**Vibration therapy**

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**Key points**

- Whole body vibration involves standing or exercising on a platform that vibrates up to 50 times per second
- Platforms differ substantially in type, magnitude and frequency of vibration
- Early studies suggested that whole body vibration could increase bone mineral density, although a number of large, recent studies saw no effect
- Whole body vibration also improves muscle power and sometimes measurements of balance, so may reduce risk of falls.

Whole body vibration training (WBV) involves standing or exercising on a vibrating platform. WBV has been suggested to benefit bone strength and neuromuscular function, so could potentially reduce risk of fracture by preventing falls as well as increasing bone strength. Whilst some potential has been demonstrated, findings have been mixed, perhaps in part due to the variation in vibration interventions that have been delivered and the groups of participants studied.

Vibration is described by its magnitude (e.g. peak acceleration, often expressed in multiples of the acceleration due to gravity, g) which is dependent upon frequency (number of oscillations per second) and amplitude (maximum displacement ; half of the peak-to-peak displacement)(1, 2). Vibration plates delivering higher magnitude vibration ($\geq$1 g) are now widely available in gyms. Most of these deliver vertical vibration, but side-alternating devices move around a central axis, so that left and right sides rise in turn, with the amplitude being dependent upon the distance of the feet from the axis. Plates delivering a lower magnitude of vibration (~0.3g) have been used in research settings. As regards vibration frequency, lower frequencies (of the order of 10Hz) are close to the resonant frequencies of body tissues, producing amplification of vibration magnitude (4), so frequencies of 30-90Hz are most widely employed. Although vibration therapy may have potential benefits, there are also risks: those exposed to vibrating hand tools may experience “vibration white finger”, demonstrating adverse vascular and neurological responses, whilst those exposed to vibration in a seated posture (e.g. drivers of heavy machinery) have increased risk of low back pain (19). On the higher magnitude plates, vibration exposures that exceed recommended limits for occupational exposure can be exceeded in just a few minutes at maximum settings (3). Protocols for high magnitude plates thus generally employ brief bouts of vibration, progressively increasing in duration.

Some early findings suggested that both high (5) and low (6) magnitude WBV could increase bone mineral density (BMD), with a meta-analysis demonstrating small (of the order of 1-2%) significant increases in BMD at the hip, but not the spine in postmenopausal women (7). The lesser benefit at the spine may be the result of lower transmission of vibration to the upper body. Vibration transmission to the upper body is lower in side-alternating with vertical vibration platforms (3). On

higher magnitude platforms, a “half squat” position is used to reduce transmission of vibration to the head, and in this position transmission to the spine is lower (3). Disappointingly though, several larger, recent, randomised controlled trials have reported no significant effect of WBV on bone density in postmenopausal women. Six months of squat exercises on a higher magnitude (<2.2g) vertical plate did not benefit BMD in institutionalised (>70 years) older women (8). It is possible that 6 months is insufficient to detect a bone mineral response to a progressive intervention, but longer studies have demonstrated similar findings. Exercises performed on a side-alternating vibration plate over 12 months produced no greater benefit to BMD than exercises without vibration in postmenopausal women (9); similarly standing on a low magnitude vibration plate for 20 minutes per day at either 30 or 90Hz did not benefit BMD or bone structural parameters at the tibia in osteopaenic postmenopausal women (10). One explanation for the limited benefit is that the strain rates generated in bone may not differ sufficiently from those from the habitual activities that bone is already adapted to in fairly active, community dwelling women. It is possible that more benefit may be observed in those who are less active and unable to exercise. Some evidence for this is that WBV increased bone formation in older people at risk of falls (11) but did not influence bone turnover in healthy (5, 12) or osteoporotic (13) postmenopausal women.

WBV may show more promise in improving neuromuscular function and hence reducing risk of falls. Muscle function and postural stability are related to fall risk (14), and a number of studies have examined the effects of vibration on these parameters. Some may be difficult to interpret, as exercises were conducted on the vibration platform so it could be hard to determine whether benefit arises from the exercise rather from the vibration per se. Meta-analyses have concluded that WBV increased knee extensor strength and jump height relative to equivalent exercise without vibration (15), with substantial increases in some studies. Findings on static postural sway have been more equivocal, but a meta-analysis suggested that side-alternating vibration improved body sway (16). Static balance and timed up and go tests were also improved by WBV plus exercise interventions, particularly in frailer populations such as faller and clinical groups, although there was considerable variability in findings between studies (17). Most of the studies that reported benefits in fall risk factors used high magnitude vertical or side-alternating vibration, but remarkably, standing on a low magnitude platform performing for 20 minute sessions on 5 days per week for 18 months WBV was reported to reduce fall incidence as well as improving some fall risk factors (muscle strength and balancing ability) in community dwelling postmenopausal women in Hong Kong (18). However, this study still detected no overall benefit to BMD.

An exciting possibility is that WBV may augment the effects of anti-osteoporotic drugs and a study is underway in Southern Denmark to investigate if WBV may benefit osteoporotic women using teriparatide by increasing its effect on bone mineral density and bone strength compared to women using teriparatide alone without WBV (personal communication with Ditte Jorgensen).

In summary , whole body vibration training may improve neuromuscular performance and so reduce risk of falls and fractures in older people. There may also be some benefit to bone strength but findings are inconsistent. It seems feasible that benefits will be greatest in those who are least active initially- and this group may be least willing and able to take part in conventional exercise. However, there is no consensus on the most effective modes and characteristics of vibration to achieve benefit and further research is needed. In the meantime, whole body vibration may benefit people with, or

at risk of, osteoporosis, particularly by improving neuromuscular function, but care should be taken not to exceed recommended exposures.


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