THE INFLUENCE OF LOW GRAVITATIONAL FORCE WBV AND TRAINING FREQUENCY ON FUNCTIONAL PERFORMANCE OF OLDER ADULTS

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The purpose of this study was to examine the influence of low gravitational force whole-body vibration (WBV) and training frequency (sessions per week) on functional performance (FP) of older adults. Seventy-three participants (age 72 ± 8 years) were randomly assigned to four groups (control, 1, 2 and 3 WBV sessions per week). Quantifiers of FP; 5-Chair Stands test, Timed Up-and-Go (TUG) test and Tinetti test, were significantly improved for the two and three WBV sessions per week groups ($p < .05$). All components of health related quality of life (HRQOL) were also significantly improved ($p < .05$). Training frequency was a determining factor to improve FP in the sample. As such, practitioners may confidently prescribe low gravitational force WBV training, at least twice per week, to improve FP and HRQOL.

KEY WORDS: Frequency, functional performance, gravitational force

INTRODUCTION:

The influence of training frequency on WBV has not been investigated. That is, the minimum number of WBV sessions per week to elicit FP improvement has not been identified. With vibration platforms, WBV improved measures of FP such as jump height (Bosco, Cardinale, Tsarpela, Colli, Tihanyi, Duvillard & Viru, 1998; Delecluse, Roelants, & Verschuren, 2003), chair rising time (Runge, Rehfeld, & Rrdnicek, 2000) and gait (Rees, Murphy & Watsford, 2007). The WBV intervention between those studies varied and the gravitational forces (*g*) generated by the vibration platforms ranged from 2.5 *g* to 16.1 *g*. Gravity is a component of WBV since the product of vibration platform amplitude (mm) and frequency (Hz) is acceleration (equation 1).

Long duration, high gravitational force WBV was necrotic to exposed muscles in animals (Necking, Dahlin, Fridén, Lundborg, Lundström & Thornell, 1992). In humans, however, the effects of high gravitational force (> 2.0 *g*) WBV are unknown at a microscopic level, and as such, the exposure may cause micro-trauma to muscle and/or bone.

The appropriate WBV training frequency, therefore, could be useful to determine the minimum number of WBV sessions per week to elicit FP improvement. Furthermore, the effect of low gravitational force WBV (< 2.0 *g*) on FP is unknown. Such information could justify the use of low gravitational force WBV, therefore, potentially reducing exposure risk and allowing the practitioner boundaries within which to safely advise and effectively prescribe WBV to clientele.

The purpose of this study, therefore, was to examine effects of WBV training frequency on FP of older adults to assess the hypothesis that low gravitational force WBV and a three sessions per week training frequency could elicit significant FP improvement in the target sample.

METHOD:

Seventy-three community dwelling older adult females and males freely consented to participate in the study (age 72 ± 8 years; stature, 167 ± 8 cm; weight, 77 ± 12 kg). Participants who had fallen in the past 12 months or had undergone any form of lower limb joint replacement procedure, suffered from reactive arthritis, had vascular disease, suffered from vertigo or were at high risk of thromboembolism were excluded from the study (Runge, Rehfeld & Rrdnicek, 2000; Bruyere, Wuidart, Di Palma, Gourlay, Ethgen, Richy & Reginster, 2005).

Each participant was randomly assigned to one of four groups: control, one WBV session per week, two WBV sessions per week and three WBV sessions per week. The control group did not participate in any WBV sessions. The WBV intervention groups attended WBV sessions for six weeks (i.e., 6 sessions, 12 sessions or 18 sessions). Each WBV session consisted of five one minute WBV bouts with one minute rest between each. A minimum 24 hour rest period was observed between each WBV session.

The frequency of the vibration platform for the first WBV session in week one was 15 Hz (g = 0.45) and increased to 25 Hz (g = 1.26) by the last WBV session in week six. The platform delivered sinusoidal rotational vibration about a sagittal axis. The peak-to-peak displacement was fixed at 1.0 mm.

$$g = \frac{A(2\pi f)^2}{9.81} \qquad (1)$$

where A = ½ peak-to-peak displacement; f = frequency.

Participants stood upon a prototype vibration platform, in normal flat soled day shoes, with legs at 110º knee extension and their feet equidistant (16 cm) from the axis of rotation on the vibration platform during each WBV bout.

Participants performed the 5-Chair Stands test, the TUG test and the Tinetti test (in that order) for pre-intervention and post-intervention. The pre-intervention battery was completed before the first vibration session, whilst the post-intervention battery was completed at least 48 hours after the final vibration session. Participants were also asked to complete the SF-36 Health Survey before the first WBV session and at least 48 hours after the final WBV session to assess HRQOL.

Statistics: One-way (between:within) repeated measures ANOVA with repeated contrasts was calculated to view effects of the independent variables (test occasion and group) for both the 5-Chair Stands test and the TUG test. Test-retest correlation (ICC) was calculated within the control group. Independent samples *t*-test were calculated to determine if there was a gender effect or group effect on the pre-intervention data. If a significant difference was found, mean difference (pre-post) data were used in the analysis. Ordinal data from the Tinetti test and SF-36 Health Survey were analysed with Wilcoxon signed ranks for dependent samples. Data were imported to a SPSS 15.0 for Windows (SPSS Inc., Chicago, IL). The level of statistical significance was set at $p \leq .05$.

RESULTS:

There was no gender effect for 5-Chair Stands test ($p = .96$) and TUG test ($p = .37$) times at pre-intervention stage. There was a between group effect for both 5-Chair Stands test and TUG test ($p < .05$) times at the pre-intervention stage. ICC for the zero WBV group were significant for test-retest reliability, where r was between 0.89 and 0.95 ($p < 0.05$) for all dependent variables.

Between WBV groups, as training frequency increased, so did FP (figure 1). The control group, however, performed significantly better than the one WBV session per week group for the 5-Chair Stands test.

Within WBV groups, FP for the two and three WBV sessions per week groups was significantly improved after the six week intervention (table 1). Within the cohort, all variables of HRQOL were significantly improved (table 2).

DISCUSSION:

This study showed that WBV training frequency can beneficially influence FP within older adults. Specifically, as a minimum, at least two WBV sessions per week should be performed for FP improvement. The maximum gravitational force (1.26 g) generated by the vibration platform of this study elicited FP improvement and no injuries were associated with the six week WBV intervention. That assertion may be supported by the HRQOL data, where all components significantly improved.

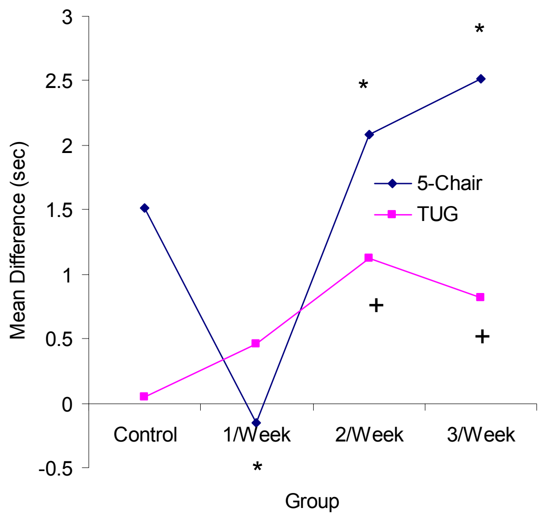

Figure 1: Between group analysis, where * indicates a significant difference from control for 5-Chair Stands test. + indicates a significant difference from control for TUG test.

Table 1 Within Group Analysis of FP tests

Sample group	5-Chair$_{Pre}$ (sec)	5-Chair$_{Post}$ (sec)	TUG$_{Pre}$ (sec)	TUG$_{Post}$ (sec)	Tinetti Total$_{Pre}$	Tinetti Total$_{Post}$
Control	14.86	13.35	8.92	8.87	24	25
n = 18	± 3.45	± 1.12	± 1.65	± 0.89	± 2	± 1
1/Week	13.64	13.79	9.37	8.91	24	25
n = 18	± 2.79	± 3.01	± 1.59	± 1.83	± 2	± 1
2/Week	15.35	13.27 *	10.29	9.17 *	23	25 *
n = 18	± 4.13	± 2.92	± 2.98	± 2.52	± 2	± 2
3/Week	14.86	12.35 *	8.47	7.65 *	23	26 *
n = 19	± 2.47	± 1.95	± 1.41	± 0.92	± 3	± 2

* indicates significant difference within

Table 2 Within Analysis of the SF-36 Health Survey for all participants

Variable	Pre	Post	Variable	Pre	Post
Physical Functioning	64 ± 22	70* ± 18	Wellbeing	75 ± 16	78* ± 12
Limitation due to Physical Health	70 ± 32	77* ± 23	Social Functioning	84 ± 20	87* ± 14
Limitation due to Emotional Health	75 ± 33	84* ± 21	Bodily Pain	73 ± 20	81* ± 14
Energy	63 ± 17	69* ± 12	General Health	69 ± 17	72* ± 11

* indicates significant difference; *n* = 73

These findings support those of Bruyere et al. (2005) who found a significant intervention effect with the Tinetti test and the SF-36 Health Survey.
Researchers' used a three WBV sessions per week method for their interventions and reported significant improvement in FP of younger and older adults (range 2.5 *g* to 16.1 *g*) (Runge, Rehfeld, & Rrdnicek, 2000; Delecluse, Roelants, & Verschuren, 2003; Torvinen, Kannus, Sievänen, Järvinen, Pasanen, Kontulainen, Nenonen, Järvinen, Paakala, Järvinen, & Vuori, 2003). This study, however, found low gravitational force (< 2.0 *g*) WBV and at least two sessions per week could significantly improve FP and HRQOL.

It was beyond the scope of this study to examine the maximum number of WBV sessions per week to elicit FP and HRQOL improvement. However, further biomechanical research may examine varying training frequency and gravitational forces upon various populations to more comprehensively develop safe guidelines for WBV prescription.

CONCLUSION:

Whole-body vibration is an increasingly used training modality. WBV improved FP and HRQOL and, therefore, may be an alternative mode of exercise for community dwelling older individuals who are, for example, less inclined to participate in activity classes or individuals who have trouble walking. Safe application of WBV, however, is of utmost importance for that population. The findings of this study may allow the practitioner to confidently prescribe low gravitational force WBV at least two sessions per week to improve FP and HRQOL in older adult clientele.

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