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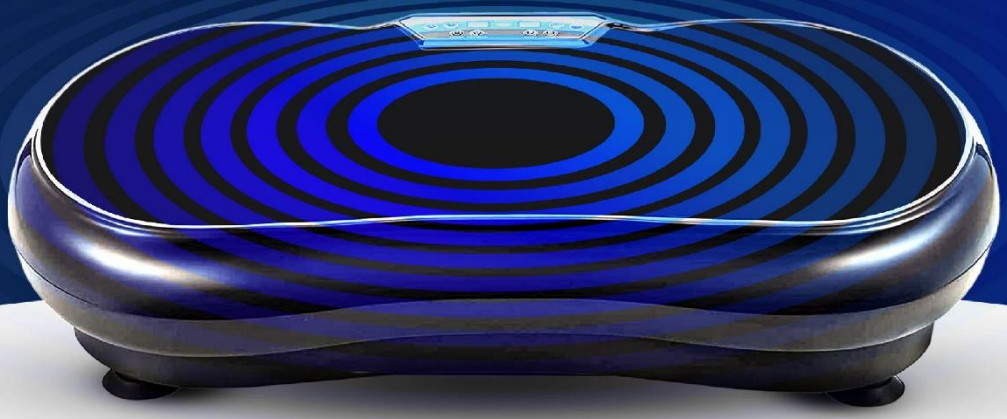
VIBRA PLATE

The Scientific Proof Behind Vibration Therapy & Testimonials



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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/

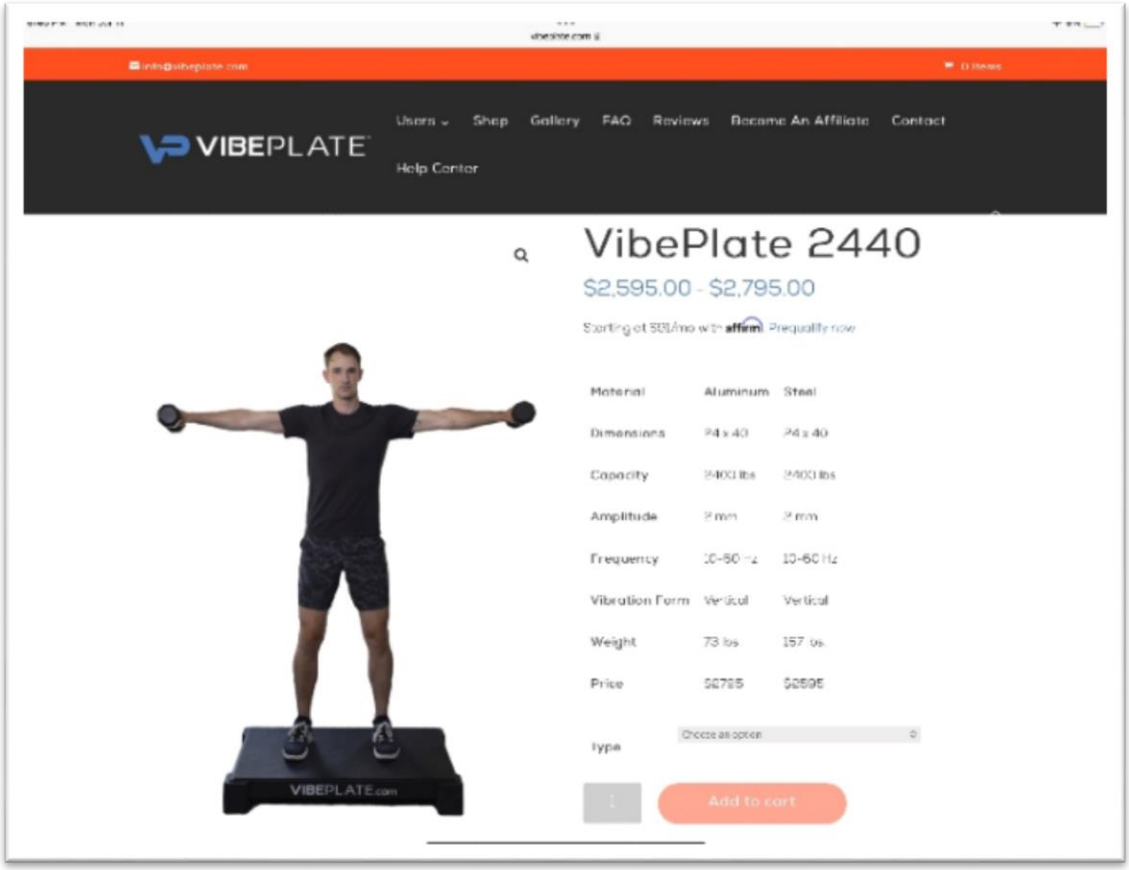
Vibra-Plate

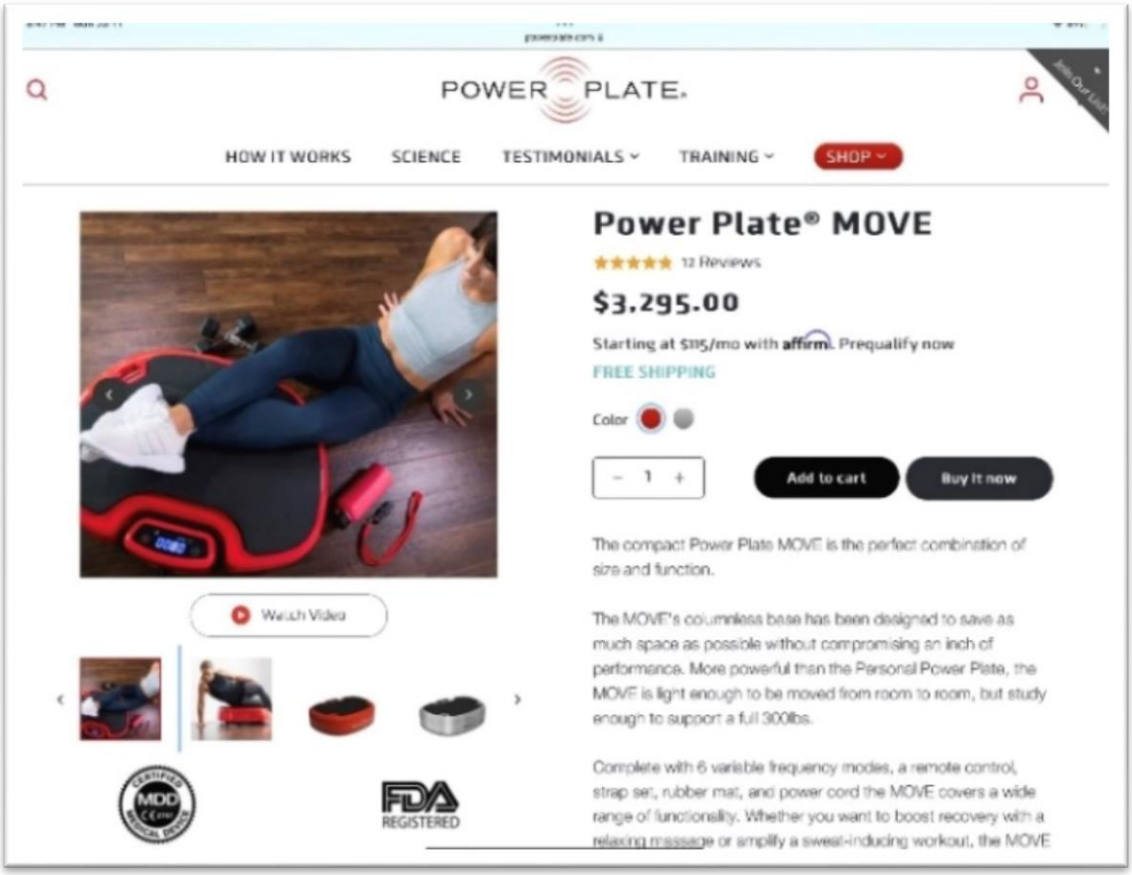
- Highest Grade Motor Design
- Lifetime Warranty
- Built with Durablity
- U.S. & Patriot Owned Company
- Portable and Small

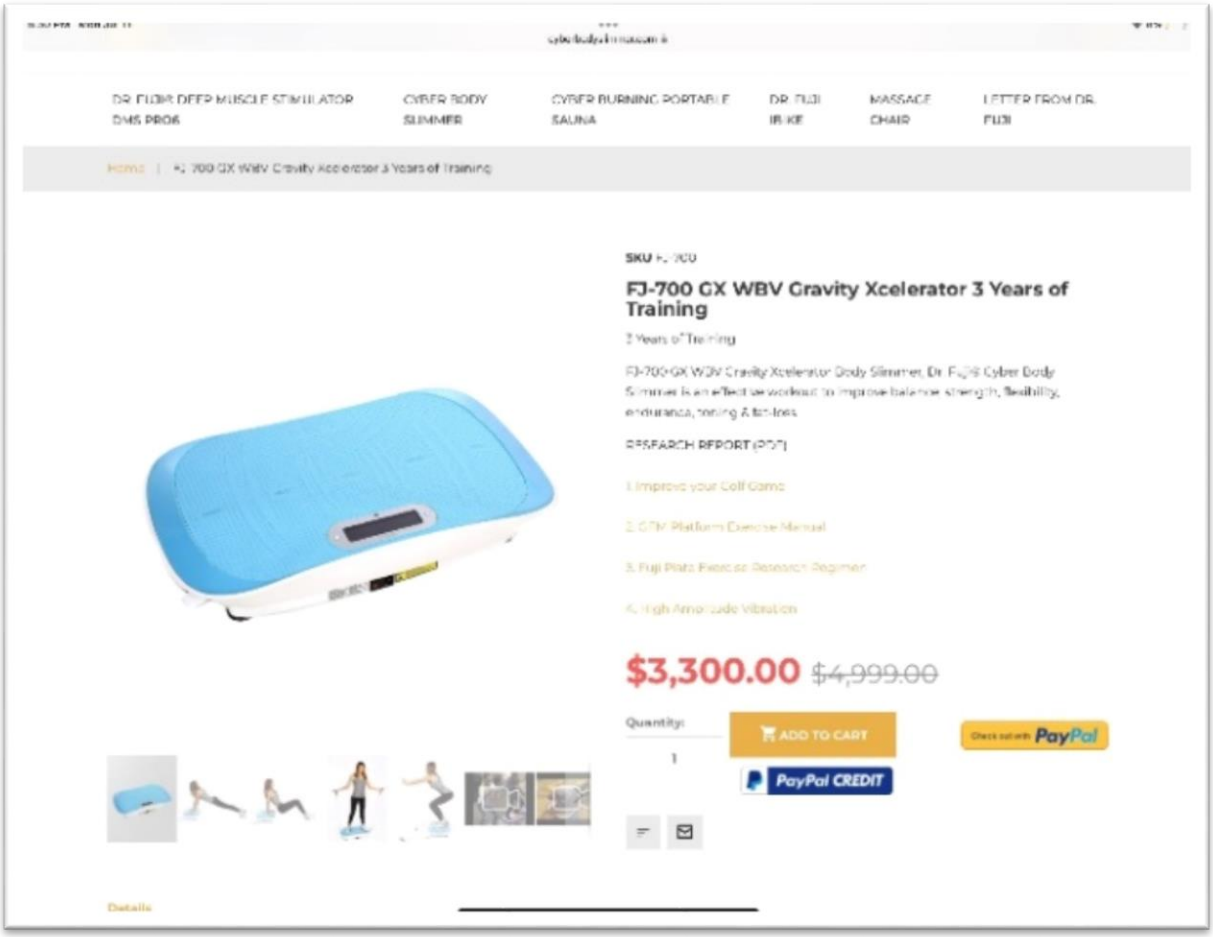
Sub $700 machine off of Amazon

- Motors Do NOT have the Necessary Capacity to Stimulate or Be Effective in Any Way
- Average 1 year Limited Warranty
- Low Quality
- Owned by Foreign Companies
- Often Heavy

Competitor Comparison






DR FUJIS DEEP MUSCLE STIMULATOR DMS PRO6
CYBER BODY SLIMMER
CYBER BURNING PORTABLE SAUNA
DR FUJI IR KIT
MASSAGE CHAIR
LETTER FROM DR FUJI
FJ-700 GX WBV Gravity Xcelerator 3 Years of Training
FJ-700 GX WBV Gravity Xcelerator 3 Years of Training
3 Years of Training
RESEARCH REPORT (PDF)
$3,300.00
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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

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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.

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.

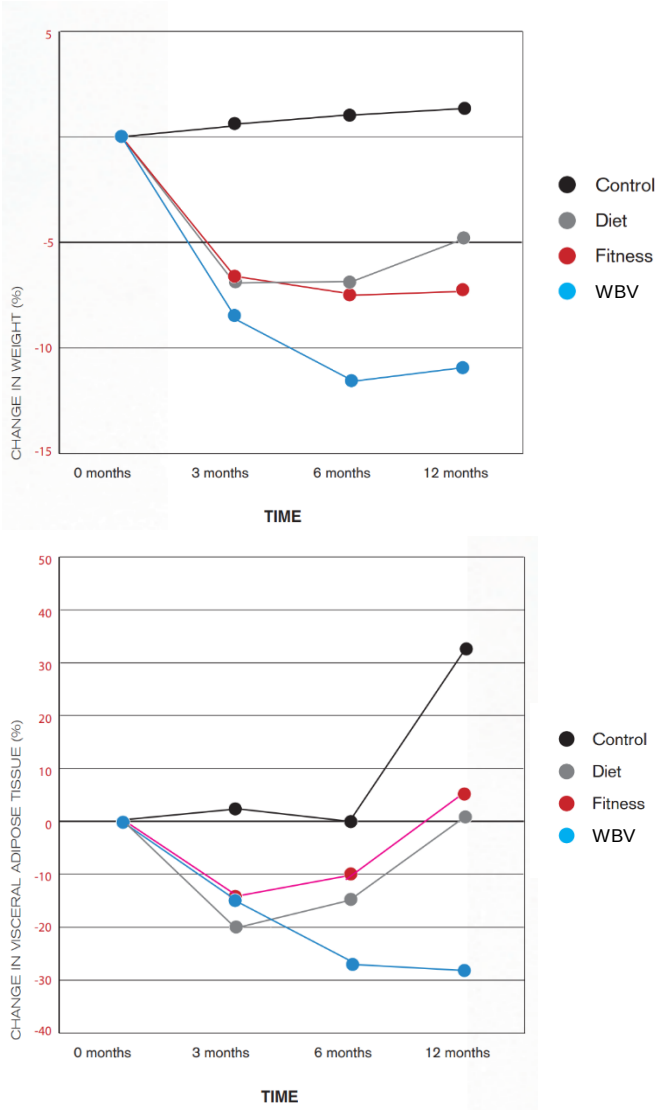
Reduction in Abdominal Fat

This is a summary of a study published in Obesity Facts. The European Journal of Obesity. Vol. 3(2). 2010. By Vissers, D., A. Verrijken, I. Mertens, C. van Gils, A. van de Sompel, S. Truijen, and L. van Gaal University of Antwerp, Belgium

Method: The study of Vissers et al. (2009) involved 79 obese adults (61 of whom completed the study), who were randomly divided into 4 groups. Group 1 received a hypocaloric (low in calories) diet only program (DIET). Group 2 received a hypocaloric diet plus fitness program (cardio and weights exercises) (FITNESS). Group 3 received a hypocaloric diet and progressive vibration therapy training program (WBV or Whole-Body Vibration). Group 4 made no changes to their lifestyle (CONTROL). Each group followed the intervention for six months and had a six-month 'no intervention' follow-up. Anthropometric data, body composition, and metabolic features were measured at three, six, and 12 months. Visceral fat tissue was also measured.

Results: In all three intervention groups (DIET, FITNESS, and WBV) bodyweight decreased significantly, by 5-10%, which is the international standard for a real impact on health, in measurements taken after the 6 intervention months. Only the FITNESS and WBV groups managed to maintain their weight loss of 5% or more in the six 'no intervention' months. **The WBV group even maintained a weight loss of over 10 %.** The mean weight loss was 9.5 kgs which is significant enough to improve health. The main difference between the WBV group and other groups is in the decrease of visceral fat that occurred. The WBV group lost twice as much visceral fat after six months when compared to the FITNESS and DIET groups. This decrease also remained at the same level in the WBV group after 12 months, while the DIET and FITNESS groups returned to their baseline values after 12 months.

Discussion: One possible explanation for why the WBV group did not return to their baseline values might be the hormonal change that vibration therapy causes, as discussed in a mice



Significant difference in weight loss percentage and change in visceral adipose tissue (The black color is for CONTROL, grey is for DIET, red is for FITNESS, and blue is for WBV)

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 has the potential to reduce VAT more than aerobic exercise in obese adults**, 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 also resulted in local increases in bone mass and density**. Also, whole-body vibration did not affect muscle function or food consumption.

The Perfect Complement to Weight Loss Programs

Cristi-Montero C, Cuevas MJ, Collado PS. Whole-body vibration training as complement to programs aimed at weight loss. Nutr Hosp. 2013 Sep-Oct;28(5):1365-71. doi: 10.3305/nh.2013.28.5.6656. PMID: 24160189.

Introduction: Whole-body vibration training (WBVT) has been shown to be an extremely useful tool for increasing muscle mass, bone tissue, muscle power, flexibility, and strength, among others. However, to date, there are few studies on the effects of WBVT on energy metabolism and whether this tool could be able to enhance weight loss in addition to a nutritional plan and/or exercise.

Objective: The aim of this review is to analyse the most recent studies on vibration training in order to determine whether this method constitutes a reliable complement to programs aimed at weight loss.

Methods: An updated literature search was conducted using PubMed, SciELO and SPORTDiscus. In addition, a detailed search was also performed from references given in selected studies.

Results: WBVT appears to be associated with three pathways involved in weight loss: inhibition of adipogenesis and reduction of fat mass, increased energy expenditure, and increase in muscle mass.

Conclusion: Even though further research is required on this subject, WBVT appears to be a safe method that yield benefits, mainly as regards muscle mass, which in turn might promote weight loss when combined with a nutritional plan and a traditional exercise program.

Reducing Fat Mass in the Adult General Population

Omidvar, M., Alavinia, S. M., & Craven, B. C. (2019). The effects of whole-body vibration therapy on reducing fat mass in the adult general population: A systematic review and meta-analyses. Journal of Musculoskeletal & Neuronal Interactions, 19(4), 455-464. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6944803/

Abstract: Whole Body Vibration (WBV) is a popular and a purported alternative to physical activity to reduce body fat, but reports of efficacy are inconsistent. We aimed to describe the efficacy of WBV therapy for reducing fat mass in the adult general population.

A systematic search was conducted using Medline, Embase, Cochrane, CINAHL, and PubMed up to March 27, 2019. Studies, which evaluated the effects of WBV on fat mass (%/kg) as a primary or secondary outcome, were considered for inclusion. Of 2,418 studies, after title and abstract screening, 45 articles underwent full-text screening. Seven controlled trials with a total of 280 subjects were included in the systematic review. The meta-analyses were performed for six studies based on reported fat mass (%/kg) changes in the intervention and control groups.

The mean change for total fat mass per kg and % body fat were -0.76 (95% CI: -1.42, -0.09) and -0.61 (95% CI: -1.51, 0.13) respectively.

This systematic review and meta-analyses showed a significant effect of WBV on total fat mass (kg).

Better Body Composition in Obese Middle-Aged Women

Sunoo, S. (2016). The effects of long-term whole-body vibration and aerobic exercise on body composition and bone mineral density in obese middle-aged women. Journal of Exercise Nutrition & Biochemistry, 20(2), 19-27. https://doi.org/10.20463/jenb.2016.06.20.2.3

Purpose: The purpose of this study was to determine the effectiveness of whole-body passive vibration exercise and its differences from aerobic exercise on body composition, bone mineral density (BMD) and bone mineral content (BMC).

Methods: Obese middle-aged women (n=33 out of 45) with 34±3% body fat completed the training protocol. They were randomly assigned into diet (n=9; control group), diet plus whole-body vibration exercise (n=13; vibration group), and diet plus aerobic exercise (n=11; aerobic group) groups and we compared their body composition, BMD, and BMC before and after 9 months of training. There were no significant differences in nutrient intake among groups during the training period.

Results: Relative body fat (%) decreased significantly ($p < .05$) in all three groups and the exercise groups showed a greater reduction in fat mass than the diet only group. BMD in the whole body, lumbar spine, hip, and forearm were not significantly different among the three groups. **Total body BMC increased significantly in the vibration group throughout the first 6 months of training.**

Conclusion: Results suggest that **long- term vibration training when used in conjunction with a diet program is as effective as aerobic exercise** with a diet program in improving body composition of obese middle-aged women without compromising BMC or BMD. Thus, it can be considered a novel and effective method for reducing body fat.

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.

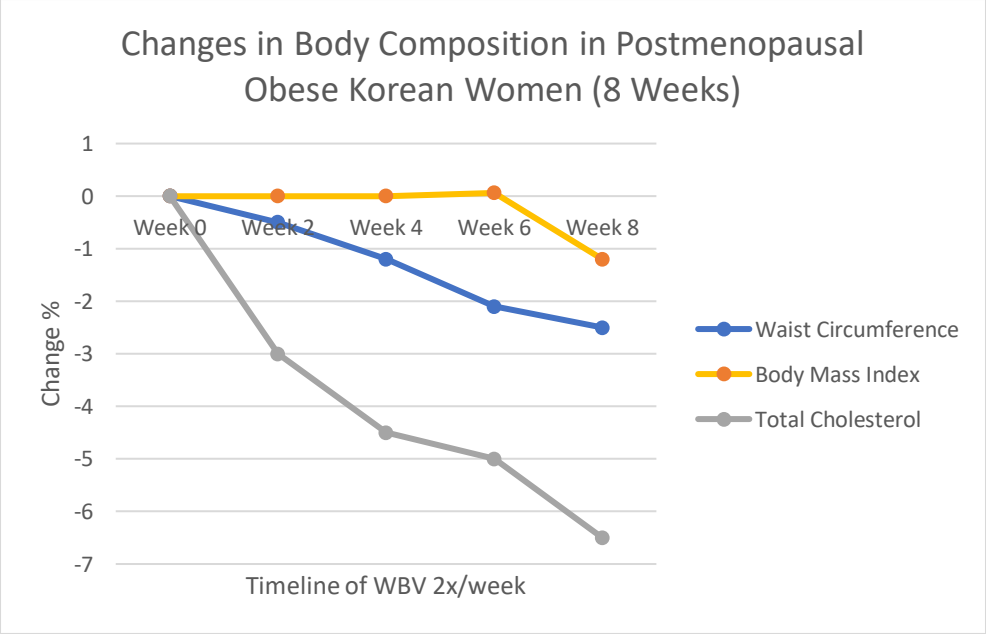
Conclusion: It **is becoming more and more clear that resistance training is a key factor in women's health**. This study demonstrates that whole-body vibration in addition to resistance training can result in positive body composition changes by **increasing lean tissue**. It was also effective in **decreasing 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.

WBV for Postmenopausal Obese Korean Women

Song, E., Kim, K., Lee, J., & Joo, S. (2011). Whole Body Vibration Effects on Body Composition in the Postmenopausal Korean Obese Women: Pilot Study. Korean Journal of Family Medicine, 32(7), 399-405. https://doi.org/10.4082/kjfm.2011.32.7.399

Background: Whole body vibration (WBV) confers a continuous vibration stimulus to the body. While some reports have described the effects of WBV on bone mineral density, muscle mass, muscle power, study of WBV effects on body composition in postmenopausal women is rare. The aim of this pilot study was to examine the effect of WBV on the changes of body weight and body composition in postmenopausal women.

Methods: Fifteen postmenopausal healthy and obese women who were on staff of one university hospital staff located in Suwon, Korea were voluntarily recruited. Inclusion criteria were age over 50 years, and body mass index (BMI) ≥25 kg/m2. WBV group training was performed in 10-minute sessions twice weekly for 8 weeks. Before and after training, anthropometric measurements and body composition analysis were performed.



Results: Weight (-1.18 ± 1.61 kg), BMI (-0.49 ± 0.66 kg/m2), waist circumference (-2.34 ± 2.48 cm) and muscle mass (-0.54 ± 0.59 kg) decreased significantly in the 8-week intervention. Decrease of muscle mass was correlated with weight (r = 0.621, P = 0.013), BMI (r = 0.596, P = 0.019) and percent body fat (r = -0.518, P = 0.048). Linear regression analysis revealed that the

changes of muscle mass had negative relationship with percent body fat change and a positive relationship with body weight changes.

Conclusion: WBV displays a positive effect on body weight and waist circumference reduction in healthy postmenopausal obese women. However, attention must be given to avoid a decrease of muscle mass.

Increased Muscle Strength in Obese Women

Milanese, C., Piscitelli, F., Zenti, M. G., Moghetti, P., Sandri, M., & Zancanaro, C. (2013). Ten-week Whole-body Vibration Training Improves Body Composition and Muscle Strength in Obese Women. International Journal of Medical Sciences, 10(3), 307-311. https://doi.org/10.7150/ijms.5161

Abstract: This work explored the short-term effect of whole-body vibration (WBV) training on anthropometry, body composition and muscular strength in obese women.

Fifty obese women (age=46.8±7.81[SD]y; BMI=35.1±3.55kg/m2) were assigned to a ten-week WBV training period, two times a week (in each session, 14min vibration training, 5min rest; vibration amplitude 2.0-5.0mm, frequency 40-60Hz), with (n=18) or without (n=17) radiofrequency, or to a non-exercise control group (n=15).

The subjects were instructed not to change their habitual lifestyle. Before and after the ten-week experimental period, anthropometric measurements, dual-energy X-ray absorptiometry (DXA), and the leg press, leg curl and leg extension strength tests were carried out.

All changes in the two groups of WBV training, with or without radiofrequency, were similar and these groups were combined in a single WBV intervention group. As compared to controls, subjects submitted to **WBV training had significantly lower BMI, total body, and trunk fat, sum of skinfolds and body circumferences**. On the other hand, **lower limb strength tests were increased** in the WBV group.

These preliminary results suggest that **WBV training improves body composition and muscular strength in obese women** and may be a useful adjuvant to lifestyle prescriptions.

Does Vibration Therapy Reduce Fat Mass?

S. Mohammad Alavinia, Maryam Omidvar & B. Catharine Craven (2021) Does whole body vibration therapy assist in reducing fat mass or treating obesity in healthy overweight and obese adults? A systematic review and meta-analyses, Disability and Rehabilitation, 43:14, 1935-1947, DOI: 10.1080/09638288.2019.1688871

Purpose: This review describes the effects of Whole-Body Vibration therapy (WBV) for reducing fat mass (%/kg) among healthy (no comorbid disease) overweight and obese adults.

Materials and Methods: Systematic literature search was conducted using Medline, Embase, Cochrane, CINAHL, and PubMed databases up to 27th March 2019. Studies evaluating the effects

of WBV therapy on fat mass as a primary or secondary outcome among healthy (no comorbid disease), overweight or obese adults (Body Mass Index ≥25) were included.

Results: Following the search, 2,420 studies were reviewed, and 1,603 studies were selected for title and abstract screening. Of 153 studies considered for full-text review, 13 controlled trials were included in the systematic review. Two meta-analyses were performed for five studies. The first random effects (I2 = 70%, p-value = 0.02) meta-analysis, revealed a statistically significant mean change for percent fat mass (−2.56, 95% CI: −3.81, −1.31). The second fixed effects meta-analysis revealed a significant mean change (−1.91, 95% CI: −2.64, −1.18) for fat mass/kg.

Conclusion: This systematic review and **meta-analyses indicate a positive effect of Whole-Body Vibration therapy on reducing fat mass (%/kg)**, especially when combined with conventional weight loss interventions specifically, diet and exercise.

Implications for rehabilitation:

- Whole Body Vibration therapy assists obese and bariatric clients with weight loss.
- Whole Body Vibration therapy with conventional weight loss strategies augments reductions in fat mass among obese clients in rehabilitation setting.

Weight Loss in Obese Female College Students

Wei Deng, "Effects of Vibration Training on Weight Loss and Heart Rate Variability in the Obese Female College Students", BioMed Research International, vol. 2022, Article ID 1041688, 7 pages, 2022. https://doi.org/10.1155/2022/1041688

Objective: The present study examined the effects of a 12-week whole-body vibration training (WBVT) regimen on heart rate variability (HRV) and body composition in the obese female college students.

Methods: Participants were assigned to either the WBVT (n=17) or obese control group (n=19). The students in the WBVT group conducted a 12-week (5 times per week and 30 min per time) exercise protocols (30 to 40 Hz of frequency and 4 mm of amplitude), and the obese control group did not perform regular physical training during 12 weeks of study. Then, body composition (body weight, BMI, body fat, body fat percentage; trunk fat mass, muscle mass, MM) and HRV (time domain and frequency domain index) were measured in all subjects before and after WBVT intervention.

Results:

1) After 12-week WBVT intervention, **body fat mass, trunk fat mass, and body fat percentage significantly decreased, and muscle mass increased in the WBVT group** (P<0.01, respectively); there was no significant change in body weight and BMI (P>0.05, respectively).
2) After 12-week WBVT intervention, LFn, LF/HF, and HR significantly decreased (P<0.05, P<0.01), R-R interval and RMSSD significantly increased (P<0.01, respectively), and there was no significant difference in HFn ($P>0.05$). Nevertheless, there was no significant change before and after the test in body composition and HRV in the obese control group (P>0.05, respectively).
3) After 12-week WBVT intervention, compared with the obese control group, body fat mass, body fat percentage, trunk fat mass, and LF/HF significantly decreased (P<0.05, P<0.01), muscle mass, and RMSSD increased (P<0.05) in the WBVT group.

4) The reduction of body fat percentage before and after the WBVT intervention are positively correlated with the reduction in the LFn and LF/HF (r=0.542, r=0.504; P<0.05 respectively) and negatively correlated with the increase in the RMSSD (r=-0.514, P<0.05), and the reduction of trunk fat mass are positively correlated with the reduction in the LF/HF (r=0.540, P<0.05).

Conclusion: The results indicate that **WBVT improves HRV and body composition in obese female college students**, and the reduction in body fat percentage and trunk fat mass are associated with a shift in cardiac autonomic regulation towards vagal dominance and improve sympathetic-vagus balance after WBVT intervention. In conclusion, WBVT is a feasible treatment to improve cardiac autonomic function and body composition.

Decrease in Body Fat % in Hispanic Women

This is a summary of a study in the Journal of Aging and Physical Activity by Gregory Severino, Marcos Sanchez-Gonzalez, Michelle Walters-Edwards, Michael Nordvall, Oksana Chernykh, Jason Adames, and Alexei Wong DOI: https://doi.org/10.1123/japa.2016-0087

Abstract: The present study examined the effects of a 6-week whole-body vibration training (WBVT) regimen on heart rate variability (HRV) and body composition in obese Hispanic postmenopausal women.

The participants were randomly assigned to either WBVT (n = 13) or a non-exercising control group (n = 14). HRV and body composition were measured before and after 6 weeks. There was a significant group by time interaction (P < .05) for heart rate, sympathovagal balance, and body fat percentage (BF%) such that all significantly decreased (P < .05); and R-R intervals significantly increased (P < .05) following WBVT compared to no changes after control. The changes in sympathovagal balance were correlated with changes in BF% (r = .63, P < .05).

Our findings indicate that **WBVT improves HRV and BF% in obese Hispanic postmenopausal women**. The improvement in BF% partially explained the decrease in sympathovagal balance. Since obese and older individuals are at increased risk of developing cardiovascular diseases, they can benefit from WBVT.

Using WBV Long-Term to Reduce Fat

This is a summary of a study published in the Journal of Exercise Nutrition & Biochemistry 2016;20(2):19-27 by Sang-seok Nam, Sub Sunoo, Hun-young Park, Hwang-woon Moon. DOI: https://doi.org/10.20463/jenb.2016.06.20.2.3

Purpose: The purpose of this study was to determine the effectiveness of whole-body passive vibration exercise and its differences from aerobic exercise on body composition, bone mineral density (BMD) and bone mineral content (BMC).

Methods: Obese middle-aged women (n=33 out of 45) with 34±3% body fat completed the training protocol. They were randomly assigned into diet (n=9; control group), diet plus whole-body vibration exercise (n=13; vibration group), and diet plus aerobic exercise (n=11; aerobic group) groups and we compared their body composition, BMD, and BMC before and after 9

months of training. There were no significant differences in nutrient intake among groups during the training period.

Results: Relative body fat (%) decreased significantly ($p < .05$) in all three groups and the exercise groups showed a greater reduction in fat mass than the diet only group. BMD in the whole body, lumbar spine, hip, and forearm were not significantly different among the three groups. **Total body BMC increased significantly in the vibration group throughout the first 6 months of training**.

Conclusion: Results suggest that long- term vibration training when used in conjunction with a diet program is as effective as aerobic exercise with a diet program in improving body composition of obese middle-aged women without compromising BMC or BMD. Thus, it can be considered a novel and effective method for reducing body fat.

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.

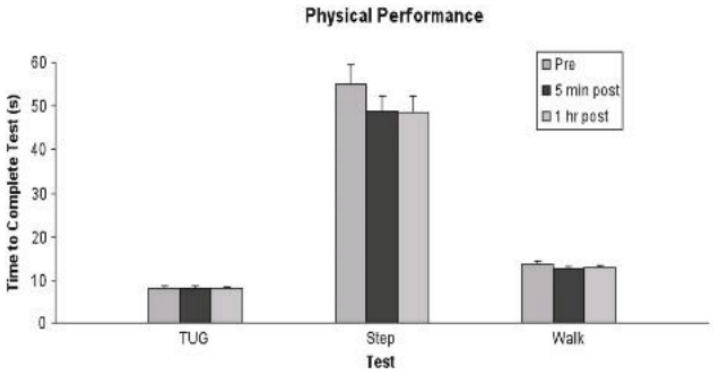
Method: Seventeen people with knee osteoarthritis were recruited from clinics and fitness centers surrounding the University of Florida to participate in this study. Participants underwent 3 tests at 3 different time periods: prior to whole-body vibration (WBV), 5 minutes after WBV, and 1 hour following 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**.



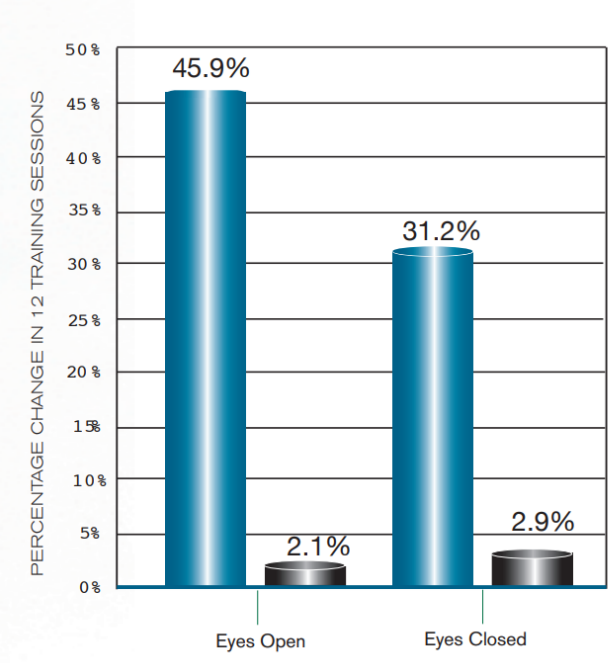
Mean and standard error before, 5 minutes after, and 1 hour after whole body vibration training for the three tests

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 is 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.

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)

Results and conclusions: The results of this study suggest that consistent use of vibration therapy by people with chronic, incomplete SCI, **helps 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.

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 is 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 50Hz for 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 the source to the 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 is 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 is 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 modeling 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 whole-body 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 analyze the currently available literature to determine the effect of WBV exercises on the 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 is 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: The 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. 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 is 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

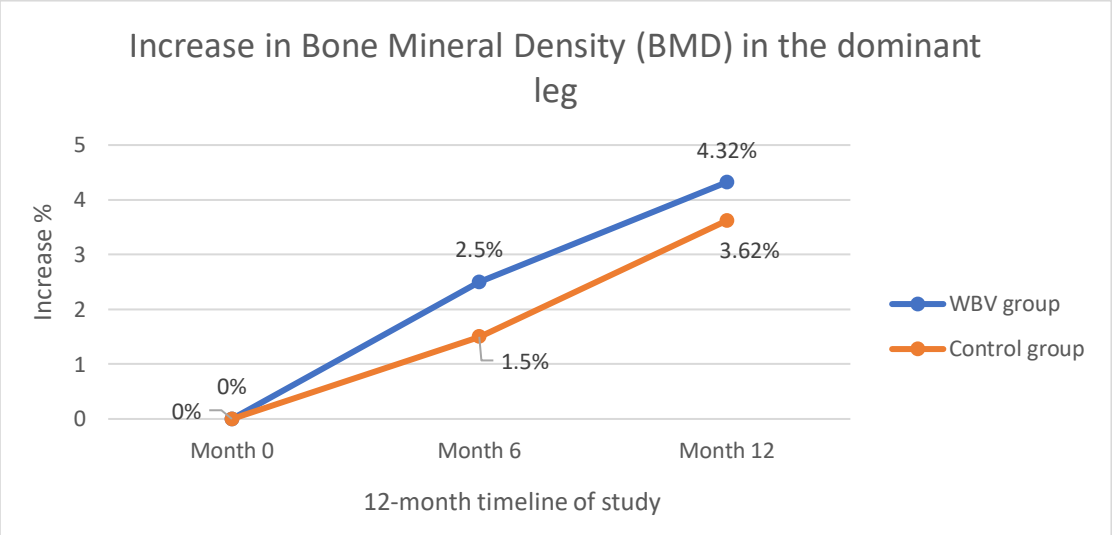
Lam TP, Ng BK, Cheung LW, Lee KM, Qin L, Cheng JC. Effect of whole-body vibration (WBV) therapy on bone density and bone quality in osteopenic girls with adolescent idiopathic scoliosis: a randomized, controlled trial. Osteoporos Int. 2013 May;24(5):1623-36. doi: 10.1007/s00198-012-2144-1. Epub 2012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

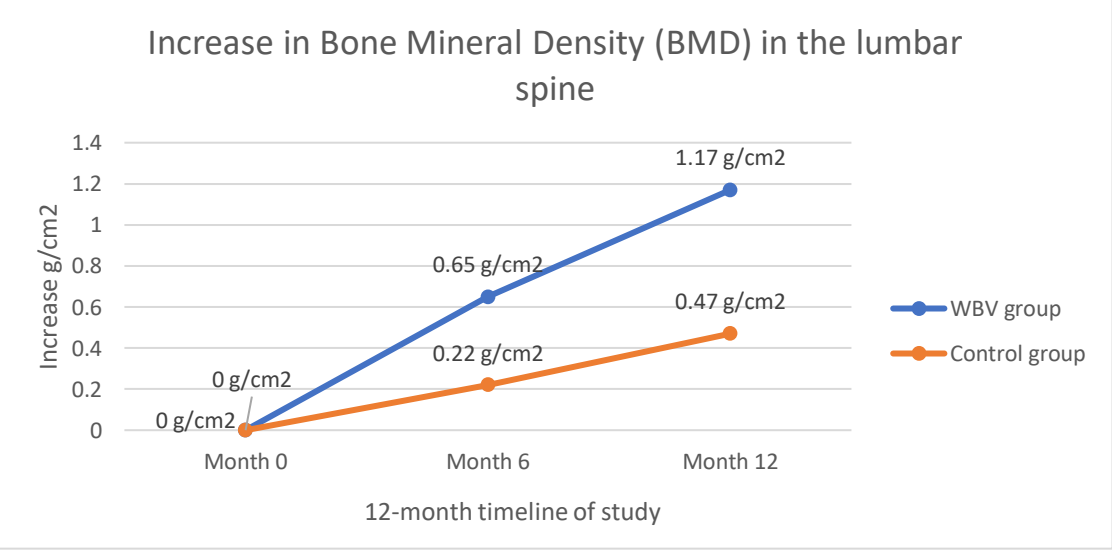
Aim: The aim of this randomized controlled trial was to determine whether whole body vibration (WBV) therapy was effective for treating osteopenia in adolescent idiopathic scoliosis (AIS) patients. Results showed that **WBV was effective for improving areal bone mineral density (aBMD) at the femoral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





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 whole-body vibration (mechanical oscillations) in comparison to a placebo administration to see which one 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 pre-application 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 in 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 (pre-application) to 8.2 s one week after whole-body vibration and increasing from 9.5 s (pre-application) to 10.2 s one week after placebo application. The mean values of the posturographic assessment increased from 70.5 points (pre-application) to 77.5 points one week after whole-body vibration and increased only from 67.2 points (pre-application) 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 positively influences postural control and mobility in multiple sclerosis patients**.

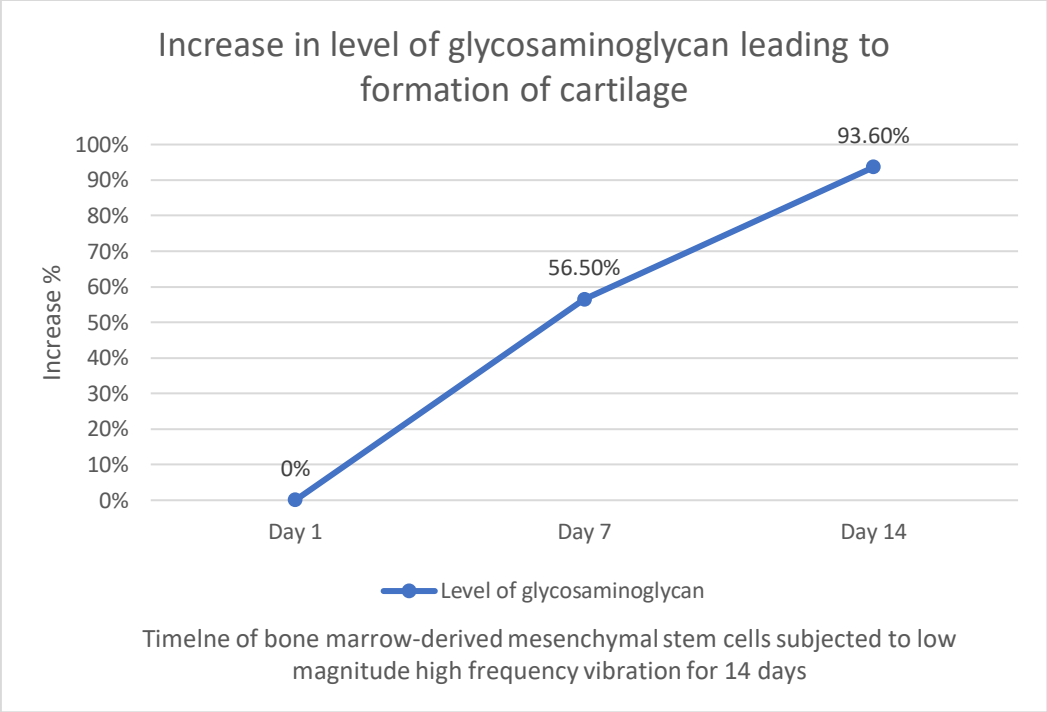
Rebuilding Cartilage and Stimulating Stem Cells

Hou, W., Zhang, D., Feng, X., & Zhou, Y. (2020). Low magnitude high frequency vibration promotes chondrogenic differentiation of bone marrow stem cells with involvement of β-catenin signaling pathway. Archives of Oral Biology, 118, 104860. https://doi.org/10.1016/j.archoralbio.2020.104860

Objective: Mesenchymal stem cells (MSCs) are well known to have the capability to form bone and cartilage, and chondrogenesis derived from MSCs is reported to be affected by mechanical stimuli. This research aimed to study the effects of low magnitude high frequency (LMHF) vibration on the chondrogenic differentiation of bone marrow-derived MSCs (BMSCs) which were cultured with chondrogenic medium, and to investigate the role of β-catenin cascade in this process.

Methods: Rat bone marrow-derived MSCs (BMSCs) were isolated and randomized into vibration and static cultures. The effect of vibration on BMSCs proliferation, differentiation and chondrogenic potential was assessed at the protein level.

Results: LMHFV did not affect the proliferation of BMSCs. However, this was accompanied by increased markers of chondrogenesis. The protein expression of chondrocyte-specific markers of Aggrecan, Sox9, and BMP7 were upregulated, and Collagen X was decreased by LMHF vibration introduced at the chondrogenic differentiation in vitro. Specifically, thicker, blue-stained particles were observed in Alcian Blue staining and the level of glycosaminoglycan were significantly increased respectively in the vibration culture group by 56.5 % and 93.6 % on the 7th and 14th day. The expression and nuclear translocation of β-catenin were activated in a significant manner. And inhibition of GSK-3β activity with Licl rearranged and intensified the cytoskeleton affected by vibration stimulation.



Conclusions: Our data demonstrated that LMHF mechanical vibration promotes BMSCs chondrogenic differentiation and implies β-catenin signal acts as an essential mediator in the mechano-biochemical transduction and subsequent transcriptional regulation in the process of chondrogenesis.

Strengthens Pelvic Floor (especially helpful for moms after childbirth)

Farzinmehr, A., Moezy, A., Koohpayehzadeh, J., & Kashanian, M. (2015). A Comparative Study of Whole Body Vibration Training and Pelvic Floor Muscle Training on Women's Stress Urinary Incontinence: Three- Month Follow- Up. Journal of Family & Reproductive Health, 9(4), 147-154. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4818376/

Objective: To determine whether Whole Body Vibration Training (WBVT) is effective at improving pelvic floor muscles strength in women with Stress Urinary Incontinence (SUI).

Materials and methods: The study was designed as a randomized clinical trial. 43 women with SUI were randomly assigned in two groups; WBVT and Pelvic Floor Muscle Training (PFMT) and received interventions for four weeks. Pelvic floor muscle (PFM) strength, quality of life and incontinence intensity were evaluated. All measurements were conducted pre and post intervention and also after 3 months in all participants. The ANOVA and the independent sample t test were applied respectively to determine the differences in each group and between the groups.

Results: This study showed the **WBVT protocol in this study was effective in pelvic floor muscles strength similar to PFMT, and also in reducing the severity of incontinence** and increasing I-QOL questionnaire score. We found significant differences in each group pre and post intervention (p = 0.0001); but no significant difference in comparison of two groups' outcomes. Also, after three-month follow up, there was no significant difference between groups.

Conclusion: The findings of this **study showed the beneficial effects of WBVT in improving pelvic floor muscles strength and quality of life in patients with urinary incontinence** in four-week treatment period and after three months follow up.

Decreased Fall Risk in Nursing Home Residents

Bruyere O, Wuidart MA, Di Palma E, Gourlay M, Ethgen O, Richy F, Reginster JY. Controlled whole body vibration to decrease fall risk and improve health-related quality of life of nursing home residents. Arch Phys Med Rehabil. 2005 Feb;86(2):303-7. doi: 10.1016/j.apmr.2004.05.019. PMID: 15706558.

Objective: To investigate the effects of whole-body vibration in the elderly.

Design: Randomized controlled trial.

Setting: Nursing home.

Participants: Forty-two elderly volunteers.

Interventions: Six-week vibration intervention plus physical therapy (PT) (n=22) or PT alone (n=20).

Main outcome measures: We assessed gait and body balance using the Tinetti test (maximum scores of 12 for gait, 16 for body balance, 28 for global score), motor capacity using the Timed Up & Go (TUG) test, and health-related quality of life (HRQOL) using the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36).

Results: After 6 weeks, the vibration intervention group improved by a mean +/- standard deviation of 2.4+/-2.3 points on the gait score compared with no score change in the control group (P <.001). The intervention group improved by 3.5+/-2.1 points on the body balance score compared with a decrease of 0.3+/-1.2 points in the control group (P <.001). TUG test time decreased by 11.0+/-8.6 seconds in the treated group compared with an increase of 2.6+/-8.8 seconds in the control group (P <.001). **The intervention group had significantly greater improvements from baseline on 8 of 9 items on the SF-36 compared with the control group**.

Conclusions: Controlled whole-body vibration improves elements of fall risk and HRQOL in elderly patients.

Rebuilding Patellar Tendon with WBV

Rieder F, Wiesinger HP, Kösters A, Müller E, Seynnes OR. Whole-body vibration training induces hypertrophy of the human patellar tendon. Scand J Med Sci Sports. 2016 Aug;26(8):902-10. doi: 10.1111/sms.12522. Epub 2015 Jul 15. PMID: 26173589.

Abstract: Animal studies suggest that regular exposure to whole-body vibration (WBV) induces an anabolic response in bone and tendon. However, the effects of this type of intervention on human tendon properties and its influence on the muscle-tendon unit function have never been investigated.

The aim of this study was to investigate the effect of WBV training on the patellar tendon mechanical, material, and morphological properties, the quadriceps muscle architecture, and the knee extension torque-angle relationship. Fifty-five subjects were randomized into either a vibration, an active control, or an inactive control group. The active control subjects performed isometric squats on a vibration platform without vibration.

Muscle and tendon properties were measured using ultrasonography and dynamometry. Vibration training induced an increase in proximal (6.3%) and mean (3.8%) tendon cross-sectional area, without any appreciable change in tendon stiffness and modulus or in muscle architectural parameters. Isometric torque at a knee angle of 90° increased in active controls (6.7%) only and the torque-angle relation remained globally unchanged in all groups.

Therefore, **this study shows for the first time that WBV elicits tendon hypertrophy in humans**.

Numerous Improvements in Total Knee Replacement Patients

He, Z., Zheng, J., Liu, S. et al. The effect of whole-body vibration in osteopenic patients after total knee arthroplasty: a randomized controlled trial. Aging Clin Exp Res 34, 1381–1390 (2022). https://doi.org/10.1007/s40520-021-02043-2

Background: Total knee arthroplasty (TKA) is an important treatment for knee osteoarthritis, but the result of whole-body vibration (WBV) in knee function rehabilitation and bone loss with osteopenia was unknown. Therefore, the purpose of this study is to study whether low-frequency, low-amplitude WBV can improve the clinical outcome of knee osteoarthritis.

Methods: This study was randomized and included 67 osteopenic patients (55–90 years, 85% women) for TKA surgery (control group N = 32, WBV group N = 35). All selected patients after TKA surgery tested clinical results, such as knee function and bone mass in baseline, 3 months after surgery, and 6 months after surgery.

Results: Compared to the control group, the **WBV group improved pain scores, thigh circumference, lower limb muscle strength, joint activity, and joint function** in 6 months after surgery. WBV intervention also **improved bone density in the spine, the microstructure of the radius and tibia, and the bone turnover marker**. At 3 months after TKA surgery, the WBV group had no significant effect on knee function and bone loss.

Conclusions: Whole-body vibration for osteopenic patients with knee arthroplasty showed good therapeutic results in 6 months after TKA surgery.

Balance and Gait Improvement in Elderly Hip Replacement Patients

This is a summary of a study published in the Journal of International Academy of Physical Therapy Research: Vol 13 No 3 (2022.12) pp.2670-2675 by Chibok Park, Woonsu Cho, Byeonggeun Kim

Background: Total hip replacement (THR) is performed in patients with femur fractures and osteoarthritis. THR patients have balance problems even after surgery. There is a lack of research on vibration stimulation interventions for balance in THR patients.

Objectives: To investigate the effect of vibration stimulation intervention on the balance and gait of THR patients.

Design: Randomized controlled trials.

Methods: 44 subjects were randomly assigned to a **vibration stimulation group** (VSG) and a non-vibration stimulation group (N-VSG). Seven study subjects dropped out, and 37 completed the study. Timed up and go (TUG) and Berg balance scale (BBS) were used for balance assessment, and 10-meter walk (10MW) was used for gait assessment. The intervention program was conducted three times a week for 4 weeks.

Results: Significant differences within the groups in balance (BBS, TUG) and gait (10MW) between the VSG and the N-VSG. There was no difference between the two groups in any variable.

Conclusion: The **VSG improved the balance and gait of THR patients** without any difference from the N-VSG. However, **VSG showed a higher effect size than N-VSG**.

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). DOI: 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 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 is 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 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 elderlies in maintaining their health and independence.

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.

Does a Short-term WBV Intervention Improve Physical Fitness in the Elderly?

Gómez-Cabello, A., González-Agüero, A., Ara, I., Casajús, J., & Vicente-Rodríguez, G. (2013). Effects of a short-term whole body vibration intervention on physical fitness in elderly people. Maturitas, 74(3), 276-278. https://doi.org/10.1016/j.maturitas.2012.12.008

Abstract: We aimed to clarify whether a short-term whole-body vibration (WBV) training has a beneficial effect on physical fitness in elderly people. Forty-nine non-institutionalized elderly (75.0 ± 4.7 years) participated in the study. Twenty-four of them trained on a vibration platform for 11 weeks.

Physical fitness included balance, lower- and upper-body strength and flexibility, agility, walking speed and endurance. In the WBV group most of the physical tests improved through the intervention (all $P < 0.01$) while in the control group only an increment was detected in lower-body strength ($P < 0.05$). In conclusion, a **short-term WBV training is beneficial for physical fitness among elderly people**.

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**.

One study published in 2013 reported a significant increase in BMD measured with peripheral qualitative computed tomography. 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**.

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** (VO_2 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.

The **VIBRA Plate** is a safe, efficient, and non-exhausting alternative to a traditional fitness training program, enhancing muscle strength and cardiorespiratory fitness in older individuals.

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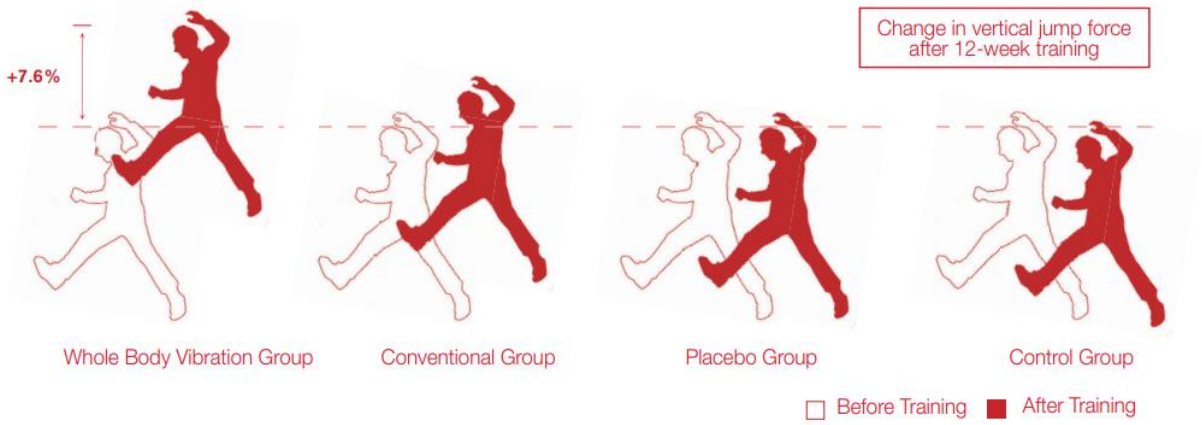
4

Fitness and Sports Performance

Strength Gains and Higher Jumps with Vibration Therapy

Roelants M, Delecluse C, Verschueren SM. Whole-body-vibration training increases knee-extension strength and speed of movement in older women. J Am Geriatr Soc. 2004 Jun;52(6):901-8. doi: 10.1111/j.1532-5415.2004.52256.x. PMID: 15161453.



This research suggests that whole-body vibration has great potential in therapeutic environments. It can enhance muscle performance in rehabilitation patients and the elderly, as well as in populations who may not be attracted to, or physically able to, perform strength training. Whole body vibration can also enhance the performance of athletes, as suggested by improved strength and vertical jump height as achieved by the subjects in this study.

Method: Sixty-seven untrained subjects were divided into four groups and exercised three times per week for 12 weeks.

1. The whole-body vibration group performed standing knee extensor exercises at a frequency of 35-40 Hz, such as lunges and squats.
2. The placebo group also used a vibration plate which was adapted so that it did not generate vertical sinusoidal vibration. They felt a vibration, but it was too subtle to elicit a training effect. They performed the same exercises as the whole-body vibration group.
3. The resistance training group performed a cardio warm-up and knee extensor exercises on two conventional strength training machines.
4. The control group did not participate in any training.

Tests: The contractile properties of the knee extensors were evaluated at the start (pre-test) and after 12 weeks (post-test). A dynamometer was used both times to measure isometric, dynamic, and ballistic knee extensor strength in all subjects.

Results: The whole-body vibration group achieved a **16.6% gain in isometric strength of knee extensors, a 9% increase in dynamic strength of the quadriceps muscles, and a 7.6% increase in vertical jump height**. There were no reports of adverse side effects. Most subjects found the vibration training enjoyable and fatiguing but did not consider it a hard or exhausting workout. The placebo group, using a non-functional vibration machine, did not achieve strength or power gains, although they performed the same standing knee extensor exercises. The resistance training group achieved strength gains of 14.4% in isometric and 7.0% in dynamic strength respectively; there was no significant improvement in power and vertical jump height. The control group showed no improvement in any of the properties measured.

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 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).

The **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.

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.

Increase in Oxygen Uptake

Rittweger J, Ehrig J, Just K, Mutschelknauss M, Kirsch KA, Felsenberg D. Oxygen uptake in whole-body vibration exercise: influence of vibration frequency, amplitude, and external load. Int J Sports Med. 2002 Aug;23(6):428-32. DOI: 10.1055/s-2002-33739. PMID: 12215962.

Abstract: Vibration exercise (VbX) is a new type of physical training to increase muscle power. The present study was designed to assess the influence of whole-body VbX on metabolic power. Specific oxygen uptake (sVO(2)) was assessed, testing the hypotheses that sVO(2) increases with the frequency of vibration (tested in 10 males) and with the amplitude (tested in 8 males), and that the VbX-related increase in sVO(2) is enhanced by increased muscle force (tested in 8 males).

With a vibration amplitude of 5 mm, a linear increase in sVO(2) was found from frequencies 18 to 34 Hz ($p < 0.01$). Each vibration cycle evoked an oxygen consumption of approximately 2.5 micro l x kg(-1). At a vibration frequency of 26 Hz, sVO(2) increased more than proportionally with amplitudes from 2.5 to 7.5 mm. With an additional load of 40 % of the lean body mass attached to the waist, sVO(2) likewise increased significantly.

A further increase was observed when the load was applied to the shoulders. The present findings indicate that metabolic power in whole-body VbX can be parametrically controlled by frequency and amplitude, and by application of additional loads.

These results further substantiate the view that **VbX enhances muscular metabolic power, and thus muscle activity**.

Improves Isokinetic Strength

Martínez-Pardo E, Romero-Arenas S, Alcaraz PE. Effects of different amplitudes (high vs. low) of whole-body vibration training in active adults. J Strength Cond Res. 2013 Jul;27(7):1798-806. doi: 10.1519/JSC.0b013e318276b9a4. PMID: 23096064.

Abstract: The aim of this study was to evaluate the effects of two different amplitudes of whole-body vibrations on the development of strength, mechanical power of the lower limb, and body composition.

Thirty-eight recreationally active participants took part in the study. The participants were divided in two experimental groups (low amplitude group [GL] = 2 mm; high amplitude group [GH] = 4 mm) and a control group.

The experimental groups performed an incremental vibratory training, 2 days per week for 6 weeks. The frequency of vibration (50 Hz), time of work (60 seconds), and time of rest (60 seconds) were constant for GL and GH groups. All the participants were on the platform in a static semi-squat position.

Maximum isokinetic strength, body composition, and performance in vertical jumps (squat and countermovement jumps) were evaluated at the beginning and at the end of the training cycle.

A **significant increase of isokinetic strength was observed** in GL and GH at angular velocities of 60°.s(-1), 180°.s(-1) and 270°.s(-1). Total lean mass was significantly increased in GH (0.9 ± 1.0 kg). There were no significant changes in the total fat mass in any of the groups. Significant changes were not observed in different variables (height, peak power, and rate of force development) derived from the vertical jumps for any of the groups submitted to study.

The vibration training, whatever the amplitude, produced significant improvements in isokinetic strength. However, high vibration amplitude training presents better adaptations for hypertrophy than the training with low vibration amplitude. In this sense, GH would be a better training if the practitioners want to develop both strength and hypertrophy of the lower limbs.

Hypertrophy of Lower Limbs

Martínez-Pardo E, Romero-Arenas S, Martínez-Ruiz E, Rubio-Arias JA, Alcaraz PE. Effect of a whole-body vibration training modifying the training frequency of workouts per week in active adults. J Strength Cond Res. 2014 Nov;28(11):3255-63. doi: 10.1519/JSC.0000000000000531. PMID: 24832971.

Abstract: The aim of this study was to evaluate the effects of whole-body vibration by varying the training frequency (2 or 3 sessions per week) on the development of strength, body composition, and mechanical power.

Forty-one (32 men and 9 women) recreationally active subjects (21.4 ± 3.0 years old; 172.6 ± 10.9 cm; 70.9 ± 12.3 kg) took part in the study divided in 2 experimental groups (G2 = 2 sessions per week, G3 = 3 sessions per week) and a control group (CG). The frequency of vibration (50 Hz), amplitude (4 mm), time of work (60 seconds), and time of rest (60 seconds) were constant for G2 and G3 groups.

Maximum isokinetic strength, body composition, and performance in vertical jumps were evaluated at the beginning and the end of the training cycle. A **statistically significant increase of isokinetic strength was observed** in G2 and G3 at angular velocities of 60, 180, and 270°·s. Total fat-free mass was statistically significantly increased in G2 (0.9 ± 1.0 kg) and G3 (1.5 ± 0.7 kg).

In addition, statistically significant differences between G3 and CG (1.04 ± 1.7%) ($p = 0.05$) were found. There were no statistically significant changes in the total fat mass, fat percentage, bone mineral content, and bone mineral density in any of the groups. Both vibration training schedules produced statistically significant improvements in isokinetic strength. The vibration magnitude of the study presented an adaptation stimulus for muscle hypertrophy. The vibration training used in this study may be valid for athletes to develop both strength and hypertrophy of the lower limbs.

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.

Introduction: 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 a preconditioning exercise with WBV at 40 Hz resulted in **superior peak power output** compared with a 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 preparation for 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 enhances 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.

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

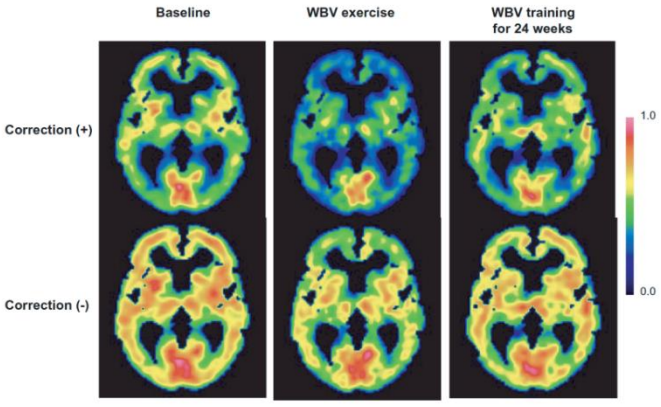
Background: Mild cognitive impairment (MCI) is defined as the boundary between memory loss and impairment. Scientists from two of Japan's leading medical institutes have published exciting new research concluding that whole body vibration, delivered by vibration therapy, increased cerebral blood flow 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 verticalization, muscle force, and modified Gross Motor Function Measure after six months of training.

Conclusions: The new physiotherapy concept, that included whole-body vibration 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 pediatric 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 improves 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 the 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, the 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 activates 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.

Introduction: 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 is 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 **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).

6

Joint Pain, Arthritis, and Pain Relief

Knee Osteoarthritis: Meta-Analysis

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.

Conclusions: Even though there was considerable variation in the parameters of the WBV included in this systematic review, it can be concluded that **WBV training reduces pain and improves function in individuals with knee OA**.

Reduces Knee Pain in Elderly Patients with Osteoarthritis

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: The intragroup results suggest that whole-body vibration represents a feasible and effective way of improving the functionality and self-perception of disease status in older adults with knee OA.

WBV Training for Knee Osteoarthritis

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) may alone 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 ($P < 0.05$).

These results suggest that **adding whole-body vibration training to strengthening training provides better treatment effects for patients with knee osteoarthritis**.

Knee Pain Relief in Japanese Women

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 knee function better than exercise without vibratory stimulus** in middle-aged and older Japanese women with knee pain.

Relief from Knee Osteoarthritis

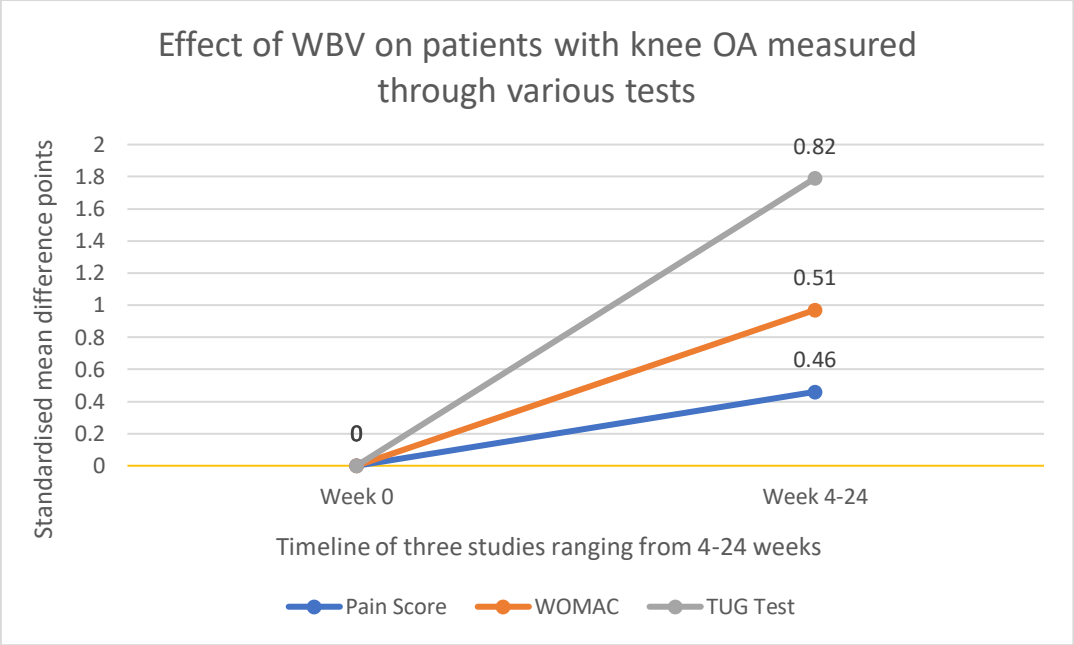
QIU, C. G., CHUI, C. S., Ho CHOW, S. K., CHEUNG, H., & Yeung WONG, R. M. (2022). EFFECTS OF WHOLE-BODY VIBRATION THERAPY ON KNEE OSTEOARTHRITIS: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMIZED CONTROLLED TRIALS. Journal of Rehabilitation Medicine, 54. https://doi.org/10.2340/jrm.v54.2032

Introduction: Knee osteoarthritis is a leading cause of disability and medical costs. The effect of whole-body vibration in knee osteoarthritis is controversial. The aim of this study was to assess the effects and safety of whole-body vibration on pain, stiffness, physical function, and muscle strength in patients with knee osteoarthritis.

Methods: PubMed, Scopus, Web of Science, Physiotherapy Evidence Database (PEDro) and EMBASE databases were searched (date last accessed 1 April 2021) using the key words “vibration” and “knee osteoarthritis”, to identify all randomized controlled trials related to whole-body vibration and knee osteoarthritis. Outcomes related to pain, stiffness, physical function, muscle strength, adverse events were included. The risk of bias and quality were assessed by the

Cochrane Collaboration tool and PEDro scale. A systematic review and meta-analysis were performed. Subgroup analysis was performed for low- and high-frequency interventions.

Results: A total of 14 randomized controlled trials involving 559 patients with knee osteoarthritis met the inclusion criteria. Nine studies were good-quality trials (PEDro score=6–8), and 5 studies were fair-quality trials (PEDro score=4–5). Ten studies were included in the meta-analysis. The duration of whole-body vibration ranged from 4 to 24 weeks.



The meta-analysis revealed that whole-body vibration with strengthening exercises has a **significant treatment effect on pain score** (standardized mean difference (SMD) = 0.46 points, 95% confidence interval (95% CI) = 0.20–0.71, p = 0.0004), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC-function) (SMD = 0.51 points, 95% CI = 0.27–0.75, p < 0.0001), Timed Up and Go (TUG) test (SMD = 0.82 points, 95% CI = 0.46–1.18, p < 0.00001), extensor isokinetic peak torque (SMD = 0.65 points, 95% CI = 0.00–1.29, p = 0.05), peak power (SMD = 0.68 points, 95% CI = 0.26–1.10, p = 0.001), and extensor isometric strength (SMD = 0.44 points, 95% CI = 0.13–0.75, p = 0.006). Both low-frequency (10–30 Hz) and high-frequency (30–40 Hz) whole-body vibration were associated with significant changes in pain, physical function, and knee extensor strength (p < 0.05). No adverse events were reported.

Conclusion: Meta-analysis showed that **low-frequency and high-frequency whole-body vibration had additional positive effects** compared with strengthening exercises alone on pain, knee extensor muscle strength, and physical function in individuals with knee OA. Whole-body vibration with strengthening exercises can be incorporated into treatment protocols.

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 non-significance 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 can 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).

Chronic Musculoskeletal Disorders

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, further work is required to identify which parameters of WBVE are ideal for patients with chronic musculoskeletal pain.

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). 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**.

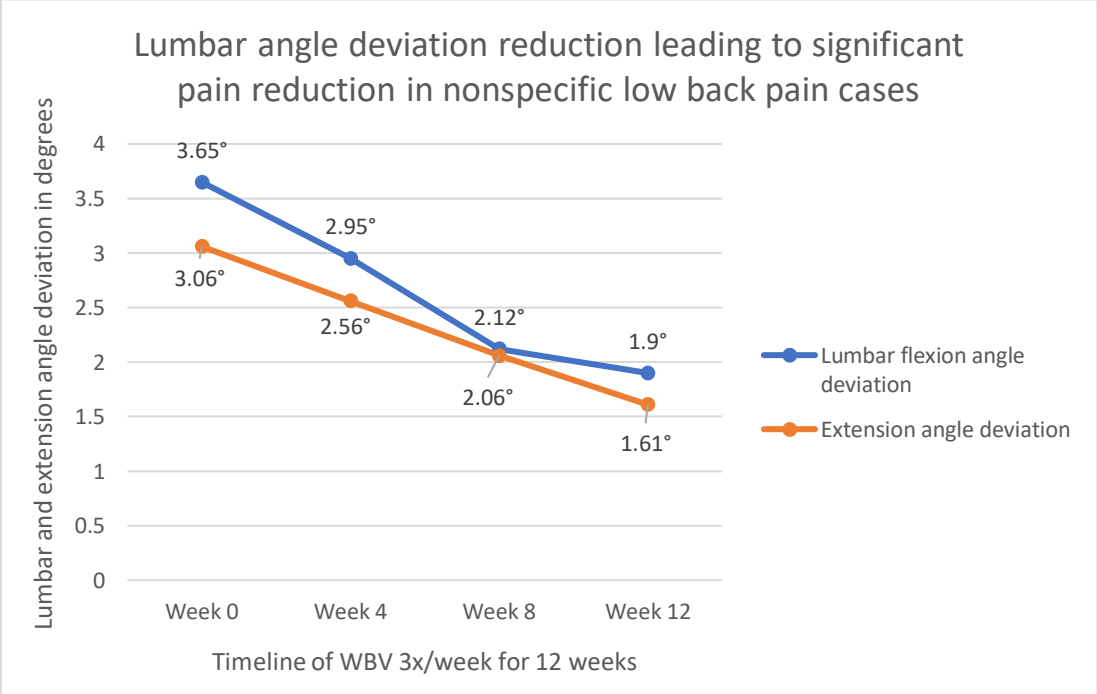
Nonspecific Low Back Pain

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.

Chronic Back Pain Caused by 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.

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

7

Heart Health, Blood Circulation, Gut Health, and Other Issues

Managing Cardiovascular Diseases with WBV

Inês Gonzáles, A., Lavarda do Nascimento, E. G., da Silva, A., Bernardo-Filho, M., da Cunha de Sá-Caputo, D., & Sonza, A. (2023). Whole-body vibration exercise in the management of cardiovascular diseases: A systematic review. Journal of Bodywork and Movement Therapies. https://doi.org/10.1016/j.jbmt.2023.04.057

Background: Cardiovascular diseases (CVDs) are an important public health problem, representing about 45% of deaths in the world. Its management is linked to medications, changes in lifestyle, and physical exercise, with the whole-body vibration exercises (WBV) being a promising therapeutic resource. This study aims to investigate the effects of WBV in isolation or associated with other types of exercises in the management of CVDs.

Methods: A systematic review following the PRISMA guidelines and registered on the PROSPERO platform was carried out. The search took place in the databases PubMed, Cochrane, PEDro, Lilacs, and Science Direct, from the beginning of the databases until January 2021. Descriptors related to WBV and CVD were used. The selected studies were assessed for quality, risk of bias, and level of evidence.

Results: In all, 84 studies were identified, and of these, three were included. The intervention protocols used were analyzed, in addition to the effects of WBV on hemodynamic, cardiovascular, vascular/arterial, and muscle parameters.

Conclusion: The use of different WBV protocols, in isolation, in the improvement of the parameters mentioned above in individuals with CVD is plausible, with **significant responses acutely or chronically** and can be considered as **a safe and effective training resource**.

Does WBV Influence 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.

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 (Maximum Oxygen Uptake), BP (Blood Pressure), HR (Heart Rate) and RPE (Retina Blood FLow) (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.

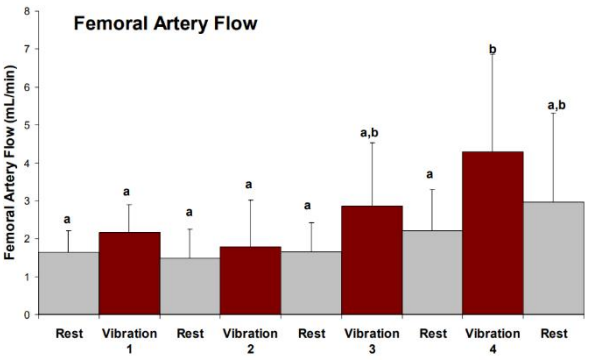


Figure 2: Influence of WBV on Femoral Artery Flow; Letters designate differences from Rest 1 ($p<0.05$)

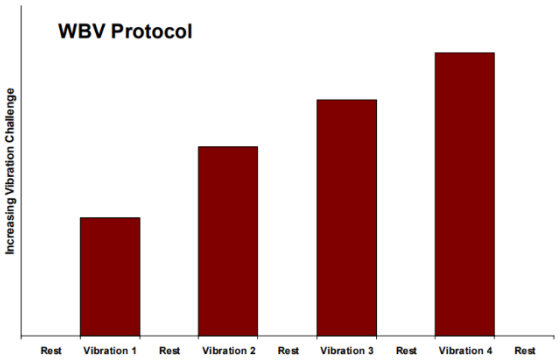


Figure 1: Schematic representation of the testing protocol

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.

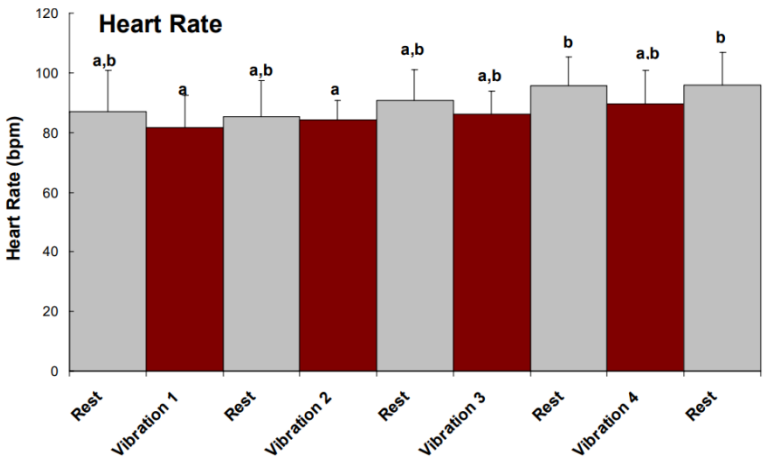


Figure 3: Influence of WBV on Heart Rate: Letters designate differences from Rest 1 ($p<0.05$)

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.

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.

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

Skin Blood Flow

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.

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 (varicose veins). 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 (similar to doing different

positions on a vibration plate). 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.

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.

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.

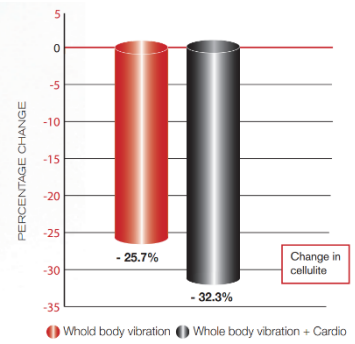


Figure 1: Change in cellulite levels (after six months) for two whole-body vibration groups. Cellulite was measured by evaluating the deposits of subcutaneous dimpled fat

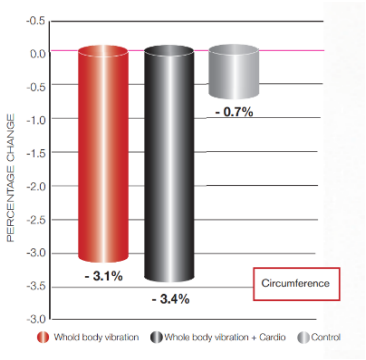


Figure 2: Change in the circumference of the buttocks of the whole-body vibration group and the whole-body vibration + cardio group.

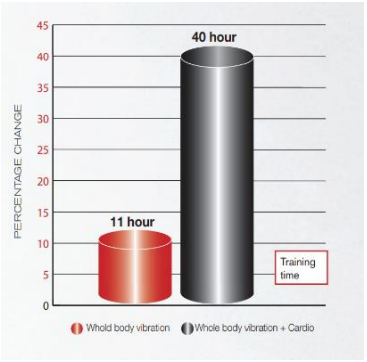


Figure 3: Training time of whole-body vibration group and whole-body vibration + cardio group

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.

Anxiety and Insomnia

This is an 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 relieves 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.

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.

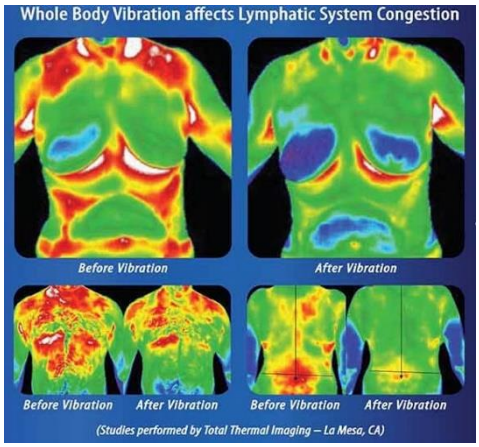
There were two objectives to this study. The first was to investigate the changes in macrophage type in blood and adipose tissues by characterizing the macrophage profiles in these tissues before and after WBV, using a well-established murine T2DM model. The second objective, as an initial step towards a proximate mechanistic exploration in trying to establish casual links between WBV and downstream effects, was to document fecal microbiome changes related to WBV.

The four key findings of the series of experiments done were:

- The baseline ratio of omental M1 to M2 macrophages in T2DM mice is 2:1.
- WBV can cause M1 to M2 polarization in both control and T2DM mice.
- **WBV restores M2 levels in T2DM to near baseline levels of the normal control.**
- WBV alters the fecal microbiome in T2DM mice, increasing bacteroides, especially those belonging to the genus Alistipes of the Rikenellaceae family, which increased by 17.75 times.

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 (a condition where fat gets built-up in legs and sometimes arms) 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**.

8

Spine Health, Diabetes, and High Blood Pressure

Vibration Therapy Tested on Type-1 Diabetic Rabbits

Jing, D., Yan, Z., Cai, J., Tong, S., Li, X., Guo, Z., & Luo, E. (2018). Low-1 level mechanical vibration improves bone microstructure, tissue mechanical properties and porous titanium implant osseointegration by promoting anabolic response in type 1 diabetic rabbits. Bone, 106, 11-21. https://doi.org/10.1016/j.bone.2017.10.001

Abstract: Type 1 diabetes mellitus (T1DM) is associated with reduced bone mass, increased fracture risk, and impaired bone defect regeneration potential. These skeletal complications are becoming important clinical challenges due to the rapidly increasing T1DM population, which necessitates developing effective treatment for T1DM-associated osteopenia/osteoporosis and bone trauma.

This study aims to investigate the effects of whole-body vibration (WBV), an easy and non-invasive biophysical method, on bone microstructure, tissue-level mechanical properties and porous titanium (pTi) osseointegration in alloxan-diabetic rabbits. Six non-diabetic and twelve alloxan-treated diabetic rabbits were equally assigned to the Control, DM, and DM with WBV stimulation (WBV) groups. A cylindrical drill-hole defect was established on the left femoral lateral condyle of all rabbits and filled with a novel non-toxic Ti2448 pTi. Rabbits in the WBV group were exposed to 1 h/day WBV (0.3 g, 30 Hz) for 8 weeks. After sacrifice, the left femoral condyles were harvested for histological, histomorphometric and nanoindentation analyses. The femoral sample with 2-cm height above the defect was used for qRT-PCR analysis. The right distal femora were scanned with μCT.

We found that all alloxan-treated rabbits exhibited hyperglycemia throughout the experimental period. WBV inhibited the deterioration of cancellous and cortical bone architecture and tissue-level mechanical properties via μCT, histological and nanoindentation examinations. T1DM-induced reduction of bone formation was inhibited by WBV, as evidenced by elevated serum OCN, and increased mineral apposition rate (MAR), whereas no alteration was observed in bone resorption marker TRACP5b. WBV also stimulated more adequate ingrowths of mineralized bone tissue into pTi pore spaces, and improved peri-implant bone tissue-level mechanical properties and MAR in T1DM bone defects. WBV mitigated the reductions in femoral BMP2, OCN, Wnt3a, Lrp6, and β-catenin and inhibited Sost mRNA expression but did not alter RANKL or RANK gene expression in T1DM rabbits.

Our findings demonstrated that **WBV improved bone architecture, tissue-level mechanical properties, and pTi osseointegration** by promoting canonical Wnt signaling-mediated skeletal anabolic response. This study not only advances our understanding of T1DM skeletal sensitivity in response to external mechanical cues but also offers new treatment alternatives for T1DM-associated osteopenia/osteoporosis and osseous defects in an economic and highly efficient manner.

WBV-based Intervention for Type-2 Diabetes

del Pozo-Cruz, B., Alfonso-Rosa, R. M., del Pozo-Cruz, J., Sañudo, B., & Rogers, M. E. (2014). Effects of a 12-wk whole-body vibration based intervention to improve type 2 diabetes. Maturitas, 77(1), 52-58. https://doi.org/10.1016/j.maturitas.2013.09.005

Objective: To test the feasibility, safety and effectiveness of a 12-wk whole body vibration (WBV) intervention on glycemic control, lipid-related cardiovascular risk factors and functional capacity among type 2 diabetes mellitus (T2DM) patients in a primary care context.

Methods: Fifty non-insulin dependent T2DM patients were randomized 1:1 to an intervention group that, in addition to standard care, received a 12-wk WBV intervention, and a control group receiving only standard care (from February 2012 through May 2012). Outcomes, including glycated hemoglobin (HbA1c), fasting blood glucose, lipid-related cardiovascular risk factors (i.e., cholesterol, triglycerides, lipoproteins, LDL/HDL and atherogenic index) and functional capacity were measured at baseline and after the 12-wk intervention.

Results: After intervention, there was a **reduction in HbA1c and fasting blood glucose** when compared to the control group, with a mean difference in change scores between groups of −0.55% (95% CI −0.15 to −0.76) and −33.95 mm/dl (95% CI −51.38 to −3.47), respectively. Similarly, most lipid-related cardiovascular risk factors (i.e., cholesterol, triglycerides, and atherogenic index) were also reduced ($p < 0.05$).

Conclusion: A 12-wk WBV intervention in a primary care context is feasible, safe and effective in improving glycemic profile, lipid-related cardiovascular risk factors and functional capacity among T2DM patients.

Effects of WBV in Older Adult Patients with Type-2 Diabetes

Gomes-Neto, M., de Sá-Caputo, D. D. C., Paineiras-Domingos, L. L., Brandão, A. A., Neves, M. F., Marin, P. J., Sañudo, B., & Bernardo-Filho, M. (2019). Effects of Whole-Body Vibration in Older Adult Patients With Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis. Canadian Journal of Diabetes, 43(7), 524-529.e2. https://doi.org/10.1016/j.jcjd.2019.03.008

Objectives: The aim of this systematic review and meta-analysis was to determine the effects of whole-body vibration training on metabolic abnormalities, mobility, balance, and aerobic capacity in older adult patients with type 2 diabetes mellitus.

Methods: We searched PubMed, Cochrane Library, PEDro, LILACS and SciELO (from the earliest date available to March 2018) for controlled trials that evaluated the effects of whole-body vibration on the health-related outcomes of patients with type 2 diabetes. Two reviewers independently selected the studies and performed statistical analyses of the studies. Weighted mean differences, standard mean differences and 95% confidence intervals (CIs) were calculated.

Results: In total, 7 studies, involving 279 patients who had type 2 diabetes, that compared whole-body vibration with other exercises and/or controls were included. Individual studies suggested that whole-body vibration was associated with improvements in pain levels, blood flow in the legs,

glycated hemoglobin levels and fasting blood glucose levels. **Whole-body vibration improved mobility weighted mean differences** (−.24 seg; 95% CI −2.0, −0.5; n=96); **balance standard mean differences** (2.34; 95% CI 1.16, 3.5; n=57); and **aerobic capacity standard mean differences** (0.7; 95% CI 0.2, 1.3; n=59).

Conclusions: Whole-body vibration is a useful strategy in the management of the symptoms and disabilities associated with type 2 diabetes.

Glycaemia Control in Type-2 Diabetic Males

Behboudi, L., Azarbayjani, A., Aghaalinejad, H., & Salavati, M. (2011). Effects of Aerobic Exercise and Whole Body Vibration on Glycaemia Control in Type 2 Diabetic Males. Asian Journal of Sports Medicine, 2(2), 83-90. https://doi.org/10.5812/asjsm.34789

Purpose: Aerobic exercise has been identified as the main treatment for type 2 diabetic patients. Such an exercise, however, is usually repined by some of patients who suffer from lack of stamina. Therefore, whole-body vibration has recently been introduced as a passive intervention. The present study is aimed at comparing how aerobic exercise and whole-body vibration affect glycaemia control in type 2 diabetic males.

Methods: Thirty diabetic males were divided into three groups, namely aerobic exercise (AE), whole body vibration (WBV), and control. Aerobic exercise schedule consisted of three walking sessions a week, each for 30-60 minutes and in 60-70% of maximum stock heartbeat. Vibration exercise was composed of 8-12-min stand-up and semi-squat positioning in frequency of 30 Hz and amplitude of 2 mm. Concentrations of fasting glycosylated hemoglobin, fasting glucose, and insulin were measured in the beginning of the trial, after the fourth week, and after the eighth week.

Results: After 8 weeks of exercise, no significant difference was detected in concentrations of fasting glycosylated hemoglobin and insulin between the groups (P=0.83, P=0.12). There were no significant differences in any of the variables between AE and WBV (P>0.05). But a more significant decrease in fasting glucose was observed in exercise groups (AE and WBV) compared with control group (P=0.02).

Conclusion: The present study showed that **AE and WBV identically stimulate metabolic system**. Thus, it can be concluded that **type 2 diabetic patients lacking stamina for aerobic exercise can opt for vibration exercise as an effective substitute**.

Glucose Level Decrease in Elderly Diabetic Women

Maíra Florentino Pessoa, Helga C. Muniz de Souza, Alanna P. Vasconcelos da Silva, Rafaela dos Santos Clemente, Daniella Cunha Brandão, Armèle Dornelas de Andrade, "Acute Whole Body Vibration Decreases the Glucose Levels in Elderly Diabetic Women", Rehabilitation Research and Practice, vol. 2018, Article ID 3820615, 7 pages, 2018. https://doi.org/10.1155/2018/3820615

Abstract: Type II diabetes (TIIDM) is characterized by high levels of blood glucose followed by excessive insulin release so that the target cells become less sensitive, developing insulin resistance, and maintaining hyperglycemic levels.

Physical activity is the strongest element to prevent and to manage the TIIDM, and the majority of patients do not remain in regularly active levels, because the premature fatigue in these patients decreases the adherence to the training. Contrastingly, the whole-body vibration (WBV) training may improve the glucose metabolism in diabetic patients, reducing the peripheral blood sugar, decreasing the physical discomfort and perceived exertion. Therefore, the purpose of the study was to determine the effect of an acute WBV session as therapy to promote fasting decreases in insulin levels in peripheral blood in TIIDM when compared to healthy elderly.

For this, fifteen healthy elderly women and fourteen diabetic elderly women, all sedentary, were allocated in diabetic or control groups, and we made an acute whole-body session composed of 10 bouts lasting 2 minutes each one, separated by a 30-second rest period. The WBV was executed on a vibration platform (similar to VIBRA Plate) at 35 hertz and a peak-to-peak displacement of 4 millimeters was chosen.

After the protocol, both groups **decreased the glycemic levels and increased lactate production** in relation to the basal levels and when compared diabetic and control, where **the most important results have been shown in diabetic women**.

This study revealed that WBV training in TIIDM has had significant beneficial effects on the control of glucose levels, still in an acute session. So that, the complete training probably will show better results about glycemic control and this finding could be especially important when prescribing exercise for elderly who are unable or unwilling to use traditional loads or who show poor exercise compliance.

Relief From Degeneration of the Lumbar Spine

Wang, S., Wang, L., Wang, Y., Du, C., Zhang, M., & Fan, Y. (2017). Biomechanical analysis of combining head-down tilt traction with vibration for different grades of degeneration of the lumbar spine. Medical Engineering & Physics, 39, 83-93. https://doi.org/10.1016/j.medengphy.2016.10.004

Abstract: In recent years, a combination of traction and vibration therapy is usually used to alleviate low back pain (LBP) in clinical settings. Combining head-down tilt (HDT) traction with vibration was demonstrated to be efficacious for LBP patients in our previous study. However, the biomechanics of the lumbar spine during this combined treatment is not well known and need quantitative analysis.

In addition, LBP patients have different grades of degeneration of the lumbar spinal structure, which are often age related. Selecting a suitable rehabilitation therapy for different age groups of patients has been challenging. Therefore, a finite element (FE) model of the L1–L5 lumbar spine and a vibration dynamic model are developed in this study in order to investigate the biomechanical effects of the combination of HDT traction and vibration therapy on the age-related degeneration of the lumbar spine.

The decrease of intradiscal pressure is more effective when vibration is combined with traction therapy. Moreover, the stresses on the discs are lower in the “traction + vibration” mode than the “traction-only” mode. The stress concentration at the posterior part of nucleus is mitigated after

the vibration is combined. The disc deformations especially posterior disc radial retraction is improved in the "traction + vibration" mode.

These beneficial effects of this therapy help **decompress the discs and spinal nerves and therefore relieve LBP**. Simultaneously, patients with grade 1 degeneration (approximately 41–50 years old) are able to achieve better results compared with other age groups. This study could be used to provide a more effective LBP rehabilitation therapy.

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 is an **effective treatment for decreasing cardiovascular risk in postmenopausal hypertensive and pre-hypertensive women** (2014), in addition to the previous populations studied.

Reducing Blood Pressure and Arterial Stiffness

Figueroa A, Gil R, Wong A, Hooshmand S, Park SY, Vicil F, Sanchez-Gonzalez MA. Whole-body vibration training reduces arterial stiffness, blood pressure and sympathovagal balance in young overweight/obese women. Hypertens Res. 2012 Jun;35(6):667-72. doi: 10.1038/hr.2012.15. Epub 2012 Feb 23. PMID: 22357522.

Abstract: Obesity is associated with early cardiovascular dysfunction and reduced muscle strength. Whole-body vibration (WBV) training may improve arterial function and muscle strength.

The effects of WBV training on arterial stiffness (brachial-ankle pulse wave velocity, baPWV), wave reflection (augmentation index, AIx), brachial systolic blood pressure (bSBP), aortic systolic blood pressure (aSBP), heart rate variability, and muscle strength (one-repetition maximum, 1RM) were examined in 10 young (21 ± 2 year) overweight/obese women (body mass index, BMI = 29.9 ± 0.8 kg m(-2)).

The participants were randomized to a 6-week WBV training or non-exercising control (CON) period in a crossover design. WBV training (3 days × week) consisted of static and dynamic squats and calf raises with vibration intensity at 25-30 Hz and 1-2 mm amplitude (2.83-4.86 G). There were significant (P<0.05) decreases in baPWV (-0.9 ± 0.3 m s(-1)), AIx (-8.0 ± 2.2 %), bSBP (-5.3 ± 1.5 mm Hg), aSBP (-5.2 ± 2.1 mm Hg), low-frequency power (-0.13 ± 0.05 nu) and sympathovagal balance (LF/HF, -0.42 ± 0.16) after WBV training compared with CON. Significant (P<0.05) increases in high-frequency power (HF, 0.19 ± 0.04 nu) and leg extension 1RM (8.2 ± 2.3 kg) occurred after WBV training compared with CON.

Six weeks of **WBV training decreased systemic arterial stiffness** and aSBP via improvements in wave reflection and sympathovagal balance in young overweight/obese normotensive women. **WBV training benefits arterial function and muscle strength in deconditioned individuals who cannot perform conventional exercise**.

Improved Blood Pressure in Obese Hypertensive Postmenopausal Women

This is a summary of a study published in The Journal of Alternative and Complementary Medicine, Vol 22, No 12, by Alexei Wong, Stacey Alvarez-Alvarado, Amber W. Kinsey, and Arturo Figueroa. DOI: https://doi.org/10.1089/acm.2016.0124

Objective: Whole-body vibration (WBV) is an unconventional exercise therapy that appears to provide the same benefits of resistance training in postmenopausal women while being safer and

gentler on the joints. This study evaluated the effect of an 8-week WBV exercise regimen on heart rate variability (HRV) and blood pressure (BP) in obese postmenopausal women.

Design: Randomized controlled study with two parallel groups.

Participants: Twenty-five (age 50–65 years) obese (body–mass index >30 and <40 kg/m2) postmenopausal women.

Intervention: Participants were randomly assigned to a WBV training group or non-exercising control group. Participants in the WBV group completed the supervised training 3 times a week. WBV training consisted of four static and four dynamic leg exercises (normal, high, and wide-stance squats and calf-raises) with vertical vibration (25–40 Hz and low-high amplitude) progressed throughout the 8 weeks.

Outcome measures: Brachial systolic BP (SBP) and diastolic BP (DBP) and HRV: sympathovagal balance (natural logarithm of low frequency [LnLF]/natural logarithm of high frequency [LnHF]; normalized low frequency [nLF]/normalized high frequency [nHF]), parasympathetic tone (LnHF, nHF, natural logarithm of root mean square of successive differences [LnRMSSD]), sympathetic tone (LnLF, nLF), natural logarithm of total power, and heart rate (HR).

Results: There were significant group × time interactions ($p < 0.05$) for brachial SBP, DBP, LnLF/LnHF, and nLF/nHF that significantly decreased ($p < 0.01$) after WBV, compared with no changes after control.

Conclusions: WBV training for 8 weeks is an adequate unconventional exercise intervention for **improving sympathovagal balance and BP in previously sedentary obese postmenopausal women**.

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Other Ailments and Benefits

Restless Legs Syndrome

This is the summary an article published in the Journal of Parkinsonism and Restless Legs Syndrome by Fred Burbank, Mark J Buchfuhrer, Branko Kopjar, Salt Creek International Women's Health Foundation, San Clemente, CA, Stanford University Center for Sleep Sciences, Downey, CA, Department of Health Services, University of Washington, Seattle, WA, USA

Background: Vibratory stimulation pads have been shown to improve sleep in patients with restless legs syndrome (RLS) to a greater extent than sham therapy. The current gold standard of treatment is drugs approved by the US Food and Drug Administration (FDA) for use in RLS. The aim of this meta-analysis was to compare the efficacy and safety of vibratory stimulation pads, sham pads, and drugs approved by the FDA for use in RLS.

Methods: We searched the PubMed, Embase, and clinical trial websites to identify the relevant randomized, double-blind, and placebo-controlled or sham-controlled studies. Fifteen studies including a combined total of 3455 patients with at least moderately severe primary RLS met our search criteria. Efficacy was defined as the standardized mean difference in sleep improvement between treatment and controls. Safety was assessed by comparing the odds ratios of any adverse events and adverse events leading to study withdrawal between treatment and control subjects.

Results: Improvement in Medical Outcomes Study (MOS) sleep inventory scores from baseline was **significantly greater in patients treated with vibratory stimulation pads** than in those receiving sham pads (Hedges's g, standardized mean difference −0.39, P # 0.02). There was no difference in improvement in sleep scores between patients treated with vibratory stimulation pads (−0.39) and those receiving an approved RLS drug (−0.44, P. 0.70). The risk of any adverse event or withdrawal because of an adverse event was not significantly different between patients treated with vibratory stimulation pads and those assigned to sham pads (Mantel-Haenszel odds ratio 2.16 [P . 0.14] and 1.39 [P . 0.80], respectively). The odds ratios for patients reporting any adverse events and adverse events leading to withdrawal were not significantly different between patients treated with vibratory stimulation pads (2.16 and 1.39, respectively) and those who received approved RLS drugs (2.11 [P . 0.89] and 2.07 [P . 0.82], respectively, mixed-effects model).

Conclusion: For patients with moderately severe RLS, **vibratory stimulation pads were more effective than sham pads for improving sleep**, as effective as FDA-approved RLS drugs, and as safe as both sham pads and FDA-approved RLS drugs.

Improved Quality of Life in Women with Systemic Lupus

Lopes-Souza, P., Dionello, C. F., Bernardes-Oliveira, C. L., Moreira-Marconi, E., Marchon, R. M., Teixeira-Silva, Y., Paineiras-Domingos, L. L., da Cunha Sá-Caputo, D., Xavier, V. L., Bergmann, A., Klumb, E. M., & Bernardo-Filho, M. (2021). Effects of 12-week whole-body vibration exercise on fatigue, functional ability, and quality of life in women with systemic lupus erythematosus: A randomized controlled trial. Journal of Bodywork and Movement Therapies, 27, 191-199. https://doi.org/10.1016/j.jbmt.2021.01.015

Background: Systemic lupus erythematosus (SLE) is a complex rheumatic autoimmune disease characterized by periods of exacerbations that can present damage in organs with important clinical manifestations.

Objective: The aim of this study was to evaluate the effect of 12-week whole-body vibration exercise (WBVE) on the fatigue, functional ability and quality of life of women with systemic lupus erythematosus (SLE) in chronic glucocorticoids use (CGU).

Methods: Twenty-one women were allocated randomly in the WBVE group or isometry group. The participants of WBVE group were positioned on the vibrating platform with 130° knee flexion and received the intervention twice a week for 12 weeks. The isometry group performed the same position and time, but without the stimulus of mechanical vibration. Fatigue, functional ability and the quality of life were evaluated at weeks 0, 6, and 12.

Results: From a sample of seventy-seven individuals, seventeen participants completed the study, 8 in WBVE group and 9 in isometry group. **Fatigue reduced in the WBVE group** at 6 and 12 weeks of intervention (p = 0.04) and (p = 0.03) respectively. There was a **significant improvement in their functional ability** evaluated by the Health Assessment Questionnaire in the WBVE group compared to the isometry group (p = 0.03).

Conclusion: WBVE is a useful intervention for control of fatigue and improvement of the functional ability of women with SLE in CGU.

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.

Is WBV an Adequate Treatment for Fibromyalgia?

Daniel Collado-Mateo, Jose C. Adsuar, Pedro R. Olivares, Borja del Pozo-Cruz, Jose A. Parraca, Jesus del Pozo-Cruz, Narcis Gusi, "Effects of Whole-Body Vibration Therapy in Patients with Fibromyalgia: A Systematic Literature Review", Evidence-Based Complementary and Alternative Medicine, vol. 2015, Article ID 719082, 11 pages, 2015. https://doi.org/10.1155/2015/719082

Objective: To review the literature on the effects of whole-body vibration therapy in patients with fibromyalgia.

Design: Systematic literature review.

Patients: Patients with fibromyalgia.

Methods: An electronic search of the literature in four medical databases was performed to identify studies on whole-body vibration therapy that were published up to the 15th of January 2015.

Results: Eight articles satisfied the inclusion and exclusion criteria and were analysed. According to the Dutch CBO guidelines, all selected trials had a B level of evidence. The main outcomes that were measured were balance, fatigue, disability index, health-related quality of life, and pain. **Whole-body vibration appeared to improve the outcomes, especially balance and disability index**.

Conclusion: Whole-body vibration is an adequate treatment for fibromyalgia as a main therapy or added to a physical exercise programme as it improves balance, disability index, health-related quality of life, fatigue, and pain.

WBV Reduces Symptoms of Fibromyalgia

Alev, A., Mihriban, A., Bilge, E., Ayça, E., Merve, K., Şeyma, C., Uğur, E., Adnan, B., Zeynel, K., & Mahmut, G. S. (2017). Effects of whole body vibration therapy in pain, function and depression of the patients with fibromyalgia. Complementary Therapies in Clinical Practice, 28, 200-203. https://doi.org/10.1016/j.ctcp.2017.06.008

Aim: Aim of the study is to search the effects of whole-body vibration (WBV) in fibromyalgia patients.

Materials and Methods: In this single blind study 20 fibromyalgia patients were diagnosed according to 2010 American College of Rheumatology criteria who participated in the study with the mean age of 57 ± 7 (years). Participants were randomized into 2 equal groups. In the intervention group (n = 10), 6 different types of exercises were combined with 30 hz frequency, 2 mm amplitude WBV for 4 weeks, The control group (n = 10) performed the same exercises on the same platform without vibration. The patients were assessed at baseline, at the 3rd and 6th months by Visual Analogue Scale (VAS), Fibromyalgia Impact Questionnaire (FIQ) and Beck Depression Inventory (BDI).

Results: Only FIQ score was significantly better in the treatment group at the 6th month evaluation (p = 0.043).

Conclusion: WBV is found to be effective in reducing symptoms of fibromyalgia.

Chronic Obstructive Pulmonary Disease (COPD)

Gloeckl R, Heinzelmann I, Kenn K. Whole body vibration training in patients with COPD: A systematic review. Chron Respir Dis. 2015 Aug;12(3):212-21. doi: 10.1177/1479972315583049. Epub 2015 Apr 22. PMID: 25904085.

Abstract: In recent years, several studies have shown that whole body vibration training (WBVT) may be a beneficial training mode in a variety of chronic diseases and conditions such as osteoporosis, fibromyalgia, multiple sclerosis, or chronic low back pain. However, a systematic review on the effects of WBVT in patients with chronic obstructive pulmonary disease (COPD) has not been performed yet.

An extensive literature search was performed using various electronic databases (PubMed, Embase, LILACS, and PEDro). They were searched from inception until September 20, 2014, using key words like "COPD" and "whole body vibration training." A total of 91 studies could be identified and were screened for relevance by two independent reviewers. Six studies were included in a qualitative analysis. Trials studied either the effects of WBVT versus an inactive control group, versus sham WBVT, during an acute COPD exacerbation or as a modality on top of conventional endurance and strength training.

All randomized trials reported a significantly superior benefit on exercise capacity (6-minute walking distance) in favor of the WBVT group. Evidence is available that says WBVT is an effective exercise modality to improve functional exercise capacity in patients with COPD.

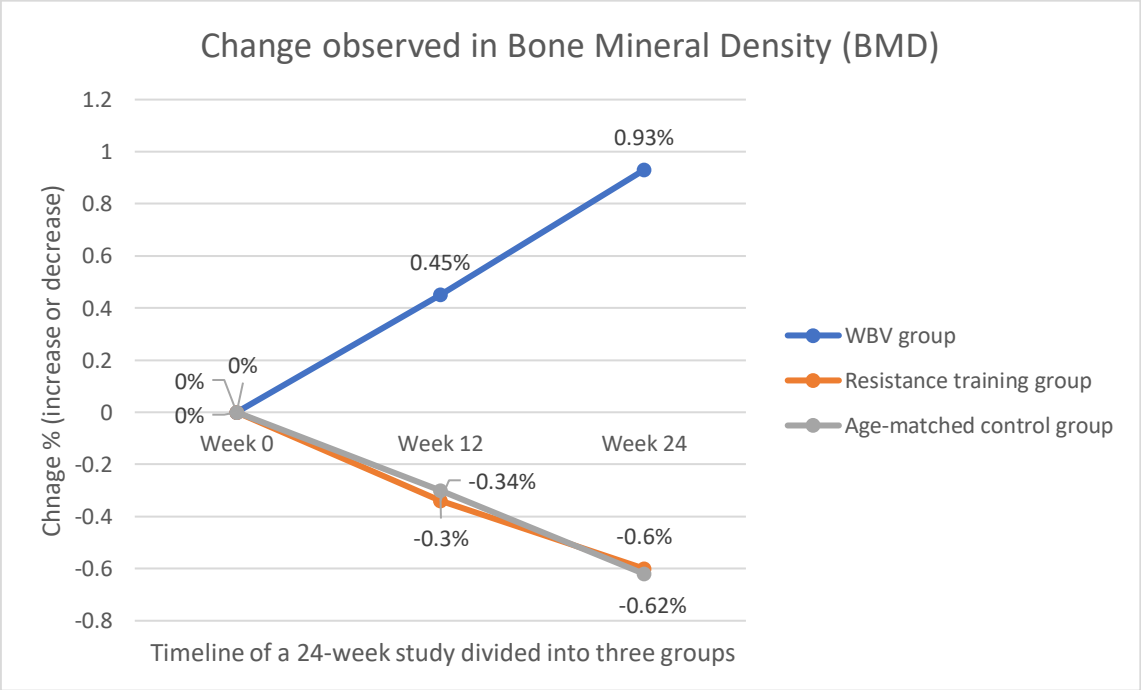
Reduces Risk of Falls and Fractures in Postmenopausal Women

Verschueren SM, Roelants M, Delecluse C, Swinnen S, Vanderschueren D, Boonen S. Effect of 6-month whole body vibration training on hip density, muscle strength, and postural control in postmenopausal women: a randomized controlled pilot study. J Bone Miner Res. 2004 Mar;19(3):352-9. doi: 10.1359/JBMR.0301245. Epub 2003 Dec 22. PMID: 15040822.

Abstract: High-frequency mechanical strain seems to stimulate bone strength in animals. In this randomized controlled trial, hip BMD was measured in postmenopausal women after a 24-week whole body vibration (WBV) training program. Vibration training significantly increased BMD of the hip. These findings suggest that WBV training is useful in the prevention of osteoporosis.

Introduction: High-frequency mechanical strain has been shown to stimulate bone strength in different animal models. However, the effects of vibration exercise on the human skeleton have rarely been studied. Particularly in postmenopausal women-who are most at risk of developing osteoporosis-randomized controlled data on the safety and efficacy of vibration loading are lacking. The aim of this randomized controlled trial was to assess the musculoskeletal effects of high-frequency loading by means of whole-body vibration (WBV) in postmenopausal women.

Materials and methods: Seventy volunteers (age, 58-74 years) were randomly assigned to a whole-body vibration training group (WBV, n = 25), a resistance training group (RES, n = 22), or a control group (CON, n = 23). The WBV group and the RES group trained three times weekly for 24 weeks. The WBV group performed static and dynamic knee-extensor exercises on a vibration platform (35-40 Hz, 2.28-5.09g), which mechanically loaded the bone and evoked reflexive muscle contractions. The RES group trained knee extensors by dynamic leg press and leg extension exercises, increasing from low (20 RM) to high (8 RM) resistance. The CON group did not participate in any training. Hip bone density was measured using DXA at baseline and after the 6-month intervention. Isometric and dynamic strength were measured by means of a motor-driven dynamometer. Data were analyzed by means of repeated measures ANOVA.



Results: No vibration-related side effects were observed. **Vibration training improved isometric and dynamic muscle strength** (+15% and + 16%, respectively; $p < 0.01$) and also **significantly increased BMD of the hip** (+0.93%, $p < 0.05$). No changes in hip BMD were observed in women participating in resistance training or age-matched controls (-0.60% and -0.62%, respectively; not significant). Serum markers of bone turnover did not change in any of the groups.

Conclusion: These findings suggest that WBV training is a feasible and effective way to modify well-recognized risk factors for falls and fractures in older women.

WBV Stimulates Stem Cell Production

A study was conducted by Alghadir et al. in 2016 that aimed to investigate the effects of whole-body vibration (WBV) on the expression of stem cell markers in healthy individuals. The researchers specifically focused on CD34, a marker associated with hematopoietic stem cells, which are responsible for the generation of new blood cells.

The study employed a randomized controlled trial design and included adults with metabolic syndrome as participants. Metabolic syndrome is a cluster of conditions that increase the risk of cardiovascular diseases, stroke, and type 2 diabetes. The researchers aimed to determine whether WBV training could have a positive impact on circulating stem cells in this population.

The participants were randomly assigned to two groups: the WBV group and the control group. The WBV group underwent a 12-week training program consisting of three sessions per week, with each session lasting for 20 minutes. The control group did not receive any intervention.

The main outcome measure of interest was the expression of CD34 in peripheral blood mononuclear cells (PBMCs), which were collected before and after the intervention period. PBMCs are a mixture of various blood cells, including lymphocytes and monocytes.

The results of the study indicated that **WBV training significantly upregulated the expression of CD34 in PBMCs** of the participants in the WBV group. This finding suggests that WBV has a stimulatory effect on hematopoietic stem cells. The control group, which did not undergo WBV training, did not show significant changes in CD34 expression.

This study provides preliminary evidence that **WBV training has the potential to modulate the expression of stem cell markers** in healthy individuals.

WBV has Anti-Inflammatory Effects

Yameena Jawed, MD and others, Whole-Body Vibration Training Increases Stem/Progenitor Cell Circulation Levels and May Attenuate Inflammation, Military Medicine, Volume 185, Issue Supplement_1, January-February 2020, Pages 404–412, https://doi.org/10.1093/milmed/usz247

Introduction: Whole-body vibration training (WBVT) may benefit individuals with difficulty participating in physical exercise. The objective was to explore the effects of WBVT on circulating stem/progenitor cell and cytokine levels.

Methods: Healthy male subjects each performed three activities randomly on separate days: a) standing platform vibration, b) repetitive leg squat exercise; and c) in combination. Pre- and post-activity blood samples were drawn. Cell populations were characterized using flow cytometry. Biomarkers were analyzed using ELISAs.

Results: Circulating progenitor cell (CPC) levels increased significantly 21% with exercise alone (1465±202 to 1770±221 cells/ml; p=0.017) and 33% with vibration alone in younger participants (1918±341 to 2559±496; p=0.02). Angiogenic CPCs increased 39% during combined activity in younger (633±128 to 882±181; p=0.05). Non-angiogenic CPCs increased 42% with vibration alone in younger (1181±222 to 1677±342; p=0.04), but 32% with exercise alone in older participants (801±251 to 1053±325; p=0.05). **With vibration alone, anti-inflammatory cytokine IL-10 increased significantly** (p<0.03), while **inflammatory IL-6 decreased**

(p=0.056); TNFα (p<0.01) and VEGF levels increased (p<0.005), which are synergistically pro-angiogenic.

Conclusions: WBVT has positive vascular and anti-inflammatory effects. **Whole-body vibration training augments and serves as an exercise surrogate in warfighters and others who cannot fully participate in exercise programs**, having important implications in military health.

WBV to Help Cancer Patients Undergoing Intensive Chemotherapy

Pahl A, Wehrle A, Kneis S, Gollhofer A, Bertz H. Feasibility of whole body vibration during intensive chemotherapy in patients with hematological malignancies - a randomized controlled pilot study. BMC Cancer. 2018 Sep 25;18(1):920. doi: 10.1186/s12885-018-4813-8. PMID: 30253746; PMCID: PMC6156963.

Background: Hospitalized cancer patients undergoing intensive or high-dose chemotherapy often experience a considerable decline in functional performance associated with the increased risk of adverse health events. Exercises, particularly resistance-based exercises that may counteract this decline are restricted by therapy-related side effects. Since **whole body vibration (WBV) is known to efficiently stimulate the neuromuscular system** without significantly raising blood pressure, we hypothesize that especially WBV is particularly feasible even during intensive or high-dose chemotherapy (primary endpoint) and thus induces beneficial functional adaptations.

Methods: Twenty hospitalized patients with hematological malignancies scheduled for intensive or high-dose chemotherapy were randomly allocated to an intervention group (IG) undergoing WBV, or an active control group (CG) cycling. Feasibility was determined by comparing the IG's and CG's training compliance. Furthermore, to assess feasibility, WBV-induced changes in chemotherapy-related side effects, blood pressure, and heart rate immediately after exercising were documented. To assess patients' functional performance, we measured jump height (cm), the duration (sec) of performing the chair rising- (CRT) and timed-up-and-go test (TUG), maximum power output during jumping and CRT (watt/kg) as well as sway path (mm) during balance tasks.

Results: Training compliance was similar between groups (IG: median 62%, range 39-77; CG: 67%, 58-100; p = 0.315). Moreover, we observed neither the IG's reported side effects worsening, nor any increase in blood pressure after WBV. IG's jump height (+ 2.3 cm, 95%CI 0.1-4.4, p = 0.028) and TUG performance (- 1.3 s, 95%CI -2.53 - -0.65, p = 0.027) improved significantly, while sway paths in semi-tandem stance were augmented after the intervention (eyes open: + 60 mm, 95%CI 2-236, p = 0.046; eyes closed: + 88 mm, 95%CI 49-214, p = 0.028). The CG's performances did not change over time. Maximum power output during CMJ and CRT and time during CRT did not change.

Conclusion: Our study is the first proving the feasibility of WBV during intensive/high-dose chemotherapy of hospitalized cancer patients. Additionally, **WBV-induced neuromuscular adaptations resulted in functional benefits relevant to patients' autonomy**. We believe that WBV can be implemented as an alternative training method during intensive chemotherapy.