Whole Body Vibration Overview

Report prepared by:

Kieran Macphail BSc (hons), CHEK III, MACSPM, MBANT
Research Associate

For Correspondence:
Kieran Macphail
Bowskill Clinic Ltd
4 Duke Street
London
W1U 3EL
020 7486 6523
Contents

1. Introduction ............................................................................................................................................. 3
2. Method (of search) .................................................................................................................................... 3
   a. Notes on search findings .......................................................................................................................... 3
3. Different Types of Vibration ..................................................................................................................... 4
4. Improving Athletic Performance ............................................................................................................... 4
   a. Jump height ........................................................................................................................................... 4
      i. Acute effects ....................................................................................................................................... 4
      ii. Chronic effects .................................................................................................................................. 6
   b. Sprint speed ......................................................................................................................................... 10
   c. Agility .................................................................................................................................................. 12
   d. Strength .............................................................................................................................................. 12
5. Enhancing Health ..................................................................................................................................... 15
   a. Hormonal Effects .................................................................................................................................. 15
   b. Metabolic Effects .................................................................................................................................. 16
   c. Body Composition ............................................................................................................................... 16
   d. Blood Flow .......................................................................................................................................... 17
   e. Bone Mineral Density .......................................................................................................................... 17
   f. Gastric Motility ..................................................................................................................................... 19
6. Assisting Rehabilitation ............................................................................................................................ 19
   a. Low Back Pain ..................................................................................................................................... 19
   b. Geriatric Conditioning ............................................................................................................................ 20
   c. Neurological Rehabilitation ................................................................................................................... 22
   d. For Immobilized Children ..................................................................................................................... 23
   e. As soft tissue therapy ............................................................................................................................ 23
7. Side Effects ............................................................................................................................................... 24
8. Contraindications ..................................................................................................................................... 24
9. How Does It Work ..................................................................................................................................... 24
10. Practical Application ................................................................................................................................ 26
11. Conclusion ............................................................................................................................................. 27
12. Glossary .................................................................................................................................................. 28
13. References ............................................................................................................................................. 29
1. **Introduction**

Vibration training has been aggressively marketed over the last decade with advertised benefits ranging from improved athletic performance to reducing cellulite. Under the umbrella of vibration training are two distinctly different applications, direct application of vibration and whole body vibration (WBV). WBV is typically applied using a vibrating plate. Vibrogym claim to have a superior design as such a review was conducted to establish credibility of claims made for Vibrogym and their potential clinical application in improving athletic performance, enhancing health and assisting rehabilitation.

2. **Method (of search)**

Preliminary reading was carried out of the 44 articles referenced on the Vibrogym website. The selected articles were then reviewed and the reference lists of these articles were then searched for suitable articles. Where an article appeared to provide only one viewpoint further searches were carried out to identify conflicting studies. Only studies using a vibrating plate were used, studies with direct application were not considered.

A. **Notes on search findings**

The reference list provided on the Vibrogym website was in general accurate. However, there were a few inclusions which had tenuous or spurious links to the claims they implied the articles supported. Kaddoura et al (1996) didn’t investigate the use of the Vibrogym or WBV but purely...
assessed the use of the 9 min walk test in assessing heart failure patients. Similarly, Schache et al (2001) compared over-ground and treadmill running on the kinematics of the lumbo-pelvic hip complex. The papers used to support the Vibrogym for soft tissue therapy are tenuous at best (Goat 1994a, b) with the other untraceable (Hovind and Nielsen 1974). Vibrogym and soft tissue therapy are discussed below.

3. Different Types of Vibration

There are multiples types of vibration training platforms available for WBV. Some, such as powerplate provide “3-dimensional” vibrations whilst others like vibrogym provide purely vertical vibration. Thornton (2009) suggests that the human body is more suited to vertical loading as transverse and frontal plane loading will subjects joints to sheer forces. This is the essence of the superiority of vibrogym platforms over other such as the powerplate. In addition the deformation that occurs in the plastic plates as opposed to the metal-based platforms means that some of the force is lost and not transferred to the trainee.

4. Improving Athletic Performance

A. Jump Height

1. Acute Effects

The acute effects of WBV on jump height have received more attention than many other areas. Of the research done Cormie et al (2006) used the most thorough study design. They compared an isometric squat on a power plate with a sham isometric squat on a power plate. They used a frequency
of 30Hz and amplitude of 2.5mm. This produced significant improvements in vertical jump height immediately following the isometric squat which diminished over time. Further Vastus medialis electromyographic activity showed a non-significant increase. However, their use of a 5 minute bicycle ergometer warm up may impair transferability of these results as opposed to a movement specific warm up. It should also be noted that the sham conditions were performed on the power plate but with the machine turned off. This is a far superior control for isolating the effects of vibration than used in other studies but would be easily detected by patients and their may well have been a placebo effect impacting the performance in subjects feeling the vibration. Nonetheless impressive performance improvements were noted up to 15 minutes after exposure to WBV. At 30 minutes there was no evidence of improvement. Thus the effects may last between 15 and 30 minutes. This gives a relatively short window of use that could be clinically applicable. For example, performing the first set of each exercise in a station-based workout on a vibrating plate may be an effective method to utilise this affect. There may be a dose response relationship. Bosco et al (2000) found a 3.9% increase in jump height from ten 60-second bouts of whole body vibration compared with the 2.2% from a single bout of 4 minutes use by Torvinen et al (2002b) and 0.7% increase from 30 seconds in Cormie et al’s (2006) study. This suggests that 6 minutes or more of total time under tension may be ideal for a warm up prior to a jump. However, movement specific durations and how these vary with training level and type of training remain to be established.
II. **Chronic effects**

Studies on the long term training effects of WBV have varied from 9 days in length to 8 months. Unsurprisingly Cochrane et al (2004) produced no significant improvements compared with identical control training on countermovement jump height and squat jump height over 9 days. This was split into 5 days consecutive training followed by 2 days rest and then a further 4 consecutive days training. Thus the subjects over-trained and had insufficient time to gain improvements from hypertrophy. De Ruiter et al (2003) completed the other study utilising identical training for control. They used 5 to 8 sets of 1 minute with 1 minute rest at 30Hz and 8mm amplitude, training 3 times a week standing on a platform with knees bent to 110 degrees. They only had 10 subjects in each group with control subjects completing the same programme stood next to the vibration platform. This protocol did not produce a statistically significant increase in countermovement jump height. This may have been due to the small sample or possibly the especially large amplitude used.

Fagnani et al (2006) carried out the only study comparing WBV with an active control group. They used WBV 3 times a week for the longer period of 8 weeks with competitive female athletes. The control group received sports specific training for their sport. The WBV used the NEMES LCB-040 at 35 Hz frequency and 4mm amplitude. Two isometric exercises were used, single leg standing and squat at 90-degrees of knee flexion. The training schedule used is shown in Table 1. CMJ significantly improved.
**Table 1. Periodisation used by Fangani et al (2006)**

<table>
<thead>
<tr>
<th>Week</th>
<th>1 &amp; 2</th>
<th>3 &amp; 4</th>
<th>5 &amp; 6</th>
<th>7 &amp; 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squat</td>
<td>3 x 20s 1 min rest</td>
<td>3 x 30s 1 min rest</td>
<td>3 x 45s 45s rest</td>
<td>4 x 1m 1m rest</td>
</tr>
<tr>
<td>Single Leg standing</td>
<td>3 x 15s 30s rest</td>
<td>3 x 20s 30s rest</td>
<td>3 x 25s 30s rest</td>
<td>4 x 30s 30s rest</td>
</tr>
</tbody>
</table>

Generally positive results have been found in the two studies comparing WBV with passive controls groups. The only trial to produce no significant improvement was Delecluse et al (2005). They used a 5-week, 3 sessions of 9-18 minutes protocol at 35-40Hz at 2.28-5.09g, 1.7-2.5mm. As this protocol was used with elite sprinters they also took part in intense sprint training. Meaning this may have negated any effects from the WBV or the additional training may have meant participants over trained and thus didn’t progress as expected. Alternatively this protocol can be seen as being similar to others used in geriatric training and potentially a more demanding protocol would garner more positive results. The larger 52 participant study of Torvinen et al (2002a) improved countermovement jump height 9% compared with passive controls. The total duration of vibration was only 4 minutes, 3-5 times a week for 4 months. Torvinen et al (2003) used a very similar protocol over 8 months and produced 7.7% increases in countermovement jump height. They used a mixture of static and dynamic exercises. Thus the work of Torvinen et al suggests a potential time efficient role for WBV in improving CMJ. Similarly Paradisis and Zacharogiannis (2007) found statistically significant improvements in CMJ.
as shown in Table 2. They used 3 sets of 40 seconds followed by 1-minute rest periods for each of 4 exercises and 2 minutes rest over 6 weeks.

### Table 2. Results obtained for the CMJ (cm).

Data are means (±SD).

#### WBV

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>%DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>33.1 (4.9)</td>
<td>28.0 (2.0)</td>
<td>25.2 (3.9)</td>
</tr>
<tr>
<td>Post</td>
<td>34.2 (4.4)*</td>
<td>30.2 (3.0)*</td>
<td>27.0 (3.7)*</td>
</tr>
<tr>
<td>%DIFF</td>
<td>3.3</td>
<td>7.8</td>
<td>7.2</td>
</tr>
</tbody>
</table>

#### Control

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>%DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>35.2 (6.1)</td>
<td>29.2 (5.0)</td>
<td>24.2 (4.3)</td>
</tr>
<tr>
<td>Post</td>
<td>35.2 (6.5)</td>
<td>30.1 (3.3)</td>
<td>23.8 (3.)</td>
</tr>
<tr>
<td>%DIFF</td>
<td>.3</td>
<td>3.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

*Significantly different from Pre test (p < 0.05) as determined by repeated measures analysis of variance and post-hoc Tukey tests.

Placebo controlled studies have produced generally encouraging results. Ronnestad (2004) took 14 recreationally resistance trained men through a 5 week squat training programme at 6-10 repetitions maximum (RM) producing no significant improvement in CMJ. There was a trend towards greater improvements compared with the placebo group but these were not significant. Delecluse et al (2003) conducted the most thorough study so far on WBV and improving athletic performance. They compared the effect of WBV, resistance training, and placebo. The control did no exercise. The WBV and placebo groups consisted of squat, deep squat, wide stance squat, 1 legged squat and lunge. The programme was periodised by reducing the
REST PERIOD, INCREASING THE NUMBER OF SETS FROM 1-3, GRADUALLY INCREASING
THE DURATION, AMPLITUDE (2.5-5MM) AND FREQUENCY (35-40HZ). HOWEVER, THEIR
EXCLUSION CRITERIA DIDN’T EXCLUDE RESPIRATORY, CARDIOVASCULAR OR
NEUROLOGICAL CONDITIONS HOWEVER THE SUBJECTS WERE AGE 21.5 +/- 1.9 YEARS.
INTERESTINGLY NEITHER THE SUPERVISING STAFF NOR SUBJECTS REPORTED ANY
DOUBTS IN THE PLACEBO GROUP. ONLY WBV PRODUCED A SIGNIFICANT IMPROVEMENT
IN CMJ (7.6%). IMPORTANTLY THE POSTTESTS WERE PERFORMED AT LEAST 72 HOURS
AFTER LAST EXPOSURE TO WBV AND AS SUCH THE RESULTS CANNOT BE ATTRIBUTED
TO ACUTE EFFECTS.

MANY OF THE STUDIES CONDUCTED THUS FAR HAVE MULTIPLE METHODOLOGICAL
FLAWS. AS SUCH THE EXCELLENT STUDY CONDUCTED BY DELECUSE ET AL (2003)
CARRIES SPECIAL WEIGHT IN THIS AREA STRONGLY SUGGESTING A POSITIVE EFFECT ON
CMJ. EVEN REMOVING THIS STUDY THE GENERAL WEIGHT OF EVIDENCE SUGGESTS
POSITIVE EFFECTS IN THE PLACEBO-CONTROLLED STUDIES, PASSIVE CONTROL STUDIES
AND ACTIVE CONTROL STUDIES. THUS THE OVERALL BODY OF EVIDENCE SUGGESTS
WBV USING EITHER DYNAMIC OR STATIC EXERCISES CAN BE EFFECTIVE IN IMPROVING
JUMP HEIGHT. FURTHERMORE A PERIOD OF AT LEAST 3 WEEKS SEEMS ESSENTIAL AND
6 WEEKS OR MORE MAY BE IDEAL. ONLY THE RESULTS OF DE RUITER ET AL (2003)
AND DELECUSE ET AL (2005) CHALLENGE THIS HYPOTHESIS BUT MAY BE EXPLAINED
BY METHODOLOGICAL FLAWS HOWEVER THEY CANNOT BE DISMISSED OUT OF HAND.
FUTURE STUDIES NEED TO IDENTIFY THE IDEAL ACUTE VARIABLES TO USE IN
ATHLETES.
**B. Sprint Speed**

The general trend towards improving CMJ in the chronic studies suggests power output can be improved using WBV and this suggests speed may also be improved due to the physiological crossover. However, to date there is little support for this. Some of the studies examining power have also examined sprint speed. Cochrane et al (2004) have conducted the only identical control group study but used an insufficient time period. Thus their negative results contribute little to clinical practice. Paradisis and Zacharogiannis (2007) used a more realistic 6-week WBV training protocol. They found statistically significant improvements in speed as shown in table 3. This is encouraging however the control did not complete any training. This does however illustrate effectiveness but not superiority over other training methods. Delecluse et al (2005) used similar parameters and only one week less but found no significant improvements compared with passive controls. Thus overall the picture is mixed but there may be some benefit.
Table 3. Time results obtained from the different distance intervals of the 60 m sprint test. Data are means (±SD).

<table>
<thead>
<tr>
<th></th>
<th>WBV</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 M (s)</td>
<td>20 M (s)</td>
</tr>
<tr>
<td>Pre</td>
<td>1.96 (.10)</td>
<td>3.30 (.16)</td>
</tr>
<tr>
<td>Post</td>
<td>1.88 (.14)</td>
<td>3.20 (.18) *</td>
</tr>
<tr>
<td>%DIFF</td>
<td>-4.3</td>
<td>-3.0</td>
</tr>
<tr>
<td></td>
<td>10 M (s)</td>
<td>20 M (s)</td>
</tr>
<tr>
<td>Pre</td>
<td>1.97 (.13)</td>
<td>3.33 (.19)</td>
</tr>
<tr>
<td>Post</td>
<td>1.96 (.15)</td>
<td>3.31 (.17)</td>
</tr>
<tr>
<td>%DIFF</td>
<td>-.7</td>
<td>-.6</td>
</tr>
</tbody>
</table>

Abbreviations: WBV = whole body vibration training group, C = control group.

* Significantly different from Pre test (p < 0.05) as determined by repeated measures analysis of variance and post-hoc Tukey tests.
C. Agility

The only study that has examined agility was Cochrane et al (2004). Again the same criticisms are valid of the insufficient training period. They found no improvements. Given the tendency for improved power following WBV it is likely there may be some benefits to gained in agility as well but as with speed training this remains to be established.

D. Strength

Despite producing gains in countermovement jump height Torvinen et al (2002) produced no change in leg press or grip strength compared with passive control. Thus their protocol may have only been suitable for recruiting higher threshold motor units. Similarly Delecluse et al (2005) produced no strength gains compared with passive controls in elite sprinters. However, their sprint training may have impacted the effectiveness of the protocol and they may have needed a more intense protocol given their athletic ability. However, earlier Delecluse et al (2003) had produced more positive results in untrained students over 12 weeks. Isometric knee-extensor torque and dynamic strength increased significantly in the WBV group by 16.6% and 9.0% respectively in line with the increases in the resistance training group of 14.4% and 7.0%. In contrast the placebo group showed only a non-significant increase. Similarly Roelants et al (2003) compared WBV with strength training. They used body weight static and dynamic exercises with WBV using 35-40Hz at 2.28-5.09g, 2.5-5.0mm, for three 20-30 minute sessions a week over 24
weeks. The resistance training group completed 2 sets of leg press and leg extensions at 8 RM. Knee strength increased at 0° 24.4%, 50° 5.9%, 100° 8.3%, and 150° 7.6%. However, these increases were not statistically significant compared with the resistance training group. Nonetheless they do illustrate parity. Comparable, non significant results were found by Ronnestad (2004) when performing squats with WBV as opposed to without in recreationally resistance trained men. Further negative results compared with placebo were found by De Ruiter et al (2003) and Schlumberger et al (2001). De Ruiter used single leg standing on leg with knees bent to 110 degrees with ten subjects trained three times a week for eleven weeks. They completed five to eight sets of 1 minute with 1 minute rest at 30hz and 8mm amplitude. Ten control subjects completed the same programme stood next to the vibration platform. This protocol shows that the vibration element it's self isn't sufficient to produce gains in isometric knee strength. Schlumberger et al's (2001) design was innovative but flawed. Twenty participants did four times 8-12 RM one legged squats, one leg on WBV and the other without three times a week for 6 weeks at 25Hz, 6mm. Both legs produced approximately a 6.5% force increase. Due to it's nature WBV effects tissues throughout the body. The "passive" leg will have received WBV. Further, the "passive" leg has a fairly active role especially at the hip and pelvis and would have received a training effect.

Baum et al (2007) compared the effects of WBV with strength training and flexibility training. 40 subjects were divided randomly in to groups. They trained three times a week for 12 weeks. Training volume and intensity were increased after 6 and 9 weeks. Flexibility training involved 30 second stretches to large muscle groups of the upper and lower body with a total session time of less than 15 minutes. Strength training involved...
resistance machines at 70% 1 rep max for 12 repetitions for key muscles groups of the upper and lower body. The total session time was 45 minutes. The strength training included a rest after each repetition to avoid critical blood pressure response. The WBV used the virbogym professional with an amplitude of 2mm at 30 Hz from weeks 1-9 and then 35Hz for weeks 10-12. Each set was 30 seconds and the same number of sets was done as for the strength training group. A full training session lasted 20 minutes. The reduced time of training was seen as a big plus however the type of training energy systems stressed will have differed significantly between the strength and WBV group. The rest between each repetition will have reduced the aerobic demand and reduced the accumulation of lactic thus reducing strength gains and decreasing the metabolic benefit of the strength training. A better comparison would have been to have used isometric weight training for the same training period. As this would have illustrated the benefits gained from the vibration component of the WBV group. The strength group produced significant gains in quad strength however the WBV group did not. This is likely due to the isometric nature of the training and the exercises used stressed stabilisers and balance over pure strength. However due to the altered training parameters the comparison is not valid and is really a comparison of the different training parameters used. It’s likely squats on the VibroGym would produce greater gains than squats without the VibroGym due to the increased motor unit recruitment.

The only study to produce positive results other than the well designed Delecluse et al (2003) paper is Fagnani et al (2006). They investigated the effect of WBV three times a week for eight weeks on muscle performance and flexibility in competitive female athletes. The control group received
Sports specific training for their sport. The WBV used the NEMES LCB-040 at 35 Hz frequency and 4mm amplitude. Two isometric exercises were used, single leg standing and squat at 90-degree knee flexion. Bilateral knee extensor strength and flexibility were significantly improved. There were no improvements in the control group.

As with most studies on improving athletic performance many studies have poor methodological design. The best designed study is Delecluse et al (2003), which produced positive results. However, there are multiple papers showing no improvement compared with control. This illustrates a general lack of superiority but also the parity with traditional training methods and superiority in one case. As this one case (Delecuse et al 2003) remains the most thoroughly designed study in the area it carries more weight than others. Nonetheless the general lack of benefit over placebo or identical training (De Ruiter 2003) is hard to reconcile with Delecluse et al (2003) findings.

5. Enhancing Health

A. Hormonal Effects

The acute influences of WBV on the hormonal system have received some interest. Increases in growth hormone and IGF-1 (Bosco et al 2000) following a single bout of WBV have been demonstrated. Similarly, increased noradrenaline levels (Di Lorretto et al 2004) have also been found. These responses are typical for exposure to traditional resistance training and suggest the mechanism for improvements from WBV are similar to those of traditional training. It would be interesting to compare the
hormonal response following WBV and placebo compared with a similar duration and intensity of resistance training.

**b. Metabolic Effects**

The limited research to date has shown oxygen consumption increased with WBV (Rittweger et al 2002) when compared with a squat or static standing off the vibration platform. This was presumed to be due to the increased motor unit recruitment driving the demand for greater oxygen (Rittweger et al 2001). In this respect WBV can be seen as an additional imposed demand further increasing metabolic demands.

**c. Body Composition**

Many claims are made for the body transformation benefits of WBV. However, there is currently a paucity of research to support some of the more exuberant claims. Rittweger et al (2006) investigated the effects of used resistive vibration exercise (RVE) consisting of squats, heel raises, toe raises and kicks done in supine. The study period lasted 56 days in 20 healthy male volunteers aged 24-43 that were randomised to either a non-exercising control group or a group that received RVE 11 times a week. Bed rest was monitored via hidden and camera and diet as also controlled. Vibration progressed from 19Hz to 25.9Hz over the training period. They found that RVE was effective at increasing exercise tolerance but did not alter the subjects weight. In contrast Roelants et al (2004a) found that a 24-week for WBV caused small gains in fat free mass and large strength gains but did not alter body fat levels. However, over time a programme
that increases fat free mass will encourage fat loss. More recent research (Paradisis and Zacharogiannis 2007) found that a 6-week WBV reduced body fat by 2.1% compared with a 5.7% increase in the control group. Thus with correct application WBV may make an effective addition to body transformation programme.

**D. Blood Flow**

Kerschan-Schindl et al (2001) investigated the effects of WBV on blood flow. They were interested as occupational exposure to high volume vibration has been shown to decrease peripheral blood flow. However, they found that following 9 minutes standing on the Gallileo that popliteal artery flow had increased. Similarly, Lohman et al (2007) found that an acute exposure of 10 minutes of WBV doubled skin blood flow. Hydrodynamic analysis shows that at the same time blood pressure rises as a response to blood vessel deformation during the vibratory period. As a result more capillaries are opened up to increase blood flow and thus peripheral blood flow increases (Mester et al 2006). The long term effects may mimic the detrimental effects seen in long-term occupational exposure. Nonetheless short term exposure may have benefits in promoting tissue healing.

**E. Bone Mineral Density**

Rubin et al (2003) state that previous research has shown 15-60Hz has a strongly anabolic effect on bone. They found that frequencies of less than 20Hz had 100% transferability to the hip and L4 when the patient was
standing. This reduced as the frequency increased further if the patient bent their knees to 20 degrees the transfer decreased to 30%. As the frequency increases the muscular recruitment increases whereas at lower frequencies the force is primarily taken through the skeletal system. Torvinen et al (2003) found no improvement in bone mineral density despite an increase in countermovement jump height. They studied WBV over 8 months for 4 minutes per day 3-5x/ week at 25-45hz in 56 participants aged 19-38. However, this age range may not see as great an improvement as more elderly patients with compromised bone mineral density. Further the frequency used may have increased muscular recruitment reducing transfer of the force to the skeletal system.

The most comprehensive study done to date on WBV and bone mineral density was conducted by Iwamoto et al (2005). They compared the effect of alendronate with alendronate and WBV on bone mineral density, bone mineral turnover and low back pain in postmenopausal women aged 55-88. Fifty women were randomly assigned to each group. The WBV group received 4 minutes of WBV at the more suitable frequency of 20Hz once a week. They found no additional benefit for bone mineral density or bone turnover with WBV. Although this was a group of postmenopausal women 4 minutes a week is a very low amount of load. Furthermore, there was no progressive increase in the time. There was no placebo group and the insensitive face scale score was used as an outcome measure. There may be benefits with an appropriately periodised program using exercises appropriate for the bone that requires strengthening.
F. Gastric Motility

Of the papers studied only Ishitake et al (1999) consider the impact of WBV on gastric motility. They found that exposure to 10mins WBV at only 4Hz produced a notable decrease in gastric motility measured by electrogastrography (EGG). Their findings suggest that exposure to WBV reduce gastric myoelectiric activity, the responses on which may be mediated by neurohumoral effects as well as the mechanical effects of WBV. Due to the nature of responses in the musculoskeletal system in response to WBV it should not be a surprise that gastric motility is delayed. However, it remains to be seen how frequencies of 20-40Hz more commonly used clinically. The effects of WBV on EGG compare with that of other training modalities. Clinically the potential effects should be considered.

6. Assisting Rehabilitation

A. Low Back Pain

WBV has received scant attention in low back pain literature. Rittweger et al (2002) found similar decreases in pain sensitivity for lumbar extension and vibration exercises. Both were done for 3 months in patients with chronic non-specific low back pain. Greater gains in lumbar extension strength were gained by the extensor training group. Meaning the results could be attributed to the placebo effect for both with the strengthening of the extensors having little impact. In postmenopausal women Iwamoto et al (2005) found a decrease in chronic low back pain when paired with...
alendronate compared with alendronate on its own. This is all the more remarkable when the loading parameters are considered. It may well be that despite the low frequency WBV appears to have some value in the management of low back pain. However, it needs to be considered as a component of a comprehensive programme.

**b. Geriatric Conditioning**

Although WBV has received commercial success in gyms there has been significant interest in its potential use in geriatric conditioning. The least successful study reviewed produced no improvement in balance or gait speed compared with the control group. However, the protocol did produce non-significant improvements. The lack of significance may have resulted from the parameters implemented, a population that was too heterogeneous, and an inclusion criterion that allowed only the healthiest individuals to participate (Thornton et al 2009). Bruyere et al (2005) found significant functional benefits in patients exposed to vibration training and physiotherapy compared with those that just received physiotherapy. Similarly, Runge et al (2000) produced 18% increase in chair rising compared with controls. They used 7-14mm amplitude and 27Hz frequency over for 3 x 2 minutes 3 times per week for 2 month training programme using a randomised crossover design. 34 patients took part in total. In a much larger but similarly designed study Kawanabe et al (2007) compared the effect of WBV in addition to strengthening, balance, and walking exercises on walking ability in the elderly. Subjects ranged from 59-86 and were divided in to a group of 27 receiving routine exercises and 40 receiving routine exercise and WBV. The WBV was done using a Galileo...
machine (Novotec, Pforzheim, Germany) using a 12-20 Hz frequency for 4 minutes, once every week for two months. Routine exercise consisted of group strength, balance training and walking twice a week for thirty minutes. Walking speed, step length, and the maximum standing time on one leg were significantly improved in the WBV exercise plus routine exercises group, while no significant changes in these parameters were observed in the routine exercises alone group. However the obvious methodological flaws in these studies mean they effectively assessed the benefits of extra exercise and time with a therapist and thus the results are highly unremarkable.

Roelants et al (2004b) compared WBV training with resistance training or no training in women aged 58 to 74. The WBV group of 30 participants took part in dynamic and static knee extension exercise on a vibration platform over 24 weeks. The resistance-training group of 30 participants took part in leg press and extension exercises, progressing from 20 RM down to 8 RM. The control of 29 people took part in no intervention. Participants were assessed pre, mid and post intervention. Static and dynamic knee extensor strength was increased 15.0% and 16.1% respectively which compares favourably with 18.4% and 13.9% in the resistance training group. Speed of movement increased at lower levels of resistance by 7.4% for WBV and 6.3% for resistance training. Counter movement jump height increased by 19.4% for WBV and 12.9% in the resistance training group. Supporting this Russo et al (2003) produced a 4.7% improvement in muscle power in post-menopausal women in 6 months using 2 sessions per week of 6 minutes WBV compared with passive controls. The frequency progressed from 12-28Hz and force from 0.1-10g. These results are in line with those of Verschueren et al (2003) who instructed 70 post menopausal women to...
TAKE PART IN EITHER NO EXERCISE (CONTROL, 23), RESISTANCE EXERCISE (22) OR WBV (25). WBV CONSISTED OF STATIC AND DYNAMIC KNEE EXERCISES ON A VIBRATION PLATFORM. RESISTANCE TRAINING CONSISTED OF LEG PRESS AND EXTENSION EXERCISES PROGRESSING FROM 20 REPETITIONS TO 8 OVER THE STUDY PERIOD. THE CONTROL DID NOT PARTICIPATE IN EXERCISE. THIS REDUCED FALLS RISK BUT RESULTED IN NO CHANGE IN BONE DENSITY. THE WBV GROUP HAD THE GREATEST GAINS IN STRENGTH OF 15.1% FOR ISOMETRIC KNEE EXTENSION AND 16.5% FOR ISOKINETIC STRENGTH. HOWEVER, THESE WERE NOT STATISTICALLY SIGNIFICANT. NO SIDE EFFECTS WERE NOTED. DESPITE THE POOR QUALITY OF STUDIES IN GERIATRIC CONDITIONING EVERY PAPER STUDIED SHOWED POSITIVE RESULTS. WBV CAN BE DONE ESPECIALLY QUICKLY AND MAY NOT BE ASSOCIATED WITH AS MUCH PERCEIVED EFFORT.

C. NEUROLOGICAL REHABILITATION

IN THE ONE STUDY EXAMINED INVESTIGATING WBV IN NEUROLOGICAL REHABILITATION VAN NES ET AL (2007) USED 6 WEEKS OF 4 SETS OF 45 SECONDS AT 30HZ AND 3MM AMPLITUDE FOR 5 DAYS A WEEK IN 53 PATIENTS WITH MODERATE TO SEVERE DISABILITY POST-STROKE AND COMPARED IT WITH EXERCISE THERAPY. THERE WAS NO STATISTICALLY SIGNIFICANT DIFFERENCE BETWEEN EACH GROUP. THIS CAN BE INTERPRETED AS PROVIDING NO ADDITIONAL BENEFIT OR AS BEING AS EFFECTIVE AS TYPICAL REHABILITATION. SIMILARLY ENCOURAGING RESULTS WERE REPORTED BY NESS AND FIELD-FOTE (2009) WHO FOUND 12 SECONDS WBV IMPROVED WALKING QUALITIES IN SPINAL CORD INJURED PATIENTS. THESE RESULTS ARE ENCOURAGING BUT MUCH MORE RESEARCH WILL BE NEEDED TO ELUCIDATE THE BENEFITS.
There has been limited interest in paediatric rehabilitation. Semler et al (2007) completed a preliminary report on 6 children using WBV on a tilt table over 6 months. They concluded that it was a promising approach for improving motor performance and mobility in severely motor impaired children.

E. As Soft Tissue Therapy

The vibrogym website includes Goat (1994a, 1994b) as a reference to support increases in stabilisation and coordination. However, the first paper (Goat 1994a) only discusses massage and has a single paragraph on therapeutic vibrations from machines in which it makes no reference to equipment similar to the vibrogym. The second paper (Goat 1994b) does mention vibratory massage but not in a positive light. They also cite Hovind and Nielsen (1974), which is another massage related paper that is unfortunately untraceable on pubmed. However it is plausible that the vibrogym could provide therapeutic vibrations similar to those applied in massage.
7. **Side Effects**

The only side effect noted in the studies examined is Itching Erythema, a reddening of the skin accompanied by itching (Rittweger et al 2000). The erythema is most likely caused by the increased peripheral blood flow. The itching however may have been caused by irritation of peripheral nerves.

8. **Contraindications**

Contraindications associated with vibration therapy include pregnancy, hip or knee implants, recently placed screws, pins, bolts or spirals, acute hernia, discopathy or spondylitis. In addition, you shouldn’t apply vibration therapy with people who have a pacemaker, serious cardiovascular disease or any heart condition, acute thrombosis or blood clots, epilepsy, serious diabetes, a history of detached retinas, advanced arthrosis, arthropathy and advanced rheumatoid arthritis (Guffey 2009).

9. **How Does It Work**

Adaptations are most likely due to increased muscle activation caused by augmented excitatory input from muscle spindles exposed to vibration. Eklund and Hagbarth (1966) and Brown et al (1967) are frequently cited for demonstrating that exposure to vibration augments excitatory input from muscle spindles. However, the tonic vibration reflex was demonstrated as a result of a high frequency vibration applied directly to the tendon. Nordlund and Thorstensson (2007) question the theory,
querying how such an effect could lead to sustained positive benefit. It would appear the benefit is due to the increased motor unit activation creating overload and thus adaptations. Nordlund and Thorstensson further state that the vibration is only transient. However, so is the motor response to most forms of exercise. It is likely this transient exposure is capable of producing overload and thus hypertrophy. They continue by stating that the frequencies used are weaker than those used to cause the tonic vibration reflex and are applied to the feet meaning the frequency and amplitude decrease as they are transplanted cranially (Yue and Mester 2002). However, Delecluse et al (2003) and Verschueren et al (2004) found that electromyographic (EMG) activity was increased in the gastrocnemius and rectus femoris when standing in a half squat during WBV. The plot thickens further though. These readings were attained between 20-25 seconds and vibration applied to the tendon for longer than 30 seconds decreases voluntary muscle activation (Bongiovanni et al 1990, Ribot-Ciscar et al 1998, Shinohara 2005 cited Nordlund and Thorstensson 2007). The cause of this decrease could be reduced Ia input to the motor neuron pool caused by a reduction in the muscle spindle firing frequency (Ribot-Ciscar cited Nordlund and Thorstensson 2007), increased presynaptic inhibition (Hultborn et al cited Nordlund and Thorstensson 2007) or a decrease in neurotransmitter release caused by homosynaptic postactivation depression (Curtis and Eccles, Hultborn et al, cited Nordlund and Thorstensson 2007). Furthermore vibration of a muscle or tendon also stimulates the interneurons in the spinal cord, which inhibit motorneurones of antagonist muscles, via reciprocal inhibition (Crone and Nielsen cited Nordlund and Thorstensson 2007). Thus less than 30 seconds would seem ideal in theory but protocols using longer periods have shown positive outcomes.
10. **Practical Application**

Unfortunately 2.5mm amplitude is frequently used purely because that’s what others have used (Cormie et al 2006). However, a more evidence-based rationale can be used for determining which acute variables to use with WBV. Martin and Park (1997) investigated the effects of 40, 80, 110, 120, 150, or 200 Hz at 0.2 or 0.3 mm amplitude on TVR in the finger flexors measured using EMG. They found harmonic synchronisation decreases with higher frequencies however sub harmonic synchronisation increases. They were unable to make specific recommendations, but they stated that greater than 150Hz decreased synchronisation and would be less effective clinically. 30Hz produces the highest activity in the vastus lateralis (Cardinale and Lim 2003). Further Luo et al (2005) concluded that 30-50Hz was optimal for maximal motor unit recruitment. Amplitude 2-6mm & frequency of 20 to 30Hz evoke muscle contractions via monosynaptic stretch reflex (Rotmuller and Cafarelli 1995). As stated above the acute effects appear to last up to 15 minutes and may be used to improve power performance at the least. Several authors also made it clear that wearing thin soled shoes is essential to reduce the dampening affects of the soles.
11. **CONCLUSION**

WBV has a well established acute effect on jumping performance of up to 3.9% for 15 minutes. However, literature on chronic effects is more clouded, although the most thoroughly designed paper did find a benefit over placebo and resistance training. WBV has been found to be effective in improving speed but has not yet been studied against placebo control over greater than two weeks. Similarly, in strength training WBV demonstrated parity with a resistance training protocol and in some studies superiority. In the most comprehensively designed study WBV was superior to placebo. Furthermore, in enhancing health WBV produces a similar hormonal and metabolic response to traditional resistance training in some parameters. The picture on body composition is suggestive of a positive effect when used correctly. In contrast, the limited research to date suggests little value in improving bone mineral density. Preliminary studies in rehabilitation are sparse but encouraging. Thus the overall body of evidence suggests there may be clinical value in using the vibrogym in improving athletic performance, enhancing health and assisting rehabilitation.
12. **Glossary**

**Passive control**
A passive control group does no intervention.

**Identical control**
An identical control group completes the same exercises but not on the vibrating platform.

**Placebo control**
Completes the same exercises on a vibrating platform but the platform is either turned off or set so low there is no known clinical benefit.

**Active control**
Takes part in some exercise e.g. sports training but not the same intervention as the trial group.
13. **References**


Guffey, JS 2009. Moving ahead with vibration therapy. Advance for physical therapy and rehab medicine 20 (12), 17


Thornton B, Sheridan B, Birk T 2009 Agent of Change: Does vibration therapy have a place in neurological rehab? Advance physical therapy and rehab medicine 20 (23), 24


352-9
