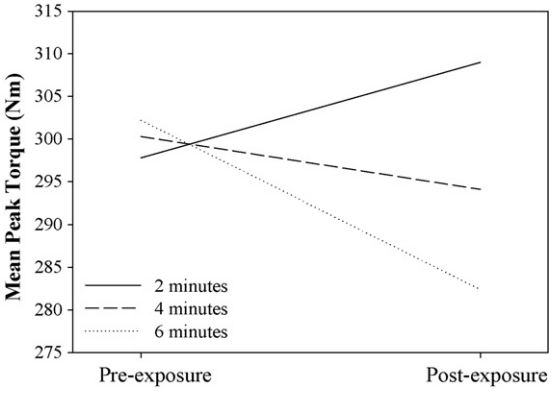

Figure 1 Pre and post mean peak torque values vs. exposure duration ($n = 12$).