THE PROS & CONS OF WHOLE BODY VIBRATION ON THE HUMAN BODY

Michael J. Urban, DC Candidate

Advisor: Dennis Enix, DC, MBA

A Senior Research project submitted in partial requirement for the degree

Doctor of Chiropractic

1 August 2008
Abstract:

Objective:
The purpose of this literature review is to compile data regarding pros and cons of vibrational training of humans. This review will discuss what studies have been found to be beneficial and studies that have found negative effects due to vibration training.

Methods:
The resources utilized in this literature review were peer reviewed indexed journal articles and internet websites. Pub-Med was the primary database that was used to find the most recent journal articles chosen for the purpose of this review.

Results:
Many of the articles dealt with non-humans such as rats, industry vibrations such as machinery and construction and human vibrational training. Human vibration, performance and training were subjects in the articles chosen. The most relevant and recent articles were chosen for the purpose of this article.

Conclusion:
Through the many reviewed articles, more pros (positives factors) outweighed the cons (negative factors). The following are the pros consistent with vibration training research: increasing jump height by activating leg extensor muscles, decrease sit to stand time in elderly, increase bone mineral density, activating proprioception, local balance control, improved muscle function, increase growth hormone and testosterone while decreasing cortisol, reaching 50% VO2 max, enhancing flexibility and increase compliance to exercising. Cons reported about vibrational training include: too much vibration is bad, itching erythema, contraindicated list before starting a vibration training program, EMG activity is needed to single out which muscles fire and validate studies, exact mechanism is still unknown, too much vibration leads to decreased jumping, testosterone and cortisol, grip strength did not change, irritation to muscle spindles lead to fatigue, no effect to balance or dynamic strength, TENS is not an ideal placebo compared to vibration, metabolism differs with age, long term exposure linked with neurovestibular, Reynaud’s and LBP.

Key Words:
Whole body vibration, total body vibration, vibration on human performance, vibration, vibration training.
**Introduction**

Vibrational training, also known as Whole Body Vibration (WBV) was first developed for Astronauts to slow the rate of progression of bone mineral density while in space. Recently, the trend of health and fitness has emerged to putting vibrational training apparatuses into the gyms to promote fitness.

This literature review is focused on achieving what is a benefit from total body vibrational loading and what is controversial. The questionnaire a patient fills out prior to starting this type of training program will be beneficial to their total well being. The underlying disease processes that are exacerbated through total body vibration should be considered. This review will look at journals and published articles to be woven into a collaboration of sources to determine what type of person may or may not use total vibrational loading and the effects on the human frame. Below are pictures to acquaint the reader to this physiological make-up which include: Muscle Spindles, Golgi Tendon Organs, the neurological system from the muscle to the cortex, the ascending and descending neurological pathways, mechanoreceptors: Merkel’s disc, Meissner’s Corpuscles, Ruffini and Pacinian Corpuscle. The chart, from Tutora then is an overview of receptors in somatic sensations.

Health care professionals have a right to their patients, clients and humankind. Research for pros and cons of any mainstream exercise equipment must be analyzed to gain the most out of the product. Professionals must be educated to discuss WBV in accordance to short and long term effects. WBV units range from $3000-12,000 USD per machine.

For Muscle physiology, Guyton and Hall comment on the detection of vibration.

“All tactile receptors are involved in detection of vibration, although different receptors detect different frequencies of vibration. Pacinian corpuscles can detect signal vibrations form 30 to 800 cycles per second because they respond extremely rapid to minute and rapid deformations of the tissues, and they also transmit their signals over type AB nerve fibers, which can transmit as many as 1000 impulses per second. Low frequency vibrations from 2 up to 80 cycles per second, in contrast, stimulate other tactile receptors,
especially Meissner’s corpuscles, which are less rapidly adapting than pacinian corpuscles\textsuperscript{15}. 

Tortora G, Derrickson B. Principles of Anatomy and Physiology. 11\textsuperscript{th} Edition. Ch16.
<table>
<thead>
<tr>
<th>Receptor Type</th>
<th>Somatic Receptors and Location</th>
<th>Adaptation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mechanoceptors</em></td>
<td><em>Hair root plexuses</em>&lt;br&gt;Capsule surrounds mass of dendrites in dermal papillae of hairless skin.</td>
<td>Rapid.</td>
</tr>
<tr>
<td><em>Mechanoceptors</em></td>
<td><em>Meissner corpuscles</em>&lt;br&gt;Free nerve endings wrapped around hair follicles in skin.</td>
<td>Slow.</td>
</tr>
<tr>
<td><em>Mechanoceptors</em></td>
<td><em>Ruffini corpuscles</em>&lt;br&gt;Stellate-shaped free nerve endings made contact with Merkel cells in epidermis.</td>
<td>Slow.</td>
</tr>
<tr>
<td><em>Thermoreceptors</em></td>
<td><em>Free nerve endings in skin and mucous membranes of mucous membranes.</em></td>
<td>Both slow and rapid.</td>
</tr>
<tr>
<td><em>Thermoreceptors</em></td>
<td><em>Free nerve endings in every tissue of the body except the brain.</em></td>
<td>Initially rapid, then slow.</td>
</tr>
<tr>
<td><em>Proprioreceptors</em></td>
<td><em>Sensory nerve endings wrap around central area of encapsulated intrafusal muscle fibers within most skeletal muscles.</em></td>
<td>Slow.</td>
</tr>
<tr>
<td><em>Proprioreceptors</em></td>
<td><em>Muscle spindles.</em></td>
<td>Slow.</td>
</tr>
<tr>
<td><em>Tendinous organs</em></td>
<td><em>Joint position and movement.</em></td>
<td>Rapid.</td>
</tr>
</tbody>
</table>

**Vibrational Therapy Pros**

There are many factors that influence the human body in vibration. First of all, each part of the human body has its own resonance frequency which in turn responds differently to different frequencies. Muscle vibration can be an interesting expedient for improving proprioception and enhancing local muscle control. Mechanoreception in the skin responds to the oscillations by developing action potentials that are transmitted through their neural afferents, with a pulse-code in which each action potential signals one cycle of a sinusoidal wave. Diseases of the sensory nerves can affect primarily large myelinated fibers, thereby affecting position sense and vibration sense with relatively little impairment in the detection of tactile or noxious stimuli. Proprioception may be an important part of the neural controller, because it encompasses the sensation of position and movement of joints; the sensation of force, effort and heaviness associated with muscle contractions; and the sensations of perceived timing of muscular contractions. Specific neuronal components ant its proprioceptive feedback mechanism are the first structure to be influenced by specific training. Whole body, low frequency vibration (WBV) has been developed to improve muscle function, and in reportedly improves proprioception. The aim of this pilot study was to investigate whether weight bearing exercise given in conjunction with WBV would affect lumbosacral position sense in healthy individuals. As little as 6-10 minutes of WBV a day 3 times a week for 6-8 weeks has shown to increase balance and gait, improve quality of life and improve exercise compliance.

Activating muscle spindles is advantageous. It results in muscle-tendon vibration and microneurography studies have demonstrated a major role of muscle spindles in proprioception. Muscle-tendon vibration is a powerful stimulus for muscle spindle primary afferents. Multifidus muscle vibration induced a significant muscle-lengthening illusion that resulted in an undershooting of the target position in healthy individuals.

Deep muscular strength plays an integral role, because without it, injury may result. Far lower doses of mechanical signals may actually be biologically beneficial to tissues such as bone or muscle, perhaps by enhancing tissue perfusion or amplifying regulatory
signals. Inefficient muscular stabilization of the lumbar spine results in an increased risk of injury to the spine. A neuromotor dysfunction of the transverse abdominis and the lumbar multifidus muscle has been demonstrated in patients with LBP. Multifidus muscle spindle input is critically important for lumbosacral repositioning accuracy during sitting. Sustained 1a sensory inflow, evoked by vibration, has a powerful after-effect on the motor system at the postural level.

**Muscle Spindles:**

- Specialized intrafusal muscle fibers enclosed in a CT capsule and innervated by gamma motor neurons
- Stretching of the muscle stretches the muscle spindles sending sensory information back to the CNS
- Spindle sensory fiber monitor changes in muscle length
- Brain regulates muscle tone by controlling gamma fibers

**Tortora, G, Derrickson B. Principles of Anatomy and Physiology. 11th Edition. Ch16.**

**Golgi Tendon Organs:**

- Found at junction of tendon & muscle
- Consists of an encapsulated bundle of collagen fibers laced with sensory fibers
- When the tendon is overly stretched, sensory signals head for the CNS & resulting in the muscle's relaxation

---

---
Timing Concerns

Timed protocols that are not too long in length are effective to the individual on WBV. A five minute bout of WBV (18Hz) combines with a static, closed chain exercise improved lumbosacral proprioception. The 4-months WBV intervention enhanced jumping power in young adults, suggesting neuromuscular adaptation to the vibrating stimulus. Platform vibration with a 26Hz frequency increases VO2. This strongly supports the view that vibration elicits muscular activity, and that we are therefore dealing with a type of exercise rather than with passive vibration.

Proprioception

Proprioception plays an integral role in the human frame. Someone could portray symptomatic or asymptomatic symptoms. Proprioceptive feedback mechanism are the first to be influenced in specific training. The dorsolateral funiculus is the principal ascending spinal cord pathway for joint position sense and kinaesthesia. Proprioception involves two components, the sense of stationary position of the limbs (limb position sense) and the sense of limb movement (kinaesthesia). Patients with LBP are known to have altered motor control (dysfunction) in the lumbopelvic region. Proprioception is known to be impaired. Balance boards to mention are an effective tool to re-train the individual with LBP problems. Regulation of posture depends not only on proprioceptive messages arising from skeletal muscles but also from extraocular muscles. Such findings indicate that extraocular proprioception is linked closely with spatial body orientation.

Neurological system:

Plvometric Training

Strength training, explosive plyometrics training and flexibility benefits have been observed by many researchers. Strength training response has been shown to be mediated by both neurogenic and myogenic factors. Biological mechanism produced by WBV is similar to the effect produced by explosive power training (jumping and bounding exercises). Applying WBV to physical active subjects could influence the mechanical behavior of the leg extensor muscles. Adaptive response of human skeletal muscles, to simulated hypergravity [WBV] conditions applied for only 3 weeks, caused a drastic enhancement of the neuromuscular functions of the leg extensor muscles. Not only nervous tissue, but also muscle tissue can be affected by vibration. 5 hours daily for 2 days of vibration exposure at two different frequencies were sufficient to induce enlargement of slow and fast twitch fibers in rats. Enhancement of athletes’ flexibility as a result of vibration training has been shown in both short term and long term studies. WBV had positive results for jumping, power and flexibility. They all showed improvement compared to the control group. The improvement of muscle performance after a short period of vibration training has been quoted to be similar to what occurs after several weeks of heavy resistance training. Another experiment compared fatigue exercise with and with out vibration. Superimposed vibration produced an average power 8% higher than in normal conditions. EMG activity recorded arm flexion with superimposed vibration was shown 14% higher than during the same task performed without superimposed vibration. Significant data supports isometric knee-extensor torque and dynamic strength was established in the resistance group but more in the vibration group. Only the vibration group had significant gain in jumping height. Strength of isometric extension of lower extremities, vertical jump height and body balance increased 2 minutes after WBV, however disappeared about 1 hour later. Strength is seen through recruitment of motor units via activation of muscle spindles and polysynaptic pathways which is seen as a temporary increase in the muscle activity. A study on 12 national level boxers, vibrations applied to the arm determined an increase in average mechanical power during a maximal arm curl with an extra load of 5% body mass. Adaptation to the training stimulus is related to the modification induced by the repetition of daily exercises. WBV is reported to increase vertical jumping height and
muscular contractile properties in healthy young subjects as well as to increase muscle strength in the elderly. This study vibrated one leg and used the other as the control. The vibrated leg showed significant improvement of strength. The results showed a significant increase in the plasma concentration of testosterone and growth hormone, whereas cortisol levels decreased. An increase in the mechanical power output of the leg extensor muscles was observed together with a reduction in EMGrms activity. Neuromuscular efficiency improved, as indicated by the decrease in the ratio between EMGrms and power jumping performance.

Vertical jumping ability was shown to increase together with serum testosterone and serum cortisol concentrations. The results suggested that 7 minutes vibration represented a stressful treatment protocol leading to an improved neuromuscular performance. An explanation for this improvement cannot easily be found, considering that the athletes in the present experiments were well accustomed with this type of exercise, and therefore any learning effect of the movement executed could be excluded.

**Neuromuscular Effects**

Neuromuscular function improvements were observed and enhanced by WBV. During the clinical examination of the nervous system it is impossible to avoid stimulation tactile afferents when testing joint position sense no matter how delicately the examiner conducts the evaluation. A remarkable improvement of the neuromuscular characteristics studied was observed after WBV in training subjects. WBV treatment may dramatically affect the neuromuscular function and properties which are the regulating muscle stiffness through the control of length and tension. The tonic vibration reflex is also able to cause an increase in recruitment of the motor units through activation of muscle spindles and polysynaptic pathways. Fatigue in vibration exercise therefore appears to be caused not by insufficiency of cardiac output, but rather occurs in the neuromuscular system. Lactate never increased in vibration exercise as much as bicycle ergometry. Torvinen et al; Clin Physiol Funct Imaging (2002); 22; 145-152; Effect of Vibration exposure on muscular performance and body balance reports a 15.7% improvement in body balance, assessed by a stability platform, after a single 4- minute
vibration in young, healthy subject.\textsuperscript{7} Vibration elicits short-term and long-term neurogenic adaptation.\textsuperscript{11}

**Analgesic Effects**

Pain relief through WBV is a remarkable phenomenon. Trunk muscle strength and endurance does not guarantee the relief of painful symptoms.\textsuperscript{6} WBV produces pronounced analgesic effects during and after vibration application to muscle.\textsuperscript{13} It is possible to hypothesize that the use of vibration is also beneficial during that phase in muscle injury when working on improved flexibility.\textsuperscript{13} LBP is a major health care problem. The results of this study suggest that both lumbar extension and whole-body vibration exercise can relieve pain and improve pain-related limitation in everyday life for patients with chronic low back pain.\textsuperscript{19}

1. physiotherapy in chronic low back pain
2. whole-body vibration exercise is beneficial
3. lumbar extension torque may not be the exclusive cause\textsuperscript{19}

A closer look inside the blood and endocrine system show testosterone levels were shown to improve 7\% following the vibration treatment. Growth hormone levels increased by 460\% and cortisol levels decreased 32\%. This protocol was for 10 minutes vibration treatments, divided into two sets of five sub-sets lasting one minute each with 6 minute rest in between sets.\textsuperscript{8} Increase in blood lactate have been shown to be in the range expected for the moderate exercise according to Rittweger et al 2000.\textsuperscript{20} The body has an anabolic factor, is mechanical stimuli and indicates a nonpharmacologic strategy for enhancing bone mass and morphology.\textsuperscript{22}

**Elderly Benefits**

Elderly patients may benefit from WBV training. Research suggests that aging and disuse attenuates motor neuron excitability and causes structural changes to the muscle spindle. The muscle spindle in older individuals may be less sensitive to the vibration because of the fiber composition and reflex deterioration that occurs with natural aging.\textsuperscript{10} WBV increased strength in the elderly which improved their sit to stand time (timed up and go).\textsuperscript{1} It also improved their balance and mobility overall. This test used the Tinetti-test.
This study is comparable to Bruyere et al, Phys Med Rehab 2005; 86; 303-307; “Controlled whole body vibration to decrease fall risk and improve health-related quality of life of nursing home residents.” Overall, these experiments have given evidence that vibration loading may have potential for preventing and treating osteoporosis. This study illustrated total hip BMD increased over time in the WBV [1.5% at 6 months] group whereas no changes in BMD were observed in women participating in resistance training or age-matched controls. With a BMD increase, subjects also showed improved recovery of balance after ballistic abduction or anteflexion of the arms and experienced an increase in muscle strength and a decline in fat mass. Transmissibility of ground based vibrations at the hip is decidedly different than at the spine. The hip exceeded 100% at frequencies less than 20Hz. Bone Mineral density and positive effects through vibration are found with C. Robin et al; Nature (2001); 412:603-604; “Low mechanical signals strengthens long bones.” and C. Robin et al; J Bone Mineral Res (2004); 19:343-351; Prevention of postmenopausal bone loss by low- magnitude, high-frequency mechanical stimuli: a clinical trial assessing compliance, efficacy, and safety. WBV is reported to increase vertical jumping height and muscular contractile properties in healthy young subjects as well as to increase muscle strength in the elderly. Signals can effectively inhibit disuse Osteopenia. The protocol applied to this study is relatively user friendly for the elderly, and the application of WBV can be used to prevent fall incidences caused by poor balancing ability, thus potentially reducing the rate of osteoporotic fractures. An 18% decrease in time to rise from a chair was observed in the vibration group compared with no change in the controls. Controlled WBV appears to be safe and well tolerated by the elderly study patients. Improvement of gait quality as assessed by the Tinetti test was also observed in the treatment group compared with no change in the control group. The findings showed significant enhancement in stability with respect to movement velocity, maximum point excursion, and directional control in elderly women after the WBV interventions as compared with the controls. WBV improved our participants’ muscle strength and balance, which are known risk factors for falls. M. Runge et al; J Musculoskeletal Interact (2000); 1: 61-65; Balance training and exercise in geriatric patients. Timed get up and Go Test showed better results overall. Compared with placebo whole-body vibration showed advantages in terms of the Sensory
Organization Test and the Timed Get up and Go Test at each time point of measurement after application. Reversing bone loss in the osteoporotic person, will have a significant and beneficial impact on reduction of fractures and associated morbidity and mortality. Vibration produced in all subjects strong, long-lasting dynamical modification of posture mainly in the anterior-posterior direction.

**Cardiovascular Effects**
Cardiovascular component of WBV has been observed as well. The diastolic BP was decreased after Vibration exercise, but not after bicycle ergometry. Cardiovascular effects include heart rate rising to 130/min-1, which corresponds to 50% maximal oxygen uptake. To elicit maximal increase in VO2 was a frequency of 30Hz and 1-mm amplitude (peak acceleration, 35.2 m/s2 or 3.6g.) This concurs with a report that squatting on a vibration platform at 30Hz elicited the highest electromyographic response in the vastus lateralis muscle, and chose a 1-mm amplitude at 30Hz for this study. Recovery to WBV include all parameters returned to normal baseline values within 15 minutes of recovery.

**Benefits to Neuromuscular Related Conditions**
Patients with neurological or muscular disorders have found benefits to WBV. Diseases of the central nervous system frequently spare tactile sensation because many pathways carry tactile information to the brain. Other advances have been seen with enhancement in postural control and mobility was detected in MS patients. M. Roelants et al; J Am Geriatric Soc (2004); 52: 901-908 “Whole-Body vibration training increases knee-extension strength and speed of movement in older women.” What shows improvement for unilateral chronic stroke patients is enhancing their neuromuscular rehabilitation program. IJ. Van Nes et al; Am J Phys Med Rehabil (2004); 83: 867-873; “Short-term effects of whole-body vibration on postural control in unilateral chronic stroke patients.” Whole-body vibrations resulted in improvement of gait parameters and coordination in patients with Parkinson’s Disease. The results of this pilot study indicated that whole-body vibration may positively influence the postural control and mobility in multiple sclerosis patients.
Here are three compiled lists form three independent studies which showed successful vibrations training leads to:

1. high frequency 15-35Hz, low level mechanical signals are effectively transmitted to the hip and spine.
2. the degree of transmissibility is dependent on stance with knees bent greatly attenuating the mechanical signals
3. considering the anabolic potential of these low level signals, and that they can be delivered to sites at greater risk of fracture, this finding provides a key step in the development of a noninvasive, nonpharmacologic intervention for osteoporosis.22

WBV, the oscillating vibration stimuli can lead to the following effects:
1. stimulation of the pressure receptors on the sole of foot (Merkel’s receptor endings, Meissner’s corpuscles, Ruffini nerve endings)
2. stimulation of proprioceptors
3. generation of reflexes23

1. vibration exercise can lead to an increase in vertical jumping ability even in well-trained subjects
2. vibration exercise increase in mechanical power of lower limbs
3. vibration exercise improves force-generating capacity of human skeletal muscles
4. vibration exercise determines specific hormonal responses based upon the treatment protocol
5. vibration exercise can improve neuromuscular performance and affect production based upon the duration and the characteristics of the vibration stimulus8

**Contraindications to Whole Body Vibration**

Contraindications or adverse effects demonstrated within different WBV studies involve too much frequency on an individual may lead to more seriously as ailments of spinal muscle, ano-rectal or gastrointestinal systems. Participants were excluded if they had a history of low back pain or any neurological disorder.14 This study excluded individuals with a recent history of inner ear infection with associated balance or coordination problem, a history of cerebral trauma with unresolved neurosensory symptoms, a recent history of vestibular disorder, a pervious spinal surgery, an involvement in specific balance or stabilization training in the 6 months before testing, and those taking pain medication.6 Exclusion criteria for this study includes: cardiovascular, respiratory, abdominal, urinary, gynecological, neurological, musculoskeletal, or other chronic
diseases; pregnancy; prosthesis; use of medication that could affect the musculoskeletal system; and regular participation in any exercise-inducing impact-type loading on the skeleton more than three times a week.13

**Contraindication List to Studies**

Limitation on some studies point out specific structures responsible for loss of proprioception were not identified.6 Limitation of some studies includes the force of vibration was not controlled. A new type of vibrator must be designed to independently control force and displacements of muscle vibration at different frequencies of vibration.6 A weakness to testing involves sensory acuity in other sensory systems (e.g. vision, hearing) varies widely among humans, it seems probable that the same type of diversity exists for proprioception, although this has yet to be systemically tested.6 Many studies state no neurogenic potentiation or modification in the morphological structure of the muscles was demonstrated since neither EMG recordings nor muscle biopsy sampling were performed.4 The exact mechanism which regulate how the body adapts to the specific demands upon it, is still unknown.8 A point of criticism could be that a TENS application is not the ideal placebo application, since TENS may enhance sensorimotor recovery in neurological patients.23 Rittweger et al (2002) Using WBV in conjunction with closed chain exercises, these researchers successfully reduced pain in LBP patients. The reason for this reduction in pain is unknown. Muscle strength did not improve, however proprioception was not measured.14 Using an EMG would help validate most of the vibrational studies.3 Further knowledge as to how many sessions per day and/or per week as well as when to progressively overload vibratory stimulation is practically nonexistent.13

**Whole Body Vibration - Cons**

**Bone Density**

Bone density remarks found include women 80 years and older, 70% have bone density measurements less than 2.5 standard deviations of young normal values.22 Pharmaceutical interventions approved by the FDA for osteoporosis work by inhibiting bone resorption. Increases in bone mass-related to antiresorptive therapy are restricted to the first 2 to 3
years of therapy, rarely normalize bone density in the most severely affected individuals, and may ultimately compromise structural properties of bone.\textsuperscript{22} No changes were observed in total lumbar spine BMD, suggesting that the effects of vibration on total hip BMD reflect a local (site specific) loading effect of vibration.\textsuperscript{27}

**Metabolic Changes**

In qualitative terms, WBV was found to affect VO\textsubscript{2} in older and younger people in a very similar way. Metabolic response was lower in young relating back to physiology that older people are less responsive to WBV in terms of aerobic metabolism.\textsuperscript{10}

**Adverse Effects**

Some adverse affects to WBV include erythema and edema of the foot after vibration was seen particularly in the first session, and particularly in women.\textsuperscript{15} Surprisingly, an itching erythema was found in about half of the individuals, and an increase in cutaneous blood flow.\textsuperscript{21} Long-term irritation of the muscle spindles by vibration leads ultimately to muscle fatigue.\textsuperscript{25} The intramuscular concentration of bradykinin has been shown to increase in a number of conditions (e.g. during pain, inflammation, ischemia and static muscular contractions), and bradykinin induces muscle pain in man.\textsuperscript{6} Long-term exposure to WBV has been determined to be a central etiologic factor in LBP, neurvestibular disorders, and Raynaud’s syndrome, and thus industries such as construction and transportation. As well as military, are working towards minimizing occupational exposure to potentially noxious mechanical stimuli.\textsuperscript{22} 7 minutes vibration represented a stressful treatment protocol leading to an impaired neuromuscular performance.\textsuperscript{8}

**Conflicting and undetermined effects**

Frequency of WBV may depend on protocols being used. Vibration frequencies lower than 40 Hz induce a shortening illusion in limb muscles. Little is known about whether the cognitive effect of vibration of trunk muscles is the same for peripheral muscles.\textsuperscript{6}
Studies That Concluded No Change

These studies found no change. The vibration showed no effect on dynamic or static balance of the subjects.\textsuperscript{24} Grip strength did not change.\textsuperscript{25} Torvinen et al; Med Sport Sci Exercise (2002); 34: 1523-1528; “Effect of 4-month vertical whole body vibration on performance and balance.”, reported no effect on the dynamic or static balance of the young subjects for either 4-month or 8-month treatment.\textsuperscript{26}

Conclusion

There are pros and cons to any type of training equipment when it comes to safety, effectiveness and contraindication lists. There are also benefits to using such types of equipment. The vibrational training offers this, benefits to people and contraindications to certain people. This is the reason for this type of literature review. This review will hopefully challenge future studies for example: protocols to exercise an athlete compared to an osteoporotic woman, regimens for neurological or muscular disorders, such as Parkinson’s, Multiple Sclerosis or unilateral Stroke patients. More studies may focus on: how much is too much, testosterone, growth hormone and cortisol levels. Others blood chemistry levels such as alkaline phosphate, insulin, or glucose can be implemented. Abundance of research was seen on explosive jumping (plyometrics), continuous jumps, squatting, neuromuscular, proprioception, HR and VO2 threshold.

This is properly designed supplemental device to use 2-3 times a week along with a cable/resistive weight program proper ages tailored to peoples health goals. Future implications to educate health care professional may include forming a list of reputable companies, which ones are worth the money, warranty and stand behind their product.

Changes of the gravitational conditions can be produced by mechanical vibrations applied to the whole body.\textsuperscript{3} All subjects completed the study without any side effects except one who complained about fatigue.\textsuperscript{23}

The time needed for adaptations to occur is relatively long compared to the possibilities offered by vibration treatments. It should be recognized that vibrations need to be viewed
not as a substitute tool of resistance exercise, but as a valid additional means to be implemented in a training routine in association with all the other traditional methodologies nowadays utilized.²

The subjects commented on vibration training that is was enjoyable and fatiguing, but they did not consider it as a hard workout.¹² Based on the literature findings it is possible to affirm that vibrations provide a strong stimulus for the neuromuscular system, the bone and the muscle tissue. Not only that, hormonal responses have been identified in human and animal experiments following vibrations treatments (i.e Mc Call et al 2000; Dmitriev & Tropinikova, 1998).⁸
REFERENCES:


8. Cardinale, M., Semmelweis University Doctoral School Faculty of Physical Education and Sports Sciences, Budapest 2002, "The Effects of Vibration on Human Performance and Hormonal Profile"


15. Guyton & Hall. Textbook of Medical Physiology. 11th Ed, 587

16. Haas et, CT. al; Journal of Neurology (2004); 251 (suppl 3); 56; Influences of Whole-body vibration on symptom structure in Parkinson’s Disease."

17. http://www.powerplate.com


