



Review

Effects of whole-body vibration on postural balance: a literature review

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Abstract

Introduction: Individuals are subject to healthy or altered aging, as well as neurological disorders, which can result in postural changes and inadequate movement. In this context, it is necessary to insert different and efficient tools from recovery. Whole Body Vibration (WBV) uses different types of vibrational movements to exert its biomechanical and physiological effects, offering exposed individuals less sensation of fatigue when exposed to functional exercises. Several benefits are achieved by WBV, including bone and muscle recovery and postural balance. **Purpose:** To review the effects of the vibrating platform on postural balance in humans. **Methods:** narrative literature review on the effects of the vibrating platform on postural balance. The following databases were searched: Virtual Health Library (VHL), United States National Library of Medicine (PubMed), Medical Literature Analysis and Retrieval System Online (Medline) Physiotherapy Evidence Database (PEDro) and Brazil Scientific Electronic Library Online (Scielo). The descriptors used were first: Whole-Body Vibration and Effects and Human Body, then the following descriptors: Whole-Body Vibration Gait Posture, and in the end 21 publications were used in English and Portuguese, between 2017 and 2023. **Results:** The studies show that WBV, combined with functional exercises, has significant results in terms of gaining muscle strength, reducing falls, postural stability and improving quality of life. In terms of balance and posture, WBV applied alone has the same results when compared to the application of functional exercises alone. Vibration has positive effects on proprioceptive activation in the ankle and hip joints, brain stimulation and reduced spasticity in the plantar flexors of the ankles, which are important factors in improving gait. However, studies show that, when combined with kinesiotherapy, vibration can enhance functional gains. **Conclusion:** It is clear that people are subject to physiological changes at every moment of their lives, and WBV is a method that can help treat patients quickly, with less feeling of fatigue and in a safe way, providing improvements in gait and balance.

Keywords: Keywords: Whole-body vibration; balance; posture; musculoskeletal system.

Introduction

The history of Whole-Body Vibration (WBV) dates back to the 1960s, when it was introduced as part of the training of astronauts, who during the first space flights faced problems with loss of muscle mass and bone density due to the lack of gravity. It is efficiently capable of transmitting loads based on Newton's second law to the musculoskeletal system in a precise and short time, adjusting the amplitude and frequency of vibrations (1).

WBV, through repeated oscillatory movements on a fixed point, is used as a form of exercise gain balance, exerting its therapeutic effect with biomechanical and physiological effects

List of Acronym: Whole Body Vibration (WBV); Cerebrovascular accident (CVA); Parkinson's disease (PD); Spinal Cord Injury (SCI); Virtual Health Library (VHL), United States National Library of Medicine (PubMed), Medical Literature Analysis and Retrieval System Online (Medline) Physiotherapy Evidence Database (PEDro); Brazil Scientific Electronic Library Online (Scielo); Controlled Clinical Trial (RCT); Quality of life (QoL); Chronic Obstructive Pulmonary Disease Doença Pulmonar Obstrutiva Crônica (COPD); Osteoarthritis (OA).

to induce adaptive neuromuscular changes (2). WBV uses different types of vibrations to promote bone, muscle and balance recovery, and thus, provoke the stimulation of cutaneous receptors, muscle spindles and activation of alpha motor neurons by varying postures and flexion angles, promoting proprioceptive improvement (2).

Balance is the ability to capture external sensory stimuli, leading them to the central nervous system to maintain an orthostatic position on a support base in the face of external disturbances, which can be static or dynamic, relying on the orientation of the body in relation to space and to a given movement (3).

Closely linked to balance, posture is formed by the musculoskeletal relationship, joints and neural system that support, maintain and guide human movement without overload and minimum effort for dynamic balance. However, each person has their own postural alignment according to their individuality and the interferences that occur intrinsically and extrinsically to their body (3).

Aging and pathophysiological changes that affect postural balance control motivate the search for measures to combat sarcopenia, hypotonia and other bodily dysfunctions, some of them involving the use of WBV (4).

Individuals exposed to WBV vibrations have less feeling of fatigue than when exposed to functional exercises with a shorter exposure time and with the same benefits, acting on neurological, musculoskeletal, endocrine and vascular levels; in addition to the ease of combining the two WBV methods and functional exercises for better results (5).

The oscillations produced at an adequate frequency and amplitude promote muscle toning and greater range of movement, which are commonly associated with neural and musculoskeletal rehabilitation of the elderly, athletes or people with disabilities that prevent this system from exercising its proper function (6).

Great benefits are achieved by WBV in patients with neurological disorders, such as cerebrovascular accident (CVA), Parkinson's disease (PD), Spinal Cord Injury (SCI), even postural dysfunctions and sarcopenia in adults and the elderly, therefore, it is essential that it be inserted as a therapeutic means for rehabilitation and improvement of physical capacity and quality of life, promoting independence in daily activities. Therefore, this research aims to review existing notes on the use of WBV and its repercussions on postural balance.

2. Methods

This research is based on a narrative literature review, where published articles that addressed the effects of WBV on the human body were searched. A search was carried out in the following databases: Virtual Health Library (VHL), United States National Library of Medicine (PubMed), Medical Literature Analysis and Retrieval System Online (Medline) Physiotherapy Evidence Database (PEDro) and Brazil Scientific Electronic Library Online (SciELO). The following descriptors were used: "Whole Body Vibration and Effects and Human Body, later, using the descriptors: Whole Body Vibration gait posture (Figure 1).

The inclusion criteria adopted in this review were: materials published in English and Portuguese from 2017 to 2023 and that addressed the association of WBV and its effects on the individual's balance and posture. The exclusion criteria adopted were for articles whose themes did not match the research objectives after preliminary reading.

3. Results

3.1 Search results

According to the first and second survey carried out through the descriptors, 328 studies were screened. After eligibility criteria adopted in this review, 315 studies were excluded. Then, 13 articles were selected as shown in Table 1.

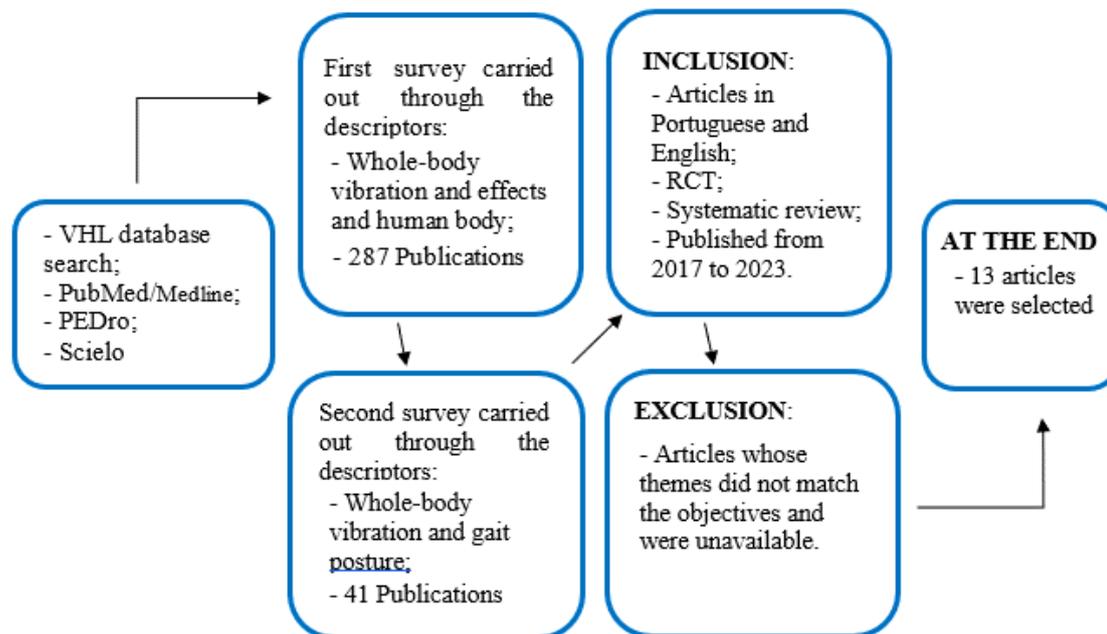


Figure 1. Flowchart of the selected studies.

3.1 Physiological and Pathophysiological Declines of the Locomotor System

The locomotor system plays a fundamental role in the capacity for human development and encompasses bones, muscles, joints, tendons and ligaments. When it comes to neurological and orthopedic conditions in childhood and adolescence, their decline is evident, preventing the complete development of systems that make up the human body. The authors also state that, when the system goes into decline, it may be accompanied by a loss of muscle mass, a decrease in muscle strength and the ability to generate movement, which can lead to difficulties in carrying out physical activities, daily tasks and changes postural problems, such as hyper dorsal kyphosis (excessive curvature of the spine in the thoracic region), changes in gait and greater propensity to falls (7).

Bone changes, such as loss of bone mineral density, depending on the level of deficiency, can increase the risk of osteoporosis and fractures. Joints also suffer wear and tear over time; but when there is excessive wear and tear, it can result in osteoarthritis, a degenerative condition that causes pain and functional limitations. Another important aspect is the reduction in flexibility and joint mobility. The stiffness of joints and connective tissues makes movements more limited, making it difficult to carry out activities that require flexibility, balance and agility (8).

This physiological and pathophysiological decline of the human locomotor system has a significant impact on quality of life. Difficulty in moving around and carrying out

daily activities can lead to loss of independence, reduced social participation and lower quality of life (8).

Furthermore, the reduction in cardiorespiratory capacity and sensory changes that can affect the perception of the environment and one's own body, highlighting physiological and pathophysiological declines in the locomotor system. It is important that the individual adopts an active lifestyle, being able to adopt the use of the vibrating platform, which has been studied as a way to promote muscle strength gains and improve mobility (9).

Table 1
Summary of the selected studies

Authors	Aim	Methods	Vibration characteristics	Conclusion
LIU, FAN, CHEN (8)	To determine the differences between the lower limb muscle activation between static and dynamic semi-squat training in middle-aged and elderly women at different frequencies and amplitudes.	15 healthy women were divided into 2 groups. One group performed WBV training in the static semi-squat position and the other group used the dynamic semi-squat position with WBV.	Frequencies ranging from 0 Hz, 30 Hz, 40 Hz and Peak to Peak displacement of 0 mm, 2 mm, and 4 mm.	The conclusion is that dynamic squats can improve the activation of the rectus femoris, more than static squats. In addition, the increase in amplitude can improve the activation of the vastus medialis and vastus lateralis. However, he did not notice a difference in the activation of the lower limb muscles when the vibration frequency changed.
ATALAY, et al. (9)	To compare the effect of aerobic exercise with whole-body vibration on exercise capacity, respiratory function, dyspnea, and quality of life (QoL) in patients with bronchiectasis.	41 patients with clinically stable bronchiectasis, aged between 18 and 74 years, were divided into 2 groups, one group using WBV and the other aerobic exercises on the treadmill. In both groups, respiratory physiotherapy and postural exercises were also performed. The treatment was carried out for 8 weeks, 3 times a week.	Frequencies from 25–50 Hz and Peak to Peak displacement of 6mm.	It was concluded that WBV can be as effective as aerobic exercise in dyspnea and functional capacity, being suggested as an easy, shorter and more pleasant exercise modality option in the rehabilitation of bronchiectasis.
OLIVEIRA, et al. (10)	To verify the impacts of WBV on muscle strength, power, and endurance in the elderly.	Systematic review and meta-analysis in order to analyze whether whole-body vibration affects muscle strength, power, and endurance in older adults.	Frequencies between 5-40 Hz (most used 20-35 Hz) and Peak to Peak displacement 0,1-8 mm (most used 2-4 mm)	It was concluded that WBV was very effective in increasing the muscle strength of the lower limbs. However, there was no difference, in muscle strength of the upper limbs and muscle endurance of the lower and upper limbs of the elderly.

Summary of the selected studies

QIU, et al. (11)	To evaluate the effects and safety of whole-body vibration on pain, stiffness, physical function, and muscle strength in patients with knee osteoarthritis (OA).	Systematic review and meta-analysis to evaluate the effects of the whole-body vibration in patients with osteoarthritis.	Frequencies ranging from 5Hz, 30Hz, 40 Hz and Peak to Peak displacement of 2mm, 2,5mm, 4mm and 6mm.	It was concluded that whole-body vibration had more positive effects when compared to strengthening exercises alone in individuals with knee OA.
PESSOA, et al. (12)	To investigate the effects of whole-body vibration (WBV) on strength and quality of life in healthy older adults.	Systematic review and meta-analysis aimed at analyzing the effects of WBV in healthy older adults.	Frequency was 10 Hz with Peak-to-Peak displacement of 3 mm. In the second and fourth series, the frequency was 26 Hz.	It was concluded that WBV can benefit healthy elderly people by increasing muscle strength and improving quality of life, especially functional capacity.
SAMBE, et al. (13)	To summarize the main features and findings that investigated the effects of muscle tendon vibration on static and dynamic balance in adults with stroke	This systematic review aimed to evaluate the effects of whole-body vibration on static and dynamic balance in post-stroke patients.	Frequency ranging from 20Hz to 200Hz, but most used was 80Hz.	It was found that the effects of vibration on the muscle-tendon can improve balance and thus influence postural control in people with stroke.
ESTES, et al. (14)	To evaluate participants with chronic spinal cord injury (SCI), the immediate and late effects of four doses of WBV in a single session compared to a sham control intervention.	35 patients with incomplete motor SCI received four different doses of WBV. Both remained on the platform for 45 seconds, with 1 minute rest between sessions. With the separation of sessions for 1 week.	Frequency ranging from 30 Hz to 50 Hz.	It was concluded that WBV with higher frequency applied for longer periods was more effective for reducing quadriceps spasticity. Therefore, WBV may be an alternative method for spasticity.
ROSADO, et al. (15)	To investigate the effects of two multimodal programs on reaction time, mobility, and dual-tasking performance in older adults at risk of falling.	51 participants were divided into 2 groups, one psychomotor group, and the other exercise program combined with a psychomotor intervention program + whole body vibration program. Performing the training for 3 sessions per week for 24 weeks.	The vibration Peak to Peak displacement (mm) and the rest time between sets were always 3 and 60, respectively. When the exercise time in the WBV program progressively increased from 45 to 60, the set increased from 4 to 6 and the frequency (Hz) increased from 12.6 to 15.	It was concluded that there were improvements in mobility and dual-task performance for the group that received psychomotor treatment. And for the group that received the psychomotor program associated with WBV, there were improvements in reaction time, mobility, and dual-task performance.
LEE (16)	To investigate the effect of WBV on horizontal direction on balance and gait ability in chronic stroke survivors.	21 post-stroke patients were divided into 2 groups. One group received WBV training and the other control group. Performing the training for 6 weeks, and a conventional rehabilitation for 30 minutes, 3 days a week.	1–36 Hz frequency, 3 mm Peak to Peak displacement.	It was concluded that WBV training in the horizontal direction has few positive effects on balance and gait function in post-stroke patients.

Summary of the selected studies

GLOECKL, et al (17)	To investigate the effects of WBV compared to conventional balance training.	48 patients with Chronic Obstructive Pulmonary Disease (COPD) and low exercise tolerance underwent the training. One group performed 4 different balance exercises, on the WBV and the other group on the conventional balance board. The training was performed 3 times a week, during 2 sets of 1 minute each.	Varying frequencies (5–26 Hz) and 4–5 mm Peak to Peak displacement.	It was concluded that the WBV can improve static balance and muscle power more than the conventional balance board
LI, CHO, CHEN (18)	To investigate the short-term effect of WBV on proprioception and motor function of individuals with moderate Parkinson's disease (PD).	32 participants with moderate PD were divided into 2 groups: one that used WBV and the other conventional therapy. Each session included five sets of 1 vibration with 1 minute of rest in between. Conventional therapy, on the other hand, included balance and mobility training for 10 minutes.	The vibration frequency and amplitude settings were 6 Hz and 3 mm, respectively.	It was concluded that WBV may be a safe and effective intervention to improve spasticity, balance, and walking ability in individuals with cervical SCI.
IN, JUNG, LEE, CHO (19)	To investigate the effects of whole-body vibration training on ankle spasticity, balance, and walking ability in patients with incomplete spinal cord injury at the cervical level.	28 patients with cervical spinal cord injury were divided into 2 groups, one using WBV and the other placebo. The sessions lasted 20 minutes, and both were held 2 times a day, 5 times a week, for 8 weeks.	Frequency was set at 30Hz, and Peak to Peak displacement was 2-4mm.	It was concluded that WBV may be a safe and effective intervention to improve spasticity, balance, and walking ability in individuals with cervical SCI.
NAWRAT et al. (20)	To determine whether whole-body vibration training (WBVT) affects intrinsic risk factors for falls in women over 60.	42 two women over 60 were divided into 2 groups. One group used WBVT and the other was the control group. The training was performed for 12 weeks, 2 times a week, and each session consisted of 10 minutes, interspersed with 1 minute of vibration and 1 minute of rest.	The frequency of vibrations was set at 20 Hz and the Peak to Peak displacement at 2 mm.	It was concluded that WBVT improves functional gait efficiency, dynamic balance, exercise tolerance, and functional muscle strength in women over 60 at risk of falls, though accomplishes not reduce the intensity of the fear of falling.

3.3 Effectiveness of the Vibrating Platform

The vibrating platform has been used as a way to stimulate muscular activity in the elderly, promoting muscle strength gains and improving mobility. Different studies have evaluated the effectiveness of this equipment in comparison with other forms of physical training (10).

The vibration platforms can be sinusoidal or vertical, with 3 types of vibrations: vertically, horizontally or laterally. The vertical mode can be subdivided into synchronous or triplanar vibration. In synchronous the base oscillates up and down uniformly. In triplanar, movements are in 3 planes: anterior/posterior, side to side and up and down. The lateral vibration occurs bilaterally, with vertical displacements. Finally, horizontal vibration presents alternating anterior and posterior movements (5).

The vibration emitted by the platform are established according to the intensity, amplitude, frequency and shape of the wave. During the application, the patient can remain standing, sitting or even perform dynamic exercises on the platform. The time and combinations of exercises, as well as the way the patient remains in WBV, vary according to the purpose of the treatment (10).

The impact of WBV training associated with exercise, when compared to conventional physical training alone in patients with osteoarthritis (OA), shows that the combined whole-body vibration training group showed a significant increase in the strength of the knee extensor muscles, demonstrating that WBV is an effective way to improve muscle strength in patients with OA (11).

A meta-analysis was performed to evaluate the effects of whole-body vibration on muscle strength and quality of life in healthy elderly people. The results considered that training with a vibrating platform was effective in improving muscle strength and the quality of life of the studied population (12).

Positive results were also observed in patients with stroke in hemiparesis. Whole-body vibration can be a useful intervention to stimulate sensory and joint receptors. The vibratory movement, associated with treadmill training, induces the production of stimuli to cutaneous proprioceptive receptors, thus being efficient in improving gait (13). WBV is also capable of reducing tonic stretching, that is, hypertonia and resistance to passive movements, through correct modulation, acting on the activation of pre-synaptic inhibitory stimuli that reduce the excitatory influence of afferent input (14).

3.4 Benefits of the Vibrating Platform in the Treatment of Balance and Posture Deficits

WBV is notably a promising approach to mitigate declines and improve musculoskeletal health. In addition to increasing muscle strength, it contributes to improving postural stability, balance and motor coordination, preventing falls and injuries (12).

The frequency, intensity and duration of training should be adapted to each person's individual capabilities, taking into account their general health, medical conditions and physical training levels. Well-practiced multimodal exercises can improve reaction time, mobility and dual-task performance (15).

For human beings to remain standing and consequently walk, several factors must be interconnected, such as activation of muscles - tibialis anterior and soleus, ankle and hip strategies, in addition to the need to maintain balance on different surfaces. It is noted that the vibrations caused by WBV can activate the ankle and hip strategies, presenting positive results in improving balance, consequently, in gait (16).

WBV with frequencies varying from 5-46 Hz, associated with kinetic-functional exercises, showed positive results in patients with changes in balance when comparing the same exercises performed only on the functional board, even in a short period of training. The patients underwent training for 3 weeks, performing the same exercise 6 days a week, in which on 3 non-consecutive days (Monday/Wednesday/Friday). The protocol included 4 balance exercises

in the training. To evaluate the participants' balance before and after treatment, the semi-tandem, Romberg and single-leg posture tests were used, using a strength measurement platform (17).

As for exercises to work on balance, patients performed the following exercises on both the WBV and the conventional plank: dynamic squats, plantar flexion, single-leg static posture, single-leg dynamic forward step. It is clear that the movements provided by vibration favor the activation of spinal reflexes more when compared to conventional training (18).

Patients with Parkinson's disease (PD) may present sensorimotor changes, making it difficult to perform functional training. In this way, WBV presents itself as an alternative method that can bring benefits equal to conventional exercises. This can be seen in a study carried out for 6 months with PD patients, aged 50 to 65 years, receiving 2 training sessions with an interval of 2 months between them, with a frequency of 6 HZ and amplitude 3mm, performing 5 vibration sessions for 1 minute, with a 1-minute break for each session. Because WBV requires a posture with isometric contraction and maintaining knee flexion, vibrations are conducted to the nerve endings of the muscle spindle fibers, causing the activation of the alpha motor neuron, resulting in muscle contraction and, finally, stimuli in brain activities (19).

The incidence of patients with spinal cord injury (SCI) increases every day, and it is noted that they present changes in balance and gait due to disorders in the sensory and motor systems. A study carried out with 28 post-SCI patients, in which 14 people were trained in WBV platform and 14 remained in the control group for 8 weeks, where sessions were held at a frequency of 30 Hz, 5 times a week, for a period of 20 minutes, 2 times a day; where patients were instructed to maintain hip, knee and ankle flexion for the vibration to remain only at the pelvic level (The control group performed the same chronological period, but with a minimum platform frequency) showed that WBV significantly reduces joint spasticity. ankle plantar flexors, as it inhibits presynaptic conduction, thus having a positive effect on improving balance, consequently, favoring gait (19).

Physical activity plays an important role for the elderly, especially when correlated with the prevention of falls, since physical exercise can maintain muscle strength, motor coordination and balance. WBV associated with functional training, applied to 22 women for 12 weeks, with a frequency of 20HZ, in which each session lasted 10 minutes, with five exercise cycles, with one cycle consisting of one minute of vibration; in a semi-squat position, performing muscle isometry; proving to be more beneficial for gait and dynamic balance, as it increases the muscular strength of the lower limb muscles, consequently reducing the risk of falls in women over 60 years of age, when compared to women who only perform functional physical activity (20).

4. Conclusion

It is evident that people are subject to physiological changes at every moment of their lives, and it is necessary to identify methods that add to Physiotherapeutic treatment, with the aim of offering patients a possible return to their daily life activities more quickly and with a better quality of life.

Therefore, WBV is a treatment method that can favor the treatment of patients within a few minutes of application, with less feeling of fatigue and in a safe

Conflicts of Interest

The authors declare that there is no conflict of interest in the preparation of this manuscript.

Authors contribution

Nunes LCR and Pin AS collaborated in the research, tabulation and filtering of the material and in writing it.

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