Abstract

Objective: The objective of this study was to investigate efficacy of a whole-body vibration (WBV) intervention on functional performance of community-dwelling older adults.

Design: The study was designed as a randomized controlled trial.

Setting: The setting was in community centers.

Subjects: There were 37 total subjects (21 women and 16 men) (age 69 ± 8 years; mean ± standard deviation).

Intervention: Participants were randomized to a WBV intervention (INT) group and control (CON) group. Whole-body vibration was administered for five 1-minute bouts per session, 3 days per week, for 6 weeks. The CON group was asked not to commence any form of physical training.

Outcome measures: Functional performance was measured with the timed-up-and-go-test (TUG) and sit-to-stand-test (STS).

Results: After WBV, TUG and STS time was less for INT than CON (INT, TUG 7.6 ± 0.3 seconds, STS 11.9 ± 2.0 seconds; CON, TUG 8.6 ± 0.9, STS 13.5 ± 1.1 seconds; \( p < 0.05 \)). Within INT, TUG improved 0.9 ± 0.4 seconds; \( p = 0.01 \) and STS improved 3.0 ± 0.9 seconds; \( p = 0.05 \).

Conclusions: The efficacy of this WBV intervention was established. Functional performance improvement after WBV may be attributed to a number of biological mechanisms that remain speculative. Further research is required to mechanistically understand the effects of WBV on older adults.

Introduction

During whole-body vibration (WBV) a person may stand on a vibration platform while the surface alternates about a midsagittal axis. With varying methods, WBV improved functional performance of older adults.\(^1\)\(^-\)\(^3\) After WBV, timed-up-and-go-test (TUG), sit-to-stand-test (STS),\(^2\) limits of stability,\(^3\) and countermovement jump height\(^3\) improved, yet a clear understanding of optimal WBV exercise prescription for functional performance improvement remains speculative. It is postulated WBV activates the stretch reflex and enhances motor unit excitability,\(^4\) yet evidence is lacking.

WBV interventions may vary by manipulating components of the vibration platform such as frequency (Hz) and peak-to-peak-displacement (mm), and therefore the gravitational force (g). Other manipulations include the frequency and duration of WBV sessions, rest intervals, and type of activity performed on the platform. Within the limited literature for healthy older adults, g forces have ranged from 6.16 g to 16.10 g,\(^2\)\(^,\)\(^3\) yet it was recommended that g force should not exceed 1.6 g at the beginning of a WBV intervention for young adults.\(^5\)

The efficacy of lower g force (>0.40 g and <6.16 g) WBV is unknown, despite the possibility of higher g forces endangering fragile bones.\(^6\) The purpose of the study, therefore, was to examine effects of a 6-week randomized controlled WBV intervention where g forces ranged from 0.45 g to 1.26 g.

Methods

Thirty-seven (37) older adults (aged 69 ± 8 years; height 169 ± 10 cm; weight 80 ± 15 kg) freely consented to participate. Participants were recruited from suburban Melbourne. The University Human Research Ethics Committee approved this research.
Participants were independent living and could complete activities of normal daily function such as nonassisted walking. Self-reported physical activity was recorded but participants were not screened for activity level. Individuals who had fallen in the past 12 months, undergone any form of lower limb joint replacement procedure, or suffered from reactive arthritis, vascular disease, or vertigo were excluded.

After baseline testing, participants were randomly assigned to 1 of 2 groups: intervention group (INT) and control group (CON). Participants were allocated to groups after a researcher blindly drew a card with a group printed on it. The INT group attended WBV sessions for 6 weeks (18 sessions, three per week). Each WBV session consisted of five 1-minute WBV bouts, interspersed with 1-minute’s rest. A minimum 48-hour rest period occurred between each vibration session. The CON group agreed not to commence any additional form of exercise during the intervention.

Functional performance was measured at baseline and postintervention (before the first WBV bout in sessions 1 and at least 48 hours after bout 18). During TUG testing, participants stood from a chair, walked 3 m to a marker on the floor, turned, returned, and sat. During STS testing, participants stood and sat five times from an armless chair2,7 placed in a seesaw motion) was delivered using a prototype floor, turned, returned, and sat.2,7 During STS testing, participants were given one familiarization trial. The average time for three trials was recorded and rest was standardized between trials. Participants completed the tests as quickly and safely as possible.7 The TUG test preceded the STS assessments.

Sinusoidal WBV (left and right feet were alternately displaced in a seesaw motion) was delivered using a prototype vibration platform. During each WBV bout, participants stood in flat-soled shoes, with knees bent to 70° knee flexion, and their feet equidistant (16.0 cm) from the axis of rotation on the platform.7 Peak-to-peak-displacement was held constant at 1.0 mm. Frequency of the vibration platform was 15 Hz (0.45 g) for the first six WBV sessions, increased to 20 Hz (0.80 g) for the next six sessions, and was 25 Hz (1.26 g) for the final six WBV sessions.

Differences in baseline values were assessed with independent t-tests. A two-way (between:within) repeated-measures analysis of variance was calculated to view effects of test occasion and group for TUG and STS tests. Effects sizes were reported as partial eta squared ($\eta^2$). Confidence intervals (95%) were calculated to describe postintervention mean changes within the INT group. Data analyses used SPSS 15.0 for Windows (SPSS Inc., Chicago, IL). In an effort to reduce familywise error rate of multiple comparisons, statistical significance was Bonferroni corrected and accepted at $p \leq 0.025$.

**Results**

Full compliance was observed within the INT and CON groups during the study. No gender or group effect was observed for TUG and STS at baseline.

The INT group was faster than the CON group post-intervention for TUG (mean difference 1.0 ± 0.3 seconds; $p = 0.02, \eta^2 = 0.39$) and STS tests (mean difference 1.6 ± 0.6 seconds; $p = 0.04, \eta^2 = 0.48$). Within the INT group, after WBV TUG time (mean difference 1.0 ± 0.4 seconds; 95% confidence interval ± 0.6 seconds; $p = 0.01$) and STS time (mean difference 3.0 ± 0.9 seconds; 95% confidence interval ± 3.9 seconds; $p = 0.05$) were reduced (Table 1).

**Discussion**

We report effects of a WBV intervention in which gravitational force ranged from 0.45 g to 1.26 g on functional performance in older adults. Improvements after this intervention followed the trend of a previous WBV intervention using a higher gravitational force range of 6.80 g to 10.88 g.2 The intervention of this study elicited beneficial adaptations in functional performance. Given 100% compliance during the intervention, results established efficacy for such a WBV intervention. For these participants, WBV provided beneficial outcomes, despite a gravitational force below 1.6 g.

One possible mechanism for observed functional performance improvements could lie in a positive adaptation in stretch reflex activity in lower limbs.8 Reasons remain speculative for the lower gravitational force eliciting comparable results to a study of higher gravitational force WBV.2 Perhaps an unidentified vibration threshold9 was exceeded during this intervention, therefore eliciting muscular activity translating into improved functional performance.

Since the CON group was not a placebo group and did not squat during the intervention, a learning effect cannot be discounted. The INT group may have improved due to the stance posture adopted (i.e., 70° knee flexion). Squatting during WBV, however, improved functional performance more than squatting alone.2 Nevertheless, further research should mechanistically investigate the effects of stance posture during WBV in which gravitational force ranges from 0.45 g to 1.26 g.

Research is needed to determine sustainability of functional performance benefits from varying gravitational force WBV interventions. Specifically, a prescription guideline for

| Table 1. Functional Performance Before and After a 6-Week Intervention |
|------------------|------------------|------------------|------------------|------------------|
| **INT (n = 19)** | **CON (n = 18)** |
| **TUG (sec)**    | Pre: 8.6 ± 1.4   | Post: 7.6 ± 0.3  | Mean difference: 1.0<sup>a</sup><sup>b</sup> | Pre: 8.6 ± 1.7   | Post: 8.6 ± 0.9 | Mean difference: 0.0 |
| **STS (sec)**    | 14.9 ± 2.5      | 11.9 ± 2.0      | 3.0<sup>a</sup> | 13.9 ± 3.5      | 13.5 ± 1.1      | 0.4 |

<sup>a</sup>Within-group difference $p \leq 0.05$.  
<sup>b</sup>Between-group difference $p \leq 0.025$ Bonferroni corrected.

INT, intervention group; CON, control group; TUG, timed-up-and-go-test; STS, sit-to-stand-test.
a gravitational force that allows familiarization, maximizes safe participation, and adaptation for older adults is needed.

Conclusions

A WBV intervention with gravitational force between 0.45 g and 1.26 g improved functional performance of this group of older adults. The intervention was easily applied in a community setting with strong compliance. If scientific research can develop prescription guidelines for WBV gravitational force, such interventions may significantly benefit older adults with the goal to improve and/or maintain functional performance.

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References


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