Health effects of whole body vibration

Felix Gritschmeier, Klaus W. Lange
Institute of Psychology, University of Regensburg, 93040 Regensburg, Germany
Correspondence: felix.gritschmeier@ur.de; klaus.lange@ur.de

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Abstract: Whole body vibration (WBV) has attracted increasing interest in recent years as an exercise modality with potential to improve neuromuscular performance and to increase bone mass and density. The utility of WBV in the management of various chronic conditions and in the promotion of physical fitness have been examined. Despite many promising findings, the question of whether WBV can play a role in the fostering of physical fitness in elderly people or the treatment of chronic diseases, such as lower back pain, fibromyalgia, osteoporosis, obesity and diabetes is currently unclear. Further research is required to explore the therapeutic potential of WBV as an exercise modality and to investigate whether WBV training could become a viable (add-on) treatment for low back pain, fibromyalgia or osteoporosis in post-menopausal women. Furthermore, potential long-term risks should be investigated.

Keywords: Whole body vibration; exercise; health; back pain; fibromyalgia; osteoporosis; obesity; diabetes.

1. Introduction

Whole body vibration (WBV) exercise uses an oscillating platform as a stimulus, transmitting forced mechanical oscillation through the legs of an individual standing on the platform [1] and stimulating subcutaneous proprioceptors, muscle spindles and Golgi tendon organs [2,3]. It has been suggested that WBV exercise can have beneficial effects on skeletal muscle strength and cardiovascular health, especially in elderly people and individuals with medical conditions [4]. In recent years, the utility of WBV in promoting physical fitness and managing various chronic conditions has been assessed.

2. Physical fitness and motor functions

Research has increasingly explored the potential value of WBV in improving athletic performance not only in elite athletes [5], but also in recreational athletes, untrained adults, children with disabilities and older people [5–13]. The evidence in regard to the effects of WBV on various performance parameters, such as vertical jump height, power, balance and agility is contradictory. While numerous studies have shown improvements in performance following exposure to WBV, others have found no positive effects (see reference 14). The differences in results may be due to the use of different protocols in respect to frequency (with a range of 20–50 Hz), amplitude (2–10 mm) and duration (30 s–10 min) of WBV.

Middle age is associated with physiological decline of, among other parameters, muscle power [15,16]. While physical exercise is known to be effective in improving muscle power and performance [17], adherence to exercise training routines tends to be low [18]. WBV may be a tool capable of overcoming barriers to regular physical exercise [14]. In comparison to a control group, a 5-week progressive WBV training in 45–55-year old women was demonstrated to improve vertical counter-movement jump and range of motion performance [19]. These findings suggest that WBV training can reduce age-related performance deterioration in middle age.

WBV training may be a useful exercise modality, especially in elderly people, since it does not require conventional dynamic exercise such as free weight or
dynamic movement. In a randomised controlled trial, for example, short training sessions using WBV three times weekly for 6 weeks improved gait, motor capacity, body balance and quality of life in elderly nursing home residents [20]. Various benefits have been reported following WBV training [21], including increased muscle strength [22] and bone density [23] as well as improved cardiorespiratory fitness [24], body balance [25–27] and quality of life [28]. WBV exercise in older people also appears to produce beneficial effects on walking ability and postural control [29–31]. A systematic review and meta-analysis, combining the evidence from randomised controlled trials of resistance training, endurance training and WBV exercise in older people, examined the comparative effects of these different approaches [32]. WBV appeared to have a small beneficial effect on physical performance. However, resistance training of a minimum 6 weeks duration was found to be the most effective intervention, achieving a substantial increase in muscle strength and a moderate improvement in physical performance when compared with people following their normal routine [32]. Furthermore, WBV provided no additional benefit in regard to muscle strength, balance or mobility when added to a comprehensive exercise programme attended regularly by institutionalised older adults [33].

3. WBV in the management of chronic conditions

WBV has been proposed to be of potential use in a variety of chronic medical conditions, such as lower back pain, fibromyalgia, osteoporosis, obesity and diabetes.

Exercise treatment is widely recommended and used in people with non-specific lower back pain [34]. Vibration has been suggested to be of value when used as an exercise modality rather than in an occupational context, and to be able to alleviate rather than aggravate chronic back pain [35,36]. WBV has also been used as a complementary treatment to relieve pain intensity and improve back function [37–41]. It has been further hypothesised that WBV exercise may be more helpful than general exercise, since vibratory stimulation may increase muscle strength and joint stability by improving neuromuscular activation [42,43]. A systematic literature review concluded that there is no clear evidence of therapeutic efficacy of WBV exercise in individuals with nonspecific chronic lower back pain [44]. However, this conclusion was based on randomised controlled trials with small sample sizes. A recent randomised controlled trial comprising 89 participants with non-specific chronic low back pain showed that WBV exercise was more effective than general exercise in relieving pain and improving functional disability [45]. Further studies should include different subgroups exposed to different WBV frequencies.

Fibromyalgia is a chronic disorder of unknown aetiology, which is characterised by chronic, widespread, non-inflammatory body pain, fatigue, insomnia, and poor physical fitness [46,47]. Exercise training is commonly recommended for adults with fibromyalgia. WBV may be helpful in the management of this disorder, since it could offer benefits in regard to balance, fatigue, pain, disability and health-related quality of life. A systematic literature review surmised that WBV could be an effective treatment for fibromyalgia as a main therapy or in addition to physical exercise programmes [48]. However, the comparison of the small number of available trials was limited by significant differences in intervention, protocol and assessment. A Cochrane study analysed whether WBV alone or in addition to mixed exercise is superior to a control condition or another intervention in women with fibromyalgia [49]. The findings of this study indicated that the small number of participants and wide confidence intervals yielded very low quality evidence. Furthermore, the few studies included in the Cochrane analysis failed to measure major outcomes such as pain intensity, stiffness, fatigue or physical function.

Low bone mineral density and associated osteoporosis are major risk factors for fragility fractures [50,51]. Mechanical stimulation is necessary for the maintenance of bone health [52], and physical exercise is an effective treatment for osteoporosis [53]. WBV training has been employed as an alternative exercise intervention and has been demonstrated to increase bone density via mechanical load [54]. A recent systematic review and meta-analysis evaluated the results of published randomised controlled trials assessing the effects of WBV on bone mineral density in postmenopausal women [55]. Statistically significant differences in lumbar spine and femoral neck bone mineral density between WBV intervention and control groups were found [55]. However, the number of published studies was small and the WBV protocols used were highly heterogeneous.

Two major health risk factors today are high body mass index and high fasting plasma glucose, both of which are increasing in prevalence at an alarming rate [56]. The majority of obese people maintain a sedentary lifestyle and show little inclination to enroll and persist in conventional exercise programs due to physical limitations, musculoskeletal discomfort or lack of self-motivation. WBV may therefore offer a low-threshold
training option. Factors that may contribute to a reduction in fat mass after WBV exercise include: (1) triggering of lipolysis through activation of the central sympathetic nervous system innervating white adipose tissue, (2) improved insulin action and glucose regulation leading to enhanced glycaemic control, and (3) an increase in the release of growth hormone, which stimulates metabolism and is usually decreased in obese people [57].

The findings of a systematic review of the scientific literature showed that WBV training is a promising adjuvant intervention in the treatment of obese women [57]. WBV training may be particularly useful in de-conditioned obese individuals with poor motivation [58]. When WBV exercise is combined with dietary intervention or used as an alternative to traditional exercise training, it may be as effective as aerobic and resistance exercise in reducing fat mass [59,60]. Improved cardiac autonomic function [61,62] and a decrease in central and peripheral arterial stiffness [63,64] have been observed following at least 6 weeks of WBV exercise, and a significant reduction in body weight and an improvement in muscle strength have been seen after 10 or more weeks of training [62,64–66]. Further long-term studies, with male as well as female participants, are needed to further evaluate the health benefits of WBV exercise in obese people.

WBV exercise has been shown to reduce blood glucose levels [67] but not to affect insulin or glucagon concentrations. The most likely explanation for this is elevated glucose uptake into contracting skeletal muscles. A pilot study examined the effect of WBV on blood glucose levels in elderly people and found a significant decrease following a single 10-minute WBV session [68]. These beneficial effects on glucose levels need to be confirmed in studies using larger samples and control groups. An acute session of WBV training has been shown to reduce glucose levels in elderly women with diabetes [69]. The findings of a systematic review and meta-analysis of randomised controlled trials suggest that a 12-week progressive intervention with WBV combined with exercise has a slight, statistically significant effect on glycaemic control in patients with type 2 diabetes [70]. High-quality trials need to establish the efficacy of WBV in diabetes and to clarify whether the effects are due to vibration, exercise or a combination of both. WBV training in addition to a hypocaloric diet may further enhance insulin sensitivity and glucose regulation [71].

WBV has often been promoted in recent years as a useful intervention and has shown favourable outcomes in the rehabilitation of various populations with chronic conditions that normally diminish quality of life. A systematic review of the available literature attempted to identify the effects of WBV on health-related quality of life in individuals with chronic conditions, such as respiratory, musculoskeletal and neurological diseases [72]. Based on the findings of randomised controlled trials comparing WBV with non-intervention or alternative intervention groups, it was found that WBV may improve health-related quality of life in patients with chronic conditions. However, the evidence provided is insufficient to warrant the recommendation of WBV as an intervention [72].

4. Conclusion and future perspectives

Despite many promising findings, it is currently far from clear whether WBV can play a role in the promotion of physical fitness and the management of chronic medical conditions. While many studies have shown improvements after exposure to WBV, others found no positive effects on performance. Major problems hampering the evaluation of the available evidence involve a wide range of methodological issues, including a lack of standardised procedures. The value of comparisons between the available studies is limited by varying interventions, vibration protocols and measurements. In order to ensure the reproducibility of WBV interventions, the information provided in research reports should include the type of vibration, frequency, amplitude, peak acceleration and duration of vibration, assessment of accuracy of vibration parameters, type of footwear, potential slipping of the feet and use of support devices during vibration exposure (e.g. in frail people) [73].

Future well-designed randomised controlled trials using larger sample sizes and different exercise intensities and intervention durations should be performed. Optimal settings regarding frequency, amplitude and duration of WBV exercise need to be determined in order to establish causal relationships between these parameters and WBV training outcomes and to develop WBV training guidelines. The question of whether the response to WBV is affected by age or sex also needs to be examined. Moreover, a comparison of the effects of WBV training on muscle strength and physical performance with effects of other types of exercise, such as resistance and endurance training would be of interest. A question meritng particular attention is whether the positive effects of WBV on body balance and postural control can reduce the risk of falls in elderly individuals. Any additional benefits of WBV when combined with other exercise programmes should also be assessed.

In summary, whether WBV training is a viable treatment for lower back pain, fibromyalgia or osteoporosis in
post-menopausal women is, at present, unclear. More research is required to explore more specifically the therapeutic potential of WBV as an exercise modality. In addition, potential long-term risks should be investigated.

Conflict of interest
The authors declare no conflict of interest.

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