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Review

The effect of whole body vibration exposure on balance and functional mobility in older adults: A systematic review and meta-analysis

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ABSTRACT

The aim of this review was to systematically evaluate the effect of WBV exposure alone on balance and functional mobility in older adults. A literature search of randomized controlled trials (RCT) reporting the effects of WBV on balance or functional mobility outcomes in older adults, was conducted using multiple databases. WBV-plus-exercise was only included if the control group performed the same exercises as the WBV group, but without vibration. The methodological quality of studies was assessed using the PEDro scale. Meta-analysis was performed if three or more studies measured the same outcome. Twenty RCTs met the inclusion criteria. Eight RCTs compared WBV-only with control and eight RCTs compared WBV-plus-exercise with the same-exercise only group. Meta-analysis indicated that WBV improved single-leg stance ($p = 0.05$) and timed up and go ($p = 0.004$) measures compared with controls. WBV improved other balance and mobility outcomes with inconsistent results. Although balance and mobility appeared to be responsive to WBV-plus-exercise, particularly in lower-functioning patients, compared with WBV-only, caution is required when interpreting the findings. Although there is some evidence for an overall effect of WBV on selected balance and mobility measures, its impact remains inconclusive. Robust RCTs examining WBV-only exposure on balance and functional mobility in older adults are warranted.

Contents

Abbreviations: CI, confidence interval; ES, effect size; PEDro, Physiotherapy Evidence Database; RCT, randomized controlled trial; SMD, standardized mean difference; SLS, single leg stance; TUG, timed up and go; WBV, whole body vibration.

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1. Introduction

Aging is generally associated with falls and fall-related injuries, contributing to the morbidity and mortality in older adults. Approximately 30% of the community-dwelling elderly, aged 65 years and over, fall at least once a year, with 20% suffering injuries requiring medical attention [1,2]. Falls may lead to functional decline, frailty and institutionalization [3]. Factors contributing to falls are numerous and include balance dysfunction, muscle weakness, muscle power deficit, impaired gait and mobility, and physical inactivity [4,5]. Because of the serious economic, social and health consequences resulting from falls, much research has focused on interventions aimed at reducing the incidence of falls and effectively modifying key falls-related risk factors such as balance and mobility impairments.

Many trials have investigated the effects of resistance/power training, balance training, Tai Chi, endurance training and multi-component exercise training on enhancing balance performance and gait ability in older adults [6–8]. Although resistance, endurance and multi-component exercise training have been shown to be efficacious modalities, they may be too strenuous and increase the risk of injury for some elderly individuals [9,10]. Recently, whole body vibration (WBV) exercise has been promoted as a potentially safe, low-impact alternative to current, conventional modalities in non-compliant, exercise-intolerant or mobility-limited individuals. Application of the vibration modality to the whole body has been reported recently to improve muscle strength, power and velocity, and bone mineral density in sub-populations described as youthful, athletic, healthy and elderly [1,11–15]. As there is evidence that muscle strength and power contribute to balance performance in older adults [16], it is feasible that WBV may be a viable modality to counteract balance and mobility impairments. Also, WBV has been observed to improve strength, postural control and mobility in patients with neurological disease such as Parkinson's disease, stroke, cerebral palsy and multiple sclerosis [17–21]. Whilst findings may be promising, recent systematic reviews caution that these are preliminary results and the effect of WBV training on balance and functional performance in neurodegenerative disease is inconclusive [22,23].

Similarly, the reports of WBV exercise on balance/postural control and functional mobility in older adults are inconclusive. Recent comprehensive systematic reviews report weak to moderate evidence for a treatment effect of WBV on static and dynamic balance [24] and functional mobility (measured by the Tinetti and timed up-and-go tests) [25,26], but also advise caution in interpreting the results and emphasize the need for more quality trials to evaluate the benefits or otherwise of WBV. Various factors may contribute to the inconsistent results in the literature. Sample size, statistical power, and the blinding of subjects and assessors are areas that have been poorly documented. The optimal WBV training dose has not been determined, and an array of training protocols has been adopted; some poorly reported in studies. These WBV parameters encompass: variability in methods of application, vibration frequency, amplitude, duration and magnitude (acceleration or g), intermittent vs continuous exposure, as well as types of vibration equipment. The traditional WBV platforms oscillate in a sinusoidal (vertical) or side-alternating (see-saw) manner with both feet standing on the platform. Recently, WBV devices have increased in complexity with the introduction of stochastic resonance vibration (the direction and the force-time behavior of the vibrations are random) whereby the participant stands on separate platforms with one foot on each. Furthermore, some studies combine various exercise modalities on the platform with WBV, or following WBV exposure.

The inclusion of resistance, balance or other exercises with WBV makes it difficult to accurately assess the impact of WBV exposure on measured outcomes. This profusion of protocols and study designs leaves the magnitude of adaptations and the precise mechanism of improvements in these studies uncertain. Thus randomized controlled trials (RCT) with more robust study designs than previous trials are needed to clarify the efficacy of WBV-only treatment.

Recent systematic reviews and meta-analyses [24–26] included studies using both WBV-only and WBV-plus-exercise interventions in older adults, thus making it problematic to differentiate between the discrete contributions of WBV and exercise to balance and mobility. That studies utilizing a combined training approach made it difficult to attribute observed effects to WBV exposure was recognized by Rogan and colleagues [24]. The authors separated WBV-only and combined WBV-plus-exercise trials to find that both interventions improved dynamic balance, albeit with differential effect sizes. However, the analysis is not enough to establish the value of WBV as an isolated intervention for the following reasons. Firstly, some studies included WBV-plus-exercise groups that may have been compared with non-exercise control groups, not permitting the sole contribution of WBV to be detected. Secondly, the meta-analyses included different balance tests and non-comparable measures.