
This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Risks and benefits of whole body vibration training in older people

PLEASE CITE THE PUBLISHED VERSION

<http://dx.doi.org/10.1093/ageing/afp036>

PUBLISHER

Oxford University Press on behalf of the British Geriatrics Society (© The Author)

VERSION

AM (Accepted Manuscript)

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Brooke-Wavell, Katherine S.F., and Neil J. Mansfield. 2019. "Risks and Benefits of Whole Body Vibration Training in Older People". figshare. <https://hdl.handle.net/2134/7546>.

This item was submitted to Loughborough's Institutional Repository (<https://dspace.lboro.ac.uk/>) by the author and is made available under the following Creative Commons Licence conditions.



For the full text of this licence, please go to:
<http://creativecommons.org/licenses/by-nc-nd/2.5/>

Risks and benefits of whole body vibration training in older people

Dr Katherine Brooke-Wavell and Dr Neil J Mansfield

Department of Human Sciences

Loughborough University

Loughborough

Leicestershire

LE11 3TU

UK

Key words: whole body vibration; bone mineral density; fall risk factors; neuromuscular function; older people

Regular whole body vibration training, i.e. standing on a platform that vibrates at a high frequency over a small amplitude, has been reported to produce neuromuscular adaptation and increase bone mineral density in some frailer populations [1]. As such, it has attracted interest for its potential benefits on physical function, fall and fracture risk in older people. These potential benefits could however be counteracted by detrimental effects associated with vibration exposure.

Harmful effects of vibration exposure were first identified almost 100 years ago through study of the health of operators of pneumatic power tools [2]. Vibration injury to the hands includes a vascular component, characterised by intermittent blanching, and a neurological component, characterised by impaired proprioception and dexterity [3]. Vibration exposure has also been associated with increased risk of low back pain for drivers of work machines [4]. As vibration is recognised as an industrial hazard, legal limits on exposure have been introduced in many countries. European occupational exposure limits can be exceeded in less than 5 minutes on some commercially available whole body vibration training platforms if used on their highest magnitude settings. It is important to balance the potential risks of adverse side-effects on the neurological and vascular systems with potential benefits when designing a whole body vibration training protocol.

The vibration protocols studied in older people have differed markedly. The mode of vibration includes very low magnitude vertical vibration as used by Rubin and colleagues [5], the higher magnitude vertical vibration used in technologies originally developed for athlete training, and the plates that tilt around an axis to elevate limbs alternately [1]. The frequencies of vibration studied in older people varied from 12.6 to 60 Hz, with reported amplitudes varying from 55 μ m to 8mm [1], although frequencies at the lower end of this range, particularly in conjunction with amplitudes greater than 0.5mm, have been reported to produce greater peak accelerations at

the body than at the platform and to cause discomfort [6]. Flexing knees is a common postural adaptation used to minimise transmission of vibration to the head [7], in order to optimise visual performance and comfort. Consequently, in most studies participants have adopted a semi-squat position, although in some they stood erect [5, 8] or performed dynamic exercises [9, 10]. The duration of intervention varied from several bouts of one minute or less to continuous standing for 10 minutes [1]. Many interventions have been progressive, with increases in duration, frequency or amplitude of vibration. Not all studies have used a matched control group that conducted similar exercise but without vibration, so benefits could be due to the semi squat stand or exercise rather than the superimposed vibration. In some studies the allocation to vibration or control groups was not randomised, whilst some studies were not blinded. There are thus methodological limitations to some existing research.

The reported benefits of vibration include improvements in bone health and neuromuscular function. Increases in femoral neck bone mineral density, relative to controls, have been reported in postmenopausal women [8, 9, 11] although no significant effect was observed in postmenopausal women taking alendronate [12]. Vibration training did not significantly influence bone mineral density at the lumbar spine [11, 12] except in one study where women stood erect with the weight on the heels [8]. Vibration training significantly improved muscle torque and power in some, but not all, trials in older men and women [1]. Improvements in muscular function were proportionately greatest in plantarflexion and to a lesser extent knee extension [13], whilst hip flexion/extension, knee flexion and dorsiflexion measures were unaltered. Neuromuscular benefits of vibration training were significantly greater than those of resistance exercise in some [9, 14] but not all [10] studies that included a control group that conducted similar exercise. Whole body vibration training also improved measures of mobility, gait and balance that have previously been related to

fall risk [1, 9, 13, 14]. There is, as yet, no direct evidence as to whether fall incidence can be reduced by whole body vibration.

Vibration training may offer some potential musculoskeletal benefits but further research is needed to evaluate the optimum vibration protocol in terms of safety and efficacy in older people, and to evaluate its effectiveness at reducing fall incidence. There is little evidence as to the optimal vibration training protocol in this population and some interventions may be delivering ineffective or unnecessarily large exposures. Vibration can result in detrimental effects and further evidence is needed on the risks and benefits of whole body vibration training on other organ systems [1]. In contrast, exercise offers a range of health benefits and there is substantially more evidence available to inform guidelines for older people [15]. Vibration training may be attractive for those who are unwilling or unable to exercise and further research studies are essential to provide the further evidence needed, and possibly reveal further benefits or risks of vibration training for older people.

References

1. Prisby RD, Lafage-Proust, MH, Malaval, L, Belli, A, Vico, L (2008) Effects of whole body vibration on the skeleton and other organ systems in man and animal models: What we know and what we need to know. *Ageing Res Rev* 7:319-329.
2. Hamilton A (1918) A study of spastic anemia in the hands of stone cutters, an affect of the air hammer on the hands of stone-cutters. *Bulletin 236: US Bureau of Labor Statistics* 19:53-61.
3. Mansfield NJ (2005) *Human Response to Vibration*. CRC Press, Boca Raton.
4. Bovenzi M, Rui, F, Negro, C, D'agostin, F, Angotzi, G, Pinto, I, Stacchini, N, Gatti, S, Rondina, I, Bramanti, L, Festa, G, Montinaro, I, Bianchi, S (2006) An epidemiological study of low back pain in professional drivers. *J Sound Vibration* 298:514-539.
5. Rubin C, Recker, R, Cullen, D, Ryaby, J, McCabe, J, McLeod, K (2004) Prevention of postmenopausal bone loss by a low-magnitude, high-frequency mechanical stimuli: a clinical trial assessing compliance, efficacy and safety. *J Bone Miner Res* 19:343-351.
6. Kiiski J, Heinonen, A, Jaervinen, TL, Kannus, P, Sievanen, H (2008) Transmission of vertical whole body vibration to the human body. *J Bone Miner Res* 23:1318-1325.
7. Subashi GHMJ, Matsumoto, Y, Griffin, MJ (2008) Modelling resonances of the standing body exposed to vertical whole-body vibration: Effects of posture. *J Sound Vibration* 317:400-418.
8. Ruan XY, Jin, FY, Liu, YL, Peng, ZL, Sun, YG (2008) Effects of vibration therapy on bone mineral density in postmenopausal women with osteoporosis. *Chin Med J* 121:1155-1158.

9. Verschueren SMP, Roelants, M, Delecluse, C, Swinnen, S, Vanderschueren, D, Boonen, S (2004) Effect of 6-month whole body vibration training on hip density, muscle strength, and postural control in postmenopausal women: a randomized controlled pilot study. *J Bone Miner Res* 19:352-359.
10. Bogaerts A, Delecluse, C, Claessens, AL, Coudyzer, W, Boonen, S, Verschueren, SMP (2007) Impact of whole-body vibration training versus fitness training on muscle strength and muscle mass in older men: A 1-year randomized controlled trial. *J Gerontol Ser A-Biol Sci Med Sci* 62:630-635.
11. Gusi N, Raimundo, A, Leal, A (2006) Low-frequency vibratory exercise reduces the risk of bone fracture more than walking: a randomized controlled trial. *BMC Musculoskelet Disord* 7.
12. Iwamoto J, Takeda, T, Sato, Y, Uzawa, M (2005) Effect of whole-body vibration exercise on lumbar bone mineral density, bone turnover, and chronic back pain in post-menopausal osteoporotic women treated with alendronate. *Aging Clin Exp Res* 17:157-163.
13. Rees SS, Murphy, AJ, Watsford, ML (2008) Effects of whole-body vibration exercise on lower-extremity muscle strength and power in an older population: A randomized clinical trial. *Phys Ther* 88:462-470.
14. Kawanabe K, Kawashima, A, Sashimoto, I, Takeda, T, Sato, Y, Iwamoto, J (2007) Effect of whole-body vibration exercise and muscle strengthening, balance, and walking exercises on walking ability in the elderly. *Keio J Med* 56:28-33.
15. Nelson ME, Rejeski, WJ, Blair, SN, Duncan, PW, Judge, JO, King, AC, Macera, CA, Castanedasceppa, C (2007) Physical Activity and Public Health in Older Adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc* 39:1435-1445.