# Effects of Whole Body Vibration on Ankle's Muscle Performance in Elderly

Ibtissam M. Saab

Department of Physical Therapy, Faculty of Health Sciences, Beirut Arab University, Egypt.
Ibtissam.Saab@bau.edu.lb

**Abstract: Background:** Impairment of muscle power of the lower extremities is a major risk factor for fall in older population. Whole body vibration can be used to improve the muscle performance and prevent fall injuries. **Purpose:** the purpose of the study was to investigate the effect of whole body vibration on ankle's muscle performance in elderly. **Material and methods:** Thirty randomly healthy older males and females ranging between 64 and 75 years of age participated in this study. They were randomly divided into two equal groups, each contains fifteen participants. The first control **group (A)** adopted a squat position with frequency 0 Hz, the second experimental **group (B)** in addition to the squat position, received a vibration frequency 50 Hz, the amplitude was from 5 – 8 mm; the training period was for 2 months, 3 times per week and the vibration protocol was 5 minutes (1 min vibration, 1 minute rest for 5 minutes); Right ankle planter flexors power was measured using the Biodex Isokinetic Dynamometer. **Results:**There was a statistical significance difference in the ANOVA test for **(group A)** pre and post treatment as the F value was 3.91 and *P* value was 0.01, as well as for **(group B)**, there was a statistical significance difference in the ANOVA test pre and post treatment as the F value was 77.41 and the *P* value was 0.0001. **Conclusion:** There was a significant effect of whole body vibration on ankle's muscle performance in elderly.

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## 1. Introduction:

Falls occur in approximately one third of adults over the age of 65 years and account for 65% of all injuries in this group [(1)]. A fall is defined as "an event which results in the person coming to rest inadvertently on the ground or other lower level [(2)].Trauma is the fifth leading cause of death in persons more than 65 years of age, and falls are responsible for 70 % of accidental deaths in persons 75 years of age and older. The elderly, who represent 12 % of the population, account for 75 % of deaths from falls. The injury rate for falls is highest among persons 85 years of age and older [(3)]. Muscle mass and thus force-generating capacity typically decline with age. This process known as Sarcopenia, results in a cascade of events: the reduction in muscle strength impairs physical function in older adults and increases their susceptibility to falls, which can result in injury and loss of independence. In addition to the decline of muscle mass and strength with age, the speed of contraction slows, likely due to selective atrophy of type II muscle fibers [(4)]. Motor coordination, muscle performance and balance are abilities that decline during the age process at least partially, by the deterioration of proprioception which is based on cross-sectional studies comparing proprioception in different age groups [(5)]. Whole Body Vibration (WBV) is a neuromuscular training method that has sparked new research interest as an intervention useful for many populations in the field of physical therapy [(6)]. It has long been noticed that vibration of muscles and tendons has an effect on their normal function, and thus, mechanical vibration has aroused interest, as a potentially very efficient training method for skeletal muscles [(7)]. WBV uses high-frequency mechanical stimuli generated by a vibrating platform which are transmitted through the body. The mechanical stimuli produced are thought to use neural pathways, stimulating muscle spindles, the sensory receptors located within the belly of the muscle. Improvements from WBV exercise have been reported in muscle function strength, power, velocity, balance, a reduction of muscle spasticity in those with cerebral palsy and postural control in those with Parkinson's disease. However, the ideal vibration dose, time course, frequency and posture to elicit an optimal response remain uncertain [(8)]. Sarcopenia, results in a cascade of events: the reduction in muscle strength impairs physical function in older adults and increases their susceptibility to falls, which can result in injury and loss of independence [(4)]. The use of the WBV system in athlete's training programs already exists since; the interest was to improve the mapping of motor adaptation. A search to the answer of the question what part the muscular and morphological system play in the process of muscle development [(9)]. Whole-body vibration constitutes a mechanical stimulus that enters the human body via the feet when standing on an oscillating platform. These vibrating platforms normally utilize high-frequency and low-amplitude vibration, which represents a strong stimulus to the skeletal muscles of the entire body, but preferably in the legs in view of the fact that the legs are closer to the vibration source [10]. Oscillatory motion can be produced in different forms: sinusoidal, multi-sinusoidal, random, stationary and transient. Only with sinusoidal motion it is possible to analyses the effects of different vibration frequencies due to the deterministic characteristic of this motion. Sinusoidal motion is a periodic motion, which repeats itself identically for a certain time interval termed period. The frequency of this motion is given by the reciprocal of the period and is expressed as cycles of motion per second [11]. It has long been noticed that vibration of muscles and tendons has an effect on their normal function, and thus, mechanical vibration has aroused interest, not only in bone research but also in exercise physiology, as a potentially very efficient training method for skeletal muscles [12].

**2. Subjects, Material and Methods:**

Thirty older healthy participants' males and females ranging between 64 and 75 years of age participated in this study. The training on the Whole Body Vibration machine during the 2 months period was done at **The Hospital of Dar Al Ajaza Al Eslameyya in Beirut – Lebanon.** The participants were randomly divided into two equal groups; each group included fifteen participants: **Group A: Control Group (CG):** 15 participants performed a static squat exercise on WBV platform with 0 Hz frequency. **Group B: Vibration Group (VG):** 15 participants In addition to the static squat exercise participants were exposed to vertical sinusoidal WBV using a 50 Hz frequency. **The peak to peak amplitude** used in the WBV for the study group was ranging from 5 to 8 mm. Participants were trained on WBV for 8 weeks (3times/week). The exclusive criteria were: Age less than 64 years old, prosthesis participation in a resistance training program, a recent bone injury, fracture or joint replacement within the past 12 months, any cognitive impairment, pacemaker, current kidney or gall stones, blood clot or thrombosis within the last 6 months, and amputation of lower extremities other than toes. The Biodex Isokinetic Dynamometer system used to assess the ankle's muscle performance as power**.** The participants were exposed to vertical sinusoidal WBV using Crazy Fit machine. Prior to being tested, each subject received a practice session followed by a 30-second rest period. Power (measured in watts) of the right ankle was determined using a Biodex isokinetic dynamometer**(Fig.1).** A standardized warm-up of 4 sub-maximal muscle contractions was performed prior to each isokinetic test velocity.The angular velocity was tested at 30 degree/sec. Maximum muscle power was recorded for the 2 sets and then reported as an average. In between trials, a 1-minute rest period was imposed. Verbal encouragement was given during the test.Isokinetic testing for the ankle flexors and extensors will involve standardized body positioning:Participants were strapped securely at the waist and chest and were instructed to fold their arms across the chest or hold the edges of the table for each contraction to minimize any contribution of the upper body[8].

Right ankle power was measured with the participants' half sitting. Their knees were 50 degree flexed and stabilized. The tested foot was fixed to the dynamometer footplate, with the ankle maintained at 10 degrees of dorsiflexion**(Fig. 2)**. The lateral malleolus will be aligned with the dynamometer's axis of rotation. Right ankle flexors strength were measured from 10 degrees of dorsiflexion to 20 degrees of plantar flexion [8].

**Fig. 1: Positioning of the participant**

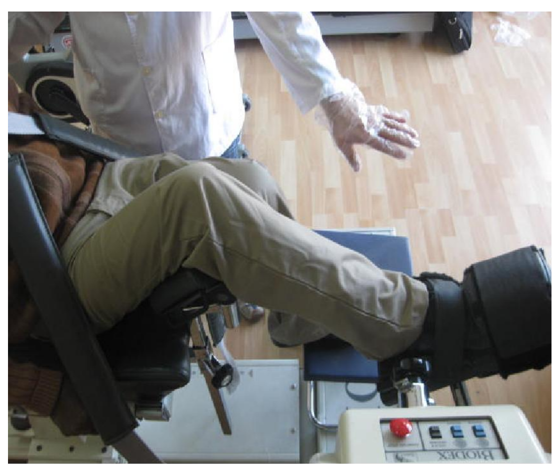

**Fig. 2: Execution of the plantar/dorsiflexion**

Before the application of the vibration intervention, all participants attended a familiarization session, where they were instructed in the correct half squat position; visually monitored knee angle of 100 degree which was held constant during the 60-second exposure and across all experimental conditions, standardized 5-minute cycle ergometer warm-up. Participants were assigned to one of the two groups (one experimental intervention groups and one control group) for two months period**(Fig. 3)**.WBV exposure is intermittent (1minute vibration: 1 minute rest for 5 min, 3 days a week for 2 months).The control trial will adopt the same position on the vibration plate for the same duration; however, the plate was turned off.All participants stood on the vibration platform with their feet shoulder width apart, hands by their sides, and wore standardized thick cotton socks to prevent any dampening that might result from footwear [13].

**Fig. 3: Standing on the vibration platform**

**3.Results:**

For group (A) the mean of right planter flexors muscles power pre- treatment was (3.68±1.66); the right planter flexors muscles power after 1 month was (3.7±1.57); the right planter flexors muscles power after 2 months was (3.86±1.58); and finally the right planter flexors muscles power 2 months after the end of the treatment was (3.74±1.59).For group (B) the mean of right planter flexors muscles power pre- treatment was (3.86±1.71); the right planter flexors muscles power after 1 month was (3.81±1.72); the right planter flexors muscles power after 2 months was (4.61±1.61); and finally the right planter flexors muscles power 2 months after the end of the treatment was (4.44±1.69).The within subjects change of the right planter flexors muscles power pre-treatment, after 1 month, after 2 months, and 2 months after the end of the treatment are presented by application of the repeated measurement ANOVA as shown in table (1).Forgroup (A), repeated measurement ANOVA revealed a significant change in right planter flexors muscles power as the F value was 3.91 and *P* value was (0.01), as well as for group (B) there was a significant change in right planter flexors muscles power as the F value was 77.41 and *P* value was (0.0001).

To reveal the differences between the right planter flexors muscles power pre-treatment, after 1 month, after 2 months, and 2 months after the end of the treatment Bonferroni post hoc test was conducted. For group (A) there was no significant difference of right planter flexors muscles power values between pre-treatment value and after 1 month value as t-value was (0.36) and *P*-value was ($P$>0.05), there was a significant difference of right planter flexors muscles power values between pre-treatment value and after 2 months value as t-value was (3.13) and p-value was ($P$<0.05), there was no significant difference of right planter flexors muscles power values between pre-treatment value and 2 months after the end of the treatment value as t-value was (1.08) and *P*-value was($P$>0.05), there was a significant difference of right planter flexors muscles power values between after 1 month value and after 2 months value as t-value was (2.77) and p-value was ($P$<0.05), there was no significant difference of right planter flexors muscles power values between after 1 month value and 2 months after the end of the treatment value as t-value was (0.72) and *P*-value was ($P$>0.05), and finally there was no significant difference of right planter flexors muscles power values between after 2 months value and 2 months after the end of the treatment value as t-value was (2.04) and p-value was ($P$>0.05). For group (B) there was no significant difference of right planter flexors muscles power values between pre-treatment value and after 1 month value as t-value was (0.71) and *P*-value was ($P$>0.05), there was significant difference of right planter flexors muscles power values between pre-treatment value and after 2 months value as t-value was (11.53) and p-value was ($P$<0.001), there was a significant difference of right planter flexors muscles power values between pre-treatment value and 2 months after the end of the treatment value as t-value was (8.97) and *P*-value was ($P$<0.001), there was a significant difference of right planter flexors muscles power values between after 1 month value and after 2 months value as t-value was

(12.24) and *P*-value was ($P<0.001$), there was a significant difference of right planter flexors muscles power values between after 1 month value and 2 months after the end of the treatment value as t-value was (9.69) and *P*-value was ($P<0.001$), and finally there was no significant difference of right planter flexors muscles power values between after 2 months value and 2 months after of the end of the treatment value as t-value was (2.55) and p-value was($P>0.05$).

**Table (1): Repeated measurement ANOVA of right planter flexors muscles power pre-treatment, after 1 month, after 2 months, and 2 months after the end of the treatment for groups (A and B).**

| Group | Source of variation | SS | DF | MS | F | *P* | S |
|---|---|---|---|---|---|---|---|
| Group (A) | Within subjects | 0.27 | 3 | 0.09 | 3.91 | 0.01 | S |
| | Between subjects | 143.28 | 14 | 10.23 | | | |
| | Error | 0.96 | 42 | 0.02 | | | |
| Group (B) | Within subjects | 7.43 | 3 | 2.47 | 77.41 | 0.0001 | S |
| | Between subjects | 158.46 | 14 | 11.31 | | | |
| | Error | 1.34 | 42 | 0.02 | | | |

**4. Discussion:**

The performance improvement was more clear and continuous in the experimental group. It can be referred to the fact that both groups are adopting static squatting exercise which can help improving the performance, in addition group B participants were receiving a whole body vibration training and that's clearly was the reason of the better improvement comparing to the control group. WBV training contributed to increase muscle strength in older adults, this supports this study which proved that the torque of planter flexors muscles are improved[8]. A single vibration bout (10 minutes in intervals at the frequency of 26 Hz) resulted in a significant temporary enhancement of muscle strength of lower extremities in female volleyball players and enhancement in of the average power of their arm flexors after (5-minutes intervals at a frequency of 30 Hz)[12]which totally supports this study.A study showed that WBV could enhance muscle performance in elderly (2 months training program, three times a week at the frequency of 27 Hz), agrees with the results of this study[14]. Another study proved that chronic whole body vibration training programs improve muscle performance and coordination, this result is compatible with the results found in the current study[15]. The findings show that the improvement was obvious at the end of the training, it may be concluded that 1 month training is not enough to improve the muscle performance and in the other hand after stopping the treatment, the muscle performance tend to decrease again and that may suggest a continuous vibration training. **Conclusion:** At the end of this study, it can be deduced that whole body vibration exercise improves the ankle's muscle performance in elderly.

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