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Short Review

Whole Body Vibration Effectiveness in Diabetes Mellitus, Osteoporosis and Parkinson's Disease

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Abstract

Whole Body Vibration (WBV) intervention has been used to further improve muscle activity and the performance of various disorders. Some studies show that the complete activation of the muscle by WBV can lead to fatigue of the motor unit and, consequently, an increase in muscle strength. It is known that physical exercise promotes glycemic control in diabetic individuals and the beneficial effect is likely to be multifactorial, including increased energy expenditure. In addition, resistance and/or strength exercises can improve gait speed, balance and muscle strength in patients with type 2 diabetes and the elderly with osteoporosis. However, some of these patients, due to clinical conditions and/or possible complications, are unable or unwilling to perform the exercises at the intensities necessary to achieve satisfactory results. In this sense, the training of whole body vibration leads us to develop protocols complementary to a traditional exercise program.

WBV has the potential to stimulate the main factors associated with improved muscle performance such as amplitude and frequency, which in patients with Parkinson's disease can be direct protective effects or, in the case of higher intensities of WBV, they can result in micro- injuries. Therefore, the types of vibration and its method of application, training intensity and exercise protocol must adapt to the specific characteristics of the dysfunctions of each group of participants.

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Introduction

Vibration is a mechanical oscillation, periodic alteration of force, acceleration and displacement over time [1]. The notion that vibration can be beneficial is relatively new, therefore is important to quote that researcher's study of vibration effects in the neuronal sciences [2]. Sander [3] was the first author to recognize the therapeutic importance of the vibratory stimuli with Whedon [4], with intervention of the cardiovascular and musculoskeletal disorders. Nazarov and Spivak [5] were the first to apply vibration as a training modality for athletes and were first used therapeutically in the Soviet Union to prevent hypotonia in cosmonauts. Initially used in segmental form, it evolved to the vibration of the whole body with the use of machines, with overall effect [6,7].

We use the Whole Body Vibration (WBV) in the rehabilitation of various populations. The elderly are therefore possible beneficiaries of WBV because they have poor muscular performance and low bone quality as well as functional and structural modifications in the organism [8]. The physiological decay of the elderly adult may lead to a reduction in the ability to balance and an increased risk of falls becoming an important issue among the elderly [9]. Balance control requires adaptations in the individual support base, which changes with age; therefore, alternatives will be directed at reactions to external disturbances that were not anticipated during gait [10].

In our clinical practice as physiotherapist, we found elderly people with diabetes mellitus and severe changes in balance as well as functional repercussions in the lives of these individuals. However, there are studies that seek treatment options for this population through various types of exercises. Some studies show that WBV is considered an effective strategy to improve balance in patients with type 2 Diabetes (DM2).A study of fifty-five elderly patients with diabetic peripheral neuropathy concluded that short-term therapy with WBV was beneficial and significant in improving balance [11]. In the work of Del Pozo-Cruz et al., [12] fifteen patients with DM2 participated in the WBV program followed by other types of exercises and the results showed that WBV is a safe and well-tolerated strategy to improve balance. Yoosefinejad et al., [13] investigated the effects of one session of WBV on muscle strength and the balance of ten diabetic patients with peripheral neuropathy; in other study they worked with twenty diabetic patients, using WBV twice a week, for 6 weeks, concluding that this intervention increased strength and muscle balance in these patients [14]. A recent systematic review study with meta-analysis conducted by Gomes-Neto et al., [15] concluded that WBV can be a useful strategy in the management of symptoms and disabilities associated with type 2 diabetes. Work carried out in our Research Laboratory (LACIRTEM), inferred that the domain of training with WBV

can help in choosing the training program for elderly people with type 2 diabetes [16].

Evidence on the effects of WBV intervention on DM comprises several types of studies and methodologies Robinson et al., [17]. In another study using an exercise program for upper and lower limbs for 12 weeks, a reduction in the time taken to perform the 6-Minutes' Walk Test (6MWT) was observed, but there was no improvement in the Timed Up and Go Test (TUG) [18]. In another work [19], after 8 weeks using WBV, it had a significant effect in reducing patients' fat mass, however no significant effects were found on blood pressure, mobility, and quality of life of diabetics.

In a study of diabetic foot with 54 patients in 12 weeks, aimed to determine whether a WBV program would favour parameters (glycated-HbA1c hemoglobin, sensitivity, transcutaneous-TcPO2 oximetry) related to associated complications of diabetic foot syndrome [20]. However, there were no significant changes in HbA1c or sensitivity, but TcPO2 registered a slight increase. In a review studying the significant effects of WBV in patients with diabetic peripheral neuropathy, it was found that WBV provided a slight improvement in the glycemic profile, plantar tactile sensitivity, pain and balance, but the quality of the evidence is low [21]. Recent work from our research laboratory checked the immediate effect of Whole Body Vibration (WBV) on quadriceps muscle strength, functional mobility and balance in elderly patients with Osteopenia and/or Osteoporosis. The sample was composed of 34 elderly and concluded that a single WBV training session was able to increase quadriceps muscle strength and the elderly balance [22].

Important studies support the effectiveness and viability of using WBV to improve muscle performance and balance in individuals with osteoporosis. One hundred and fifty-one postmenopausal women over 65 years of age performed training sessions and after 6 months, the falls were significantly reduced by the training protocol including WBV exposure [23]. In another review article have found that there was a significant increase in articles on this topic and that the majority of studies have shown an improvement of the Bone Mineral Density (BMD) or other parameters regarding muscle, bone and functional outcomes, like reduction of falls [24]. Moreira-Marconi et al., [25] found in the literal relevance of WBV exercises in decreasing the number of fractures in women with osteoporosis, even though little research exists on the topic, they consider WBV to be an effective strategy to improve balance. After 6 months of the WBV exercises with fifty two osteoporotic women the indices for flexibility, body balance, and walking velocity were significantly improved [26]. Moreira et al., [27] after review concluded that WBV body balance and can be a useful tool as part of the prevention and treatment protocol for osteoporosis. Similar findings were reported by Weber-Rajek et al., [28] and corroborated by Bemben et al., [29].

Slatkovsla et al., [30] in order to verify the beneficial effects of WBV on bones of postmenopausal women, conducted a study of daily training of low magnitude WBV (0.3 g) at 2 frequencies (90 and 30 Hz) versus without WBV and verified that WBV at 0.3g and 90 or 30Hz for 12 months did not alter BMD in women who received calcium and vitamin D supplementation. According a systematic review, the related the effects of the vibrating platform on the bone tissue of osteoporotic women considering 11 eligible articles, however with several methodological differences, they concluded that the evidence proving the increase in bone mass resulting from the vibration seems to be inconclusive, since authors demonstrate divergent and conflicting results [31]. Another study infers that is premature to recommend WBV as a safe and effective training for preventing osteoporosis due to differences in the type of used vibration (lateral alternating vs. oscillation), frequency, intensity, cumulative dose, body positioning and study methodology [32].

Benedetti et al., [33] reported that training with WBV promotes increased muscle strength, improves balance, and reduces the risk of falling in osteoporosis patients. However, the results are controversial about the improvement in bone mineral density, a fact, in accordance with other studies literature [34-36]. Individuals with Parkinson's Disease (PD) are affected by the second most common neurodegenerative disorder that mainly promotes motor and cognitive disability [37,38], providing an increase in the potential for falls in the elderly, impacting the quality of life and costs for the person and the family. There is weak evidence of a positive short-term effect of WBV on lower limb spasticity, mobility, balance and postural control [39], as its benefits are long-term, where WBV training improves mobility while minimizing neurological disorders since the findings of Charcot [40].

There is no clear evidence of a reducing effect on motor symptoms, balance, gait and mobility [41]. Only a few studies have found significant differences between groups regarding mobility and motor symptoms [37,42]. Aerobic exercise on the treadmill performs a dynamic movement compared to the WBV, which is isometric, where the treadmill training improves blood flow which facilitates the recovery phases (free fatty acid and amino acid feedback), in contrast to the WBV, where sustained isometric contractions produce compartmental and intramuscular pressures that can limit blood flow [37]. In another study, when WBV was compared with conventional therapy, parameters like mobility ("Up & Go" Test, a 10-m walk test, and a stand-walk-sit test) haven't had any significant treatment effect after multiple sessions of WBV. In patients diagnosed with idiopathic Parkinson's disease, using de protocol of 5 weeks, 2-3 times a week with static position, 5 × 60 s/60 s, knees slightly bent, 6 Hz, 3 mm. No significant difference was observed between the WBV group and the placebo group for the TUG test (SMD = -0.37; 95% CI: -1.34, 0.59), gait velocity (SMD = -0.21; 95% CI: -1.17, 0.74) and step length (SMD = 0.14; 95% CI: -0.81, 1.09) [43]. Research results should be analyzed with caution due to the lack of homogeneity in interventions and methodologies in some studies [44]. In our clinical practice, the established vibration frequency was 24 Hz. The 4-mm displacement peak was maintained throughout the program and was determined by the width of the volunteers' position on the platform. The intervention time was 45 s, with eight series being performed and, for each, the recovery time was maintained at 30 s for all intervals, totaling 600 s of intervention [16].

As physiotherapists, we found that the patient with Parkinson's disease, most of the time has severe physical problems such as tremor and cognition, which leads to anxiety and difficulties in social life. This led us to look for therapeutic options in addition to conventional treatment. Making the WBV exercises accessible, with an emphasis on complementing exercise programs, is essential for elderly populations resistant to certain types of treatments with physical activity, regardless of the functional level of the patients. A study investigating non-drug treatment for Parkinson's disease reports that training

with WBV has an insufficient level of evidence even in improving the time-rhythmic correction of walking in patients with Parkinson's disease [45]. Analyzing four systematic reviews we can highlight that WBV improves strength, postural control and mobility in patients with neurological disease such as Parkinson's disease, stroke and cerebral palsy [43,46-48]. They also found that balance and mobility seem to respond better to the association of WBV with therapeutic exercises, particularly in patients with low function, compared to only WBV, so care is needed when interpreting the findings. Although there is some evidence for a general effect of WBV on selected balance and mobility measures, the impact remains inconclusive. The great difficulty is in the different models of training programs, since some studies use single sessions while other studies use multiple sessions and longer periods of time, therefore, the differences between short and long term interventions need to be better examined.

When this type of therapy is compared with aerobic training, according to our clinical practice, WBV does not seem to require much recovery time as well as reduction in the feeling of fatigue after training. In fact, the feeling of fatigue of some types of stimulus to patients with Parkinson's seems to clearly minimize its effects due to fatigue, which is an important fact to be interpreted by the physiotherapist in his clinical practice, because vibratory stimulation has provided an improvement in trunk oscillation, gait in space-time parameters and cadence, which facilitates the patient's postural control [49-51], as well as the characteristics of responses in the initial and final stages of the disease [52,53].

Thus, in our view, the use of whole body vibration is an important tool for elderly people with Parkinson's disease, from medium to high functional levels. We need to continue researching our ability to improve neurological control, developing training programs, in an accessible and easy to use manner, whenever necessary.

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