INTRODUCTION

Ageing is associated with the deterioration of the neuromuscular and sensorimotor function, which might affect physical activities and postural stability (PS) during the daily life. Among these functional disability, falls are the major problem for both the elderly and broader community, resulting fractures to the upper limb, lower limb, hip, head, and trunk. PS has been defined as the ability to maintain an upright posture in a weight carrying position without falling and to keep the center of gravity within the limits of the base of support. It is also defined as the act of maintaining, achieving, or restoring a state of balance during any postural disturbance or physical activity [1, 2].

Whole-body vibration (WBV) is a new biophysical modality to provide systemic vibration signals for mechanical stimulation and has recently emerged as an exercise intervention that can have positive effects on the neural, muscular and skeletal systems. WBV exercise involves standing on a platform that oscillates at a particular frequency and amplitude, which activating muscle contractions via stimulation of sensory receptors. WBV was reported to improve the neuromuscular performance such as the 5-Chair Stands test, the Timed Up and Go test, and the Tinetti test in community-dwelling older adults [3]. To date, most investigations have reported acute WBV effects in young adults, but chronic WBV effects on PS in older adults are relatively unknown. Therefore, the purpose of this study was to examine the effects of an 8-week WBV exercise program on dynamic PS in the elders.

METHODS

Twenty-two elderly people with normal ability of movement were recruited and randomized as the WBV group (13 elders, Age: 67 ± 6 yrs; Ht: 162 ± 6 cm; Mass: 63 ± 8 kg), and the control group (9 elders, Age: 70 ± 8 yrs; Ht: 159 ± 8 cm; Mass: 64 ± 10 kg). Participants were excluded if their activity habit had changed during the study period. The study was approved by the ethics committee of the university, and informed consent was obtained from all the participants before enrollment into the study.

Participants in the WBV group were asked to receive a WBV exercise 3 times a week for 8 weeks in bare feet throughout the study. The WBV was performed on a vertical vibration device with amplitude of low, 2.5 or high, 5 mm and frequency of 30 to 45 Hz. The amplitude and frequency were controlled by adjusting the setting from the top panel, with the larger the number, the greater the acceleration. Participants performed static and dynamic knee-extensor exercises on the vibration platform: squat, deep squat, wide stance squat, one-legged squat, and lunge.

Training volume increased systematically over the training period by increasing the duration of one vibration session, the number of series of one exercise, or the number of different exercises. Training intensity was increased by shortening the rest periods or by changing the execution form of the exercises from predominantly two-legged to one-legged exercises. The duration of the WBV program was a maximum of 30 minutes, which included warm up (10 min) and cool down (5 min). During the training, all participants were under direct supervision by the same instructor and were instructed on how to perform each exercise.
The PS was assessed by the Biodex Stability System (Biodex Medical System, NY) which uses a circular platform that is free to move in the anterior-posterior and medial-lateral axes simultaneously. The BBS calculates three different parameters according to the direction of the deviations from the horizontal plane; total stability index (OSI), anterior-posterior index (API) and medial-lateral index (MLI). The stability of the platform can be varied by adjusting the level of resistance given by the springs under the platform. In this study, subjects were barefooted and tested on a bipedal stance at levels 2 representing unstable situations.

One-way ANCOVA (pretest as covariate) were used to analyze the differences between groups on PS parameters: OSI, API, and MLI, after WBV. The level of significance difference was set at $p < .05$. Statistical analyses were conducted in Statistical Package for Social Science for Microsoft Windows, version 12.0 (SPSS Inc, Chicago, Ill, US).

RESULTS AND DISCUSSION

After 8 weeks of training, the improvements of PS in the WBV group was significantly greater than that in the control group, implying that the WBV group showed significant decreased the OSI, API, and MLI in post-test than pretest (Fig. 1, * represented significant differences between groups).

![Figure 1: PS Performance in the WBVT group before and after training at Level 2](image)

This study demonstrated the positive effect of WBV in PS which showed that significant improve the performance of unstable dynamic conditions in the elders. The repetitive vibration might be a rearrangement of balance control strategies, which results in improvement of PS after regular WBV. The findings of this study showed significant improvements in the indices of PS (OSI, API and MLI) after training in the WBV group in the level 2, unstable testing condition, which in agree with the results of authors who studied the positive effects of vibration in patients’ balance [4,5]. This might be due to positive effects of WBV on muscle strength, improved synchronization of firing of the motor units and improved co-contraction of synergist muscles, which could bring about better PS strategies during the unstable condition [6].

It was suggested that WBV can stimulate the exteroceptive receptors on the sole of the foot (Merkel, Meissner, and Ruffini receptors), that lead to physiological changes at numerous levels including stimulation of skin receptors, muscle spindles, joint mechanoreceptors, and changes in neurotransmitter which can improve PS and neuromuscular control. Furthermore, mechanistic findings indicate that WBV induces underlying neural and muscular changes, such as stimulation of human spindle endings, and changes in biogenic amines, which should help to enhance the balancing ability. Moreover, in this study it was noted that WBV was a very pleasant experience for all participants, and the acceptance of the program by participants of the WBV group was encouraging.

CONCLUSIONS

Eight-week WBV can improve the dynamic PS in the elders, not only in the medial-lateral directions, but also in the anterior-posterior directions during unstable condition.

REFERENCES


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