THERAVIBE™

CLINICAL STUDIES

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Introduction

If you cannot back a health claim by means of hard scientific facts, people find it very difficult to believe in you and your product. This is especially true for health-related things. This is what is being tackled in this short collection of studies and research papers that outline why vibration therapy is beneficial for a wide variety of issues and for performance.

Whole-body vibration (WBV) is an umbrella term for when vibrations of any frequency are transferred to the body. Vibration training or vibration therapy is the deliberate exposure of varying frequencies to the body. When it is used to help with rehabilitation after some illness or for sports performance, a vibrating platform is used. You can stand on it or do various exercises to get these benefits.

People all over the world use this transformative way of movement to maximize their workouts and reap the multitude of health benefits it offers. Celebrities like Morgan Freeman, Clint Eastwood, Mark Wahlberg, and Hillary Swank advocate for vibration therapy. Doctors, chiropractors, world-level athletes, singers, fitness trainers worldwide are now believers after seeing results for themselves and their clients. Basketball and football leagues like the NFL, NBA, NLB, NHL, etc also have their players include vibration training in their regimen.

In 2019, a survey was done in which 187 people were polled, out of which 53 responded. These people had bought vibration machines and out of the 53 respondents:

- 93% were 50-80 years of age
- 58% were female
- 43% were male
- 55% had their machines for 1-2 years
- 43% had their machines for 1-12 months

Strength, energy, mobility, mood, and anxiety all improved with vibration therapy.

All of these parameters improved at a rapid pace.

- 15-20% improved after a few WBV sessions
- 45-60% total within a month
- 60-70% total within several months

75% of people in pain saw an average 52% drop in pain within a few months.

Pain reduction was noticed in many areas like muscles, joints, back, and even nerve pain. After beginning vibration therapy, 20% of the people who participated in the survey reduced their over-the-counter pain medications and other prescription drugs. Some switched to less powerful meds.

Joints all over the body improved, especially knee joints. This improvement were noticed by people because they start noticing them very quickly with only a small amount of vibration therapy.

Almost half of those who wanted to lose weight lost weight.

This weight loss was impressive because of the age range of the respondents. Weight loss after the age of 40 has been proven to be harder. Most people simply used a vibration machine and followed a healthy low-carb approach to their diet. 98% were not taking any medication or supplements to help them lose weight.

Other than the weight loss:

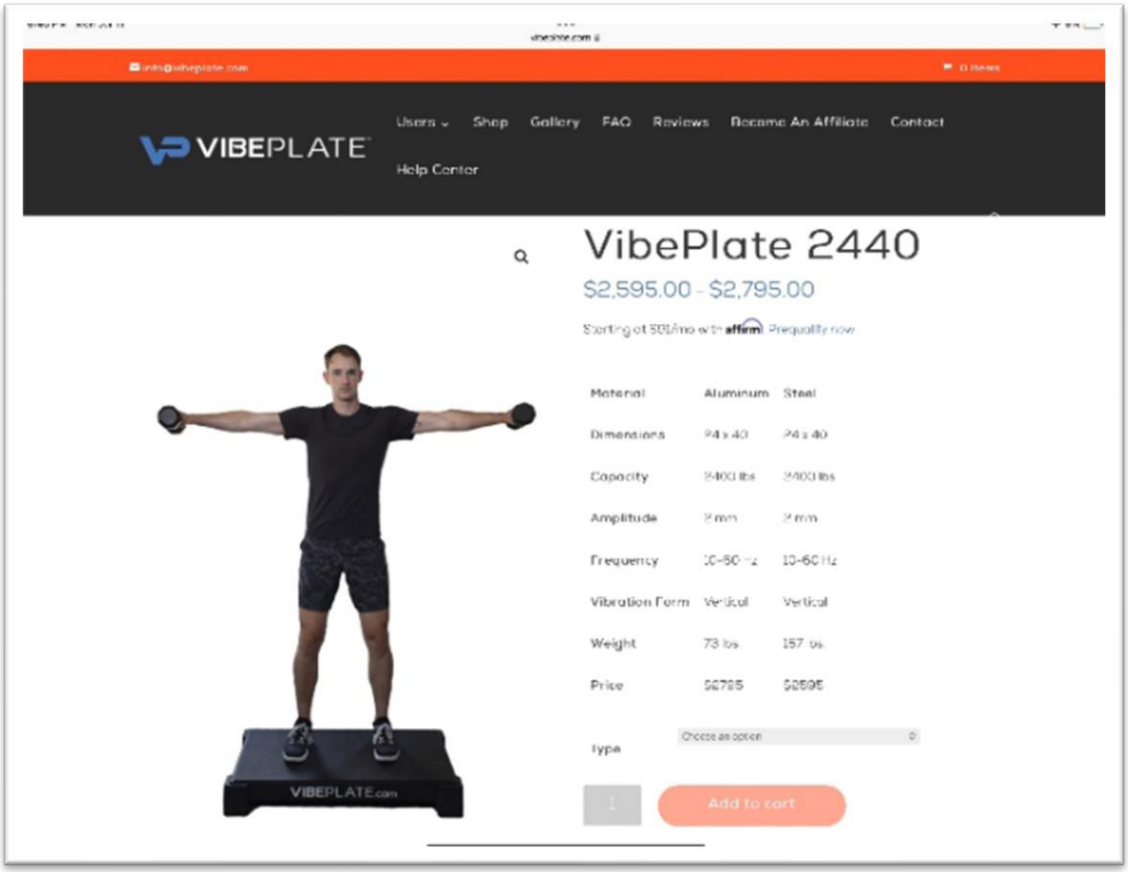
- 40% of survey respondents increased their bone density or did not lose bone density since using the vibration machine
- 0% of respondents lost bone
- 60% did not have recent bone density tests and could not answer this question

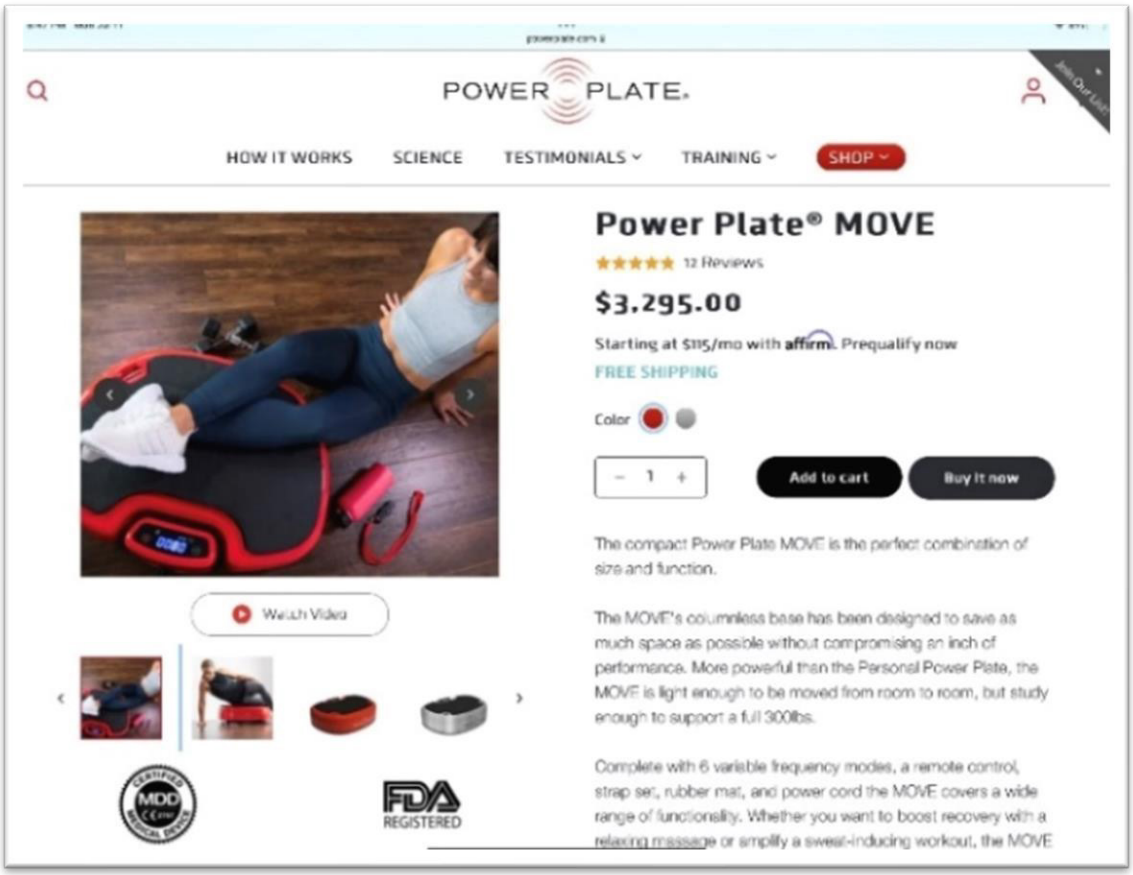
In this book, we are going to look at various studies done with vibration therapy and how it can improve our health and performance. We have included studies in all areas from weight loss and athletic performance to aging gracefully and fighting disease.

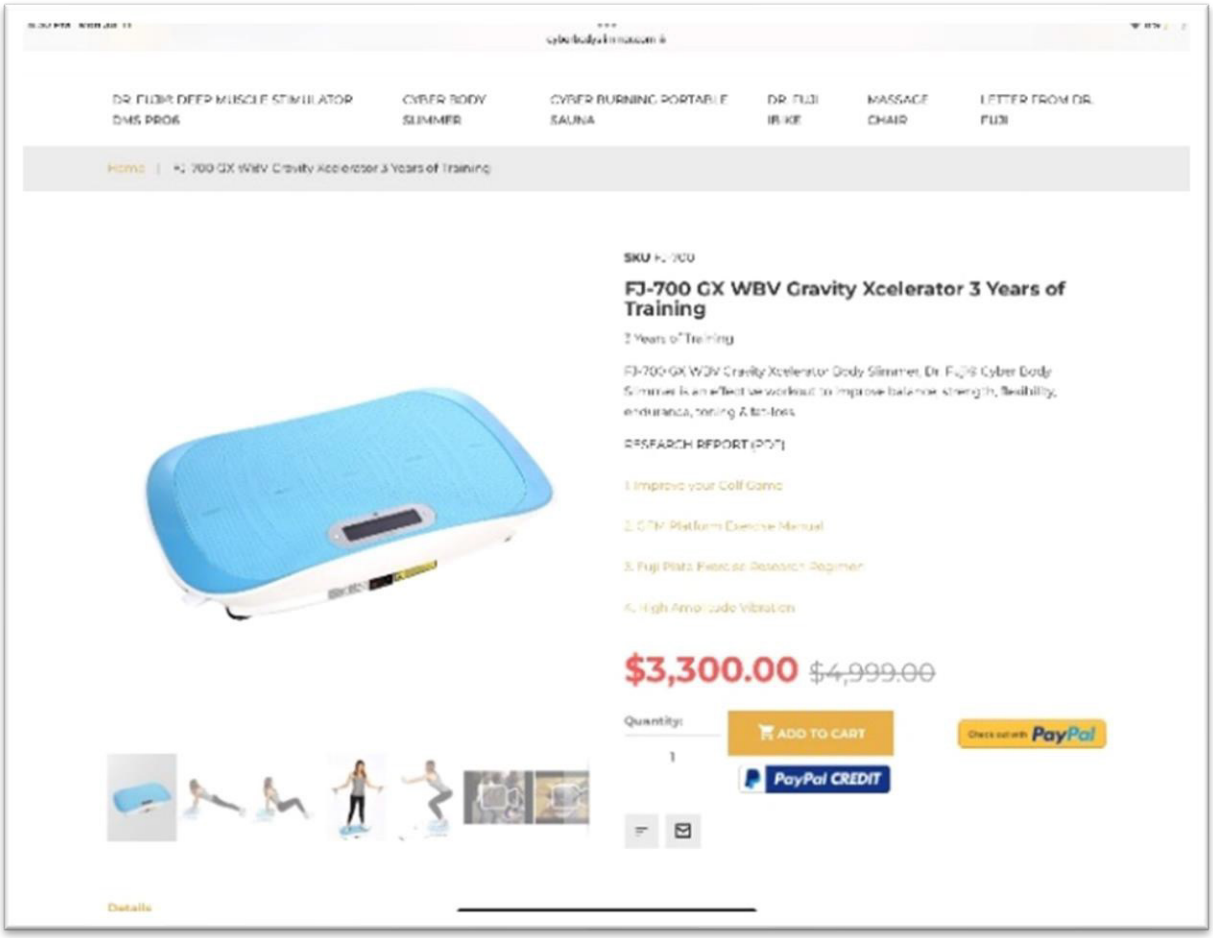
VIBRA Plate is an industry-leading vibration therapy platform that can help you increase caloric burn, increase bone density, and help in muscle recovery and pain relief.

https://vibra-plate.com/

Competitor Comparison






DR. FUJI DEEP MUSCLE STIMULATOR DMS PRO6
CYBER BODY SLIMMER
CYBER BURNING PORTABLE SAUNA
DR. FUJI IR KIT
MASSAGE CHAIR
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RESEARCH REPORT (PDF)
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Details

Testimonials

"I was diagnosed with Osteoporosis in my lower spine a few years ago. I was put on the drug Actonel. After taking the drug faithfully for three years my Osteoporosis developed in my neck and hip and stayed in my spine. I was concerned by the side effects of Actonel and decided to go off it and try yoga. After a year I found that I had lost 5% of my bone density. At this time, I was advised by my chiropractor to use Vibration Therapy and with encouragement from my doctor, I purchased one. After about eight months of using the Vibration plate for twenty minutes a day, I was found to only have osteopenia in my lower spine. I am extremely pleased with the results."

– Margaret M.

"The Vibration plate gave me the best relief I could imagine. Four years ago, after chemotherapy treatment for cancer, I developed diabetes and peripheral neuropathy which gave me constant pain and tingling in my feet and one hand. Everybody I went to said no cure, no relief. I was desperate, I tried everything, studied peripheral neuropathy, even tried acupuncture. I tried everything I could to relieve the pain. With no results. Then I tried the Vibration Therapy. In just 5 minutes the pain and tingling went away. The warmth came back into my feet and hand. I had to see it to believe it. It has improved my quality of life, there are no words that can describe how I feel after the Vibration platform. I use the Vibration plate every couple of days, and that manages the suffering and pain I had for, four years."

– Dale B.

"I had been diagnosed with osteoporosis with the highest number being a -2.7 in my hip area. I got serious about it and I use it consistently as part of my fitness routine. My doctor said I didn't need to have another dexascan because my ankle scan came back -1.7, which puts me in the moderate risk of getting osteoporosis category. Needless to say, I'm very pleased. Buying the vibration plate has proven to be the best thing I could have possibly done for myself. Thank you so much!"

– Betty

"I've been raving about the vibration machine to everybody I know. I'm stronger, noticeably more toned, my mood is decidedly better, and now my entire family is coming with me to use the vibration machine. I've been so pleased…that I've cancelled my gym membership."

- Judy Garland

"I'm like the Energizer Bunny, my hay fever is gone, my mood is better and more stable, I lost 30 pounds, and am much stronger than I have ever been."

– Doreen Hadge

"I had been vibrating just a few times when I went home after my three or four minutes of vibration, and I had so much energy I started scrubbing the kitchen floor by hand. When I finished with the floor, I started in on the walls. My husband, who was half asleep on the couch where we would usually both be after a long day at work, said to me, 'What has gotten into you?"

- Marianne L.

"I have finally been able to lose that stubborn weight that I have been trying to lose for years…I have noticed increased energy and strength, and improved moods."

- Darlyne Skladony

"I am sleeping more soundly… which helped me to focus and remain alert during the day. Thank-you for introducing this new technology to Cynthia and me."

- Brian Cichella

"I felt relief after the first five-minute session. Now, I simply stand on my WBV machine for five minutes each morning and head off to work with a happy song in my heart. The pain has gone. Imagine that."

- Wayne Young

"I've been trying hard to lose weight and tone up for two years…Now, after one month I've lost at least 6 lbs, and during the holidays too! My clothes all fit much better, and my friends are noticing how toned I am. My daughter poked my stomach last week and said "Are those your abs? Oh my God!" The biggest thing for me though is that I am sleeping!"

- Mary Jane Langone

"After a year of using the vibration machine, my bone density increased by 6% in both my hip and spine. When I reported the results to a doctor, he called it 'a massive increase."

- Diane Warshovski

Part: 1
Weight Loss

Significant Fat Reduction

ZAGO M, CAPODAGLIO P, FERRARIO C, TARABINI M, GALLI M. WHOLE-BODY VIBRATION TRAINING IN OBESE SUBJECTS: A SYSTEMATIC REVIEW. PLOS ONE. 2018 SEP 5;13(9):E0202866. DOI: 10.1371/JOURNAL.PONE.0202866. PMID: 30183742; PMCID: PMC6124767.

Objective: (1) to determine the outcomes of whole-body vibration training (WBVT) on obese individuals, and the intervention settings producing such effects; (2) identify potential improper or harmful use of WBVT.

Design: Systematic review.

Data sources: Medline, Scopus, Web of Science, PEDro and Scielo until July 2018.

Eligibility criteria: Full papers evaluating the effect of WBVT on body composition, cardiovascular status and functional performance in obese adults. Papers with PEDro score<4 were excluded.

Study appraisal and synthesis: Risk of bias and quality of WBVT reporting were assessed with PEDro scale (randomized controlled trials) or TREND checklist (non-randomized studies) and a 14-items checklist, respectively. Weighted acceleration, daily exposure and Hedges' adjusted g were computed.

Results: We included 18 papers published 2010-2017. Typical interventions consisted in three sessions/week of exercises (squats, calf-raises) performed on platforms vibrating at 25-40 Hz (amplitude: 1-2 mm); according to ISO 2631-1:1997, daily exposure was "unsafe" in 7/18 studies. Interventions lasting ≥6 weeks improved cardiac autonomic function and reduced central/peripheral arterial stiffness in obese women; 10 weeks of WBVT produced significant weight/fat mass reduction, leg strength improvements as resistance training, and enhanced glucose regulation when added to a hypocaloric diet. No paper evidenced losses of lean mass. Isolated cases of adverse effects were reported.

Summary: To date, WBVT is a promising adjuvant intervention therapy for obese women; long-term studies involving larger cohorts and male participants are required to demonstrate the associated safety and health benefits. The therapeutic use of WBVT in the management of obese patients is still not standardized and should be supported by extensive knowledge of the causality between vibration parameters and outcomes.

therapy causes, as discussed in a mice study (Rubin et al. 2007) that showed that adipogenesis (formation of fat cells) dropped by 27%.

The FITNESS group lost more visceral fat because they used more calories than the DIET group, because of their extra fitness training. During and up to 24 hours after fitness training, the human body needs energy, which is called the 'after-burning' effect. To get that energy, the human body will burn the 'easy' fat tissue (such as the subcutaneous fat) first. This means more subcutaneous fat is burned, rather than visceral fat.

Visceral Adipose Tissue: Long-Term Weight Loss Effects

THIS IS A SUMMARY OF AN ARTICLE PUBLISHED IN OBESITY FACTS, THE EUROPEAN JOURNAL OF OBESITY BY DIRK VISSERS, AN VERRIJKEN, ILSE MERTENS, CAROLINE VAN GILS, ANNEMIE VAN DE SOMPEL, STEVEN TRUIJEN, AND LUC VAN GAAL.

Aim: To determine the effect of whole-body vibration (WBV), combined with caloric restriction, on weight, body composition and metabolic risk factors in overweight and obese adults.

Methods: A randomized, controlled study with a 6-month intervention period and a 6-month 'no intervention' follow-up. 61 of the 79 participants completed the study. Data were collected at baseline and at 3, 6 and 12 months in the control group (CONTROL), the diet only group (DIET), the diet plus fitness group (FITNESS), and the diet plus WBV group (VIBRATION).

Results: Weight decreased significantly in all three intervention groups. Only FITNESS and VIBRATION managed to maintain a weight loss of 5% or more in the long term. Visceral adipose tissue (VAT) changed most in VIBRATION: 47.8 ± 41.2 and −47.7 ± 45.7 cm^2 after 6 and 12 months respectively compared to CONTROL (−3.6 ± 20.5 or +26.3 ± 30.6 cm^2), DIET (−24.3 ± 29.8 or −7.5 ± 28.3 cm^2) and FITNESS (−17.6 ± 36.6 or −1.6 ± 33.3 cm^2) ($p < 0.001$).

Conclusions: Combining aerobic exercise or WBV training with caloric restriction can help to achieve a sustained long-term weight loss of 5–10%. These preliminary data show that WBV training may have the potential to reduce VAT more than aerobic exercise in obese adults, possibly making it a meaningful addition to future weight loss programs.

Slowing Down Acquisition of Fat in Rats

MADDALOZZO GF, IWANIEC UT, TURNER RT, ROSEN CJ, WIDRICK JJ. WHOLE-BODY VIBRATION SLOWS THE ACQUISITION OF FAT IN MATURE FEMALE RATS. INT J OBES (LOND). 2008 SEP;32(9):1348-54. DOI: 10.1038/IJO.2008.111. EPUB 2008 JUL 29. PMID: 18663370; PMCID: PMC2586051.

Objective: To evaluate the effects of whole-body vibration on fat, bone, leptin and muscle mass.

Methods/design: Thirty 7-month-old female 344 Fischer rats were randomized by weight into three groups (baseline, vibration or control; n=8-10 per group). Rats in the vibration group were placed inside individual compartments attached to a Pneu-Vibe vibration platform (Pneumex, Sandpoint, ID, USA) and vibrated at 30-50 Hz (6 mm peak to peak) for 30 min per day, 5 days per

week, for 12 weeks. The vibration intervention consisted of six 5-min cycles with a 1-min break between cycles.

Results: There were significant body composition differences between the whole-body vibration and the control group. The whole-body vibration group weighed approximately 10% less (mean+/-s.d.; 207+/-10 vs 222+/-15 g, P<0.03) and had less body fat (20.8+/-3.8 vs 26.8+/-5.9 g, P<0.05), a lower percentage of body fat (10.2+/-1.7 vs 12+/-2.0%, P<0.05), and lower serum leptin levels (1.06+/-0.45 vs 2.27+/-0.57 ng ml(-1), P<0.01) than the age-matched controls. No differences were observed for total lean mass, bone mineral content (BMC), bone mineral density (BMD), insulin-like growth factor-I (IGF-I) or soleus (SOL), and extensor digitorum longus (EDL) mass or function. Regional high-resolution dual-energy X-ray absorptiometry scans of the lumbar spine (L1-4) revealed that the whole-body vibration group had significantly greater BMC (0.33+/-0.05 vs 0.26+/-0.03 g, P<0.01) and BMD (0.21+/-0.01 vs 0.19+/-0.01 g cm(-2), P<0.01) than the control group. No differences between the groups were observed in the amount of food consumed.

Conclusion: These findings show that whole-body vibration reduced body fat accumulation and serum leptin without affecting whole-body BMC, BMD, or lean mass. However, the increase in vertebral BMC and BMD suggests that vibration may have resulted in local increases in bone mass and density. Also, whole-body vibration did not affect muscle function or food consumption.

Part: 2
Rehab Benefits

Walking Without Pain

THIS IS A SUMMARY OF A STUDY PUBLISHED IN THE JOURNAL OF STRENGTH AND CONDITIONING RESEARCH IN NOV. 2012. BY JAY R. SALMON, JAIMIE A. ROPER, AND MARK D. TILLMAN, UNIVERSITY OF FLORIDA.

Background: Knee osteoarthritis is a joint disorder that decreases strength in surrounding muscles and impairs neuromuscular functions. It can also affect Activities of Daily Living (ADLs), such as walking, getting up, and climbing stairs. Those with knee osteoarthritis are typically prescribed to do physical routines to preserve muscle function. Vibration therapy can help increase muscle activation and reduce pain.

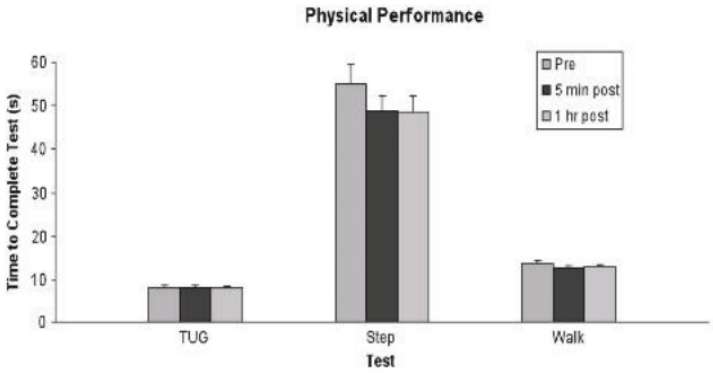
Method: Seventeen people with knee osteoarthritis were recruited from clinics and fitness centers surrounding the University of Florida to participate in this study. Participants underwent 3 tests at 3 different time periods: prior to whole-body vibration (WBV), 5 minutes after WBV, and 1 hour following WBV. The three tests included Timed-Up-and-Go Test (TUG), a step test, and a 20m walk test. Pain levels with the tests were also recorded.

For the TUG test, participants stood from a seated position and walked around a cone placed 3 meters in front of them and then returned to a seated position in the chair. During the step test, participants were asked to step up and down off a 20cm step, 20 times at the pace of their choosing. The 20m walk test asked participants to walk as fast as they could for 20m in a straight line, starting from a standstill. Participants used the vibration plates in 60-second increments for a total of 10 minutes, receiving WBV at 35Hz for 60 seconds on and 60 seconds off. Two of the seventeen participants were unable to complete the protocol due to knee and ankle pain, so their data were not analyzed with the group.

Results: Results from the TUG Test and 20m walk test showed no major changes, however, time to complete the step test improved significantly, 5 minutes after WBV training compared to the initial test. No change was detected one hour from the pretest to WBV training.

Conclusion:

- Quick usage of WBV training was effective in improving the ability of individuals with knee osteoarthritis to complete their step test by 11%.
- The improvement in time to complete the walk test 5 minutes after WBV training had a mean improvement of more than 1 second.
- Those suffering from knee osteoarthritis may struggle from completing ADLs and WBV training can improve their quality of life.



Mean and standard error before, 5 minutes after, and 1 hour after whole body vibration training for the three tests

Lower Blood Pressure and Hypertension

FIGUEROA A, KALFON R, MADZIMA TA, WONG A. EFFECTS OF WHOLE-BODY VIBRATION EXERCISE TRAINING ON AORTIC WAVE REFLECTION AND MUSCLE STRENGTH IN POSTMENOPAUSAL WOMEN WITH PREHYPERTENSION AND HYPERTENSION. J HUM HYPERTENS. 2014 FEB;28(2):118-22. DOI: 10.1038/JHH.2013.59. EPUB 2013 JUL 4. PMID: 23823582.

Cardiac Dysfunction: The leading cause of death in the developed world is myocardial infarction (heart attack), a direct consequence of atherosclerosis or the hardening of the arteries. As the arteries lose their flexibility, the heart pumps blood but the walls of the arteries do not move as they should, causing an increase in blood pressure. As the heart pulses, and the pressure is higher, the heart has to work harder to contract. The higher the pressure gets, the greater likelihood an individual will have a cardiac incident (heart attack or stroke). Atherosclerosis is primarily caused by chronic dietary habits but also has environmental and genetic factors. Conventional exercise reduces blood pressure by increasing the strength of the heart but does not affect arterial stiffness to a significant degree (Casey, et al. 2007).

A Potential Solution via Reflexes: Medical researchers have been studying methods to decrease the stiffness of arteries with pharmaceutical interventions, but in 2005, researchers in Japan found that the muscular reflexive engagement of the body through whole-body vibration (WBV) exercise significantly increased blood flow and oxygenation (Yamada, et al.). Three years later a different group of Japanese researchers found that WBV acutely decreased arterial stiffness in males in their mid-twenties. (Otsuki, et al. 2008) This research has now given way to a greater level of understanding of what WBV can do for de-conditioned patients who suffer from cardiac dysfunction, as well as creating interest from the scientific research community.

Dr. Arturo Figueroa, an associate professor at Florida State University, has conducted numerous studies on the effect of using WBV/reflexive activation to decrease arterial stiffness. The findings of Dr. Figueroa and his research group showed a decrease in arterial stiffness in a young obese/overweight female population. This population differed from the young males that were previously studied, as obese/overweight females are often not able to engage in conventional exercise. Subjects decreased their arterial stiffness significantly using WBV therapy 3 times weekly over 6 weeks. Dr. Figueroa has continued to study populations who are at greater risk of heart attack and stroke, with greater levels of de-conditioning. In 2013, he and other researchers began studying similar protocols with post-menopausal hypertension and pre-hypertension patients (Figueroa, et al. 2014).

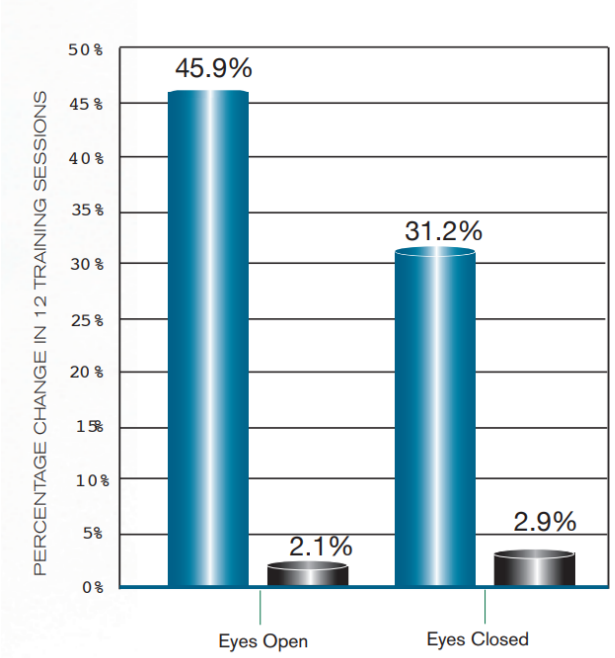
Results were also seen passively with stroke survivors in a parallel study at Florida State University. Stroke survivors in this study could not engage paralyzed lower limbs yet still received the benefit of lower blood pressure and a decrease in arterial stiffness using the standard squatting protocol (Koutnik, et al. 2014). Finally, Dr. Figueroa and his research group found that blood pressure reduction and reduction of arterial stiffness with a lower leg strength increase. With conventional exercise, these two elements are not necessarily correlated. This suggests that WBV can be an effective treatment for decreasing cardiovascular risk in postmenopausal hypertensive and pre-hypertensive women (2014), in addition to the previous populations studied.

ACL Recovery

THIS IS A SUMMARY OF A STUDY PUBLISHED IN THE BRITISH JOURNAL OF SPORTS AND MEDICINE, ONLINE JAN. 2008. BY AZAR MOEZY, GHOLAMREZA OLYAEI, MOHAMMADREZA HADIAN, MOHAMMAD RAZI AND SOGHRAT FAGHIHZADEH TEHRAN UNIVERSITY OF MEDICAL SCIENCES, IRAN.

Method: A total of 20 male athletes who underwent ACL reconstruction surgery participated in this study. The participants were randomly allocated to a vibration therapy group (10 subjects) or a conventional therapy group (10 subjects). Both groups participated in 12 training sessions within one month (3 times a week). The vibration therapy group performed prescribed exercises (squats, wide stance, lunges, etc.), and the conventional therapy group performed conventional strength exercises (hip abductors, adductors, flexors, extensors, leg press, leg curl, and squat). Both groups performed a progressive schedule.

Results: Both groups were tested pre and post-intervention. The subjects performed postural stability tests (with eyes open and closed) and a knee joint reposition test. These are standard tests, used to measure postural control and balance. The improvements found were significantly greater in the vibration therapy group than in the conventional therapy group. Most patients suffer from anterior-posterior instability after ACL reconstruction. The vibration therapy group shows a 22 times greater improvement in their anterior-posterior stability than the conventional group (see chart). This means that WBV training may be a valuable contribution to the rehabilitation of anterior-posterior stability, which is very important for the recovery of the patient.



Improvement of anterior-posterior stability index in vibration therapy and conventional therapy group with eyes open or closed. The blue bar indicates the vibration therapy group, and the black bar indicates the conventional group.

This study showed that WBV training resulted in a greater improvement in joint stability and balance than conventional strength training. WBV training also has the advantage of a shorter training time and is therefore a useful addition to the rehabilitation process after ACL reconstruction.

Walking Function

THIS IS A SUMMARY OF A STUDY PUBLISHED IN THE INTERNATIONAL SCIENTIFIC JOURNAL GAIT & POSTURE (2009). BY LANITIA L. NESS, AND EDELLE C. FIELD-FOTE UNIVERSITY OF MIAMI MILLER SCHOOL OF MEDICINE, USA.

Introduction: Spinal cord injury (SCI) is defined as damage to the white or grey matter contained within the spinal cord, which carries signals to and from the brain. A common consequence of SCI is loss of walking function, but where the tissue has not been totally damaged (an incomplete lesion), there is the possibility that patients may be able to walk again. In these cases, muscle weakness and sensory impairment can limit a person's ability to walk. Rehabilitation of SCI patients focuses on regaining walking function. The purpose of this pilot study (a small-scale study to test feasibility, methods, and procedures) was to determine whether repeated use of vibration therapy could result in improvements in walking function, as defined by changes in walking speed, in individuals with chronic, incomplete SCI.

Method: The study involved 17 subjects with SCI, all of whom had the physical ability to rise from sitting to standing (using upper body support) for at least one minute. Each person participated in a vibration therapy exercise program of three sessions per week for four weeks. Each session included four 45-second periods of vibration, with one minute of seated rest in between. The vibration machine was set at 50Hz low.

Results: To evaluate the effectiveness of the vibration therapy exercises, measurements were taken at the start of the study, and after four weeks of training. The researchers measured:

- Walking speed, measured in kilometers per hour (km/h)
- Cadence (number of steps taken in a given time)
- Strong and weak leg step length
- Strong and weak intralimb (within one limb alone) coordination (This is the ability to produce a consistent relationship of the hip angle to knee angle coupling over multiple steps)

Discussion and conclusions: The results of this study suggest that consistent use of vibration therapy by people with chronic, incomplete SCI, can help to increase walking speed, cadence, and step length, all of which will help to improve walking function. An improvement in the consistency of intralimb coordination over multiple steps was also noted. Although the change in walking speed (0.23 km/h) may not appear high, other scientific research (Perera et al. 2006) indicates that a change of 0.18 km/h is considered to be clinically meaningful. Therefore, the improvement noted in this particular study is clinically meaningful.

Parkinson's

CHRISTIAN T. HAASA,*, STEPHAN TURBANSKIA, KIRN KESSLERB AND DIETMAR SCHMIDTBLEICHERA
AINSTITUTE OF SPORT SCIENCES, JOHANN WOLFGANG GOETHE-UNIVERSITY, FRANKFURT, GERMANY
BDEPARTMENT OF NEUROLOGY, JOHANN WOLFGANG GOETHE-UNIVERSITY, FRANKFURT, GERMANY

Introduction: Apart from this phenomenon that vibration applied to the muscular tendon system can elicit a reflex muscle contraction, it has become evident in numerous studies that

vibratory stimuli modify a wide variety of physiological functions e.g. brain activation, hormone concentrations, or neurotransmitter releases.

In contrast to the results found in healthy subjects, vibrations seem to have a lower impact on coordination in Parkinson's disease patients. Rickards and Cody found significantly lower undershooting errors in PD patients compared to healthy subjects during voluntary wrist extension movements and vibration transfer to the flexor carpi radialis.

Materials and methods: Sixty-eight patients (15 female, 53 male) diagnosed with idiopathic Parkinson's disease participated in the study. The mean age (± SD) was 65.0 ± 7.8 years, and the duration of the disease was 5.9 ± 4.6 years.

For the treatment, the patient stood with shoes and with the knees slightly bent on a platform allowing separate and unsynchronised multidimensional WBV applied to both feet. WBV was administered in 5 series lasting one minute each with a one-minute pause between each series. With respect to information selection processes, a random vibration characteristic was chosen. Based on basic analyses it is known that variable stimuli provide greater potential to improve adaptation processes of the sensory-motor system. Furthermore, these stimuli cannot generate resonance catastrophes or kinaesthetic illusions. The mean frequency of the vibration was 6 Hz (± 1 Hz/s) and the amplitude was 3 mm.

Discussion: As the treatment was connected, significant improvements in the motor score were seen. While the control condition led to small, insignificant changes only, one has to conclude that the treatment has beneficial effects on PD motor symptoms.

Biomechanical experiments, which enable a comprehensive and valid assessment of different components of postural control, showed that the WBV treatment leads to significant improvements in postural control.

Vibration therapy provides external cues and might normalize SMA (supplementary motor area) activation. Apart from SMA functions, Nelson and colleagues showed that an unpredictable treatment leads to relatively strong activations of prefrontal areas and an overall better quality of life.

Spinal Cord Injury

SADEGHI M, SAWATZKY B. EFFECTS OF VIBRATION ON SPASTICITY IN INDIVIDUALS WITH SPINAL CORD INJURY: A SCOPING SYSTEMATIC REVIEW. AM J PHYS MED REHABIL. 2014 NOV;93(11):995-1007. DOI: 10.1097/PHM.0000000000000098. PMID: 24743464.

Abstract: The objective of this systematic review was to evaluate how whole-body vibration (WBV) or focal vibration (FV) would change spasticity in individuals with spinal cord injury (SCI). A search was conducted of MEDLINE, EMBASE, CINAHL, and PsycINFO electronic databases. A hand search was conducted of the bibliographies of articles and journals relevant to the research question. The inclusion criteria were three or more individuals, 17 yrs or older, with SCI who experience spasticity, and WBV or FV application. The evidence level of all ten identified studies (195 SCI subjects) was low on the basis of Centre for Evidence Based Medicine level of evidence. WBV (n = 1) and FV (n = 9) were applied to assess the effects of vibration on different measures of spasticity in individuals with SCI. FV application resulted in a short-term spasticity reduction lasting for a maximum of 24 hrs. Neurophysiologic measures showed H-reflex inhibition in individuals with SCI after FV application. WBV resulted in a decrease in spasticity lasting for 6-8

days after the last vibration session. WBV and FV might decrease spasticity for a short period, but no evidence-based recommendation can be drawn from the literature to guide rehabilitation medicine clinicians to manage spasticity with vibration application.

Walking Function

Ness LL, Field-Fote EC. Whole-body vibration improves walking function in individuals with spinal cord injury: a pilot study. Gait Posture. 2009 Nov;30(4):436-40. doi: 10.1016/j.gaitpost.2009.06.016. Epub 2009 Aug 3. PMID: 19648013; PMCID: PMC2753701.

Abstract: Injury to the central nervous system often results in impairments that negatively affect walking function. Prior evidence suggests that vibration may improve walking function. The purpose of this study was to determine whether repeated use of whole-body vibration (WBV) is associated with improvements in walking function in individuals with spinal cord injury (SCI). Subjects were 17 individuals with chronic (≥ 1 year), motor-incomplete SCI. Subjects were tested before and after participation in a 12-session (3 days/week- for 4 weeks) intervention of WBV. We assessed change in walking function via 3D motion capture, with walking speed as the primary outcome measure. We also assessed the influence of the WBV intervention on secondary gait characteristics, including cadence, step length, and hip angle-to-knee angle intralimb coordination. Walking speed increased by a mean of 0.062 ± 0.011 m/s, a change that was statistically significant ($p<0.001$). The WBV intervention was also associated with statistically significant increases in cadence, and both the stronger and weaker legs exhibited increased step length and improved consistency of intralimb coordination. Changes in cadence and step length of the stronger leg were strongly correlated with improvements in walking speed. The improvement in walking speed observed with the WBV intervention was comparable to that reported in the literature in association with locomotor training. This magnitude of change has been identified as being clinically meaningful, even in non-clinical populations. These findings suggest WBV may be useful to improve walking function with effects that may persist for some time following the intervention.

Seated Muscle Activation

Zaidell LN, Mileva KN, Sumners DP, Bowtell JL. Experimental evidence of the tonic vibration reflex during whole-body vibration of the loaded and unloaded leg. PLoS One. 2013 Dec 30;8(12):e85247. doi: 10.1371/journal.pone.0085247. PMID: 24386466; PMCID: PMC3875536.

Abstract: Increased muscle activation during whole-body vibration (WBV) is mainly ascribed to a complex spinal and supraspinal neurophysiological mechanism termed the tonic vibration reflex (TVR). However, TVR has not been experimentally demonstrated during low-frequency WBV, therefore this investigation aimed to determine the expression of TVR during WBV. Whilst seated, eight healthy males were exposed to either vertical WBV applied to the leg via the plantar surface of the foot, or Achilles tendon vibration (ATV) at 25Hz and 50Hzfor 70s. Ankle plantar-flexion force, tri-axial accelerations at the shank and vibration source, and surface EMG activity of m. soleus (SOL) and m. tibialis anterior (TA) were recorded from the unloaded and passively

loaded leg to simulate body mass supported during standing. Plantar flexion force was similarly augmented by WBV and ATV and increased over time in a load- and frequency-dependent fashion. SOL and TA EMG amplitudes increased over time in all conditions independently of vibration mode. 50Hz WBV and ATV resulted in greater muscle activation than 25Hz in SOL when the shank was loaded and in TA when the shank was unloaded despite the greater transmission of vertical acceleration from source to shank with 25Hz and WBV, especially during loading. Low-amplitude WBV of the unloaded and passively loaded leg produced slow tonic muscle contraction and plantar-flexion force increase of similar magnitudes to those induced by Achilles tendon vibration at the same frequencies. This study provides the first experimental evidence supporting the TVR as a plausible mechanism underlying the neuromuscular response to whole-body vibration.

ACL

THIS IS THE ABSTRACT OF A STUDY PUBLISHED IN THE JOURNAL OF SPORTS SCIENCE AND MEDICINE (2014) BY GEREON BERSCHIN, BJÖRN SOMMER, ANTJE BEHRENS, AND HANS-MARTIN SOMMER.

Abstract: The suitability and effectiveness of whole-body vibration (WBV) exercise in rehabilitation after injury of the anterior cruciate ligament (ACL) was studied using a specially designed WBV protocol. We wanted to test the hypothesis if WBV leads to superior short-term results regarding neuromuscular performance (strength and coordination) and would be less time consuming than a current standard muscle strengthening protocol. In this prospective randomized controlled clinical trial, forty patients who tore their ACL and underwent subsequent ligament reconstruction were enrolled. Patients were randomized to the whole-body vibration (n=20) or standard rehabilitation exercise protocol (n=20).

Both protocols started in the 2nd week after surgery. Isometric and isokinetic strength measurements, clinical assessment, Lysholm score, and neuromuscular performance were conducted in weeks 2, 5, 8, and 11 after surgery. Time spent on rehabilitation exercise was reduced to less than half in the WBV group. There were no statistically significant differences in terms of clinical assessment, Lysholm score, isokinetic and isometric strength. The WBV group displayed significantly better results in the stability test.

In conclusion, preliminary data indicate that our whole-body vibration muscle exercise protocol seems to be a good alternative to a standard exercise program in ACL rehabilitation. Despite its significantly reduced time requirement, it is at least equally effective compared to a standard rehabilitation protocol.

Muscle Spasms

NESS LL, FIELD-FOTE EC. EFFECT OF WHOLE-BODY VIBRATION ON QUADRICEPS SPASTICITY IN INDIVIDUALS WITH SPASTIC HYPERTONIA DUE TO SPINAL CORD INJURY. RESTOR NEUROL NEUROSCI. 2009;27(6):621-31. DOI: 10.3233/RNN-2009-0487. PMID: 20042786.

Purpose: Individuals with spinal cord injury (SCI) often have involuntary, reflex-evoked muscle activity resulting in spasticity. Vibration may modulate reflex activity thereby decreasing spasticity. This study suggests feasibility of using whole-body vibration (WBV) to decrease quadriceps spasticity in individuals with SCI.

Methods: Participants were individuals (n=16) with spastic quadriceps hypertonia due to chronic SCI (> 1 year). Quadriceps spasticity was measured by gravity-provoked stretch (Pendulum Test) before (initial) and after (final) a 3-day/week, 12-session WBV intervention. In addition, differences between immediate (immediate post-WBV) and delayed (delayed post-WBV) within-session effects were quantified. Finally, we assessed response differences between subjects who did and those who did not use antispastic agents.

Results: There was a significant reduction in quadriceps spasticity after participation in a WBV intervention that persisted for at least eight days. Within a WBV session, spasticity was reduced in the delayed post-WBV test compared to the immediate post-WBV test. The WBV intervention was associated with similar changes in quadriceps spasticity in subjects who did and those who did not use antispastic agents.

Conclusions: Vibration may be a useful adjunct to training in those with spasticity. Future studies should directly compare the antispastic effects of vibration to those of antispastic agents.

Leg Strength After Injury

BOSVELD R, FIELD-FOTE EC. SINGLE-DOSE EFFECTS OF WHOLE-BODY VIBRATION ON QUADRICEPS STRENGTH IN INDIVIDUALS WITH MOTOR-INCOMPLETE SPINAL CORD INJURY. J SPINAL CORD MED. 2015 NOV;38(6):784-91. DOI: 10.1179/2045772315Y.0000000002. EPUB 2015 FEB 9. PMID: 25664489; PMCID: PMC4725812.

Context: Paresis associated with motor-incomplete spinal cord injury (SCI) impairs function. Whole body vibration (WBV) may increase strength by activating neuromuscular circuits.

Method: The effects of a single session of WBV on lower extremity strength in individuals with motor-incomplete SCI were assessed. It was designed as a single session blinded randomized controlled trial in a rehabilitation research laboratory.

The subjects (n = 25; age 49.7 ± 12.5 years) had chronic SCI (>1 year) and were able to stand for at least 45 seconds. They were randomized either to WBV (n = 13) consisting of four 45-second bouts with 1-minute intervening rest periods (frequency: 50 Hz, amplitude: 2 mm) or to sham electrical stimulation (n = 12).

Maximal voluntary isometric quadriceps force was measured with a fixed dynamometer. A modified Five-Time-Sit-To-Stand (FTSTS) test was used to assess functional lower extremity strength. Measures were made at pre-test, immediate post-test, and delayed post-test 20 minutes later.

Result and conclusion: Immediately post-test, the change in voluntary isometric force in the WBV group was 1.12 kg greater than in the sham group. The within-group change for the WBV group was significant with a moderate effect size (P = 0.05; ES = 0.60). No force-related changes were observed in the sham group. The modified FTSTS scores improved in both groups, suggesting that this measure was subject to practice effects.

Evidence from the present study suggests that even a single session of WBV is associated with a meaningful short-term increase in quadriceps force-generating capacity in persons with motor-incomplete SCI. The multi-session use of WBV as part of a strengthening program deserves exploration

Balance and Posture With Osteopenia

SÁ-CAPUTO DC, DIONELLO CDF, FREDERICO ÉHFF, PAINEIRAS-DOMINGOS LL, SOUSA-GONÇALVES CR, MOREL DS, MOREIRA-MARCONI E, UNGER M, BERNARDO-FILHO M. WHOLE-BODY VIBRATION EXERCISE IMPROVES FUNCTIONAL PARAMETERS IN PATIENTS WITH OSTEOGENESIS IMPERFECTA: A SYSTEMATIC REVIEW WITH A SUITABLE APPROACH. AFR J TRADIT COMPLEMENT ALTERN MED. 2017 MAR 1;14(3):199-208. DOI: 10.21010/AJTCAM.V14I3.22. PMID: 28480432; PMCID: PMC5412226.

Background: Patients with *osteogenesis imperfecta* (OI) have abnormal bone modelling and resorption. The bone tissue adaptation and responsivity to dynamic and mechanical loading may be of therapeutic use under controlled circumstances. Improvements due to the wholebody vibration (WBV) exercises have been reported in strength, motion, gait, balance, posture and bone density in several osteopenic individuals, as in post-menopausal women or children with disabling conditions, as patients with OI. The aim of this investigation was to systematically analyse the current available literature to determine the effect of WBV exercises on functional parameters of OI patients.

Materials and methods: Three reviewers independently accessed bibliographical databases. Searches were performed in the PubMed, Scopus, Science Direct and PEDro databases using keywords related to possible interventions (including WBV) used in the management of patients with *osteogenesis imperfecta*.

Results: Three eligible studies were identified by searches in the analyzed databases.

Conclusion: It was concluded that WBV exercises could be an important option in the management of OI patients improving mobility and functional parameters. However, further studies are necessary for establishing suitable protocols for these patients.

WBV for Children with Cystic Fibrosis

O'Keefe K, Orr R, Huang P, Selvadurai H, Cooper P, Munns CF, Singh MA. The effect of whole body vibration exposure on muscle function in children with cystic fibrosis: a pilot efficacy trial. J Clin Med Res. 2013 Jun;5(3):205-16. doi: 10.4021/jocmr1137w. Epub 2013 Apr 23. PMID: 23671546; PMCID: PMC3651071.

Background: To examine the effects of whole-body vibration (WBV) exposure on muscle function in children with Cystic Fibrosis (CF). Non-randomised controlled cross-over trial.

Methods: The setting was home-based WBV exposure. The participants were children (8 - 15 years) with CF (n = 7).

Intervention: participants served as their own controls for the first four weeks (usual care), then underwent four weeks of parentally-supervised home-based WBV exposure followed by four weeks washout (usual care). The WBV exposure consisted of 20 - 30 minutes of intermittent (1 min vibration:1 min rest) exposure on a Galileo platform (20 - 22Hz, 1 mm amplitude) 3 days/week. The primary outcome measures of absolute and relative lower body (leg extension (LE), leg press (LP)), upper body (chess press (CP)) strength and power, and power were measured at baseline, and weeks 4, 8 and 12. Secondary exploratory outcomes were cardiorespiratory fitness, pulmonary function and health-related quality of life.

Results: Six participants completed the training without adverse events. Muscle function changes following WBV exposure were not statistically significant. However, moderate-to-large relative effect sizes (ES) favoring WBV were evident for leg extension strength (ES = 0.66 (-0.50, 1.82)), LP relative strength (ES = 0.92 (-0.27, 2.11)), leg press peak power (ES = 0.78 (-0.50, 2.07)) and CMJ height (ES = 0.60 (-0.56 to 1.76)).

Conclusions: The results from this first controlled trial indicate that WBV may be a potentially effective exercise modality to safely increase leg strength and explosive power in children with CF. Potentially clinically relevant changes support continued investigation of the efficacy, mechanism, and feasibility of this intervention in future large-scale studies.

Osteopenia

Lam TP, Ng BK, Cheung LW, Lee KM, Qin L, Cheng JC. Effect of whole body vibration (WBV) therapy on bone density and bone quality in osteopenic girls with adolescent idiopathic scoliosis: a randomized, controlled trial. Osteoporos Int. 2013 May;24(5):1623-36. doi: 10.1007/s00198-012-2144-1. Epub 2012 Sep 26. PMID: 23011683.

Aim: The aim of this randomized controlled trial was to determine whether whole body vibration (WBV) therapy was effective for treating osteopenia in adolescent idiopathic scoliosis (AIS) patients. Results showed that WBV was effective for improving areal bone mineral density (aBMD) at the femoral neck of the dominant side and lumbar spine BMC in AIS subjects.

Introduction: AIS is associated with osteopenia. Although WBV was shown to have skeletal anabolic effects in animal studies, its effect on AIS subjects remained unknown. The objective of

this study was to determine whether WBV could improve bone mineral density (BMD) and bone quality for osteopenia in AIS subjects.

Methods: This was a randomized, controlled trial recruiting 149 AIS girls between 15 and 25 years old and with bone mineral density (BMD) Z-scores <-1. They were randomly assigned to the Treatment or Control groups. The Treatment group (n = 61) stood on a low-magnitude high-frequency WBV platform 20 min/day, 5 days/week for 12 months. The Control group (n = 63) received observation alone. Bone measurement was done at baseline and at 12 months: (1) aBMD and BMC at femoral necks and lumbar spine using dual-energy X-ray absorptiometry (DXA) and (2) bone quality including bone morphometry, volumetric BMD (vBMD), and trabecular bone microarchitecture using high-resolution peripheral quantitative computed tomography (HR-pQCT) for non-dominant distal radius and bilateral distal tibiae.

Results: The Treatment group had numerically greater increases in all DXA parameters with a statistically significant difference being detected for the absolute and percentage increases in femoral neck aBMD at the dominant leg (0.015 (SD = 0.031)g/cm(2), 2.15 (SD = 4.32)%) and the absolute increase in lumbar spine BMC (1.17 (SD = 2.05)g) in the Treatment group as compared with the Control group (0.00084 (SD = 0.026)g/cm(2), 0.13 (SD = 3.62)% and 0.47 (SD = 1.88)g, respectively). WBV had no significant effect on other bone quality parameters.

Conclusions: WBV was effective for improving aBMD at the femoral neck of the dominant side and lumbar spine BMC in AIS subjects.

Osteoporosis From Atrophy

STARK C, HOYER-KUHN HK, SEMLER O, HOEBING L, DURAN I, CREMER R, SCHOENAU E. NEUROMUSCULAR TRAINING BASED ON WHOLE BODY VIBRATION IN CHILDREN WITH SPINA BIFIDA: A RETROSPECTIVE ANALYSIS OF A NEW PHYSIOTHERAPY TREATMENT PROGRAM. CHILDS NERV SYST. 2015 FEB;31(2):301-9. DOI: 10.1007/S00381-014-2577-2. EPUB 2014 NOV 5. PMID: 25370032.

Introduction: Spina bifida is the most common congenital cause of spinal cord lesions resulting in paralysis and secondary conditions like osteoporosis due to immobilization. Physiotherapy is performed for optimizing muscle function and prevention of secondary conditions. Therefore, training of the musculoskeletal system is one of the major aims in the rehabilitation of children with spinal cord lesions.

Intervention and methods: The neuromuscular physiotherapy treatment program Auf die Beine combines 6 months of home-based whole-body vibration (WBV) with interval blocks at the rehabilitation center: 13 days of intensive therapy at the beginning and 6 days after 3 months. Measurements are taken at the beginning (M0), after 6 months of training (M6), and after a 6-month follow-up period (M12). Gait parameters are assessed by ground reaction force and motor function by the Gross Motor Function Measurement (GMFM-66). Sixty children (mean age 8.71 ± 4.7 years) who participated in the program until February 2014 were retrospectively analyzed.

Results: Walking velocity improved significantly by 0.11 m/s (p = 0.0026) and mobility (GMFM-66) by 2.54 points (p = 0.001) after the training. All changes at follow-up were not significant, but significant changes were observed after the training period. Decreased contractures were observed with increased muscle function.

Conclusion: Significant improvements in motor function were observed after the active training period of the new neuromuscular training concept. This first analysis of the new neuromuscular

rehabilitation concept Auf die Beine showed encouraging results for a safe and efficient physiotherapy treatment program that increases motor function in children with spina bifida.

WBV for Multiple Sclerosis

THIS IS THE ABSTRACT OF A STUDY PUBLISHED BY SCHUHFRIED O, MITTERMAIER C, JOVANOVIC T, PIEBER K, PATERNOSTRO-SLUGA T. DEPARTMENT OF PHYSICAL MEDICINE AND REHABILITATION, MEDICAL UNIVERSITY OF VIENNA, AUSTRIA.

Objective: To examine whether a whole-body vibration (mechanical oscillations) in comparison to a placebo administration leads to better postural control, mobility and balance in patients with multiple sclerosis.

Design: Double-blind, randomized controlled trial.

Setting: Outpatient clinic of a university department of physical medicine and rehabilitation.

Subjects: Twelve multiple sclerosis patients with moderate disability (Kurtzke's Expanded Disability Status Scale 2.5-5) were allocated either to the intervention group or to the placebo group.

Interventions: In the intervention group a whole-body vibration at low frequency (2.0-4.4 Hz oscillations at 3-mm amplitude) in five series of 1 min each with a 1-min break between the series was applied. In the placebo group a Bursttranscutaneous electrical nerve stimulation (TENS) application on the nondominant forearm in five series of 1 min each with a 1-min break between the series was applied as well.

Main Outcome Measures: Posturographic assessment using the Sensory Organization Test, the Timed Get Up and Go Test and the Functional Reach Test immediately preceding the application, 15 min, one week and two weeks after the application. The statistical analysis was applied to the change score from preapplication values to values 15 min, one week and two weeks post intervention.

Results: Compared with the placebo group the intervention group showed advantages in terms of the Sensory Organization Test and the Timed Get Up and Go Test at each time point of measurement after the application. The effects were strongest one week after the intervention, where significant differences for the change score ($p = 0.041$) were found for the Timed Get Up and Go Test with the mean score reducing from 9.2 s (preapplication) to 8.2 s one week after whole-body vibration and increasing from 9.5 s (preapplication) to 10.2 s one week after placebo application. The mean values of the posturographic assessment increased from 70.5 points (preapplication) to 77.5 points one week after whole-body vibration and increased only from 67.2 points (preapplication) to 67.5 points one week after the placebo application. No differences were found for the Functional Reach Test.

Conclusion: The results of this pilot study indicated that whole-body vibration may positively influence postural control and mobility in multiple sclerosis patients.

Bone Density With Rats

Huang Y, Fan Y, Salanova M, Yang X, Sun L, Blottner D. Effects of Plantar Vibration on Bone and Deep Fascia in a Rat Hindlimb Unloading Model of Disuse. Front Physiol. 2018 May 23;9:616. doi: 10.3389/fphys.2018.00616. PMID: 29875702; PMCID: PMC5974101.

Abstract: The deep fascia of the vertebrate body comprises a biomechanically unique connective cell and tissue layer with integrative functions to support global and regional strain, tension, and even muscle force during motion and performance control. However, limited information is available on deep fascia in relation to bone in disuse.

We used rat hindlimb unloading as a model of disuse (21 days of hindlimb unloading) to study biomechanical property as well as cell and tissue changes to deep fascia and bone unloading.

Rats were randomly divided into three groups (n = 8, each): hindlimb unloading (HU), HU + vibration (HUV), and cage-control (CON). The HUV group received local vibration applied to the plantar of both hind paws. Micro-computed tomography analyzed decreased bone mineral density (BMD) of vertebra, tibia, and femur in HU vs. CON. Biomechanical parameters (elastic modulus, max stress, yield stress) of spinal and crural fascia in HU were always increased vs. CON. Vibration in HUV only counteracted HU-induced tibia bone loss and crural fascia mechanical changes but failed to show comparable changes in the vertebra and spinal fascia on lumbar back. Tissue and cell morphometry (size and cell nuclear density), immunomarker intensity levels of anti-collagen-I and III, probed on fascia cryosections well correlated with biomechanical changes suggesting crural fascia a prime target for plantar vibration mechano-stimulation in the HU rat.

We conclude that the regular biomechanical characteristics as well as tissue and cell properties in crural fascia and quality of tibia bone (BMD) were preserved by local plantar vibration in disuse suggesting common mechanisms in fascia and bone adaptation to local mechanovibration stimulation following hind limb unloading in the HUV rat.

Jaw Pain

Muir B, Brown C, Brown T, Tatlow D, Buhay J. Immediate changes in temporomandibular joint opening and pain following vibration therapy: a feasibility pilot study. J Can Chiropr Assoc. 2014 Dec;58(4):467-80. PMID: 25550672; PMCID: PMC4262808.

Objective: The purpose of this pilot study was to determine the scientific and process feasibility in an effort to direct future larger trials.

Methods: Scientific Feasibility: Twelve subjects were randomly allocated to an intervention and a control group. The intervention protocol consisted of intraoral vibration therapy on the muscles of mastication bilaterally for a period of 1 minute per muscle. Process Feasibility: Several feasibility outcomes were examined including recruitment and retention rates and consent.

Results: Scientific Feasibility: Large effect sizes were generated for both mouth opening and VAS in favour of the intervention group. Process Feasibility: a recruitment ratio of 2.3 respondents to 1 participant was determined, along with a retention to loss ratio of 13:1 and a consent to loss ratio of 12:0.

Conclusion: Scientific Feasibility: The scientific results should be interpreted with caution due to the small sample sizes employed. The study seems to support the scientific feasibility of a future larger **single treatment** trial. Process Feasibility: Recruitment and retention rates and ratios

seem to support future studies. Utilizing the feasibility results of the current study to direct a future larger **multiple treatment** trial consistent with other comparable TMD studies however is limited.

Part: 3
Anti - Aging

Fall Prevention and Flexibility

LACHANCE, C., WEIR, P., KENNO, K. ET AL. IS WHOLE-BODY VIBRATION BENEFICIAL FOR SENIORS?. EUR REV AGING PHYS ACT 9, 51–62 (2012).

https://doi.org/10.1007/s11556-011-0094-9

Abstract: Normal aging processes result in losses of functional flexibility and muscular strength, which increase seniors' fall risk and dependence on others. A relatively new intervention to reduce and/or reverse the adverse effects of aging is whole-body vibration (WBV) exercise. A systematic search utilizing PubMed and Sport Discus databases uncovered journal articles specific to seniors and whole-body vibration. An extensive hand search supplemented the database results to find other relevant articles. Twenty-seven articles were obtained; all articles have been published in the past 8 years, reflecting the recent and growing interest in this area. Researchers have determined that WBV training can reduce fall risk and improve postural control in seniors. It has also been determined that WBV training can be as effective as conventional resistance training to improve seniors' lower body strength. However, little is known about the effect of WBV exercise on flexibility and upper body strength in the aging population. More research is required to establish how effective WBV training is on these specific components and how it may affect seniors' quality of life.

Balance and fall prevention: Thirteen published articles discussed the effects of WBV on seniors' postural control and balance. Twelve of the articles showed significant benefits of using WBV to improve balance and/or postural control, while one showed no significant improvement. A potential limitation of the Carlucci et al. study was that their intervention consisted of one session of WBV.

In an attempt to decrease fall risk and improve health-related quality of life in nursing home residents, Bruyere and colleagues investigated the effects of WBV on 42 seniors who resided in a nursing home. Participants were randomized to receive physical therapy alone or physical therapy plus a WBV intervention. Physical therapy consisted of a standard exercise program with components of balance and gait training along with strengthening exercises. The experimental group participated in three sessions of WBV training per week for 6 weeks. A typical session involved the participant standing on the vibration platform for 1 min of vibration stimulus four times, with 90 s of rest between sets.

Other trials and studies were also conducted (you can view the full article using the citation) that concluded that WBV was beneficial for balance and postural steadiness.

Lower extremity power and strength: Fourteen studies examined muscular power and/or strength while using WBV. A pilot study examining polio patients was the only study that did not show increased strength benefits with WBV training. For the remaining 13 articles specific to lower body strength, two main themes exist; WBV improves muscular strength in seniors and WBV is as effective as conventional resistance training.

To measure the improvement in physical power and strength many tests were performed such as measuring participants' reaction forces from jumps on a force plate and seeing how they performed while doing various static and dynamic lower-body exercises on the vibration platform.

Flexibility: Bautmans and colleagues were the first researchers to test an element of flexibility training with WBV in seniors. Twenty-four nursing home residents (9 male and 15 female) were

randomly selected into either a WBV group or a control group. Participants from both groups were examined on flexibility pre- and post-test utilizing the chair sit-and-reach test (lower body flexibility) and the back scratch test (upper body flexibility). The WBV group performed lunges along with various types of squats and calf raises on a vibration platform, which target all the lower limb muscles. After 6 weeks, lower body flexibility improved significantly in the WBV group, indicating that general exercises may benefit flexibility. No significant differences were found in upper body flexibility pre- to post-test in either group, which may be attributed to participants not performing any exercises that targeted the upper body specifically.

Similarly, Bissonnette et al. examined upper and lower extremity flexibility using the same protocol. Nineteen participants (60–85 years) performed the chair sit-and-reach test and back scratch test pre- and post-WBV training. After completing the initial assessment, participants performed squats, calf raises, tricep extensions, and bicep curls on the WBV platform three times per week for 8 weeks. At week 4, lunges were added to the participants' exercise regimen. Both upper and lower body flexibility increased significantly from 0 to 8 weeks. Although the two aforementioned articles studied flexibility somewhat indirectly, results suggest WBV can be a very promising intervention to maintain or regain flexibility. This is noteworthy considering that flexibility can decline by up to 50% in certain joints by age 70. Based upon the search of the literature, these are the only two studies that tested a component of flexibility, indicating a vast potential to examine the effects of targeted flexibility exercises using WBV.

Upper body studies: Along with flexibility, upper body studies are one of the least established areas of WBV research with older adults. Bissonnette and colleagues are the sole investigators of the 27 articles to examine upper body strength. Nineteen participants (60–85 years) were tested on upper body strength at baseline and after 4 and 8 weeks of training by performing a standardized arm curl test. Following their initial assessment, participants performed static WBV tricep extensions and bicep curls three times per week for 8 weeks. After the training participants could lift 49% more weight compared to baseline performance, on average. This implies meaningful improvement in upper body strength can be attained from WBV exercises targeting those specific muscles.

VIBRA Plate:

The VIBRA Plate uses powerful vibrations to trigger one hundred muscle contractions per minute and unlike other WBV machines, it boasts a compact design with the same benefits.

https://vibra-plate.com/

Muscle Mass

THIS IS A SUMMARY OF A STUDY PUBLISHED IN JOURNAL OF GERONTOLOGY: MEDICAL SCIENCES 2007, VOL. 62A, NO. 6, 630–635. BY AN BOGAERTS, CHRISTOPHE DELECLUSE, ALBREACHT L. CLAESSENS, WALTER COUDYZER, STEVEN BOONEN AND SABINE M. P. VERSCHUEREN KATHOLIEKE UNIVERSITEIT LEUVEN, BELGIUM

Method: In this study, 97 participants were divided into three groups: a vibration therapy group, a fitness group and a control group. Both the vibration therapy group and the and fitness group trained three times a week for one year. The vibration therapy group exercised for a maximum of 40 minutes, whereas the fitness group trained for about 90 minutes, performing cardiovascular, resistance, balance, and flexibility exercises. The control group was advised not to change their lifestyle or physical activity during the project.

Results: Participants of both training groups showed an increase in isometric and explosive strength. Muscle mass increased as well. The conclusion the researchers reached was that training that involved vibration therapy is at least equivalent to regular fitness training. The participants achieved the same results with both kinds of training. However, the training time of the vibration therapy group was less than half that of the conventional fitness group.

This study shows that using a vibration plate/platform can be beneficial to fight age-related problems such as sarcopenia. It is thought that this loss of muscle mass, strength, and function may contribute to several other disorders, such as osteoporosis, type 2 diabetes, insulin resistance, and arthritis. Previous research has shown vibration therapy to have a positive effect on osteoporosis, balance, and postural control. It is an effective tool in helping to prevent some of the negative effects of aging and may assist the growing number of elderly in maintaining their health and independence.

Weight Loss in Postmenopausal Women

THIS IS A SUMMARY OF A STUDY PUBLISHED IN THE MATURITAS IN MAR. 2009. BY CECILIE FJELDSTAD, IAN J. PALMER, MICHAEL G. BEMBEN, AND DEBRA A. BEMBEN, UNIVERSTIY OF OKLAHOMA.

Background: As people age, changes in body composition include increases in fat mass, decrease in lean body mass, and a redistribution of body fat patterns. Postmenopausal women experience hormone changes, which can lead to the development of insulin resistance and the metabolic syndrome.

In this study, the goal was to determine the effects of combined traditional high intensity interval training and whole-body vibration on body composition in postmenopausal women.

Method: The subjects of this study were estrogen-deficient postmenopausal women between the ages of 60-75. 55 subjects completed the entire 32 weeks of the study. The women were non-randomly assigned to either a resistance training group, a vibration plus resistance training group, or a non-exercising control group.

Prior to the study, total and regional body composition was measured by dual-energy X-ray absorptiometry (DXA).

For resistance training intervention, resistance training and strength testing were performed using Cybex isotonic weight training equipment. Eight resistance exercises were conducted: supine leg press, hip flexion, hip extension, hip abduction, hip adduction, seated military press, latissimus pull-down, and seated row. Participants performed a 5-minute warm-up and a warm-up at each exercise machine prior to the 1-RM testing (finding the maximum weight lifted through a full range of motion). The resistance exercise protocol consisted of training 3 times a week for 8 months, with 1-hour sessions each time.

The whole-body vibration (WBV) training was conducted with the use of a vibration platform. Participants performed dynamic movements in three positions:

1. dynamic squats while standing on the vibration platform
2. performing shoulder extension/flexion movements using the straps while seated on the vibration platform
3. performing wrist curls with the attached straps while standing on the floor

Vibration exposures started at a low intensity and increased throughout the study. There was a 15-second rest interval between every vibration exercise.

Results: Fifty-five women were assigned to either resistance only, vibration plus resistance, or non-exercising control groups. In the vibration plus resistance group, the total percentage of body fat decreased whereas the control group experienced a significant increase in total body fat percentage. In addition, both training groups experienced increases in bone-free lean tissue mass for the total body, arm, and trunk regions. The control group experienced no changes in lean tissues.

Conclusion: It is becoming more and more clear that resistance training is a key factor in women's health. This study demonstrates that whole-body vibration in addition to resistance training can result in positive body composition changes by increasing lean tissue. It was also effective in decreasing body fat percentage. This study varies from previous studies because most other studies look solely at whole-body vibration against a control, whereas this study included resistance training for optimal results.

Anti-Aging and Regenerative Hormonal Response

BOSCO C, IACOVELLI M, TSARPELA O, CARDINALE M, BONIFAZI M, TIHANYI J, VIRU M, DE LORENZO A, VIRU A. HORMONAL RESPONSES TO WHOLE-BODY VIBRATION IN MEN. EUR J APPL PHYSIOL. 2000 APR;81(6):449-54. DOI: 10.1007/S004210050067. PMID: 10774867.

Regeneration of energy, skin, mind and body: Naturally produced growth hormone (GH) maintains bodily functions such as tissue repair, muscle growth, brain function, bone density development, skin thickness, energy, and metabolism, throughout life. As we age, GH levels diminish, and associated body functions suffer (Rudman et al. 1990). Researchers, who focus on anti-aging, have been searching for ways to maintain and increase GH levels throughout adulthood. Since Rudman et al reported it, physicians have been prescribing GH for anti-aging purposes. These GH therapy prescriptions cost patients up to $30,000 USD per year and require daily injections. With the desire to find an easier, safer, and more affordable way to stimulate the

creation of GH naturally within the body, researchers have begun to look at the reflexive movement of the human body as a gateway to stimulate this natural anti-aging effect.

Reflexes can create positive hormonal responses: Medical researchers have been studying methods to decrease the Deconditioning affiliated with aging is similar to the deconditioning experience in space travel in a weightless environment. Whole-Body Vibration (WBV) was first developed by Soviet scientists in an effort to heal cosmonauts from deconditioning from being in a weightless environment (Rittweger, 2010). They noticed that even when an individual is too weakened to voluntarily contract a muscle, their reflexes engage the muscle. They designed a platform to destabilize the body in order to engage reflexes throughout the body to accomplish their objective. Positive outcomes led to clinical research and an understanding of the health benefits. Researchers in Italy (Bosco et al. 2000) demonstrated this destabilization had a more powerful effect on the hormonal balance of the body than regular exercise. They saw a naturally occurring 460% increase in GH post destabilization stimulation with athletic males (Bosco et al. 2000). This was more than double the GH compared to existing research on conventional exercise and GH stimulation. Numerous researchers replicated this study with GH changes ranging from 435% (DiLoreto et al, 2004) - 560% to 2,600% (Sartorio, et al. 2010) - 1,375% (Guinta, 2012) following exposure to vibration. These results indicate a similar but safer benefit can be achieved with WBV than with anti-aging GH prescriptive therapy, as this response is created naturally.

Destabilization: While there is a relationship between WBV and GH response, the cause-and-effect relationship is not fully understood. In a 1988 literature review on endocrine response to exercise, a 220% increase in GH was demonstrated with conventional resistance training, but heavy (70-85% of 1RM) Olympic lifting had a 609% increase in GH (Kraemer, 1988). With Olympic lifting, stabilization is a key element to moving and balancing the heavy load throughout space, which appears to initiate reflexive balancing neuromuscular engagement. This is similar to the effect of WBV, as the platform destabilizes and, in the destabilization, reflexive balancing neuromuscular engagement occurs.

Chronic Stroke

WEI N, CAI M. OPTIMAL FREQUENCY OF WHOLE-BODY VIBRATION TRAINING FOR IMPROVING BALANCE AND PHYSICAL PERFORMANCE IN THE OLDER PEOPLE WITH CHRONIC STROKE: A RANDOMIZED CONTROLLED TRIAL. CLIN REHABIL. 2022 MAR;36(3):342-349. DOI: 10.1177/02692155211050564. EPUB 2021 NOV 19. PMID: 34796725.

Objective: To explore the optimal frequency of whole-body vibration training for improving the balance and physical performance in older people with chronic stroke.

Design: a single-blind randomized controlled trial.

Setting: Two rehabilitation units in the Wuhan Brain Hospital in China.

Participants: A total of 78 seniors with chronic stroke.

Interventions: Low-frequency group (13 Hz), high-frequency group (26 Hz), and zero-frequency group (Standing on the vibration platform with 0 Hz) for 10 sessions of side-alternating WBV training.

Main measures: The timed-up-and-go test, five-repetition sit-to-stand test, 10-meter walking test, and Berg balance scale were assessed pre- and post-intervention.

Results: Significant time × group interaction effects in five-repetition sit-to-stand test (p = 0.014) and timed-up-and-go test at self-preferred speed (p = 0.028) were observed. The high-frequency group outperformed the zero-frequency group in both five-repetition sit-to-stand test (p = 0.039) and timed-up-and-go test at self-preferred speed (p = 0.024) after 10-sessions training. The low-frequency group displayed only a significant improvement in five-repetition sit-to-stand test after training (p = 0.028). No significant within- or between-group changes were observed in the Berg balance scale and walking speed (p > 0.05). No significant group-difference were found between low-frequency and high-frequency groups. No adverse events were reported during study.

Conclusions: Compared with 13 Hz, 26 Hz had no more benefits on balance and physical performance in older people with chronic stroke.

Prevention of Osteoporosis

SWE M, BENJAMIN B, TUN AA, SUGATHAN S. ROLE OF THE WHOLE-BODY VIBRATION MACHINE IN THE PREVENTION AND MANAGEMENT OF OSTEOPOROSIS IN OLD AGE: A SYSTEMATIC REVIEW. MALAYS J MED SCI. 2016 SEP;23(5):8-16. DOI: 10.21315/MJMS2016.23.5.2. EPUB 2016 OCT 5. PMID: 27904420; PMCID: PMC5101982.

Abstract: A literature search of related articles was carried out in electronic data sources. Initially, 276 randomised controlled trials related to the title were collected, after which 44 were selected using the keywords. Overlapping articles, articles with a study duration of less than six months, and studies involving young participants were removed from the list. The remaining 20 articles were checked for entitlement using the PEDro scale. A total of nine eligible articles with 1486 participants were analysed. Seven trials used dual-energy x-ray absorptiometry (DXA) to measure bone mineral density (BMD). The six trials published from 2005 to 2013 found a significant increase in BMD. In the remaining one trial, there was no significant increase in BMD. One study published in 2013 reported a significant increase in BMD measured with peripheral qualitative computed tomography, whereas another trial published in 2014 stated that there was a reduction in calcaneal bone density measured by peripheral qualitative ultrasound. From these findings it can be concluded that the whole-body vibration machine is a good adjunctive therapy for the prevention and management of osteoporosis in postmenopausal women. However, further investigations are necessary before the same can be recommended for elderly men.

Cardiorespiratory Fitness and Muscle Strength in the Elderly

THIS IS A SUMMARY OF A STUDY PUBLISHED IN THE INTERNATIONAL SCIENTIFIC JOURNAL AGE AND AGEING (MAY 2009). BY AN BOGAERTS, CHRISTOPHE DELECLUSE, ALBRECHT CLAESSENS, THIERRY TROOSTERS, STEVEN BOONEN, AND SABINE VERSCHUEREN KATHOLIEKE UNIVERSITEIT, LEUVEN, BELGIUM

Introduction: Increased age is associated with a decline in cardiorespiratory fitness and muscular performance. However, for elderly people to continue to function independently and

perform daily activities, it is essential they maintain sufficient muscle strength and cardiorespiratory fitness. To do so, they should perform progressive resistance and aerobic training. However, a significant proportion of elderly people are unable or unwilling to undertake two training regimens. Exercise on a vibration plate offers a viable alternative, as a combination of both training methods.

Method: In this study 220 participants (180 of whom completed the study) were randomly divided into three groups. The first group (vibration therapy group) only performed basic exercises on the vibration platform. The training intensity and time were gradually progressed, to a maximum duration of 40 minutes for one session (including warming up, cooling down, and resting between exercises). The second group (fitness group) performed a fitness program consisting of cardiovascular, resistance, balance, and flexibility exercises. The maximum duration of one session was 90 minutes. Both groups performed three sessions of exercise each week over the course of one year. The third group (control group) was asked to not change their lifestyle or physical activity during the study.

To gauge the effectiveness of the different workouts, measurements were taken at the start of the study and after one year, including peak oxygen uptake (maximum amount of oxygen uptake), time-to-peak exercise (the time from the start of the cycle ergometer test to exhaustion), isometric muscle strength (static muscle strength), and participants' heart rate.

Results and discussion: Vibration therapy training resulted in an increase in peak oxygen uptake, time-to-peak exercise, and isometric muscle strength. The increases are almost equal to the changes noted in the fitness group, except for time-to-peak exercise, for which there are two possible reasons. First, one of the main components of the fitness group's training program was cardiorespiratory training, while the vibration therapy group's training regime did not include this element. Also, the fitness group performed better in the cycle ergometer test because their training program included specific bicycle training.

These results indicate training on a vibration platform is a good intervention to improve cardiorespiratory fitness (VO2 peak and time-to-peak exercise), which in turn can help to improve the quality of life for the elderly. Significantly, the participants in the vibration therapy group did not perceive the training sessions as a hard or strenuous workout, in contrast to the fitness group. As the duration of the vibration therapy training (maximum of 40 minutes) was also much shorter than the fitness groups' sessions (maximum of 90 minutes), it is a more time-effective way to achieve similar results.

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Part: 4
Fitness Performance

Improvement in Motor Function

AMAN JE, ELANGOVAN N, YEH IL, KONCZAK J. THE EFFECTIVENESS OF PROPRIOCEPTIVE TRAINING FOR IMPROVING MOTOR FUNCTION: A SYSTEMATIC REVIEW. FRONT HUM NEUROSCI. 2015 JAN 28;8:1075. DOI: 10.3389/FNHUM.2014.01075. PMID: 25674059; PMCID: PMC4309156.

This review examined different forms of proprioceptive training and improvements associated with vibration are noted.

Objective: Numerous reports advocate that training of the proprioceptive sense is a viable behavioral therapy for improving impaired motor function. However, there is little agreement on what constitutes proprioceptive training and how effective it is. We, therefore, conducted a comprehensive, systematic review of the available literature in order to provide clarity to the notion of training the proprioceptive system.

Methods: Four major scientific databases were searched. The following criteria were subsequently applied:

(1) A quantified pre- and post-treatment measure of proprioceptive function.
(2) An intervention or training program believed to influence or enhance proprioceptive function.
(3) Contained at least one form of treatment or outcome measure that is indicative of somatosensory function.

From a total of 1284 articles, 51 studies fulfilled all criteria and were selected for further review.

Results: Overall, proprioceptive training resulted in an average improvement of 52% across all outcome measures. Applying muscle vibration above 30 Hz for longer durations (i.e., min vs. s) induced outcome improvements of up to 60%. Joint position and target-reaching training consistently enhanced joint position sense (up to 109%) showing an average improvement of 48%. Cortical stroke was the most studied disease entity, but no clear evidence indicated that proprioceptive training is differentially beneficial across the reported diseases.

Conclusions: There is converging evidence that proprioceptive training can yield meaningful improvements in somatosensory and sensorimotor function. However, there is a clear need for further work. Those forms of training utilizing both passive and active movements with and without visual feedback tended to be most beneficial. There is also initial evidence suggesting that proprioceptive training induces cortical reorganization, reinforcing the notion that proprioceptive training is a viable method for improving sensorimotor function.

Improvement in Hamstring Flexibility

HOUSTON MN, HODSON VE, ADAMS KK, HOCH JM. THE EFFECTIVENESS OF WHOLE-BODY-VIBRATION TRAINING IN IMPROVING HAMSTRING FLEXIBILITY IN PHYSICALLY ACTIVE ADULTS. J SPORT REHABIL. 2015 FEB;24(1):77-82. DOI: 10.1123/JSR.2013-0059. PMID: 25606860.

Clinical scenario: Hamstring tightness is common among physically active individuals. In addition to limiting range of motion and increasing the risk of muscle strain, hamstring tightness

contributes to a variety of orthopedic conditions. Therefore, clinicians continue to identify effective methods to increase flexibility. Although hamstring tightness is typically treated with common stretching techniques such as static stretching and proprioceptive neuromuscular facilitation, it has been suggested that whole-body vibration (WBV) training may improve hamstring flexibility.

Clinical question: Can WBV training, used in isolation or in combination with common stretching protocols or exercise, improve hamstring flexibility in physically active young adults?

Summary of Key Findings: Of the included studies, 4 demonstrated statistically significant improvements in hamstring flexibility in the intervention group, and 1 study found minor improvements over time in the intervention group after treatment.

Clinical Bottom Line: There is moderate evidence to support the use of WBV training to improve hamstring flexibility in physically active young adults.

Strength of recommendation: There is grade B evidence that WBV training improves hamstring flexibility in physically active adults. The Centre of Evidence-Based Medicine recommends a grade of B for level 2 evidence with consistent findings.

Sprint Running Kinematics and Explosive Strength Performance

This is the summary of a study in the Journal of Sports Science and Medicine by Giorgos Paradisis and Elias Zacharogiannis, Track and Field Unit, Department of Sport and Exercise Science, University of Athens, Athens, Greece

Abstract: The aim of this study was to investigate the effect of 6 weeks of whole-body vibration (WBV) training on sprint running kinematics and explosive strength performance. Twenty-four volunteers (12 women and 12 men) participated in the study and were randomised (n = 12) into the experimental and control groups. The WBV group performed a 6-week program (16-30 min·d-1, 3 times a week) on a vibration platform. The amplitude of the vibration platform was 2.5 mm, and the acceleration was 2.28 g. The control group did not participate in any training. Tests were performed Pre and post the training period. Sprint running performance was measured during a 60 m sprint in which running time, running speed, step length, and step rate was calculated. Explosive strength performance was measured during a counter movement jump (CMJ) test, where jump height and the total number of jumps performed in a period of 30 seconds are measured (30CVJT). Performance in 10 m, 20 m, 40 m, 50 m, and 60 m improved significantly after 6 weeks of WBV training with an overall improvement of 2.7%. The step length and running speed improved by 5.1% and 3.6%, and the step rate decreased by 3.4%. The countermovement jump height increased by 3.3%, and the explosive strength endurance improved overall by 7.8%.

In conclusion, the WBV training period of 6 weeks produced significant changes in sprint running kinematics and explosive strength performance.

Vibration Therapy for Elite Female Synchronized Swimmers

WILLIAM A. SANDS, JENI R. MCNEAL, MICHAEL H. STONE, WENDY L. KIMMEL, G. GREGORY HAFF & MONEM JEMNI (2008) THE EFFECT OF VIBRATION ON ACTIVE AND PASSIVE RANGE OF MOTION IN ELITE FEMALE SYNCHRONIZED SWIMMERS, EUROPEAN JOURNAL OF SPORT SCIENCE, 8:4, 217-223, DOI: 10.1080/17461390802116682

Abstract: The purpose of this study was to assess the acute effects of vibration and stretching on passive and active forward split range of motion in elite adult female synchronized swimmers. Eleven athletes performed a passive forward split test measuring the height of the anterior superior iliac spine on both sides and an active split test on both sides by adopting an inverted split position. Then athletes were assigned randomly by the right or left leg to receive vibration on one leg while stretching. The contralateral leg was stretched but did not receive vibration and served as the control. The treatment involved a 40-second exposure to vibration of the forward leg in a split and 40-second of vibration to the rear leg in a split. The athletes were then post-tested using the same protocols. The results indicated that the vibration had a statistically significant influence on passive forward split flexibility, but not active split flexibility. The results of this study confirm earlier work and further demonstrate the efficacy of vibration in enhancing the range of motion in a passive split position. Given that it is often difficult to achieve large changes in the range of motion with already highly trained elite athletes, this methodology shows considerable promise. Vibration may not be powerful enough to evoke changes in the active range of motion in spite of the changes in the passive range of motion.

Effects of WBV on Muscle Strength and Power

THIS IS THE ABSTRACT OF A STUDY PUBLISHED IN THE J MUSCULOSKELET NEURONAL INTERACT 2013; 13(3):380-390 BY Y. OSAWA, Y. OGUMA, AND N. ISHII

Abstract: Exercise with whole-body vibration (WBV) is becoming popular as an alternative to conventional training or as supplementary training. However, despite increasing research efforts in this field, additive effects of WBV on muscle performance remain unclarified. In this review, we investigated the additive effects of long-term WBV on muscle strength and power. This meta-analysis was restricted to randomized controlled trials lasting for at least 5 weeks comparing exercise with and without WBV or comparing only WBV exposure and control. Data from a total of 314 participants in 10 studies on knee extension muscle strength and 249 participants in 7 studies on countermovement jump height were pooled using random-effect models. Meta-analysis showed significant additional effects of WBV on muscle strength (standardized mean difference [SMD]=0.76, 95% confidence interval [CI]=0.21-1.32; p=0.007) and countermovement jump (SMD=0.87, 95% CI=0.29-1.46; p=0.003). Based on these findings, we concluded that the use of WBV would lead to greater improvements in both knee extension muscle strength and countermovement jump than under identical conditions without WBV.

Knee Pain Relief

Tsuji T, Yoon J, Aiba T, Kanamori A, Okura T, Tanaka K. Effects of whole-body vibration exercise on muscular strength and power, functional mobility and self-reported knee function in middle-aged and older Japanese women with knee pain. Knee. 2014 Dec;21(6):1088-95. doi: 10.1016/j.knee.2014.07.015. Epub 2014 Jul 28. PMID: 25153612.

Background: Whole-body vibration training using vertical-vibration machines is called "acceleration training" (AT). The purpose of this study was to elucidate the effect of AT on lower-limb muscular strength and power, functional mobility, and self-reported knee function in middle-aged and older Japanese women with knee pain.

Methods: Thirty-eight middle-aged and older Japanese women (aged 50-73 years) with knee pain were divided into two groups: (1) the AT group (n=29) engaged in AT three times per week for eight weeks, and (2) the control group (C group, n=9). The AT program consisted of flexibility training, strength training of mainly the quadriceps and surrounding muscles and cool-down exercises. The C group was encouraged to perform the same or similar exercises at home without vibratory stimulus. We evaluated knee strength and power, functional mobility (timed up and go: TUG) and self-reported knee function (Japanese Knee Osteoarthritis Measure: JKOM).

Results: No one in the AT group dropped out during the program. All JKOM categories except degree of pain improved significantly post-intervention indicating improved knee function, and TUG was significantly shorter in these participants. All knee strength and power parameters except isometric knee extension peak torque improved significantly. The degree of change in JKOM total score and TUG was significantly different between the two groups.

Conclusion: Vibratory stimulus during an eight-week AT program can promote participation and safely improve functional mobility and self-reported knee function better than exercise without vibratory stimulus in middle-aged and older Japanese women with knee pain.

Cycling Benefits

Rønnestad BR, Falch GS, Ellefsen S. The Effect of Whole-Body Vibration on Subsequent Sprint Performance in Well-Trained Cyclists. Int J Sports Physiol Perform. 2017 Aug;12(7):964-968. doi: 10.1123/ijspp.2016-0428. Epub 2016 Dec 14. PMID: 27967282.

Postactivation-potentiation exercise with added whole-body vibration (WBV) has been suggested as a potential way to acutely improve sprint performance. In cycling, there are many competitions and situations where sprinting abilities are important.

Purpose: To investigate the effect of adding WBV to warm-up procedures on subsequent cycle sprint performance.

Methods: Eleven well-trained cyclists participated in the study. All cyclists performed a familiarization session before 2 separate test sessions in randomized order. Each session included a standardized warm-up followed by 1 of the following preconditioning exercises: 30 s of half-

squats without WBV or 30 s of half-squats with WBV at 40 Hz. A 15-s Wingate sprint was performed 1 min after the preconditioning exercise.

Results: Performing preconditioning exercise with WBV at 40 Hz resulted in superior peak power output compared with preconditioning exercise without WBV (1413 ± 257 W vs 1353 ± 213 W, P = .04) and a tendency toward superior mean power output during a 15-second all-out sprint (850 ± 119 W vs 828 ± 101 W, P = .08). Effect sizes showed a moderate practical effect of WBV vs no WBV on both peak and mean power output.

Conclusions: Preconditioning exercise performed with WBV at 40 Hz seems to have a positive effect on cycling sprint performance in young well-trained cyclists. This suggests that athletes can incorporate body-loaded squats with WBV in preparations to specific sprint training to improve the quality of the sprint training and also to improve sprint performance in relevant competitions.

Footspeed Quickness

DONAHUE RB, VINGREN JL, DUPLANTY AA, LEVITT DE, LUK HY, KRAEMER WJ. ACUTE EFFECT OF WHOLE-BODY VIBRATION WARM-UP ON FOOTSPEED QUICKNESS. J STRENGTH COND RES. 2016 AUG;30(8):2286-91. DOI: 10.1519/JSC.0000000000001014. PMID: 27328378.

Abstract

The warm-up routine preceding a training or athletic event can affect the performance during that event. Whole-body vibration (WBV) can increase muscle performance, and thus the inclusion of WBV to the warm-up routine might provide additional performance improvements. The purpose of this investigation was to examine the acute effect of a WBV warm-up, using a vertical oscillating platform and a more traditional warm-up protocol on feet quickness in physically active men. Twenty healthy and physically active men (18-25 years, 22 ± 3 years, 176.8 ± 6.4 cm, 84.4 ± 11.5 kg, 10.8 ± 1.4% body fat) volunteered for this study. A 2 × 2 factorial design was used to examine the effect of 4 warm-up scenarios (no warm-up, traditional warm-up only, WBV warm-up only, and combined traditional and WBV warm-up) on subsequent 3-second Quick feet count test (QFT) performance.

The traditional warm-up consisted of static and dynamic exercises and stretches. The WBV warm-up consisted of 60 seconds of vertical sinusoidal vibration at a frequency of 35 Hz and amplitude of 4 mm on a vibration platform. The WBV protocol significantly ($p \leq 0.0005$, $\eta = 0.581$) augmented QFT performance (WBV: 37.1 ± 3.4 touches; no-WBV: 35.7 ± 3.4 touches). The results demonstrate that WBV can enhance the performance score on the QFT. The findings of this study suggest that WBV warm-up should be included in warm-up routines preceding training and athletic events which include very fast foot movements.

Part: 5
Brain Health/Disabled Minors

Delay Dementia

ODANO, I., MAEYATSU, F., ASARI, M. ET AL. WHOLE-BODY VIBRATION EXERCISE AND TRAINING INCREASE REGIONAL CBF IN MILD COGNITIVE IMPAIRMENT WITH ENHANCED COGNITIVE FUNCTION. ANN NUCL MED 36, 82–94 (2022).

https://doi.org/10.1007/s12149-021-01687-4

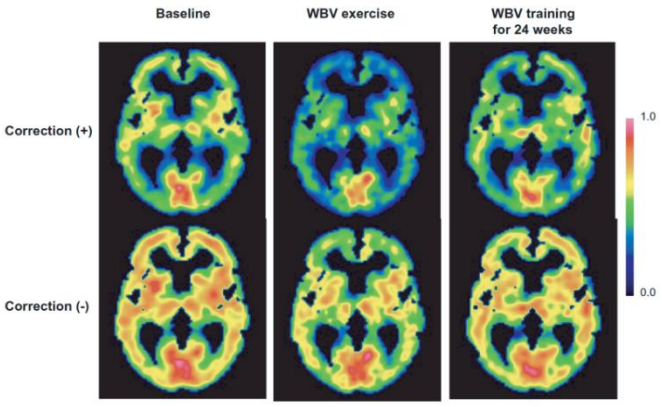
Background: Mild cognitive impairment (MCI) is defined as the boundary between memory loss and impairment. Scientists from two of Japan's leading medical institutes have published exciting new research concluding that whole body vibration, delivered by vibration therapy, increased cerebral blood flow and enhanced cognitive function in patients with mild cognitive impairment, a pre-clinical stage of dementia. The average rate of progression of dementia is 5-15% each year. Using advanced brain imaging technologies, these researchers discovered an increased regional cerebral blood flow ratio (rCBF) in the parietal and occipital lobes. The authors assert that due to the lack of effective drug therapies for Alzheimer's disease, "preclinical and non-medical interventions are essential for preventing and treating cognitive decline in patients with mild cognitive impairment." This suggests that vibration therapy can be a critical tool in mitigating the progression of cognitive decline.

Method: There were 16 subjects in this study who visited Miyagi Koseikyokai Izumi Hospital with forgetfulness. The mean age was 63.5 and 7 men and 9 women participated. A baseline single photon emission computer tomography (SPECT) study and CBF measurements were performed at rest with the eyes closed. Four weeks later, whole body vibration (WBV) exercise was conducted. The WBV exercises were performed on the vibration platform and continued for approximately 20 mins at a frequency of 35-40Hz with a low amplitude. Six patients underwent a 24-week WBV exercise protocol, twice a week with their eyes open. Following training, SPECT with CBF measurements were taken with eyes closed.

Results: Neuropsychological tests in 6 out of the 16 patients with Amnestic MCI (aMCI), who performed 24 weeks of WBV training, revealed a significant improvement in cognitive assessment and a slight improvement in Mini-Mental State Examination after training.

Conclusion:

- Exercise and training with whole body vibration may increase rCBF in patients with aMCI, which is expected to delay the conversion of MCI to dementia.
- This study suggests that vibration therapy can be a critical tool in mitigating the progression of cognitive decline.
- This research further supports and strengthens other high-quality clinical research studies on WBV and vascular health.



Images of rCBF ratio of a 56-year-old male patient with aMCI with Lassen's correction and without. The rCBF ratio is apparently reduced in the frontal region of the WBV exercise image.

Reduction of Disability Handicaps

RITZMANN R, STARK C, KRAUSE A. VIBRATION THERAPY IN PATIENTS WITH CEREBRAL PALSY: A SYSTEMATIC REVIEW. NEUROPSYCHIATR DIS TREAT. 2018;14:1607-1625 https://doi.org/10.2147/NDT.S152543

Abstract: The neurological disorder cerebral palsy (CP) is caused by unprogressive lesions of the immature brain and affects movement, posture, and the musculoskeletal system. Vibration therapy (VT) is increasingly used to reduce the signs and symptoms associated with this developmental disability. The purpose of this narrative review was systematically to appraise published research regarding acute and long-term effects of VT on functional, neuromuscular, and structural parameters. Systematic searches of three electronic databases identified 28 studies that fulfilled the inclusion criteria. Studies were analyzed to determine participant characteristics, VT-treatment protocols, effect on gross motor function (GMF), strength, gait, posture, mobility, spasticity, reflex excitability, muscle tone, mass, and bone strength within this population, and outcome measures used to evaluate effects. The results revealed that one acute session of VT reduces reflex excitability, spasticity, and coordination deficits. Subsequently, VT has a positive effect on the ability to move, manifested for GMF, strength, gait, and mobility in patients with CP. Effects persist up to 30 minutes after VT. Long-term effects of VT manifest as reduced muscle tone and spasticity occurring concomitantly with improved movement ability in regard to GMF, strength, gait, and mobility, as well as increased muscle mass and bone-mineral density. Posture control remained unaffected by VT. In conclusion, the acute and chronic application of VT as a nonpharmacological approach has the potential to ameliorate CP symptoms, achieving functional and structural adaptations associated with significant improvements in daily living. Even though further studies including adult populations validating the neuromuscular mechanisms underlying the aforementioned adaptations should be fostered, growing scientific evidence supports the effectiveness of VT in regard to supplementing conventional treatments (physiotherapy and drugs). Therefore, VT could reduce CP-associated physical disability and sensorimotor handicaps. Goals for patients and their caregivers referring to greater independence and improved safety may be achieved more easily and time efficiently.

Stronger Handicapped Children

STARK C, NIKOPOULOU-SMYRNI P, STABREY A, SEMLER O, SCHOENAU E. EFFECT OF A NEW PHYSIOTHERAPY CONCEPT ON BONE MINERAL DENSITY, MUSCLE FORCE AND GROSS MOTOR FUNCTION IN CHILDREN WITH BILATERAL CEREBRAL PALSY. J MUSCULOSKELET NEURONAL INTERACT. 2010 JUN;10(2):151-8. PMID: 20516632.

Objective: The purpose of this study was to determine the effect of a new physiotherapy concept on bone density, muscle force and motor function in bilateral spastic cerebral palsy children.

Methods: In a retrospective data analysis 78 children were analysed. The concept included whole body vibration, physiotherapy, resistance training and treadmill training. The concept is structured in two in-patient stays and two periods of three months of home-based vibration

training. Outcome measures were dual-energy x-ray absorption (DXA), Leonardo Tilt Table and a modified Gross Motor Function Measure before and after six months of training.

Results: Percent changes were highly significant for bone mineral density, -content, muscle mass and significant for angle of verticalisation, muscle force and modified Gross Motor Function Measure after six months training.

Conclusions: The new physiotherapy concept had a significant effect on bone mineral density, muscle force and gross motor function in bilateral spastic cerebral palsy children. This implicates an amelioration in all International Classification of Functioning, Disability and Health levels. The study serves as a basis for future research on evidence based paediatric physiotherapy taking into account developmental implications.

Improved Mobility in Handicapped Children

LEE BK, CHON SC. EFFECT OF WHOLE-BODY VIBRATION TRAINING ON MOBILITY IN CHILDREN WITH CEREBRAL PALSY: A RANDOMIZED CONTROLLED EXPERIMENTER-BLINDED STUDY. CLIN REHABIL. 2013 JUL;27(7):599-607. DOI: 10.1177/0269215512470673. EPUB 2013 FEB 14. PMID: 23411791.

Objective: To evaluate ambulatory function and leg muscle thickness after whole body vibration training in children with cerebral palsy.

Design: A block randomized controlled trial with two groups.

Setting: Physical therapy department laboratory.

Subjects: A total of 30 (15 experimental, mean (SD) age 10.0 (2.26) years and 15 control, 9.6 (2.58)) children with cerebral palsy, 15 males and 15 females.

Interventions: The experimental group underwent whole body vibration training combined with conventional physical therapy training; the control group underwent conventional physical therapy training three days a week for eight weeks respectively.

Main outcome measures: Three-dimensional gait analyses and ultrasonographic imaging of the leg muscles were measured at pre- and post-test of intervention for eight weeks.

Results: Whole body vibration training resulted in significantly better gait speed (P = 0.001, from 0.37 (0.04) m/s to 0.48 (0.06)), stride length (P = 0.001, from 0.38 (0.18) m to 0.48 (0.18)) and cycle time (P = 0.001, from 0.85 (0.48) s to 0.58 (0.38)) in the experimental group compared with that in the control group. The ankle angle (P = 0.019, from 7.30 (4.02) degree to 13.58 (8.79)) also showed a remarkable increase in the experimental group, but not the hip (P = 0.321) and knee angle (P = 0.102). The thicknesses of the tibialis anterior (P = 0.001, 0.48 (0.08) mm to 0.63 (0.10)) and soleus (P = 0.001, 0.45 (0.04) mm to 0.63 (0.12)) muscles were significantly higher in the experimental group than in the control group. However, no significant effect was observed in the thickness of the gastrocnemius muscle (P = 0.645).

Conclusions: These findings suggest that whole-body vibration may improve mobility in children with cerebral palsy, probably through a positive effect on the leg muscles.

Better Balance for Handicapped Children

SAQUETTO MB, PEREIRA FF, QUEIROZ RS, DA SILVA CM, CONCEIÇÃO CS, GOMES NETO M. EFFECTS OF WHOLE-BODY VIBRATION ON MUSCLE STRENGTH, BONE MINERAL CONTENT AND DENSITY, AND BALANCE AND BODY COMPOSITION OF CHILDREN AND ADOLESCENTS WITH DOWN SYNDROME: A SYSTEMATIC REVIEW. OSTEOPOROS INT. 2018 MAR;29(3):527-533. DOI: 10.1007/S00198-017-4360-1. EPUB 2018 JAN 12. PMID: 29330572.

Abstract

The aim of this study is to verify the effects of whole-body vibration (WBV) training on the muscle strength of children and adolescents with Down syndrome. We searched MEDLINE, Cochrane, SciELO, Lilacs and PUBMED databases and included manual searches to identify randomised controlled trials to investigate the effects of WBV on the structure and body function of children and adolescents with Down syndrome. Two reviewers independently selected the studies and performed statistical analysis. In total, five studies with 171 patients that compared WBV with exercise and/or control were included. Two studies demonstrated a significant difference between the muscle strength of children and adolescents with Down syndrome who received WBV training and that of those who did not receive the intervention. The studies included in this systematic review showed that WBV training has positive effects on bone mineral density (BMD), body composition and balance. Results of this study showed that WBV training improves muscle strength, BMD, body composition, and balance of children and adolescents with Down syndrome, and a more in-depth analysis of its effects on other variables in this population is required, as well as of parameters to be used.

Brain Function With Seated Vibration

MAIKALA RV, KING S, BHAMBHANI YN. CEREBRAL OXYGENATION AND BLOOD VOLUME RESPONSES TO SEATED WHOLE-BODY VIBRATION. EUR J APPL PHYSIOL. 2005 DEC;95(5-6):447-53. DOI: 10.1007/S00421-005-0013-8. EPUB 2005 SEP 22. PMID: 16177916.

Abstract: Role of backrest support and hand grip contractions on regional cerebral oxygenation and blood volume were evaluated by near infrared spectroscopy in 13 healthy men during whole-body vibration (WBV). Subjects were exposed to three WBV (3, 4.5, and 6 Hz at approximately 0.9 g(rms) in the vertical direction), in a randomized order on separate days. During WBV, subjects performed right-hand maximal voluntary intermittent rhythmic hand grip contractions for 1 min. Subjects demonstrated highest oxygenation and blood volume values at 4.5 Hz, however, these responses were similar with and without backrest support (P>0.01). Compared to WBV alone, addition of hand grip exercise during WBV further increased oxygenation (0.07+/-0.11 vs. 0.004+/-0.11 od, P=0.003) and blood volume (0.156+/-0.20 vs. 0.066+/-0.17 od, P=0.000) in the right forehead. Peak oxygen uptake did not correlate to changes in oxygenation and blood volume (P>0.01). Based on the increase in ventilation volume and no change in the ratio of ventilation volume and expired carbon dioxide (P>0.01), it is concluded that WBV induces hyperventilation that might activate the pre-frontal cortical region, thus influencing cerebral responses through neuronal activation.

Increase Walking Distance

Ribeiro VGC, Lacerda ACR, Santos JM, Coelho-Oliveira AC, Fonseca SF, Prates ACN, Flor J, Garcia BCC, Tossige-Gomes R, Leite HR, Fernandes JSC, Arrieiro AN, Sartorio A, Sañudo B, Sá-Caputo DC, Bernardo-Filho M, Figueiredo PHS, Costa HS, Lima VP, Cardoso RF, Bastone AC, Soares LA, Mendonça VA, Taiar R. Efficacy of Whole-Body Vibration Training on Brain-Derived Neurotrophic Factor, Clinical and Functional Outcomes, and Quality of Life in Women with Fibromyalgia Syndrome: A Randomized Controlled Trial. J Healthc Eng. 2021 Nov 30;2021:7593802. doi: 10.1155/2021/7593802. PMID: 34900203; PMCID: PMC8654532.

Abstract: This study aimed to investigate the efficacy of whole-body vibration training (WBVT) on blood brain-derived neurotrophic factor (BDNF) levels and determine the clinical and functional outcomes in patients with fibromyalgia syndrome (FMS). Thirty-two women with FMS were randomized into an intervention group (IG), receiving 6 weeks of WBVT, or a control group (CG) with no intervention. The outcomes at the baseline and follow-up in both groups included blood BDNF levels, sit-to-stand test (STS), 6-minute walk test (6MWT), Fibromyalgia Impact Questionnaire (FIQ), Pittsburgh Sleep Quality Index (PSQI), Beck Depression Inventory (BDI), and visual analogue scale (VAS). WBVT resulted in a group-by-time interaction effect. Thus, after the intervention time, the IG had increased blood BDNF levels ($p=0.045$), a higher number of repetitions on the STS test ($p=0.011$), and increased walking distance on the 6MWT ($p=0.010$), compared to CG. Moreover, there was a reduction in the scores of the FIQ ($p=0.001$), the PSQI ($p=0.001$), the BDI ($p=0.017$), and pain assessed using VAS ($p=0.008$) in IG. The results demonstrate that WBVT promotes an increase in blood BDNF levels, with concomitant improvement in lower limb muscle strength, aerobic capacity, clinical symptoms, and quality of life in women with FMS.

Multi-Mechanical Waves Against Alzheimer's Disease Pathology

Monteiro F, Sotiropoulos I, Carvalho Ó, Sousa N, Silva FS. Multi-mechanical waves against Alzheimer's disease pathology: a systematic review. Transl Neurodegener. 2021 Sep 24;10(1):36. doi: 10.1186/s40035-021-00256-z. PMID: 34560902; PMCID: PMC8464104.

Abstract: Alzheimer's disease (AD) is the most common cause of dementia, affecting approximately 40 million people worldwide. The ineffectiveness of the available pharmacological treatments against AD has fostered researchers to focus on alternative strategies to overcome this challenge. Mechanical vibrations delivered in different stimulation modes have been associated with marked improvements in cognitive and physical performance in both demented and non-demented elderly. Some of the mechanical-based stimulation modalities in efforts are earlier whole-body vibration, transcranial ultrasound stimulation with microbubble injection, and more recently, auditory stimulation. However, there is a huge variety of treatment specifications, and in many cases, conflicting results are reported. In this review, a search on Scopus, PubMed, and Web of Science databases was performed, resulting in 37 papers. These studies suggest that

mechanical vibrations delivered through different stimulation modes are effective in attenuating many parameters of AD pathology including functional connectivity and neuronal circuit integrity deficits in the brains of AD patients, as well as in subjects with cognitive decline and non-demented older adults. Despite the evolving preclinical and clinical evidence on these therapeutic modalities, their translation into clinical practice is not consolidated yet. Thus, this comprehensive and critical systematic review aims to address the most important gaps in the reviewed protocols and propose optimal regimens for future clinical application.

Neuropathy Relief

KESSLER NJ, LOCKARD MM, FISCHER J. WHOLE BODY VIBRATION IMPROVES SYMPTOMS OF DIABETIC PERIPHERAL NEUROPATHY. J BODYW MOV THER. 2020 APR;24(2):1-3. DOI: 10.1016/J.JBMT.2020.01.004. EPUB 2020 FEB 11. PMID: 32507132.

Whole Body Vibration (WBV) is an innovative therapy that may be effective for reducing chronic pain associated with diabetic peripheral neuropathy (DPN), Current treatments for DPN pain have demonstrated questionable efficacy and significant risk of adverse events. Preliminary research has indicated that WBV may be effective for controlling chronic pain symptoms of DPN.

Methods: 20 participants (9 male, 11 female), 58.51 ± 10.69 years old, and BMI of 33.60 ± 8.20 kg/m2 were randomly assigned to a sham-treatment (n = 8) or WBV treatment (n = 12) group in a pre-post design. Pain was assessed with a 10-point verbal analog pain scale (VAS). Treatment consisted of three sessions/week with at least one day between sessions, 12 min/session (four bouts of 3 min), for four weeks. Control was established with a sham vibration protocol for two weeks in which the participants were blinded to the treatment.

Results: VAS scores of the treatment group decreased significantly at both 2 and 4 weeks ($p = 0.019$). The treatment group was found to have a significantly lower VAS score than the controls at two weeks ($p = 0.033$). After cessation of WBV vibration treatment, participants reported reduced DPN-related pain from 1 to 5 weeks later.

Conclusion: WBV is effective for reducing DPN-associated pain over a two- and four-week interval. This was the first study to demonstrate this using a sham vibration control. We further saw a persistence in pain reduction beyond the day of treatment, indicating a potential chronic effect of WBV treatment.

Neuropathy Relief

Streckmann F, Lehmann HC, Balke M, Schenk A, Oberste M, Heller A, Schürhörster A, Elter T, Bloch W, Baumann FT. Sensorimotor training and whole-body vibration training have the potential to reduce motor and sensory symptoms of chemotherapy-induced peripheral neuropathy-a randomized controlled pilot trial. Support Care Cancer. 2019 Jul;27(7):2471-2478. doi: 10.1007/s00520-018-4531-4. Epub 2018 Oct 31. PMID: 30382392.

Abstract: Chemotherapy-induced peripheral neuropathy (CIPN) is a prevalent and clinically relevant side effect of chemotherapy. The symptoms diminish patients' quality of life and represent a decisive limiting factor for medical therapy. To date, effective treatment options are lacking. Specific exercise interventions have proven promising to target relevant symptoms. We conducted a prospective, four-armed, randomized, controlled trial, to evaluate the effects of sensorimotor training (SMT) and whole-body vibration training (WBV) on patients with CIPN. Participants ($N = 40$) were randomized to either one of two intervention groups (SMT $N = 10$ or WBV $N = 10$) or oncological control group ($N = 10$) and matched by gender and age with a healthy control ($N = 10$). The intervention groups exercised twice a week for 6 weeks. Primary endpoint was the reduction of CIPN-related symptoms (improve peripheral deep sensitivity, Achilles tendon reflex (ASR) and patellar tendon reflex (PSR), light-touch perception, sense of position, and lower leg strength). Secondary endpoints were nerve conduction velocity and amplitude, balance control, quality of life, and CIPN-related pain. Patients exercising improved sensory and associated motor symptoms. Significant intergroup differences were found for the tendon reflexes (ASR $P = .017$ and PSR $P = .020$), peripheral deep sensitivity ($P = .010$), and pain ($P = .043$). Furthermore, tendencies were found regarding the subjective improvement of symptoms ($P = .075$) and two subscales of the EORTC-QLQ-C30 questionnaire: pain ($P = .054$) and dyspnea ($P = .054$). The results for the SMT group were superior regarding the tendon reflexes, and a tendency regarding the subjective report of symptoms, while WBV was superior regarding pain. SMT and WBV behold a large potential to reduce CIPN-related symptoms and can be considered feasible and safe for patients with CIPN (compliance 97.5%, no adverse events).

Part: 6
Joint Pain, Arthritis, and Pain Relief

Lower Back Pain

DONG Y, WANG W, ZHENG J, CHEN S, QIAO J, WANG X. WHOLE BODY VIBRATION EXERCISE FOR CHRONIC MUSCULOSKELETAL PAIN: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMIZED CONTROLLED TRIALS. ARCH PHYS MED REHABIL. 2019 NOV;100(11):2167-2178. DOI: 10.1016/J.APMR.2019.03.011. EPUB 2019 APR 17. PMID: 31004565.

Objective: This study systematically reviews previous work on the effects of whole body vibration exercise (WBVE) on pain associated with chronic musculoskeletal disorders.

Data sources: Seven electronic databases (PubMed, Embase, CINAHL, Web of Science, Cochrane, Physiotherapy Evidence Database [PEDro], and the China National Knowledge Infrastructure) were searched for articles published between January 1980 and September 2018.

Study selection: Randomized controlled trials involving adults with chronic low back pain (CLBP), osteoarthritis (OA), or fibromyalgia were included. Participants in the WBVE intervention group were compared with those in the nontreatment and non-WBVE control groups.

Data extraction: Data were independently extracted using a standardized form. Methodological quality was assessed using PEDro.

Data synthesis: Suitable data from 16 studies were pooled for meta-analysis. A random effects model was used to calculate between-groups mean differences at 95% confidence interval (CI). The data were analyzed depending on the duration of the follow-up, common disorders, and different control interventions.

Results: Alleviation of pain was observed at medium-term (standardized mean difference [SMD], -0.67; 95% CI, -1.14 to -0.21; I2, 80%) and long-term (SMD, -0.31; 95% CI, -0.59 to -0.02; I2, 0%). Pain was alleviated in osteoarthritis (OA) (SMD, -0.37; 95% CI, -0.64 to -0.10; P<.05; I2, 22%) and CLBP (SMD, -0.44; 95% CI, -0.75 to -0.13; P<.05; I2, 12%). Long-term WBVE could relieve chronic musculoskeletal pain conditions of OA (SMD, -0.46; 95% CI, -0.80 to -0.13; P<.05; I2, 0%). WBVE improved chronic musculoskeletal pain compared with the treatment "X" control (SMD, -0.37; 95% CI, -0.61 to -0.12; P<.05; I2, 26%), traditional treatment control (SMD, -1.02; 95% CI, -2.44 to 0.4; P>.05; I2, 94%) and no treatment control (SMD, -1; 95% CI, -1.76 to -0.24; P<.05; I2, 75%).

Conclusions: Evidence suggests positive effects of WBVE on chronic musculoskeletal pain, and long durations of WBVE could be especially beneficial. However, WBVE does not significantly relieve chronic musculoskeletal pain compared with the traditional treatment. Further work is required to identify which parameters of WBVE are ideal for patients with chronic musculoskeletal pain.

Arthritis

Coelho-Oliveira AC, Lacerda ACR, de Souza ALC, Santos LMM, da Fonseca SF, Dos Santos JM, Ribeiro VGC, Leite HR, Figueiredo PHS, Fernandes JSC, Martins F, Filho RGT, Bernardo-Filho M, da Cunha de Sá-Caputo D, Sartorio A, Cochrane D, Lima VP, Costa HS, Mendonça VA, Taiar R. Acute Whole-Body Vibration Exercise Promotes Favorable Handgrip Neuromuscular Modifications in Rheumatoid Arthritis: A Cross-Over Randomized Clinical. Biomed Res Int. 2021 Dec 2;2021:9774980. doi: 10.1155/2021/9774980. PMID: 34901282; PMCID: PMC8660187.

Objective: Rheumatoid arthritis (RA) causes progressive changes in the musculoskeletal system compromising neuromuscular control especially in the hands. Whole-body vibration (WBV) could be an alternative for the rehabilitation in this population. This study investigated the immediate effect of WBV while in the modified push-up position on neural ratio (NR) in a single session during handgrip strength (HS) in women with stable RA.

Methods: Twenty-one women with RA (diagnosis of disease: ±8 years, erythrocyte sedimentation rate: ±24.8, age: 54± 11 years, BMI: 28 ± 4 kg·m-2) received three experimental interventions for five minutes in a randomized and balanced cross-over order: (1) control-seated with hands at rest, (2) sham-push-up position with hands on the vibration platform that remained disconnected, and (3) vibration-push-up position with hands on the vibration platform turned on (45 Hz, 2 mm, 159.73 m·s-2). At the baseline and immediately after the three experimental interventions, the HS, the electromyographic records (EMGrms), and range of motion (ROM) of the dominant hand were measured. The NR, i.e., the ratio between EMGrms of the flexor digitorum superficialis (FDS) muscle and HS, was also determined. The lower NR represented the greater neuromuscular efficiency (NE).

Results: The NR was similar at baseline in the three experimental interventions. Despite the nonsignificance of within-interventions ($p = 0.0611$) and interaction effect ($p = 0.1907$), WBV exercise reduced the NR compared with the sham and control ($p = 0.0003$, $F = 8.86$, $\eta 2 = 0.85$, power = 1.00).

Conclusion: Acute WBV exercise under the hands promotes neuromuscular modifications during the handgrip of women with stable RA. Thus, acute WBV exercise may be used as a preparatory exercise for the rehabilitation of the hands in this population. This trial is registered with trial registration 2.544.850 (ReBEC-RBR-2n932c).

Knee Pain

Anwer S, Alghadir A, Zafar H, Al-Eisa E. Effect of whole body vibration training on quadriceps muscle strength in individuals with knee osteoarthritis: a systematic review and meta-analysis. Physiotherapy. 2016 Jun;102(2):145-51. doi: 10.1016/j.physio.2015.10.004. Epub 2015 Oct 22. PMID: 26619822.

Background: Several studies have reported the effects of whole-body vibration (WBV) training on muscle strength. This systematic review investigates the current evidence regarding the effects of WBV training on quadriceps muscle strength in individuals with knee osteoarthritis (OA).

Data sources: PubMed, CINAHL, Embase, Scopus, PEDro, and Science citation index was searched for research articles published prior to March 2015 using the keywords whole-body vibration, vibration training, strength and vibratory exercise in combination with the Medical Subject Heading 'Osteoarthritis knee'.

Study selection: This meta-analysis was limited to randomized controlled trials published in the English language.

Data extraction: The quality of the selected studies was assessed by two independent evaluators using the PEDro scale and criteria given by the International Society of Musculoskeletal and Neuronal Interactions (ISMNI) for reporting WBV intervention studies. The risk of bias was assessed using the Cochrane collaboration's tool for domain-based evaluation. Isokinetic quadriceps muscle strength was calculated for each intervention.

Results: Eighteen studies were identified in the search. Of these, four studies met the inclusion criteria. Three of these four studies reached high methodological quality on the PEDro scale. Out of the four studies, only one study found significantly greater quadriceps muscle strength gains following WBV compared to the control group.

Conclusions: In three of the four studies that compared a control group performing the same exercise as the WBV groups, no additional effect of WBV on quadriceps muscle strength in individuals with knee OA was indicated.

Knee Pain

AVELAR NC, SIMÃO AP, TOSSIGE-GOMES R, ET AL. THE EFFECT OF ADDING WHOLE-BODY VIBRATION TO SQUAT TRAINING ON THE FUNCTIONAL PERFORMANCE AND SELF-REPORT OF DISEASE STATUS IN ELDERLY PATIENTS WITH KNEE OSTEOARTHRITIS: A RANDOMIZED, CONTROLLED CLINICAL STUDY. JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE (NEW YORK, N.Y.). 2011 DEC;17(12):1149-1155. DOI: 10.1089/ACM.2010.0782. PMID: 22087576.

Objectives: The study objectives were to evaluate the effects of adding whole-body vibration to squat training on functional performance and self-report of disease in elderly individuals with knee osteoarthritis (OA).

Design: This was a prospective, randomized trial in which selected variables were evaluated at three periods: 3 weeks prior to the training, immediately prior, and after the end of the training.

Subjects: Twenty-three (23) elderly subjects were evaluated using four functional performance tests: Berg Balance Scale (BBS), Timed Get Up and Go Test (TGUG), Chair Stand Test (CST), and 6-Minute Walk Test (6MWT), and a self-report of the status of disease (WOMAC).

Interventions: The intervention lasted for 12 weeks, 3 times per week. The participants were randomized into two groups: (1) squat training with whole-body vibration, and (2) squat training without vibration.

Results: Although there was no statistical difference in functional performance and self-report of disease status between the groups, performance in all the functional tests and in all the domains

of WOMAC improved in the vibration group compared to their initial status. In the exercise group, performance improved only two tests (BBS and 6MWT), and there was a reduction in self-reported pain (WOMAC) compared to their initial status.

Conclusions: Although the addition of whole-body vibration to squat training failed to result in a significant improvement in functional performance and self-reported status of knee osteoarthritis in the elderly, the intragroup results suggest that whole-body vibration may represent a feasible and effective way of improving the functionality and self-perception of disease status in older adults with knee OA.

Ankle Stability

BAUMBACH, S.F., FASSER, M., POLZER, H. ET AL. STUDY PROTOCOL: THE EFFECT OF WHOLE BODY VIBRATION ON ACUTE UNILATERAL UNSTABLE LATERAL ANKLE SPRAIN- A BIPHASIC RANDOMIZED CONTROLLED TRIAL. BMC MUSCULOSKELET DISORD 14, 22 (2013). HTTPS://DOI.ORG/10.1186/1471-2474-14-22

Background: Ankle sprains often result in ankle instability, which is most likely caused by damage to passive structures and neuromuscular impairment. Whole body vibration (WBV) is a neuromuscular training method improving those impaired neurologic parameters. The aim of this study is to compare the current gold standard functional treatment to functional treatment plus WBV in patients with acute unilateral unstable inversion ankle sprains.

Methods/Design: Sixty patients, aged 18–40 years, presenting with an isolated, unilateral, acute unstable inversion ankle sprain will be included in this bicentric, biphasic, randomized controlled trial. Samples will be randomized by envelope drawing. All patients will be allowed early mobilization and pain-dependent weight bearing, limited functional immobilization by orthosis, PRICE, NSARDs as well as home and supervised physiotherapy. Supervised physical therapy will take place twice a week, for 30 minutes for a period of 6 weeks, following a standardized intervention protocol. During supervised physical therapy, the intervention group will perform exercises similar to those of the control group, on a side-alternating sinusoidal vibration platform. Two time-dependent primary outcome parameters will be assessed: short-term outcome after six weeks will be postural control quantified by the sway index; mid-term outcome after one year will be assessed by subjective instability, defined by the presence of giving-way attacks. Secondary outcome parameters include: return to pre-injury level of activities, residual pain, recurrence, objective instability, energy/coordination, Foot and Ankle Disability Index, and EQ 5D.

Discussion: This is the first trial investigating the effects of WBV in patients with acute soft tissue injury. Inversion ankle sprains often result in ankle instability, which is most likely due to damage of neurological structures. Due to its unique, frequency-dependent, influence on various neuromuscular parameters, WBV is a promising treatment method for patients with acute unstable inversion ankle sprains.

Low Back Pain

Brumagne S, Cordo P, Lysens R, Verschueren S, Swinnen S. The role of paraspinal muscle spindles in lumbosacral position sense in individuals with and without low back pain. Spine (Phila Pa 1976). 2000 Apr 15;25(8):989-94. doi: 10.1097/00007632-200004150-00015. PMID: 10767813.

Study design: A two-group experimental design with repeated measures on one factor was used.

Objectives: To investigate the role of paraspinal muscle spindles in lumbosacral position sense in individuals with and without low back pain.

Summary of background data: Proprioceptive deficits have been identified in patients with low back pain. The underlying mechanisms, however, are not well documented.

Methods: Lumbosacral position sense was determined before, during, and after lumbar paraspinal muscle vibration in 23 young patients with low back pain and in 21 control subjects. Position sense was estimated by calculating the mean absolute error, constant error, and variable error between six criterion and reproduction sacral tilt angles.

Results: Repositioning accuracy was significantly lower in the patient group than in healthy individuals (absolute error difference between groups = 2.7 degrees, $P < 0.0001$). Multifidus muscle vibration induced a significant muscle-lengthening illusion that resulted in an undershooting of the target position in healthy individuals (constant error = -3.1 degrees, $P < 0.0001$). Conversely, the position sense scores of the patient group did not display an increase in negative directional error but a significant improvement in position sense during muscle vibration ($P < 0.05$). No significant differences in absolute error were found between the first and last trial in the healthy individuals ($P >/= 0.05$) and in the patient group ($P > 0.05$).

Conclusions: Patients with low back pain have a less refined position sense than healthy individuals, possibly because of an altered paraspinal muscle spindle afference and central processing of this sensory input. Furthermore, muscle vibration can be an interesting expedient for improving proprioception and enhancing local muscle control.

Knee Pain

Bokaeian HR, Bakhtiary AH, Mirmohammadkhani M, Moghimi J. The effect of adding whole body vibration training to strengthening training in the treatment of knee osteoarthritis: A randomized clinical trial. J Bodyw Mov Ther. 2016 Apr;20(2):334-40. doi: 10.1016/j.jbmt.2015.08.005. Epub 2015 Aug 25. PMID: 27210851.

Abstract: Strengthening training (ST) and whole body vibration training (WBV) alone may improve symptoms of osteoarthritis of the knee. In this study, we investigated the effect of adding WBV training to quadriceps and hamstring muscles strengthening training on functional activity, pain, quality of life and muscle strength in patients with knee osteoarthritis. 28 volunteers were randomly allocated to two groups.

1) Quadriceps and hamstring muscles strengthening training (ST group, 13 patients)
2) Quadriceps and hamstring muscles strengthening training along with WBV training (ST + WBV group, 15 patients)

The treatment protocol for both groups involved 3 sessions per week for 8 weeks. All measurements were performed before and after intervention. The measurements included: pain by means of a visual analogue scale (VAS), quality of life by means of the WOMAC scale, functional activity by the 2 min walking test (2MWT), time up & go test (TUGT) and 50-foot walking test (50FWT) and the muscle peak torque (MPT), total work (TW) and muscle power (MP) as muscle performance of quadriceps and hamstring muscles by an Isokinetic Biodex machine. After the intervention, the comparison of mean changes between the two groups showed improvement in the WBV + ST group in terms of 2MWT, MPT, TW, and MP variables ($P < 0.05$). However, no significant difference was found between the experimental groups in terms of pain, quality of life, TUGT, and 50FWT. These results suggest that adding whole-body vibration training to strengthening training may provide better treatment effects for patients with knee osteoarthritis.

Muscle Relaxation

ELFERING A, ZAHNO J, TAEYMANS J, BLASIMANN A, RADLINGER L. ACUTE EFFECTS OF STOCHASTIC RESONANCE WHOLE BODY VIBRATION. WORLD J ORTHOP. 2013 OCT 18;4(4):291-8. DOI: 10.5312/WJO.V4.I4.291. PMID: 24147265; PMCID: PMC3801249.

Aim: To investigate the acute effects of stochastic resonance whole body vibration (SR-WBV) training to identify possible explanations for preventive effects against musculoskeletal disorders.

Method: Twenty-three healthy, female students participated in this quasi-experimental pilot study. Acute physiological and psychological effects of SR-WBV training were examined using electromyography of descending trapezius (TD) muscle, heart rate variability (HRV), different skin parameters (temperature, redness and blood flow) and self-report questionnaires. All subjects conducted a sham SR-WBV training at a low intensity (2 Hz with noise level 0) and a verum SR-WBV training at a higher intensity (6 Hz with noise level 4). They were tested before, during and after the training. Conclusions were drawn on the basis of analysis of variance.

Results: Twenty-three healthy, female students participated in this study (age = 22.4 ± 2.1 years; body mass index = 21.6 ± 2.2 kg/m^2). Muscular activity of the TD and energy expenditure rose during verum SR-WBV compared to baseline and sham SR-WBV (all $P < 0.05$). Muscular relaxation after verum SR-WBV was higher than at baseline and after sham SR-WBV (all $P < 0.05$). During verum SR-WBV the levels of HRV were similar to those observed during sham SR-WBV. The same applies for most of the skin characteristics, while microcirculation of the skin of the middle back was higher during verum compared to sham SR-WBV ($P < 0.001$). Skin redness showed significant changes over the three measurement points only in the middle back area ($P = 0.022$). There was a significant rise from baseline to verum SR-WBV (0.86 ± 0.25 perfusion units; $P = 0.008$). The self-reported chronic pain grade indicators of pain, stiffness, well-being and muscle relaxation showed a mixed pattern across conditions. Muscle and joint stiffness ($P = 0.018$) and muscular relaxation did significantly change from baseline to different conditions of SR-WBV ($P < 0.001$). Moreover, muscle relaxation after verum SR-WBV was higher than after sham SR-WBV ($P < 0.05$).

Conclusion: Verum SR-WBV stimulated musculoskeletal activity in young healthy individuals while cardiovascular activation was low. Training of musculoskeletal capacity and immediate

increase in musculoskeletal relaxation are potential mediators of pain reduction in preventive trials.

Back Pain From Osteoporosis

IWAMOTO J, TAKEDA T, SATO Y, UZAWA M. 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. 2005 APR;17(2):157-63. DOI: 10.1007/BF03324589. RETRACTION IN: AGING CLIN EXP RES. 2019 DEC;31(12):1855. PMID: 15977465.

Background and aims: Exercise may enhance the effect of alendronate on bone mineral density (BMD) and reduce chronic back pain in elderly women with osteoporosis. The aim of this study was to determine whether whole-body vibration exercise would enhance the effect of alendronate on lumbar BMD and bone turnover and reduce chronic back pain in postmenopausal women with osteoporosis.

Methods: Fifty post-menopausal women with osteoporosis, 55-88 years of age, were randomly divided into two groups of 25 patients each: one taking alendronate (5 mg daily, ALN) and one taking alendronate plus exercise (ALN+EX). Exercise consisted of whole-body vibration using a vibration plate, at an intensity of 20 Hz, frequency once a week, and duration of exercise 4 minutes. The study lasted 12 months. Lumbar BMD was measured by dual energy X-ray absorptiometry (Hologic QDR 1500W). Urinary cross-linked N-terminal telopeptides of type I collagen (NTX) and serum alkaline phosphatase (ALP) levels were measured by enzyme-linked immunosorbent assay and standard laboratory techniques, respectively. Chronic back pain was evaluated by face scale score at baseline and every 6 months.

Results: There were no significant differences in baseline characteristics, including age, body mass index, years since menopause, lumbar BMD, urinary NTX, and serum ALP levels, or face scale score between the two groups. The increase in lumbar BMD and the reduction in urinary NTX and serum ALP levels were similar in the ALN and ALN+EX groups. However, the reduction in chronic back pain was greater in the ALN+EX group than in the ALN group.

Conclusions: The results of this study suggest that whole-body vibration exercise using a vibration plate appears to be useful in reducing chronic back pain, probably by relaxing the back muscles in post-menopausal osteoporotic women treated with alendronate.

Treatment of Chronic Lower-Back Pain

RITTWEGER J, JUST K, KAUTZSCH K, REEG P, FELSENBERG D. TREATMENT OF CHRONIC LOWER BACK PAIN WITH LUMBAR EXTENSION AND WHOLE-BODY VIBRATION EXERCISE: A RANDOMIZED CONTROLLED TRIAL. SPINE (PHILA PA 1976). 2002 SEP 1;27(17):1829-34. DOI: 10.1097/00007632-200209010-00003. PMID: 12221343.

Study design: A randomized controlled trial with a 6-month follow-up period was conducted.

Objective: To compare lumbar extension exercise and whole-body vibration exercise for chronic lower back pain.

Summary of background data: Chronic lower back pain involves muscular as well as connective and neural systems. Different types of physiotherapy are applied for its treatment. Industrial vibration is regarded as a risk factor. Recently, vibration exercise has been developed as a new type of physiotherapy. It is thought to activate muscles via reflexes.

Methods: In this study, 60 patients with chronic lower back pain devoid of "specific" spine diseases, who had a mean age of 51.7 years and a pain history of 13.1 years, practiced either isodynamic lumbar extension or vibration exercise for 3 months. Outcome measures were lumbar extension torque, pain sensation (visual analog scale), and pain-related disability (pain disability index).

Results: A significant and comparable reduction in pain sensation and pain-related disability was observed in both groups. Lumbar extension torque increased significantly in the vibration exercise group (30.1 Nm/kg), but significantly more in the lumbar extension group (+59.2 Nm/kg; SEM 10.2; $P < 0.05$). No correlation was found between gain in lumbar torque and pain relief or pain-related disability ($P > 0.2$).

Conclusions: The current data indicate that poor lumbar muscle force probably is not the exclusive cause of chronic lower back pain. Different types of exercise therapy tend to yield comparable results. Interestingly, well-controlled vibration may be the cure rather than the cause of lower back pain.

Knee Pain Relief

Zafar H, Alghadir A, Anwer S, Al-Eisa E. Therapeutic effects of whole-body vibration training in knee osteoarthritis: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2015 Aug;96(8):1525-32. doi: 10.1016/j.apmr.2015.03.010. Epub 2015 Mar 28. PMID: 25827655.

Objective: To examine the current evidence regarding the effects of whole-body vibration (WBV) training in individuals with knee osteoarthritis (OA).

Data sources: We searched PubMed, CINAHL, Embase, Scopus, Physiotherapy Evidence Database (PEDro), and Science Citation Index for research articles published prior to January 2015 using the keywords whole body vibration, vibration training, and vibratory exercise in combination with the Medical Subject Heading osteoarthritis knee.

Study selection: This meta-analysis was restricted to randomized controlled trials published in the English language. The quality of the selected studies was assessed by the PEDro Scale. The risk of bias was assessed using the Cochrane collaboration's tool in the domain-based evaluation. We also evaluated the quality of each study based on the criteria given by the International Society of Musculoskeletal and Neuronal Interactions for reporting WBV intervention studies, consisting of 13 factors.

Data extraction: Descriptive data regarding subjects, design, intervention, WBV parameters, outcomes, and conclusions were collected from each study by 2 independent evaluators. The mean and SD of the baseline and final endpoint scores for pain, stiffness, and function were extracted from the included studies.

Data synthesis: A total of 83 studies were found in the search. Of these, 5 studies met the inclusion criteria and were further analyzed. Four of these 5 studies reached high methodologic quality on the PEDro Scale. Overall, studies demonstrated mixed results in favor of the additive effects of WBV for reducing pain and improving function in knee OA. There was considerable variation in the parameters of the WBV included in this systematic review.

Conclusions: WBV training reduces pain and improves function in individuals with knee OA.

Nonspecific Low Back Pain

ZHENG YL, WANG XF, CHEN BL, GU W, WANG X, XU B, ZHANG J, WU Y, CHEN CC, LIU XC, WANG XQ. EFFECT OF 12-WEEK WHOLE-BODY VIBRATION EXERCISE ON LUMBOPELVIC PROPRIOCEPTION AND PAIN CONTROL IN YOUNG ADULTS WITH NONSPECIFIC LOW BACK PAIN. MED SCI MONIT. 2019 JAN 15;25:443-452. DOI: 10.12659/MSM.912047. PMID: 30644383; PMCID: PMC6342063.

Background: Nonspecific low back pain (NSLBP) accounts for a large proportion of low back pain cases. The present study aimed to investigate the effect of the whole-body vibration (WBV) exercise on lumbar proprioception in NSLBP patients. It was hypothesized that WBV exercise enhances lumbar proprioception.

Material/Methods: Forty-two patients with NSLBP performed an exercise program 3 times a week for a total of 12 weeks of WBV. The lumbar proprioception was measured by joint position sense. Outcomes were lumbar angle deviation and visual analogue scale (VAS) score.

Results: After the 12-week WBV exercise, lumbar flexion angle deviation was reduced from 3.65±2.26° to 1.90±1.07° (P=0.0001), and extension angle deviation was reduced from 3.06±1.85° to 1.61±0.75° (P=0.0001), significantly lower than baseline. After participating in the 12-week WBV exercise, a significant pain reduction was observed (P=0.0001). Men in the whole group (n=32) indicated significantly lower angle deviations in flexion and extension, whereas women (n=10) indicated significantly lower flexion angle deviation (P=0.037), and no significant difference was found in extension angle deviation (P=0.052). However, by subdividing the entire group (n=42) into poor and good proprioceptive groups, WBV exercise presented significant enhancement of lumbar proprioceptive ability in the poor flexion proprioception subgroup, poor extension proprioception subgroup, and good extension proprioception subgroup (each P=0.0001), but not in the subgroup with good flexion proprioceptive ability (P=0.165).

Conclusions: Lumbar flexion and extension proprioception as measured by joint position sense was significantly enhanced and the pain was significantly reduced after 12-week WBV exercise in NSLBP patients. However, the patients with good flexion proprioceptive ability had limited proprioceptive enhancement.

Part: 7
Heart, Bone, Cellulite, Sleep, Circulation, Varicose Veins, Gut, and Lymph

Improved Circulation

MARK A., MACDONALD M., RAKOBOWCHUCK, M., GORDON, C., BLIMKIE, C. METABOLIC AND CARDIOVASCULAR RESPONSES DURING WBV: A PILOT STUDY.

Introduction:

- Whole body vibration (WBV) is currently being researched for potential therapeutic and sport performance benefits (4).
- Little is known about the psychological and physiological effects of WBV on humans.
- WBV results in increased gravitational loading (g forces) - as a result of stretch reflex activation.
- Previous studies have found WBV load dependent increases in VO2, BP, HR and RPE (2,3).
- Increases in blood flow in the popliteal artery using power and colour Doppler (1) and in the calf and foot using cutaneous laser Doppler flow (2) have also been reported.
- No studies have examined the simultaneous effect of WBV on both central and peripheral cardiovascular variables in combination with assessment of psychological stress.

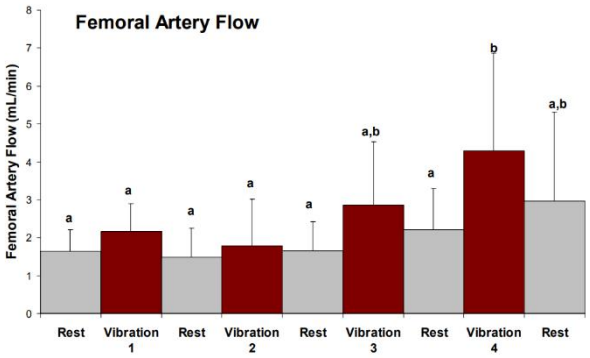


Figure 2: Influence of WBV on Femoral Artery Flow; Letters designate differences from Rest 1 ($p<0.05$)

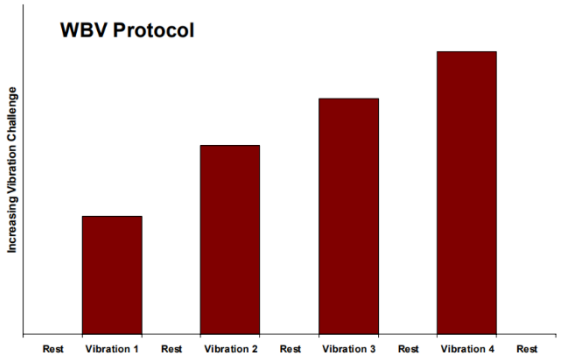


Figure 1: Schematic representation of the testing protocol

Purposes:

- To examine the influence of WBV on peripheral and central cardiovascular responses.
- To examine the influence of graded WBV on metabolic stress (VE, VO2, RER).
- To examine the influence of WBV on psychological stress (RPE).

Methods:

- Six healthy college age females (24.2 ± 3.1 y; 165 ± 3.5cm; 56 ± 2 kg).
- Four 3-minute stages of WBV separated by three minutes of rest (Fig 1).
- Increasing vibration challenge was achieved by varying frequency of WBV and foot placement on WBV platform- Galileo 2000.
- Measures of HR, MAP, femoral artery diameter (FAD) and flow (FAF), VE, VO2, RER and RPE were taken at the end of each rest and WBV cycle.

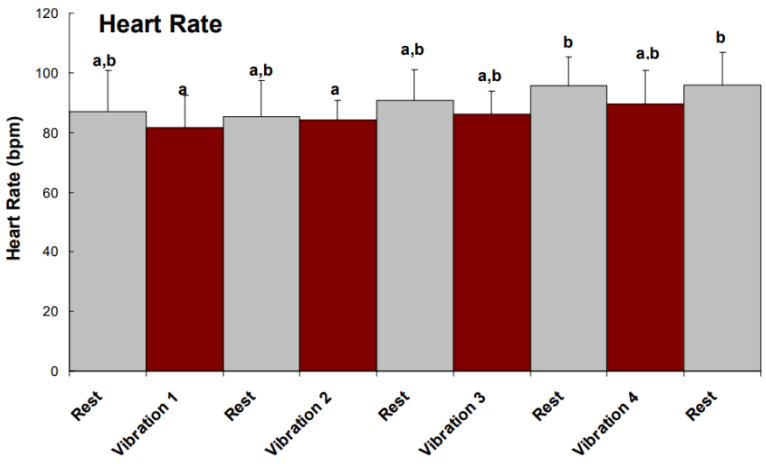


Figure 3: Influence of WBV on Heart Rate: Letters designate differences from Rest 1 ($p<0.05$)

Results:

- WBV resulted in increased flow at the highest vibration challenge compared to rest.
- No change in femoral artery diameter.
- HR was higher at final two rest stages compared to first two WBV stages.
- No change in MAP.
- No change in RER or VE but VO2 approached significance ($p=0.07$).
- Increase in RPE at final vibration challenge with large variability.

Conclusions:

- Moderate intensity WBV results in increased femoral artery blood flow without a significant change in artery diameter.
- Variability in RPE among participants suggesting wide range of tolerance for WBV and a possible training effect of vibration causing a decrease in perceived exertion.
- Significant small increases in HR and a trend towards VO2 showing mild physiological strain of WBV at higher loading.
- WBV using this protocol results in mild cardiovascular and metabolic stress, but significant and highly variable psychological stress.
- The psychological stress of WBV exercise may limit individual tolerance to this exercise modality

References:

1. Kerschan-Schindl, K. et al., Clin. Physiol. 21(3): 377- 382, 2001.
2. Rittweger, J. et al., Clin. Physiol. 20(3): 134-142, 2000.
3. Rittweger, J. et al. Eur. J. Appl. Physiol. 86: 169-173, 2001
4. Rittweger, J. et al. Int. J. Sports Med. 23: 428-432, 2002

Shown to Eliminate Osteoporosis

THIS IS A SUMMARY OF A STUDY PUBLISHED IN THE JOURNAL OF BONE AND MINERAL RESEARCH (VOL. 19 (3), 2004) BY SABINE VERSCHUEREN, MACHTELD ROELANTS, CHRISTOPHE DELECLUSE, STEPHAN SWINNEN, DIRK VANDERSCHUEREN AND STEVEN BOONEN KATHOLIEKE UNIVERSITEIT LEUVEN, BELGIUM

Method: The 90 participants, postmenopausal women ranging in age from 58 to 70, were divided into three research groups.

1. The whole-body vibration (WBV) group trained three times per week on a vibration platform, for no more than 30 minutes per session. They performed static and dynamic exercises for the upper leg and hip area, such as squats and lunges.
2. The conventional weight training group trained three times per week, for about one hour per session, including a separate warm-up and cool-down.
3. The control group did no training at all.

The WBV group performed workouts of 30 minutes or less, including static and dynamic exercises for the upper leg and hip area. The vibration therapy training variables started at a low level, which was gradually intensified by:

- Increasing duration (exercise time)
- Increasing the number of exercises performed
- Shortening the rest periods between exercises
- Increasing frequency from 35Hz to 40Hz
- Increasing amplitude from low to high

The weight training group performed conventional weight training exercises for a total of one hour per session, including a separate warm-up and cool-down.

Results: The WBV group got positive results: strength increased as much as 16% in upper leg muscles, while bone density at the hip increased by 1.5%. In addition, the WBV group showed an improvement in postural control and balance, and an increase in muscle strength and lean mass, while losing body fat and fat mass. The conventionally trained subjects were able to slow the rate of bone loss, which is consistent with previously published studies on weight training and bone loss. The control group subjects continued to lose bone mineral density at the average rate.

Conclusions:

Vibration therapy training:

- Increases bone mineral density
- Is a viable solution to reverse bone loss and eliminate osteoporosis
- Is an accessible training tool to help many populations prevent falls and fractures
- Increases strength
- Improves balance and equilibrium
- Improves posture
- Stimulates fat loss
- Improves overall health

Circulation

THIS IS A SUMMARY OF TWO STUDIES CONDUCTED AT LOMA LINDA UNIVERSITY (USA) PUBLISHED IN THE MEDICAL SCIENCE MONITOR, VOL. 13(2), PP: CR71-76, 20071 AND VOL. 14(3), PP: CR112-116, 20082. STUDY 1 "THE EFFECT OF WHOLE-BODY VIBRATION ON LOWER EXTREMITY SKIN BLOOD FLOW IN NORMAL SUBJECTS" BY EVERETT B. LOHMAN, JERROLD SCOTT PETROFSKY, COLLEEN MALONEY-HINDS, HOLLY BETTS-SCHWAB AND DONNA THORPE STUDY 2 "THE EFFECT OF 30 HZ VS. 50 HZ PASSIVE VIBRATION AND DURATION OF VIBRATION ON SKIN BLOOD FLOW IN THE ARM" BY COLLEEN MALONEY-HINDS, JERROLD SCOTT PETROFSKY AND GRENITH ZIMMERMAN

Method: The study of Lohman et al. (2007) involved 45 subjects who were randomly divided into 3 groups. Group 1 performed static exercises, namely squats and two kinds of calf raises at 30 Hz on a vibration plate. Group 2 performed the same exercises with the vibration plate turned off. Group 3 received three lots of 60-second calf massages at 30 Hz on the same vibration plate.

Skin blood flow was measured before, immediately after, and 10 minutes after the exercise. An increase in skin blood flow was recorded both immediately and 10 minutes after the massage amongst the participants in Group 3. However, no change in skin blood flow was recorded amongst the participants in the other two groups at either of those times. An explanation for not finding an increase in circulation in the exercise groups could be due to several reasons, namely that the blood flow requirements of the active muscles were greater than the increased blood supply, or the fact that the blood flow was directed away from the skin and directed towards areas where it is needed, such as muscles. This study shows that short spurts of massage on a vibration plate significantly increases skin blood flow on the lower extremities like the calves.

In the study of Maloney-Hinds et al. (2008), 18 subjects were randomly divided into a 30 Hz or 50 Hz vibration group. Both groups received 10-minute massages on their arms. Skin blood flow was measured every minute from baseline (pre-vibration) up until 15 minutes after massage.

Result: There was a marked increase in skin blood flow after massage at both 30 Hz and 50 Hz high, with the greatest peak after five minutes of massage in both groups. Although there is no significant difference between both groups, the blood flow increased more rapidly and reached a higher level amongst participants in the 50 Hz high group. Another difference between both groups is the blood flow during the recovery period, which remained higher amongst the 50 Hz high group.

Reduction of Cellulite

THIS RESEARCH WAS CONDUCTED AT THE SANADERM PROFESSIONAL CLINIC FOR SKIN DISEASE AND ALLERGOLOGY, BAD MERGENTHEIM, GERMANY (MAY-NOVEMBER, 2004) BY DR. HORST FRANK AND DR. BIRGIT MOOS

Introduction: Cellulite is the dreaded "orange peel" or "cottage cheese" skin condition many women suffer from. The subcutaneous tissues are a web of connective tissue, where much of a woman's body fat is stored. As the separate layers of tissue are connected to the skin by relatively inelastic fibres, the service of the skin can become dimpled and puckered when the fatty cells get enlarged. Contributing to the "mattress" effect is fluid retention, the storage of environmental toxins, hormonal factors, and lack of circulation. When circulation within this web of connective tissues becomes blocked, cellular waste stagnates, and these tissues harden as the skin loses its elasticity. The puckering or "mattress" effect is caused by this act of shriveling, dimpling and adherence of the skin to tissues underneath. Specific areas that concern many women are the buttocks, thighs, calves and upper arms. Healthy solutions for reducing cellulite have been elusive, but this study suggests that vibration therapy is effective. The German Sanaderm Clinic performed a six-month research project investigating the effects of whole-body vibration (WBV) training on cellulite.

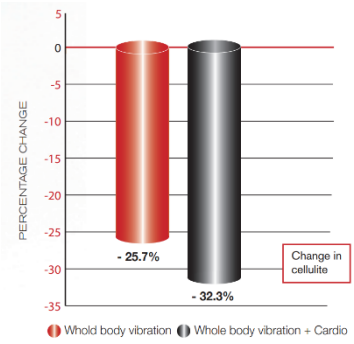


Figure 1: Change in cellulite levels (after six months) for two whole-body vibration groups. Cellulite was measured by evaluating the deposits of

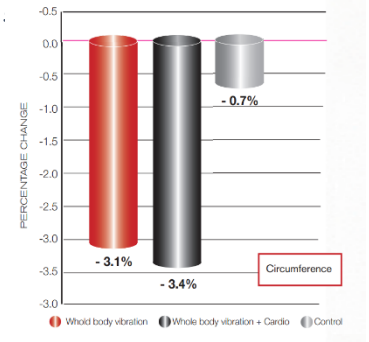


Figure 2: Change in the circumference of the buttocks of the whole-body vibration group and the whole-body vibration + cardio group.

Method: Fifty-five subjects were divided into two groups. The first group only trained on the vibration plate; 2-3 times per week, for sessions of 8-13 minutes. The second group also used whole-body vibration but supplemented their workouts with 24-48 minutes of cardio training. Baseline measurements and tests were completed at the beginning of the study and repeated six months later. The data collected consisted of, (1) skin condition (the measure of cellulite or evaluation of the deposits of dimpled fat under the skin), (2) circumference of calf muscles, buttocks, and upper thigh, and (3) body composition: body fat percentage, and lean mass percentage.

Conclusions: In six months, the WBV group achieved a 25.7% reduction of cellulite on their thighs and buttocks. The WBV + cardio group achieved a 32.3% reduction of cellulite on their thighs and buttocks.

These research findings reveal a new and exciting solution for fat loss and collagen remodeling. Finally, cellulite loss can be healthy, efficient, time-saving, and fun, allowing whole body vibration users to maintain a youthful and lean, healthy look in a relatively short time and in just a few sessions per week.

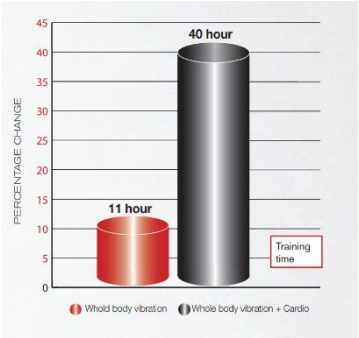


Figure 3: Training time of whole-body vibration group and whole-body vibration + cardio group

Anxiety and Insomnia

THIS IS THE ABSTRACT OF A STUDY PUBLISHED BY HELSINGFORS UNIVERSITET AND AUTHORED BY TUOMI, JANNE, KUURNE-KOIVISTO, MINNA, PARTINEN, MARKKU

Background: Treatment of chronic insomnia is problematic and alternative methods besides drug therapy are sought out for. The aim of the study was to find out about the effects of Neurosonic-low frequency therapy chair on patients with primary insomnia. Therapy is based on Whole-Body Vibration (WBV).

Methods: This pilot study consisted of 16 adults (12 men, 4 women; age range 28 - 65) that suffered from insomnia with an Insomnia Severity Index (ISI) of at least 15. They were randomized into control and intervention groups (8 + 8). Both groups received WBV-treatment for five times. At the start of the study control group had a three week period when they did not receive treatment. Measurements were taken using actigraphy, SCL-90-, WHO-5-, PSQI-, ISI-, EQ-5D-questionnaires and a structured sleep questionnaire based on the Basic Nordic Sleep Questionnaire.

Results: After treatment ISI-scores decreased in both groups. After treatment the WHO-5- and EQ-5D VAS-score were also ameliorated. Treatment also lowered SCL-90 scores related to anxiety, obsessive compulsive and somatization symptoms.

Conclusions: Our results indicate that WBV-treatment has beneficial effects for people suffering from primary insomnia. WBV-treatment also seems to relieve anxiety. No major adverse effects were detected. WBV-treatment may be useful for example in the treatment of insomnia in situations where pharmacological treatment is insufficient. Further studies should be done to have more information about the usefulness of WBV based therapy in treatment of insomnia.

Cardiovascular Function

Robbins D, Yoganathan P, Goss-Sampson M. The influence of whole body vibration on the central and peripheral cardiovascular system. Clin Physiol Funct Imaging. 2014 Sep;34(5):364-9. doi: 10.1111/cpf.12103. Epub 2013 Nov 17. PMID: 24237890.

Abstract: The purpose of this study was to investigate the physiological changes of the cardiovascular system in response to whole body vibration during quiet standing and identify whether there is a greater influence on the central or peripheral cardiovascular system.

Twenty healthy participants (12 male and 8 female) were assessed over two separate testing sessions for changes in peripheral skin temperature, peripheral venous function, blood flow velocity in the dorsalis pedis artery, blood pressure and heart rate during quiet standing with 40 Hz 1·9 mm synchronous vibration. Vibration exposure totalled 5 min in 1 min increments with 5 min recovery during each testing session.

There were no significant changes in heart rate, blood pressure or peripheral skin temperature. Significant results were obtained for blood flow velocity with increases from 0·5 + 0·2 cm·s(-1) at baseline to 1 + 0·2 cm·s(-1) during vibration, returning to baseline levels during the recovery period. Due to the absence of changes in heart rate, blood pressure or lower leg and foot temperature, the change in blood flow velocity can be attributed to changes in peripheral vascular function.

The results suggest a high level of sensitivity of the peripheral vascular system to vibration exposure; therefore, further studies should be completed to ascertain the physiological mechanisms underlying the effects of vibration on the peripheral vascular system.

Varicose Veins

Klyscz T, Ritter-Schempp C, Jünger M, Rassner G. Biomechanische Stimulationstherapie (BMS) zur physikalischen Behandlung des arthrogenen Stauungssyndroms [Biomechanical stimulation therapy as physical treatment of arthrogenic venous insufficiency]. Hautarzt. 1997 May;48(5):318-22. German. doi: 10.1007/s001050050589. PMID: 9303905.

Abstract: We report about a new type of physical therapy which can be used in patients with joint immobility secondary to by chronic venous insufficiency. Biomechanical stimulation therapy (BMS) uses mechanical vibration of standardised frequencies from 18-35 Hz spectrum to expose the feet and legs to longitudinal mechanical stimuli. Therapeutic benefit and clinical improvement can be achieved after a short period of treatment.

We describe a 76-year-old female patient suffering from both impaired motion and recurrent venous ulceration due to chronic venous insufficiency. After 10 days treatment with BMS, mobility of upper ankle joints improved by 16 degrees and 19 degrees and was accompanied by healing of venous ulcerations after skin flap transplantation. Biomechanical stimulation methods were developed in the former Soviet Union where they were used in sports medicine to

improve relaxation of strained muscle structures and to increase the stretching ability of capsules and tendons.

We have successfully treated 6 patients with impaired mobility and chronic venous insufficiency. We believe that BMS is likely to become a valuable therapeutic tool in patients with this problem in the near future.

Gut Health

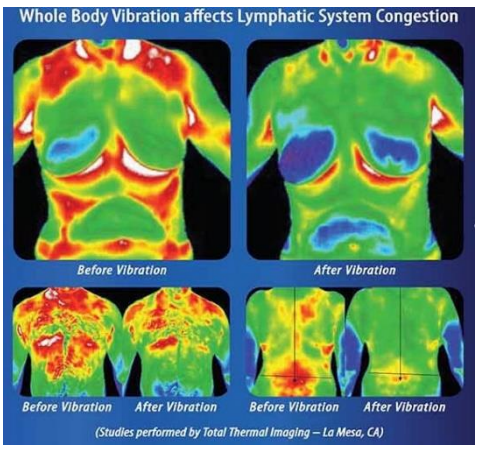
YU JC, HALE VL, KHODADADI H, BABAN B. WHOLE BODY VIBRATION-INDUCED OMENTAL MACROPHAGE POLARIZATION AND FECAL MICROBIOME MODIFICATION IN A MURINE MODEL. INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES. 2019; 20(13):3125. HTTPS://DOI.ORG/10.3390/IJMS20133125

Abstract

Human nutrient metabolism, developed millions of years ago, is anachronistic. Adaptive features that offered survival advantages are now great liabilities. The current dietary pattern, coupled with massively reduced physical activities, causes an epidemic of obesity and chronic metabolic diseases, such as type 2 diabetes mellitus. Chronic inflammation is a major contributing factor to the initiation and progression of most metabolic and cardiovascular diseases. Among all components of an innate immune system, due to their dual roles as phagocytic as well as antigen-presenting cells, macrophages play an important role in the regulation of inflammatory responses, affecting the body's microenvironment and homeostasis. Earlier studies have established the beneficial, anti-inflammatory effects of whole-body vibration (WBV) as a partial exercise mimetic, including reversing the effects of glucose intolerance and hepatic steatosis. Here for the first time, we describe potential mechanisms by which WBV may improve metabolic status and ameliorate the adverse consequences through macrophage polarization and altering the fecal microbiome.

Lymphatic Drainage

RAINER SCHNEIDER (2020) LOW-FREQUENCY VIBROTHERAPY CONSIDERABLY IMPROVES THE EFFECTIVENESS OF MANUAL LYMPHATIC DRAINAGE (MLD) IN PATIENTS WITH LIPEDEMA: A TWO-ARMED, RANDOMIZED, CONTROLLED PRAGMATIC TRIAL, PHYSIOTHERAPY THEORY AND PRACTICE, 36:1, 63-70, DOI: 10.1080/09593985.2018.1479474



Purpose: Although the exact prevalence of lipedema is unknown the number of women suffering from this condition is ever-growing. When treated conservatively, manual lymphatic drainage is regarded the gold standard. However, the rate of its effectiveness varies considerably with some women showing minimal to no improvement depending on severity of the disease and medical history.

Method: Thirty female patients diagnosed with lipedema stage 2–3 referred to physiotherapeutic treatment were randomly allocated to either six treatments of MLD or to

six treatments of combined MLD and vibrotherapy treatment. Outcome parameters were the volume of lipedema at four locations of either the lower (n = 29) or the upper extremities (n = 1), as well as quality of life.

Findings: A very large superiority of effectiveness was found for the combined treatment. Reduction of the sizes of lipedema varied between $1.1 < d < 3.2$. These patients' quality of life was also considerably better (d = 1.0).

Conclusion: Combining MLD with vibrotherapy treatment drastically enhances the effectiveness of treating lipedema.

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