

## Whole Body Vibration Training (WBV) – Sample of Published Clinical Research Studies

### 1. Synchronous whole-body vibration increases oxygen consumption $VO_2$ during and following acute exercise.

<http://www.ncbi.nlm.nih.gov/pubmed/21573780>

[Hazell TJ<sup>1</sup>](#), [Lemon PW.](#) [Eur J Appl Physiol.](#) 2012

<http://www.ncbi.nlm.nih.gov/pubmed/21573780>

#### Abstract

Single bout whole-body vibration (WBV) exercise has been shown to produce small but significant increases in oxygen consumption ( $VO_2$ ). How much more a complete whole-body exercise session (multiple dynamic exercises targeting both upper and lower body muscles) can increase  $VO_2$  is unknown. The purpose of this study was to quantify  $VO_2$  during and for an extended time period (24 h) following a multiple exercise WBV exercise session versus the same session without vibration (NoV).  $VO_2$  of healthy males ( $n = 8$ ) was measured over 24 h on a day that included a WBV exercise session versus a day with the same exercise session without vibration (NoV), and versus a control day (no exercise). Upper and lower body exercises were studied (five, 30 s, 15 repetition sets of six exercises; 1:1 exercise:recovery ratio over 30 min). Diet was controlled.  $VO_2$  was 23% greater ( $P = 0.002$ ) during the WBV exercise session versus the NoV session ( $62.5 \pm 12.0$  vs.  $50.7 \pm 8.2$  L  $O_2$ ) and elicited a higher ( $P = 0.033$ ) exercise heart rate versus NoV ( $139 \pm 6$  vs.  $126 \pm 11$  bpm). Total  $O_2$  consumed over 8 and 24 h following the WBV exercise was also increased ( $P < 0.010$ ) ( $240.5 \pm 28.3$  and  $518.9 \pm 61.2$  L  $O_2$ ) versus both NoV ( $209.7 \pm 22.9$  and  $471.1 \pm 51.6$  L  $O_2$ ) and control ( $151.4 \pm 20.7$  and  $415.2 \pm 51.6$  L  $O_2$ ). NoV was also increased versus control ( $P < 0.003$ ). A day with a 30-min multiple exercise, WBV session increased 24 h  $VO_2$  versus a day that included the same exercise session without vibration, and versus a non-exercise day by 10 and 25%, respectively.

### 2. The effect of whole body vibration short-term exercises on respiratory gas exchange in overweight and obese women.

<http://www.ncbi.nlm.nih.gov/pubmed/20048532>

[Vissers D<sup>1</sup>](#), [Baeyens JP](#), [Truijen S](#), [Ides K](#), [Vercauysse CC](#), [Van Gaal L](#).

#### CONCLUSION:

The addition of whole body vibration to both static and dynamic exercises appears to significantly increase oxygen uptake in overweight and obese women. More research is needed to determine the physiological pathway and clinical relevance of this increase.

3. <http://www.ncbi.nlm.nih.gov/pubmed/19439517>

**Effects of whole body vibration training on cardiorespiratory fitness and muscle strength in older individuals (a 1-year randomised controlled trial).**

[Bogaerts AC](#)<sup>1</sup>, [Delecluse C](#), [Claessens AL](#), [Troosters T](#), [Boonen S](#), [Verschueren SM](#).

[Age Ageing](#). 2009

#### **Abstract**

#### **BACKGROUND:**

whole body vibration (WBV) training appears to be an efficient alternative for conventional resistance training in older individuals. So far, no data exist about the vibratory effect on cardiorespiratory fitness.

#### **OBJECTIVES:**

this randomised controlled trial assessed the effects of 1-year WBV training on cardiorespiratory fitness and muscle strength in community-dwelling adults over the age of 60.

#### **METHODS:**

a total of 220 adults (mean age 67.1 years) were randomly assigned to a WBV group, fitness group or control group. The WBV group exercised on a vibration platform, and the fitness group performed cardiovascular, resistance, balance and stretching exercises. The control group did not participate in any training. Heart rate was measured during a single WBV session. Peak oxygen uptake (VO<sub>2</sub>peak) and time-to-peak exercise (TPE) were measured during progressive bicycle ergometry. Muscle strength was assessed by a dynamometer.

#### **RESULTS:**

heart rate increased significantly during WBV training. After 1 year, VO<sub>2</sub>peak, TPE and muscle strength increased significantly in the WBV and fitness groups. Both training groups improved similarly in VO<sub>2</sub>peak and muscle strength. The fitness group improved significantly more in TPE than the WBV group.

#### **CONCLUSION:**

WBV training in community-dwelling elderly appears to be efficient to improve cardiorespiratory fitness and muscle strength.

4. [J Gerontol A Biol Sci Med Sci](#). 2007 Jun;62(6):630-5.

<http://www.ncbi.nlm.nih.gov/pubmed/17595419>

**Impact of whole-body vibration training versus fitness training on muscle strength and muscle mass in older men: a 1-year randomized controlled trial.**

[Bogaerts A](#)<sup>1</sup>, [Delecluse C](#), [Claessens AL](#), [Coudyzer W](#), [Boonen S](#), [Verschueren SM](#).

#### Author information

#### Abstract

#### BACKGROUND:

This randomized controlled study investigated the effects of 1-year whole-body vibration (WBV) training on isometric and explosive muscle strength and muscle mass in community-dwelling men older than 60 years.

#### METHODS:

Muscle characteristics of the WBV group (n = 31, 67.3 +/- 0.7 years) were compared with those of a fitness (FIT) group (n = 30, 67.4 +/- 0.8 years) and a control (CON) group (n = 36, 68.6 +/- 0.9 years). Isometric strength of the knee extensors was measured using an isokinetic dynamometer, explosive muscle strength was assessed using a counter movement jump, and muscle mass of the upper leg was determined by computed tomography.

#### RESULTS:

Isometric muscle strength, explosive muscle strength, and muscle mass increased significantly in the WBV group (9.8%, 10.9%, and 3.4%, respectively) and in the FIT group (13.1%, 9.8%, and 3.8%, respectively) with the training effects not significantly different between the groups. No significant changes in any parameter were found in the CON group.

#### CONCLUSION:

WBV training is as efficient as a fitness program to increase isometric and explosive knee extension strength and muscle mass of the upper leg in community-dwelling older men. These findings suggest that WBV training has potential to prevent or reverse the age-related loss in skeletal muscle mass, referred to as sarcopenia.

## 5. Whole-body vibration training: metabolic cost of synchronous, side-alternating or no vibrations.

<http://www.ncbi.nlm.nih.gov/pubmed/22845178>

*J Sports Sci.* 2012;30(13):1397-403. doi: 10.1080/02640414.2012.710756. Epub 2012 Jul 30.  
[Gojanovic B](#)<sup>1</sup>, [Henchoz Y](#).

### Author information

#### Abstract

Whole-body vibration training improves strength and can increase maximal oxygen consumption ( $\dot{V}O_{2max}$ ). No study has compared the metabolic demand of synchronous and side-alternating whole-body vibration. We measured  $\dot{V}O_2$  and heart rate during a typical synchronous or side-alternating whole-body vibration session in 10 young female sedentary participants. The 20-min session consisted of three sets of six 45-s exercises, with 15 s recovery between exercises. Three conditions were randomly tested on separate days: synchronous at 35 Hz and 4 mm amplitude, side-alternating at 26 Hz and 7.5 mm amplitude (peak acceleration matched at 20 g in both vibration conditions), and no vibrations. Mean  $\dot{V}O_2$  (expressed as % $\dot{V}O_{2max}$ ) did not differ between conditions:  $29.7 \pm 4.2\%$ ,  $32.4 \pm 6.5\%$ , and  $28.7 \pm 6.7\%$  for synchronous, side-alternating, and no vibrations respectively ( $P = 0.103$ ). Mean heart rate (% maximal heart rate) was  $65.6 \pm 7.3\%$ ,  $69.8 \pm 7.9\%$ , and  $64.7 \pm 5.6\%$  for synchronous, side-alternating, and no vibrations respectively, with the side-alternating vibrations being significantly higher ( $P = 0.019$ ). When analysing changes over exercise sessions, mean  $\dot{V}O_2$  was higher for side-alternating ( $P < 0.001$ ) than for synchronous and no vibrations. In conclusion, side-alternating whole-body vibration elicits higher heart rate responses than synchronous or no vibrations, and could elevate  $\dot{V}O_2$ , provided the session lasts more than 20 min.

## 6. Effects of whole body vibration therapy on main outcome measures for chronic non-specific low back pain: a single-blind randomized controlled trial.

[del Pozo-Cruz B](#)<sup>1</sup>, [Hernández Mocholí MA](#), [Adsuar JC](#), [Parraca JA](#), [Muro I](#), [Gusi N](#).

*J Rehabil Med.* 2011 Jul;43(8):689-94. doi: 10.2340/16501977-0830.

<http://www.ncbi.nlm.nih.gov/pubmed/21687923>

#### Abstract

##### OBJECTIVE:

The aim of this study was to determine whether a 12-week course of low-frequency vibrating board therapy is a feasible therapy for non-specific chronic low back pain, and whether it improves the main outcome measures.

##### DESIGN:

Randomized controlled trial.

##### PATIENTS:

A total of 50 patients with non-specific low back pain were included. They were randomly assigned to either a vibrating plate via reciprocation therapy group ( $n = 25$ ) or a control group ( $n = 25$ ).

## METHODS:

The 12-week vibration therapy programme consisted of a total of 24 training sessions (2 times/week, with 1 day of rest between sessions). Assessments of the main outcome measures for non-specific low back pain were performed at baseline and at 12 weeks.

## RESULTS:

In the vibration therapy group there was a statistically significant improvement, of 20.37% ( $p = 0.031$ ) in the Postural Stability Index (anterior-posterior); 25.15% ( $p = 0.013$ ) in the Oswestry Index; 9.31% in the Roland Morris Index ( $p = 0.001$ ); 8.57% ( $p = 0.042$ ) in EuroQol 5D-3L; 20.29% ( $p = 0.002$ ) in the Sens test; 24.13% ( $p = 0.006$ ) in visual analogue scale back; and 16.58% ( $p = 0.008$ ) in the Progressive Isoinertial Lifting Evaluation test.

## CONCLUSION:

A 12-week course of low-frequency vibrating board therapy is feasible and may represent a novel physical therapy for patients with non-specific low back pain.

## 7. Whole body vibration exercises and the improvement of the flexibility in patient with metabolic syndrome.

[Sá-Caputo Dda C<sup>1</sup>](#), [Ronikeili-Costa P<sup>2</sup>](#), [Carvalho-Lima RP<sup>2</sup>](#), [Bernardo LC<sup>2</sup>](#), [Bravo-Monteiro MO<sup>3</sup>](#), [Costa R<sup>1</sup>](#), [de Moraes-Silva J<sup>4</sup>](#), [Paiva DN<sup>5</sup>](#), [Machado CB<sup>6</sup>](#), [Mantilla-Giehl P<sup>3</sup>](#), [Arnobio A<sup>2</sup>](#), [Marin PJ<sup>7</sup>](#), [Bernardo-Filho M<sup>2</sup>](#).

### Abstract

Vibrations produced in oscillating/vibratory platform generate whole body vibration (WBV) exercises, which are important in sports, as well as in treating diseases, promoting rehabilitation, and improving the quality of life. WBV exercises relevantly increase the muscle strength, muscle power, and the bone mineral density, as well as improving the postural control, the balance, and the gait. An important number of publications are found in the PubMed database with the keyword "flexibility" and eight of the analyzed papers involving WBV and flexibility reached a level of evidence II. The biggest distance between the third finger of the hand to the floor (DBTFF) of a patient with metabolic syndrome (MS) was found before the first session and was considered to be 100%. The percentages to the other measurements in the different sessions were determined to be related to the 100%. It is possible to see an immediate improvement after each session with a decrease of the %DBTFF. As the presence of MS is associated with poorer physical performance, a simple and safe protocol using WBV exercises promoted an improvement of the flexibility in a patient with MS

8. J Aging Res. 2011; 2011: 379674.

Published online Jan 3, 2011. doi: [10.4061/2011/379674](https://doi.org/10.4061/2011/379674)

PMCID: PMC3022164

## Aerobic Exercise and Whole-Body Vibration in Offsetting Bone Loss in Older Adults

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### Abstract

Osteoporosis and its associated fractures are common complications of aging and most strategies to prevent and/or treat bone loss focused on antiresorptive medications. However, aerobic exercise (AEX) and/or whole-body vibration (WBV) might have beneficial effect on bone mass and provide an alternative approach to increase or

maintain bone mineral density (BMD) and reduce the risk of fractures. The purpose of this paper was to investigate the potential benefits of AEX and WBV on BMD in older population and discuss the possible mechanisms of action. Several online databases were utilized and based on the available literature the consensus is that both AEX and WBV may increase spine and femoral BMD in older adults. Therefore, AEX and WBV could serve as nonpharmacological and complementary approaches to increasing/maintaining BMD. However, it is uncertain if noted effects could be permanent and further studies are needed to investigate sustainability of either type of the exercise.

9. BMC Musculoskelet Disord. 2006; 7: 92.

Published online Nov 30, 2006. doi: [10.1186/1471-2474-7-92](https://doi.org/10.1186/1471-2474-7-92)

PMCID: PMC1693558

## **Low-frequency vibratory exercise reduces the risk of bone fracture more than walking: a randomized controlled trial**

[Narcís Gusi](#)<sup>1</sup>, [Armando Raimundo](#)<sup>2</sup> and [Alejo Leal](#)<sup>3</sup>

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1693558/Abstract>

### **Background**

Whole-body vibration (WBV) is a new type of exercise that has been increasingly tested for the ability to prevent bone fractures and osteoporosis in frail people. There are two currently marketed vibrating plates: a) the whole plate oscillates up and down; b) reciprocating vertical displacements on the left and right side of a fulcrum, increasing the lateral accelerations. A few studies have shown recently the effectiveness of the up-and-down plate for increasing Bone Mineral Density (BMD) and balance; but the effectiveness of the reciprocating plate technique remains mainly unknown. The aim was to compare the effects of WBV using a reciprocating platform at frequencies lower than 20 Hz and a walking-based exercise programme on BMD and balance in post-menopausal women.

### **Methods**

Twenty-eight physically untrained post-menopausal women were assigned at random to a WBV group or a Walking group. Both experimental programmes consisted of 3 sessions per week for 8 months. Each vibratory session included 6 bouts of 1 min (12.6 Hz in frequency and 3 cm in amplitude with 60° of knee flexion) with 1 min rest between bouts. Each walking session was 55 minutes of walking and 5 minutes of stretching. Hip and lumbar BMD ( $\text{g}\cdot\text{cm}^{-2}$ ) were measured using dual-energy X-ray absorptiometry and balance was assessed by the blind flamingo test. ANOVA for repeated measurements was adjusted by baseline data, weight and age.

### **Results**

After 8 months, BMD at the femoral neck in the WBV group was increased by 4.3% ( $P = 0.011$ ) compared to the Walking group. In contrast, the BMD at the lumbar spine was unaltered in both groups. Balance was improved in the WBV group (29%) but not in the Walking group.

### **Conclusion**

The 8-month course of vibratory exercise using a reciprocating plate is feasible and is more effective than walking to improve two major determinants of bone fractures: hip BMD and balance.

## Effects of acute synchronous whole-body vibration exercise

Hazell, Tom J., "Effects of acute synchronous whole-body vibration exercise" (2010).

### Summary

Together these studies demonstrate that moderate intensity WBV exercise composed of traditional body mass resistive exercises significantly increases oxygen consumption while having small effects on the cardiovascular system, muscle function/damage, and glucose tolerance. Further, the 24 h VO<sub>2</sub> results indicate that regular WBV dynamic exercise has considerable body fat loss potential and the glucose tolerance data demonstrate WBV exercise has an insulin sensitizing effect that could have considerable potential for those who are glucose intolerant. Therefore, given the range of intensities possible, WBV exercise could be a beneficial training modality for a variety of population groups. More work is recommended to document fully the effects of WBV exercise on both health and performance.

**Extract:** The oxygen consumption study (Chapter 3) demonstrated that a WBV exercise protocol (involving both upper and lower body dynamic exercises) with dietary control increased oxygen consumption (VO<sub>2</sub>) both during the exercise session as well into recovery (8 and 24 h) vs the same exercise session without vibration. The increased muscle contractions with WBV exercise also resulted in an increased heart rate. **These results suggest that a regular program of dynamic WBV exercises could produce significant fat mass loss (assuming constant energy intake).** The exercise intensity used in this study was moderate but it could be adjusted up or down for other populations

### 11. Cardiac Dysfunction [High Blood pressure] - summary of studies

The leading cause of death in the developed world is myocardial infarction (heart attack), a direct consequence of atherosclerosis or hardening of the arteries. As the arteries lose their flexibility, the heart pumps blood but the walls of the arteries do not move as they should, causing an increase in blood pressure. As the heart pulses, and the pressure is higher, the heart has to work harder to contract. The higher the pressure gets, the greater likelihood an individual will have a cardiac incident (heart attack or stroke). Atherosclerosis is primarily caused by chronic dietary habits, but also has environmental and genetic factors. Conventional exercise reduces blood pressure by increasing the strength of the heart but does not affect arterial stiffness to a significant degree (Casey, et al. 2007).

#### A Potential Solution via Reflexes

Medical researchers have been studying methods to decrease the stiffness of arteries with pharmaceutical interventions, but in 2005, researchers in Japan found that the muscular reflexive engagement of the body through whole body vibration (WBV) exercise significantly increased blood flow and oxygenation (Yamada, et al.). Three years later a different group of Japanese researchers found that WBV (using Power Plate) acutely decreased arterial stiffness with males in their mid twenties. (Otsuki, et al. 2008) This research has now given way to a greater level of understanding of what WBV can do for de-conditioned patients who suffer from cardiac dysfunction, as well as creating interest from the scientific research community.

Dr. Arturo Figueroa, an associate professor at Florida State University, has conducted numerous studies on the effect of using WBV/reflexive activation to decrease arterial stiffness. The findings of Dr. Figueroa and his research group showed decrease in arterial stiffness in a young obese/overweight female population. This population differed from the young males that were previously studied, as obese/overweight females are often not able to engage in conventional exercise. Subjects decreased their arterial stiffness significantly using WBV therapy 3 times weekly over 6 weeks. (2011, 2012)

Dr. Figueroa has continued to study populations who are at greater risk of heart attack and stroke, with greater levels of de-conditioning. In 2013, he and other researchers began studying similar protocols with post menopausal hypertension and pre-hypertension patients. (Figueroa, et al. 2014) Results were also seen passively with stroke survivors in a parallel study at Florida State University. Stroke survivors in this study could not engage

paralyzed lower limbs yet still received the benefit of lower blood pressure and decrease in arterial stiffness using the standard squatting protocol. (Koutnik, et al. 2014)

Finally, Dr. Figueroa and his research group found that blood pressure reduction and reduction of arterial stiffness with lower leg strength increase. With conventional exercise, these two elements are not necessarily correlated. This suggests that WBV can be an effective treatment for decreasing cardiovascular risk in postmenopausal hypertensive and pre-hypertensive women (2014), in addition to the previous populations studied.

Casey DP, Beck DT, Braith RW. (2007). Progressive resistance training without volume increases does not alter arterial stiffness and aortic wave reflection. *Exp Biol Med (Maywood)* ;232:1228-1235.

Figueroa, A., Kalfon, R., Madzima, T. A., & Wong, A. (2014). Whole-body vibration exercise training reduces arterial stiffness in postmenopausal women with prehypertension and hypertension. *Menopause*, 21(2), 131-136.

Figueroa, A., Kalfon, R., Madzima, T. A., & Wong, A. (2014). Effects of whole-body vibration exercise training on aortic wave reflection and muscle strength in postmenopausal women with prehypertension and hypertension. *Journal of human hypertension*, 28(2), 118-122.

Figueroa, A., Gil, R., & Sanchez-Gonzalez, M. A. (2011). Whole-body vibration attenuates the increase in leg arterial stiffness and aortic systolic blood pressure during post-exercise muscle ischemia. *European Journal of Applied Physiology*, 111(7), 1261-1268.

Figueroa, A., Gil, R., Wong, A., Hooshmand, S., Park, S. Y., Vicil, F., & Sanchez-Gonzalez, M. A. (2012). Whole-body vibration training reduces arterial stiffness, blood pressure and sympathovagal balance in young overweight/obese women. *Hypertension Research*, 35(6), 667-672.

Figueroa, A., Vicil, F., & Sanchez-Gonzalez, M. A. (2011). Acute exercise with whole-body vibration decreases wave reflection and leg arterial stiffness. *American journal of cardiovascular disease*, 1(1), 60.

Koutnik, A. P., Wong, A., Kalfon, R., Madzima, T. A., & Figueroa, A. (2014). Acute passive vibration reduces arterial stiffness and aortic wave reflection in stroke survivors. *European Journal of Applied Physiology*, 114(1), 105-111.

Otsuki, T., Takanami, Y., Aoi, W., Kawai, Y., Ichikawa, H., & Yoshikawa, T. (2008). Arterial stiffness acutely decreases after whole-body vibration in humans. *Acta physiologica*, 194(3), 189-194.

Yamada, E., Kusaka, T., Miyamoto, K., Tanaka, S., Morita, S., Tanaka, S., ... & Itoh, S. (2005). Vastus lateralis oxygenation and blood volume measured by near-infrared spectroscopy during whole body vibration. *Clinical physiology and functional imaging*, 25(4), 203-208.

#### **Further References:**

“Several chronic studies ranging from 5 days to 12 weeks have reported WBV-induced increases in strength (Delecluse et al. 2003; Roelants et al. 2004; Ronnestad 2004; Savelberg et al. 2007), power (Bosco et al. 1998; Lamont et al. 2008, 2009, 2010), and performance (Bosco et al. 1998; Delecluse et al. 2003; Di Giminiani et al. 2009; Lamont et al. 2008, 2009, 2010; Torvinen et al. 2002) in young healthy adults.”