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Original Article

Effect of Whole Body Vibration Exercise in the Horizontal Direction on Balance and Fear of Falling in Elderly People: A Pilot Study

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Abstract. [Purpose] The purpose of the present study was to investigate the effects of whole body vibration exercise in the horizontal direction on balance and fear of falling in the elderly. [Methods] This study was a case series of 17 elderly individuals. Participants performed whole body vibration exercise in the horizontal direction using a whole body vibration device for 15 minutes a day, 3 times a week, for 6 weeks. At baseline and after the 6-week intervention, balance was measured using the Berg Balance Scale and Timed Up and Go test, and fear of falling was assessed using the Falls Efficacy Scale. [Results] After the intervention, significant improvements from baseline values in the Berg Balance Scale, Timed Up and Go test, and Falls Efficacy Scale were observed in the study participants. [Conclusion] Elderly individuals who performed whole body vibration exercise in the horizontal direction showed significant improvements in balance and fear of falling. However, the observed benefits of whole body vibration exercise in the horizontal direction need to be confirmed by additional studies.
Key words: Whole body vibration, Elderly, Balance

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INTRODUCTION

The word fall refers to an accident in which an individual falls on the floor or to a lower location and is injured regardless of his/her own will, except for cases caused by acute paralysis or external forces[1, 2)]. According to the World Health Organization, falling is a critical health problem, ranking second after traffic accidents interms of factors causing death due to unintentional injury accidents around the globe[3)]. Falling occurs in all age groups but occurs frequently in older individuals, with 30–50% of those aged over 65 years experiencing a fall[4)]. With the older population gradually increasing in modern society, falling and subsequent injury are common[5)]; one-third of older people living in the community experience a fall every day, and more than 90% of pelvic fractures are associated with injury caused by falling[6)].

It has been reported that 10–25% of elderly individuals who sustain a bruise from a fall report falling due to a decline in balance and abnormal gait[7)]. The body maintains its balance by continually collecting information about its position and environment through the sensory system and then initiating appropriate joint and muscle action by performing appropriate and effective central processing based on this information. If even only one of these factors has a defect, it is difficult to maintain balance, which may lead to falling[8)]. After falling, physical activity can deteriorate even if falling results in a nonserious injury, which may cause social isolation, thus leading to deteriorated overall quality of life[9)]. In addition, falling not only causes physical damage, but fear of falling again may limit one's physical activities[10)]. For this reason, prevention of falling in the older population is important above all[11)].

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Various interventions have been used to prevent falling. In particular, training that provides vibration to the body can minimize injuries that may occur in difficult or intense exercise and can be a safe, low-intensity intervention for patients who have limitations in movement[12]. Lam et al.[13] reported that whole body vibration (WBV) exercise improves elderly individuals' balance and gait and is an effective intervention for fall prevention. Other researchers have reported that WBV exercise is effective in improving bone strength, muscle strength of the lower extremities, and functional mobility[14, 15]. In addition, Pollock et al.[16] conducted an 8-week intervention of WBV exercise in participants over 80 years of age and found that balance, gait, and fall efficacy improved significantly in this group compared with a control group. Cheung et al.[17] reported that 3 months of WBV exercise in an older female population significantly improved direction adjustment, speed of movement, and balance control.

In the existing WBV exercise, vibration is provided rotationally or vertically. However, previous studies have reported that vibration applied rotationally or vertically may cause adverse effects, such as erythema[18], knee pain without objective clinical signs[18], headache[19], and soreness or itching in the first session[19, 20]. Many attempts to compensate for such limitations have been made, including the development of training equipment that provides vibration horizontally. However, we have little information on the positive or adverse effects of such a WBV method because no studies have been conducted on horizontally applied vibration.

Therefore, this study aimed to apply WBV exercise in the horizontal direction in elderly individuals to investigate its impact on balance and fear of falling.

SUBJECTS AND METHODS

This study was based on a case series. Seventeen community-dwelling adults over 65 years of age were recruited for this study. Participants with medical conditions that limited daily activities or were likely to cause sensory or motor impairments (e.g., stroke, diabetes) were excluded. We also excluded participants taking medications that affected balance and those with knee or hip joint replacement. All participants provided their informed consent after receiving a detailed explanation of the study, and all procedures were approved by the Institutional Review Board of Kyungnam University. Participants performed WBV training for 6 weeks. Before and after the intervention, participants were evaluated for balance function and fall efficacy.

Dynamic balance was measured using the Berg Balance Scale (BBS) and Timed Up and Go (TUG) test. The interrater reliability coefficients for the BBS and TUG test range from 0.83 to 0.96 and 0.83 to 0.96, respectively[21, 22]. Fall efficacy was measured using the Falls Efficacy Scale (FES). The interrater reliability coefficients for the FES range from 0.83 to 0.96[23].

WBV exercise was performed using a WBV device (Extream 1000; AMH International Co., Ltd., Incheon, Republic of Korea) at frequency of 18–27 Hz for a duration of 15 minutes, 3 times a week, for 6 weeks. The Extream 1000 applies WBV in the horizontal direction. The device is a slide-alternating vibrator working as a platform with an amplitude of 30 mm (anterior to posterior) and a frequency of 1–36 Hz. Before the intervention, procedures for using the device and its safety issues were explained by a research assistant. During WBV exercise, participants stood with their knees and hips slightly bent on a platform that alternately moved anteriorly and posteriorly. Any reports of discomfort during WBV exercise were documented.

SPSS 18.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The paired t test was used to compare differences within groups. Null hypotheses of no difference were rejected if p values were less than 0.05.

Table 1. Characteristics of the study participants

N	Gender (M/F)	Age (years)	Height (cm)	Weight (kg)
17	7/10	75.8±6.3	159.9±5.5	55.2±5.6

Values are frequencies or means.

Table 2. The comparison of BBS, TUG, and FES between before and after the intervention

	Before	After
BBS (score)	52.9±2.1	53.8±2.0*
TUG test (sec)	11.0±1.1	9.7±1.8*
FES (score)	23.0±19.2	11.2±10.4*

Values are means. * Significant, $p < 0.05$.
BBS, Berg Balance Scale; TUG test, Timed Up and Go test; FES, Fall Efficacy Scale

RESULTS

The mean age of the subjects was 75.76. There were 7 male and 10 female subjects. The average height and weight were 159.88 cm and 55.18 kg, respectively (Table 1). The BBS score increased from 52.94 ± 2.11 at baseline 53.76 ± 2.02 after the intervention, while the TUG test score decreased from 11.02 ± 1.14 to 9.70 ± 1.77. There were significant improvements in the BBS and TUG test scores for dynamic balance compared with the baseline ($p < 0.05$). Also, the FES score for fall efficacy decreased significantly from 23.00 ± 19.16 at baseline to 11.18 ± 10.41 at the follow-up ($p < 0.01$) (Table 2).

DISCUSSION

This study was performed to investigate the effects of WBV training on dynamic balance and fall efficacy in elderly individuals. We found that dynamic balance and fall efficacy improved significantly after the intervention compared with the baseline.

There were significant improvements in the BBS and TUG test scores in terms of dynamic balance compared with the baseline ($p < 0.05$). The results of this study are consistent with those of previous studies. Pollock et al.[16]

reported that, in an 8-week study of WBV exercise in participants over 80 years of age, there were significant improvements in the TUG test and BBS scores from the fourth week. Bautmans et al.[14] reported that, in a 6-week study of WBV exercise in individuals over 70 years of age, there was a significant improvement in the TUG test scores. In addition, Bruyere et al.[24] reported a significant improvement in the TUG test scores after 6 weeks of WBV exercise in participants over 80 years of age. Through WBV exercise, lower limb power and strength may increase, which may improve balance and functional mobility[16]. Improvements in such factors seem to have caused significant improvements in the BBS and TUG test scores, which assess dynamic balance, even though lower limb sensations and muscle strength of the participants were not assessed in this study. Actual existence of muscle strength improvement was not identified because lower extremity strength was not evaluated. Further studies are needed to determine the impact of WBV exercise on such variables as muscle strength and sensation at the level of damage. Furthermore, existing studies have reported that the FES score improved significantly after WBV exercise[16]. This study also reported that the FES scores of participants improved significantly after the intervention compared with the baseline. Fall-related self-efficacy is an expression of each individual's confidence in performing activities of daily living without loss of balance or fall[25–27]. Many previous researchers have already reported that fear of falling is closely related to balance and mobility[28, 29]. The elderly individuals who participated in this study showed reduced fear of falling with improvement in balance.

Ankle strategy, hip strategy, and a combined strategy can be used to maintain body balance. Ankle strategy refers to moving the ankle back and forth to maintain balance without extension of the hip joint. Hip strategy refers to moving the hip back and forth to maintain balance. In general, these 2 strategies are mobilized together[30]. It has been reported that if a platform shakes when a person stands, he/she moves his/her ankle without extension of the hip joint to maintain balance, and if a platform shakes at a rapid speed, he/she largely uses a combined strategy to maintain balance[31]. In particular, the center of gravity of the head and body moves in the same direction as the ankle strategy or moves back and forth to deal with shaking in the forward/backward direction. If sufficient compensation is not achieved with only the ankle strategy, the hip strategy is used[32]. It has been reported that WBV exercise activates muscle spindles and strengthens proprioceptive sense and lower limb muscles for postural stability[33]. In particular, horizontal WBV exercise provides a form of ankle strategy training when the platform moves back and forth that increases muscle strength, which may improve balance.

Studies have been conducted on various interventions to improve balance and prevent falling, but few have been performed on WBV exercise in which vibration has been provided horizontally. This is the first study to investigate the effects of horizontal WBV exercise. Through this study, we were able to confirm the potential of WBV in the horizontal direction as a device to improve balance in elderly people. However, we were no less certain advantages of horizontal WBV compared with rotational or vertical WBV. And this study has a few limitations. First, it did not have a control group, which would be necessary for comparison with the experimental group that underwent WBV exercise. Since this study did not have a control group, it is difficult to confirm the significant improvements in the experimental group. In addition, there was no follow-up regarding on the effects of WBV exercise; thus the length of time for which the effects of WBV exercise lasted was not identified. In addition, this study did not investigate the kinds of improvement that appeared at the level of damage, such as in muscle strength or senses. This is why we were not able to accurately identify the factors that were improved by balance improvement. Finally, although no serious adverse effects were noted in the study, the adverse effects caused by horizontal vibration were not identified. Therefore, future studies are necessary to investigate the long-term effects of WBV exercise through follow-up with a high-quality research design, and to examine the variables at the level of damage. Furthermore, studies are needed to identify the adverse effects of horizontal vibration.

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