

Whole Body Vibration: A new exercise approach

Presented by:

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What are we talking about?

- WBV is a mechanical stimulus characterized by **oscillatory motion** that is delivered to the entire body (usually in a vertical manner)
- a.k.a., vibration exercise (VE) or vibration training (VT)
- Biomechanical parameters include amplitude, frequency, magnitude, and duration

Effects of WBV depend on the training parameters used:

- Amplitude (*mm or cm*) = the extent of the vertical displacement
- Frequency (*Hz*) = number of impulses delivered per second
- Magnitude (*G*) = the acceleration power/force of the movement
- Duration (*sec. or min.*) = the amount of time one spends on the apparatus

Commercial devices that deliver WBV:

- Galileo™ and Vibraflex® platforms
 - *manufactured by Novtec (Germany)*
 - *distributed in US by OrthoMetrix Inc. (White Plains, NY)*
- NEMES™ and NBS® platforms
 - *manufactured by Nemesis (The Netherlands) and FitMed Corp. (Cleveland Heights, OH)*
- Power Plate™
 - *Power Plate of North America (Culver City, CA)*
- Pneu-vibe™
 - *manufactured by Pneumex (Sandpoint, ID)*

Galileo™ Vibrating Platform

- Works as a **teeterboard** with 0 -5 mm amplitude (medial to distal) and variable frequency; sometimes referred to as rotational vibration
- **25 - 27 Hz** seems optimal for increasing muscle power
- This frequency corresponds with time required for a single up-down movement to cause a natural stretch reflex plus relaxation of the agonists and antagonists



The Galileo 2000™



"The 25 Hz speed of the Galileo produces 1500 repetitions per minute, and therefore a very strong training effect. Additional reflex benefits can be achieved by adding voluntary movements such as rotating the hips, moving the arms, etc. during the Galileo session."

www.orthometrix.net

Galileo 100™ (handheld dumbbell for UE exercise)



“The Galileo is particularly suited for such people because it is easy to use, and its exercise sessions are short (due to its fast 25 Hz stimulation rate). The Galileo allows people with osteoarthritis to enjoy the benefits of exercise.”

VibraFlex® 500, VibraFlex® Rx, and Mini-VibraFlex®

- Newer models of Galileo equipment
- Have preset frequencies and treatment times
- Widely marketed to athletic clubs/teams



www.vibraflex.com

NEMES™ Vibrating Platform



- NEMES is the abbreviation for **NEuro-MEchanical-Stimulation**
- Provides vertical vibration in the **30-50 Hz** range
- Shown effective in several muscle strengthening studies

www.nemesis-europe.nl/index.php?option=content&task=category§ionid=2&id=7&Itemid=27

NBS® (Nemes Bosco System)

- FitMed products are based on Bosco's original design
- Home units also available

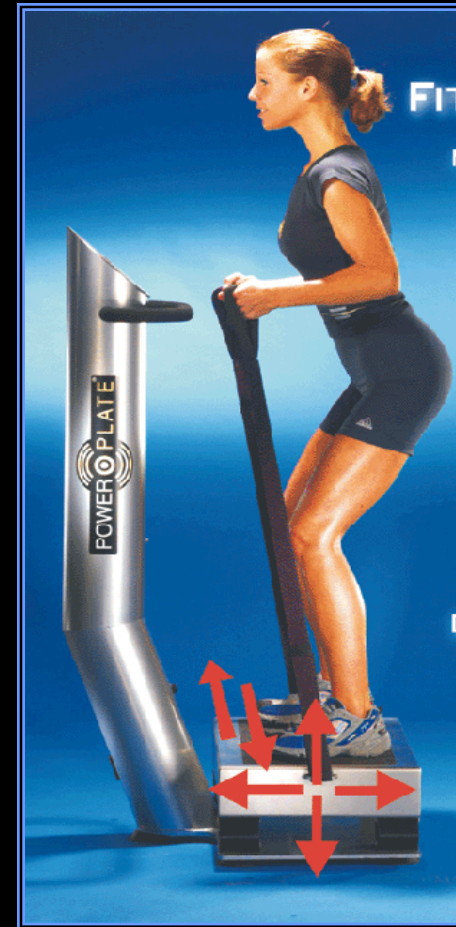


www.fit-med.com

Power Plate™ Vibrating Platform

- Developed by an Olympic coach in The Netherlands
- Vibrates at 30 –50 Hz
- Similar in design to the NEMES; claims to be a multi-planar motion
- Personal units have fixed 35 Hz frequency

www.powerplateusa.com



Beware of marketing ploys!

“Overall, the PowerPlate contributes to a more youthful feeling due to an increase in oxygenation, increased secretion of serotonin (the happiness hormone), mental stimulation and improved basic brain functions (such as better concentration). Almost immediately you will notice positive influences to your overall strength and well-being. By decreasing cortisol levels the Power Plate helps eliminate the effects of stress making the Power Plate a great tool for relaxation.”



Many companies overstate the health benefits of WBV exercise!

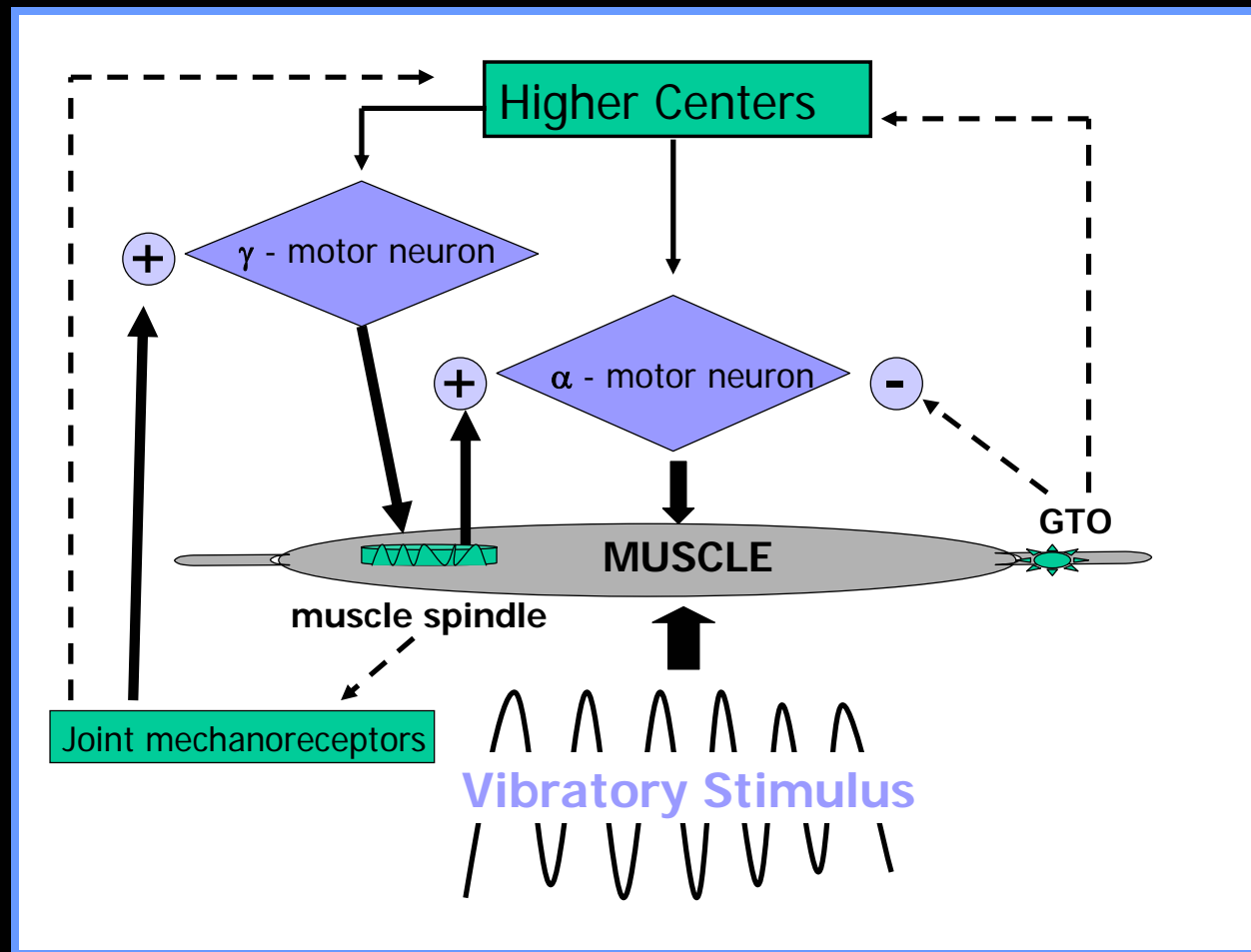
"The NBS® is considered as The Golden Standard of the Whole Body Vibration Training...It takes just 2 weeks to reach your optimal level of training."

"Amazing! By just standing passively on the machine's vibrating base, you dramatically improve:

- Strength and physical performance
- Flexibility and stability
- Body shape and solidification
- Being awake at day and sleep well at night
- Burning of fat tissue (healthy way of dieting)"

Let's look at some of the
evidence...

Physiology of WBV - stretch reflex



from Cardinale & Bosco, *Ex Sport Sci Rev*, 2003, 31:3-7

Conditions treated in Europe with WBV

- strength and power training for athletes
- ligamentous knee injuries/repairs
- acute back problems
- osteoporosis
- neuromuscular disorders
- obesity (via hormonal effects)
- PVD/diabetes (to improve circulation)
- incontinence (via muscle strengthening)
- postural stability

Contraindications/Precautions

- pregnancy
- recent or possible thrombosis
- cardiovascular complaints, e.g. valve disorder
- advanced arthrosis, arthropathy, acute RA
- recent sutures, scars and fresh wounds
- foot, knee and hip implants
- any metal/synthetic implants, e.g. pacemaker
- lumbar disc problems
- acute inflammations or infections
- migraine headaches
- epilepsy

How much research has been done to support the efficacy of WBV?

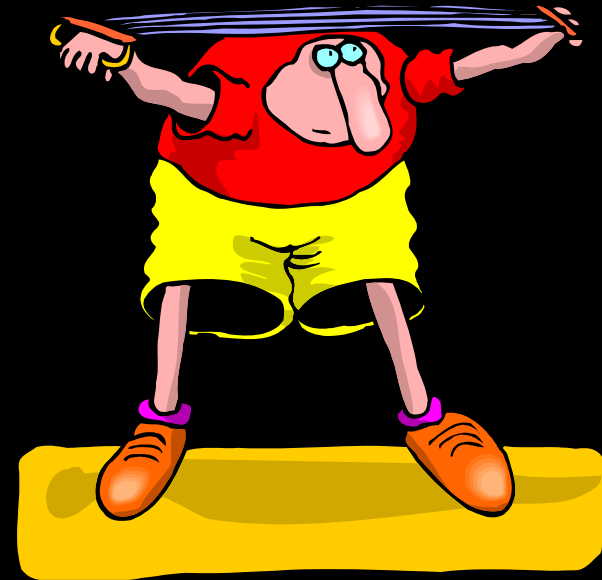
- WBV to enhance the performance of Soviet athletes began in the '60s & '70s by **Nazarov**; studies continued by the Israeli scientist, **Issurin**.
- Introduced in Western Europe ~ 1994
- **Carmelo Bosco**, Italian physiologist, studied neuromuscular & hormonal effects of high-magnitude WBV (developed NEMES platform)
- **Jörn Rittweger** (Germany) and **Saila Torvinen** (Finland) have also published several studies using the Galileo platform

How much research has been done to support the efficacy of WBV?

- **Clinton Rubin**, anatomist and biomechanist at SUNY @ Stony Brook, NY, has studied skeletal effects of very low magnitude vibrations mostly on animal subjects
- Two pilot studies on human subjects using Rubin's platform have also been conducted
 - *Children with disabilities (e.g., CP) (Ward, et al)*
 - *Post-menopausal women (Rubin, et al)*
- Currently conducting a bed rest study for NASA at UTMB-Galveston

Immediate and Short-Term Effects of WBV

- Muscle strength and power
- Motor performance
 - *Vertical jump*
 - *Running speed*
 - *Balance*
- Other measures
 - *Hormone concentrations*
 - *Cardiovascular changes*

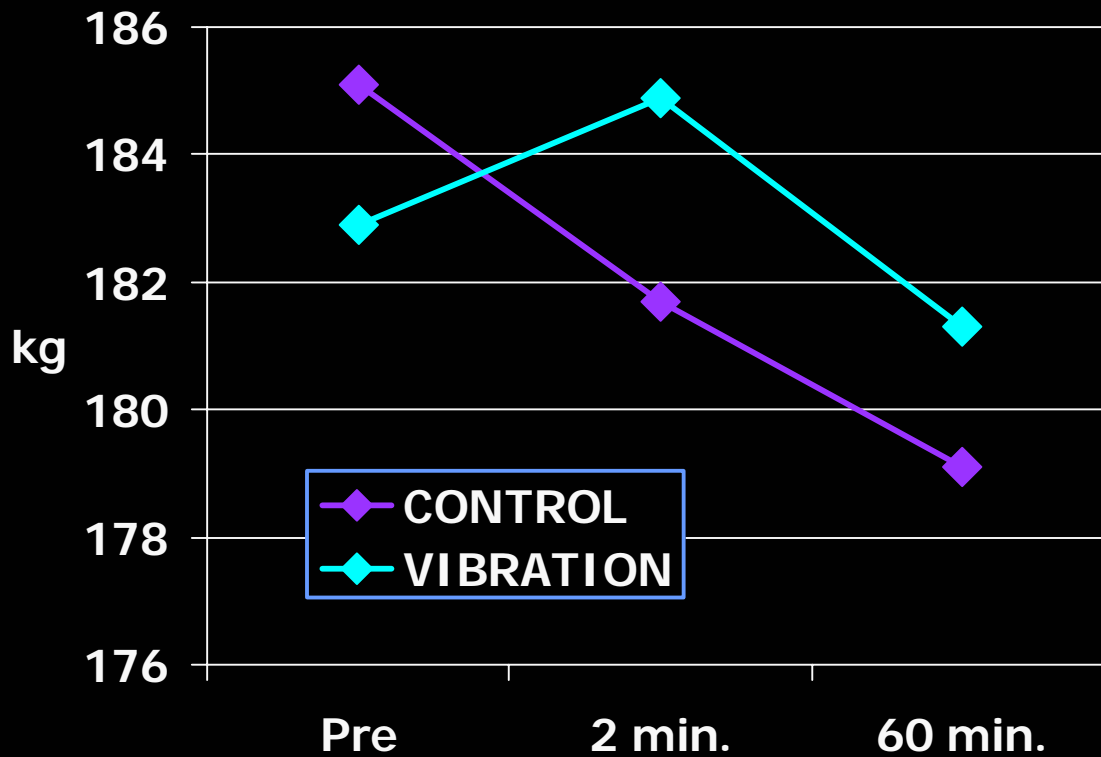


Effect of WBV on Muscle Strength and Motor Performance

- Torvinen tested 16 young adults who performed a single bout of WBV x 4 min. on 2 days (WBV vs. none)
- Used Galileo platform: amplitude = 28 mm; frequency increased from 15 – 30 Hz; est. acceleration force = 3.5 – 14 g

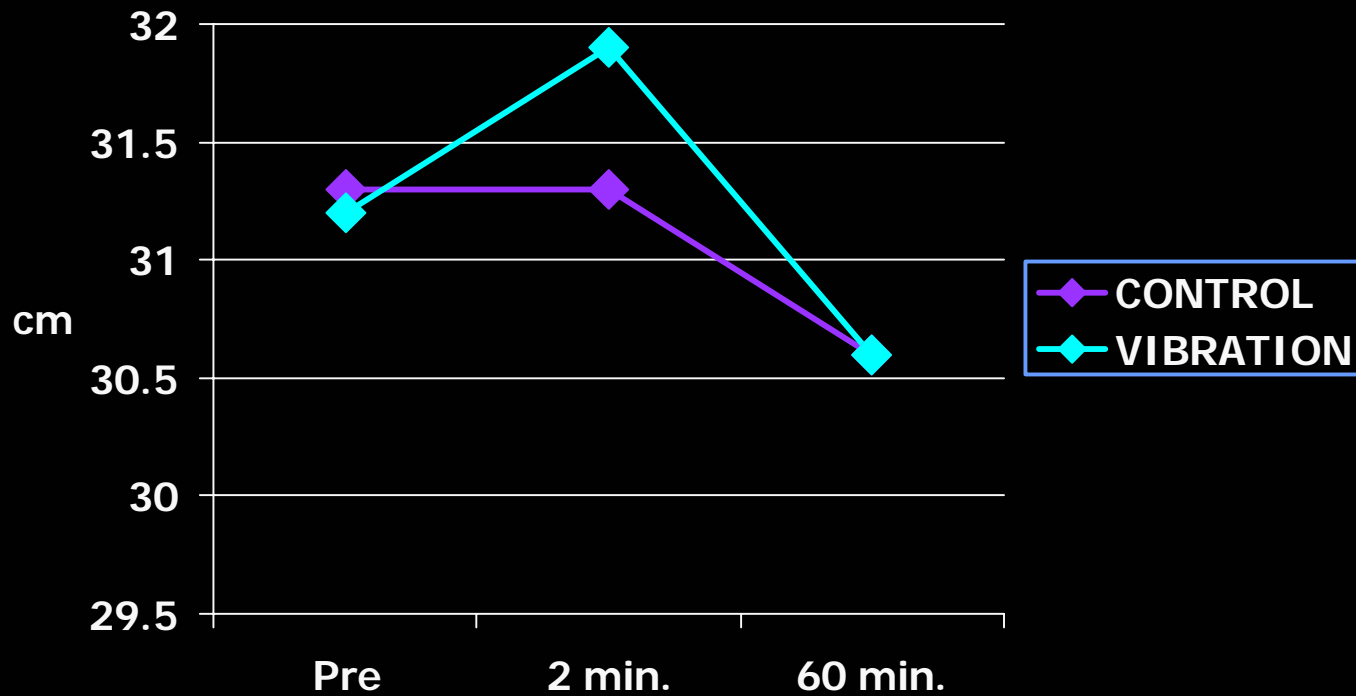
Torvinen et al, *Clin Physiol & Func Im*, 22:145-152

Changes in leg extension strength



Torvinen et al, *Clin Physiol & Func Im*, 22:145-152

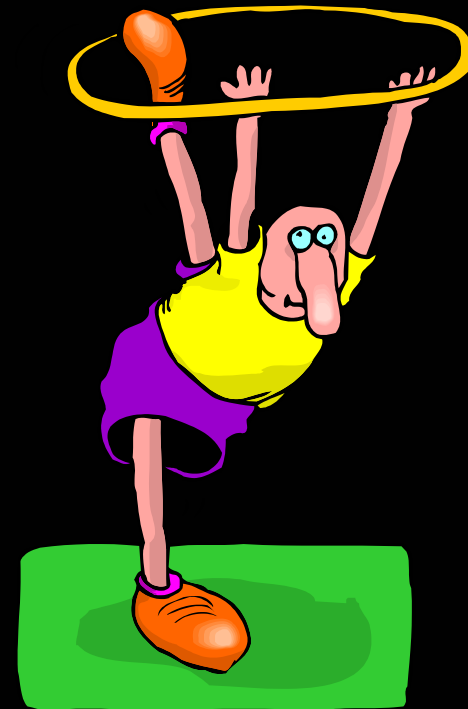
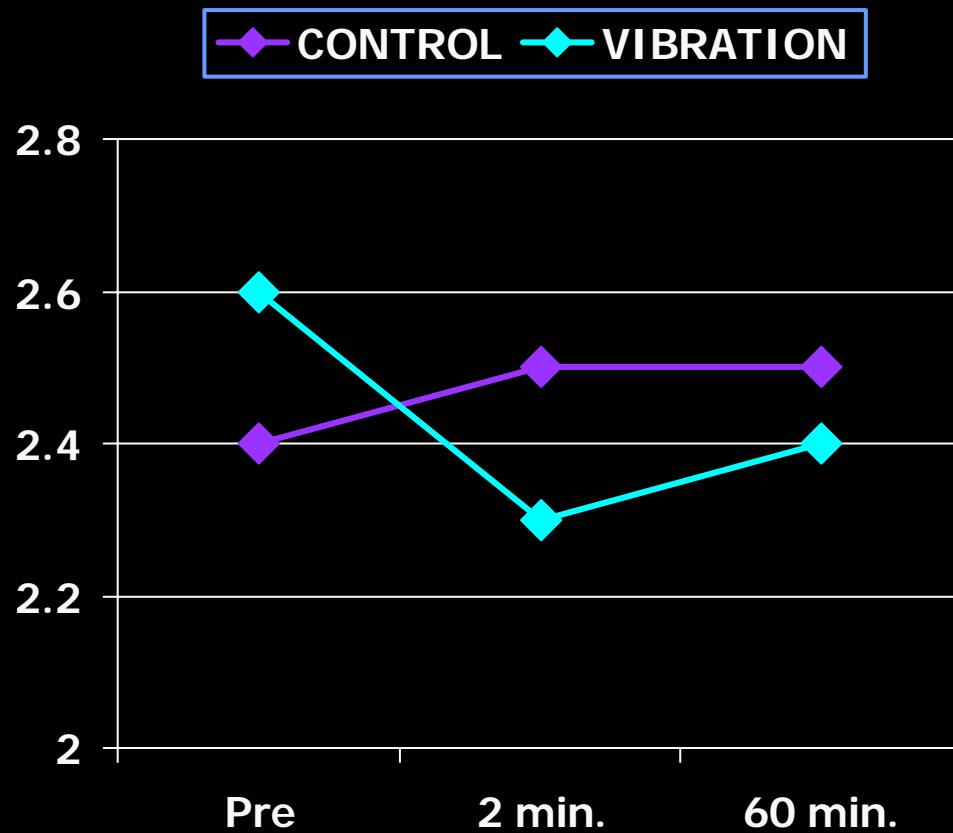
Changes in vertical jump



Torvinen et al, *Clin Physiol & Func Im*, 22:145-152

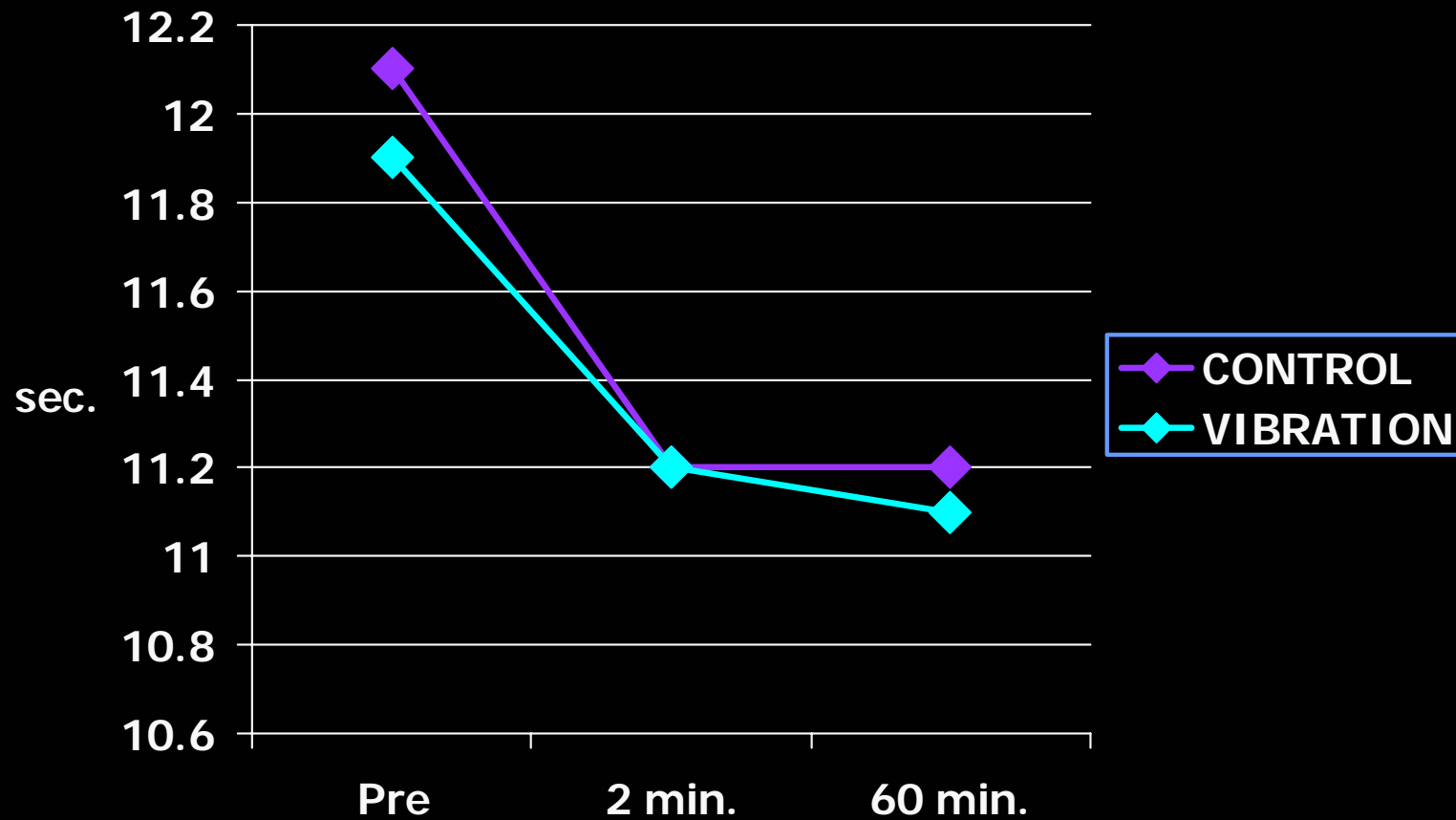
Changes in Balance

(using Biodex Stability Index; ↓ = improvement)



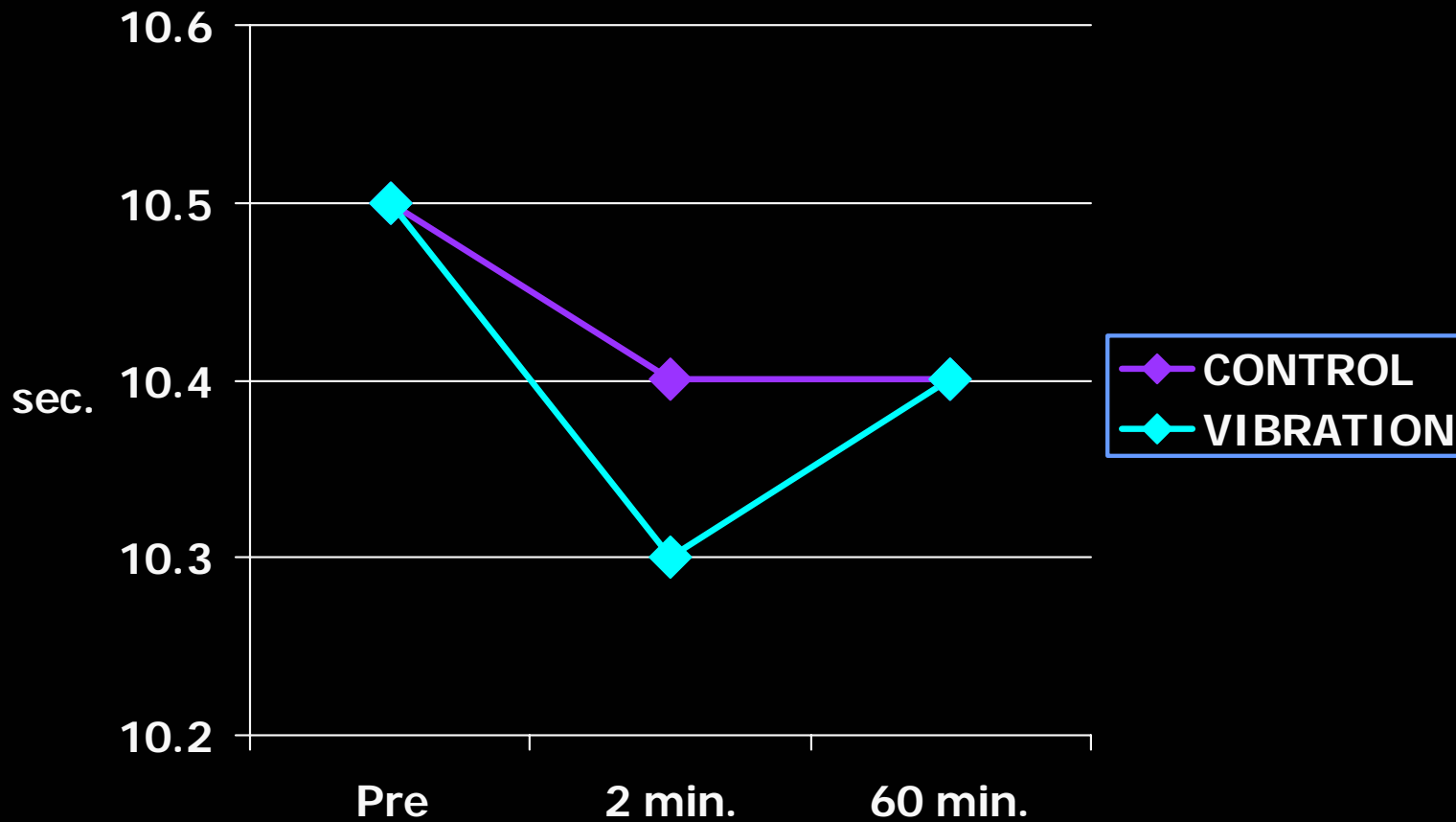
Torvinen et al, *Clin Physiol & Func Im*, 22:145-152

Changes in Tandem Walk



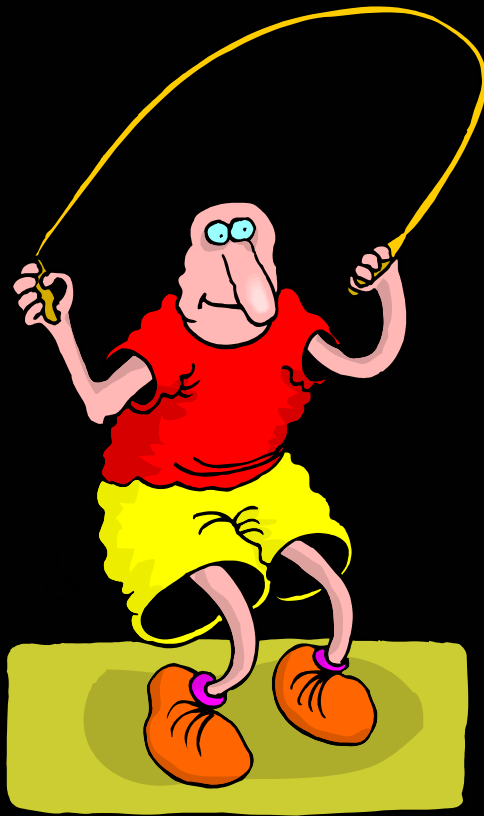
Torvinen et al, *Clin Physiol & Func Im*, 22:145-152

Changes in Shuttle Run



Torvinen et al, *Clin Physiol & Func Im*, 22:145-152

Effects of WBV on Muscle Power



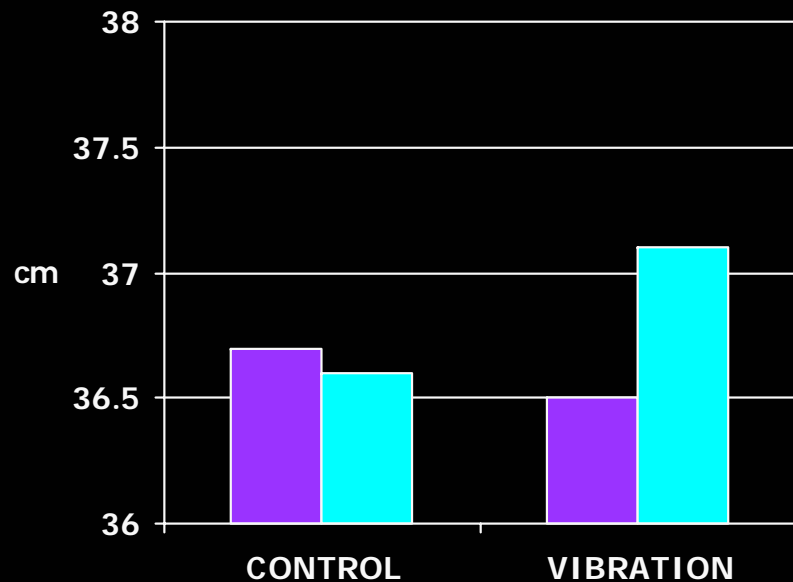
- Bosco examined effect of WBV on vertical jump in 14 active young adults who underwent 5, 90-120 sec. bouts of WBV x 10 days
- Used Galileo platform: amp. = 10 mm, frequency = 26 Hz

Bosco et al, 1998, *Biol Sport*, 15:157-164

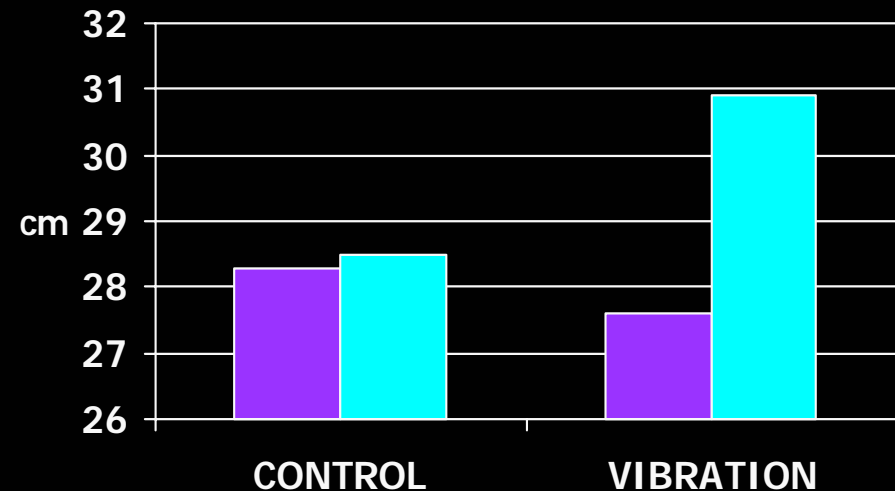
Effect of WBV on Vertical Jump

■ Pretest ■ Posttest

Single Jump



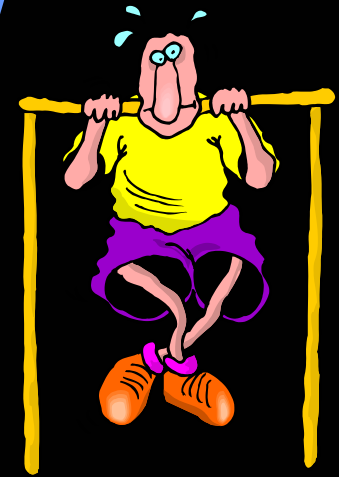
Repetitive Jumping



Bosco et al, 1998, *Biol Sport*, 15:157-164

Effect on UE muscle activity

- McBride et al, exercised 8 men to fatigue using vibrating and non-vibrating dumbbells (1 week apart)
- EMG patterns observed with vibration indicated "more efficient and effective recruitment of high threshold motor units during fatiguing contractions."



McBride et al, 2004, *J Strength Cond Res*, 18:777-781

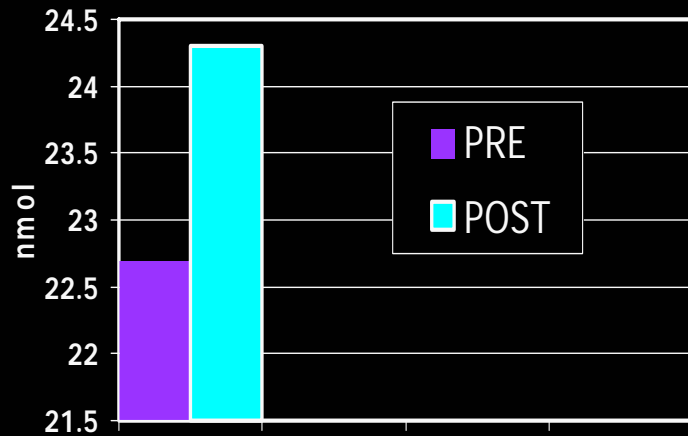
Hormonal Responses to WBV

- Bosco observed changes in neuromuscular performance and plasma hormone levels in 14 young, athletic men following WBV
- 60 sec. WBV followed by 60 sec. rest, repeated 10 times
- Used NEMES platform: amp. = 4 mm @ 26 Hz; est. acceleration force = 17 g

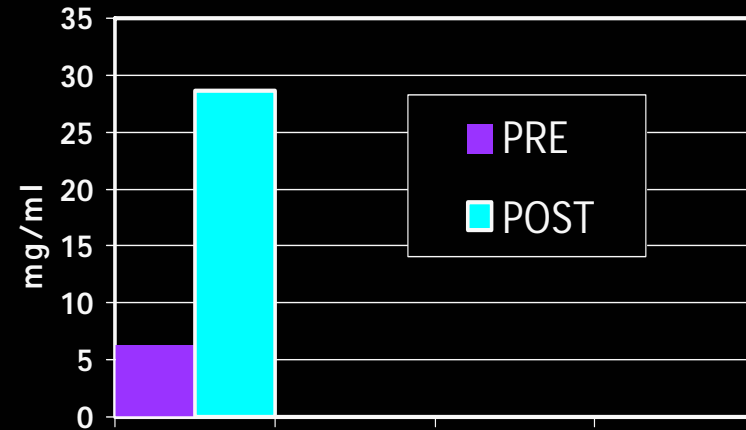
Bosco et al, *Eur J Appl Physiol*, 2000, 81:449-454

Hormonal Changes after WBV

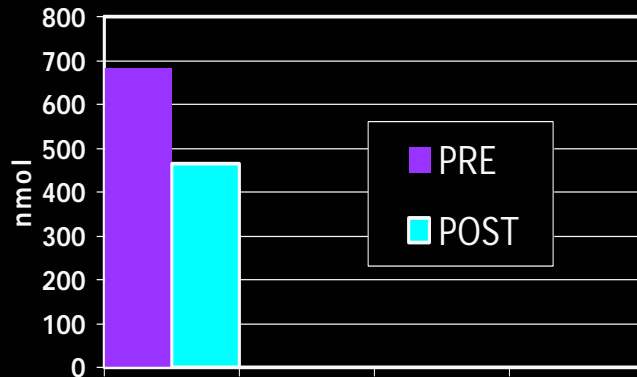
TESTOSTERONE



GROWTH HORMONE



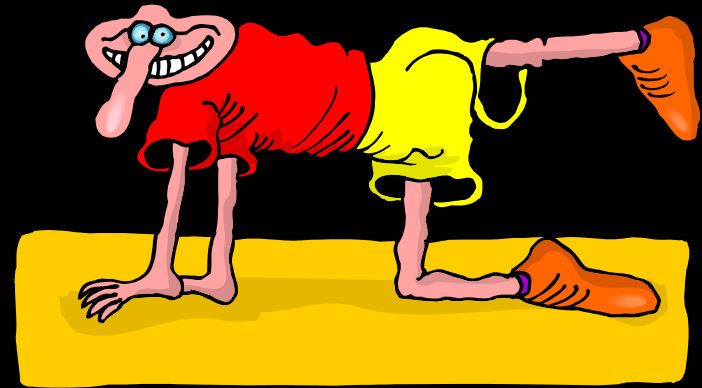
CORTISOL



Bosco et al, *Eur J Appl Physiol*, 2000, 81:449-454

Other Findings and Conclusions

- Mechanical work output of leg extensor muscles was significantly \uparrow while EMG activity was \downarrow



- Jumping performance also improved
- \uparrow plasma concentrations of T and GH suggest "neural potentiation effect" similar to power weight training but without the general stress response (i.e., decreased cortisol levels)

Acute Physiological Effects of WBV

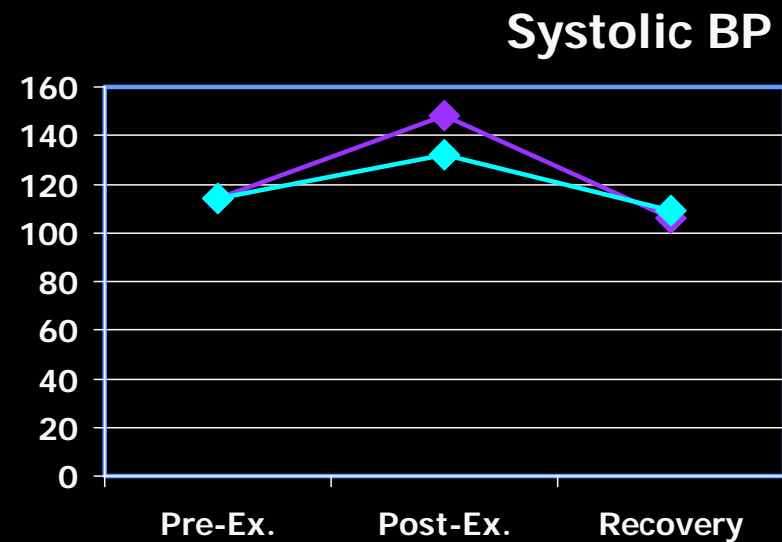
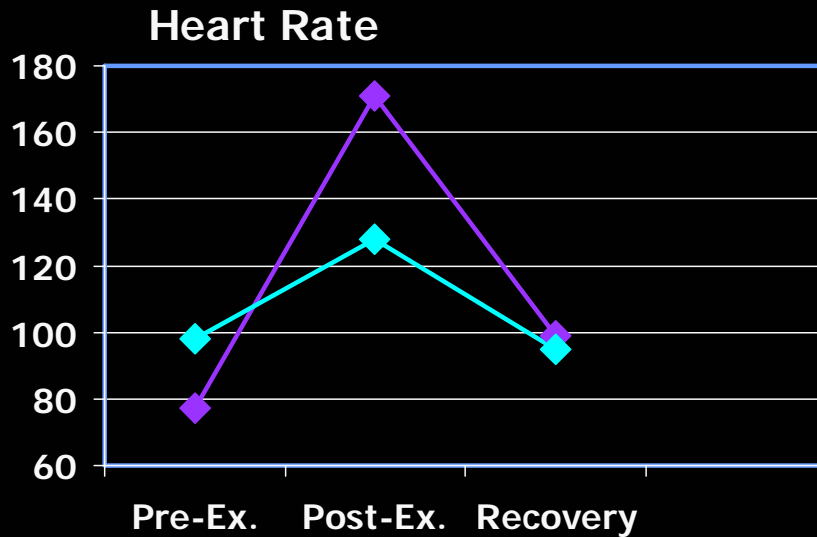
- Rittweger examined HR, BP, oxygen uptake, lactate levels, and perceived exertion in 37 young adults who exercised (using WBV) to exhaustion with weights added to their waists
- Results of two WBV exercise sessions compared to bicycle ergometry
- Used Galileo platform @ 26 Hz; est. acceleration force = 15 g

Rittweger et al, *Clin Physiol*, 2000, 20(2):134-142

Cardiovascular Effects of WBV



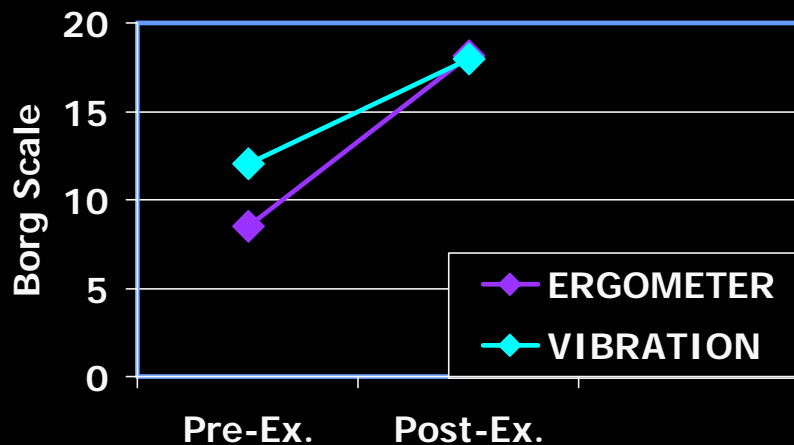
◆ ERGOMETER ◆ VIBRATION



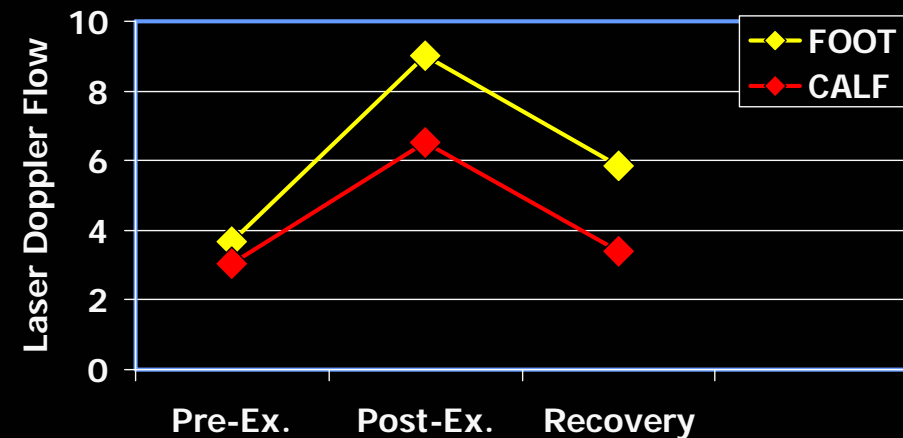
Rittweger et al, *Clin Physiol*, 2000, 20(2):134-142

Exercise Effects of WBV

Perceived Exertion



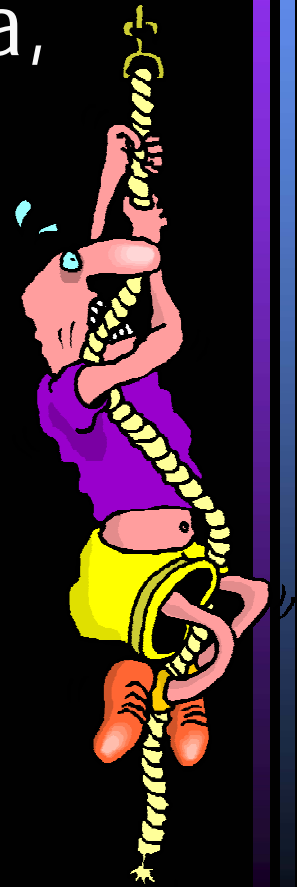
LE Blood Flow (WBV only)



Rittweger et al, *Clin Physiol*, 2000, 20(2):134-142

Other Findings and Conclusions:

- Comparable perceptions of fatigue
- Some subjects experienced leg edema, erythema, and itching from WBV
- Fatigue associated with intense WBV attributed to neuromuscular system, not cardiovascular insufficiency
- Cardiovascular risk for this exercise with elderly considered "negligible."



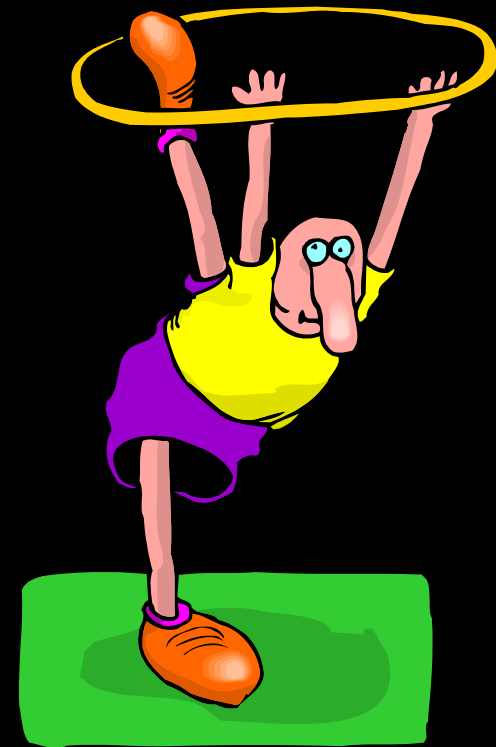
Other Short-Term Systemic Effects

- Temporary vestibular impairment and motion sickness with high-amplitude vibration of long duration.
- Increased gastric secretions, but no effect on rate of stomach emptying.
- Decreased attention to other stimuli, but no sig. reduction in reaction time, eye-hand coordination, or visual acuity.

Kjellberg et al, *Ergonomics*, 1985, 28(3):535-544

Long-Term Effects of WBV

- Muscle strength/performance
- Motor control
- Balance
- Chronic pain
- Bone density/strength



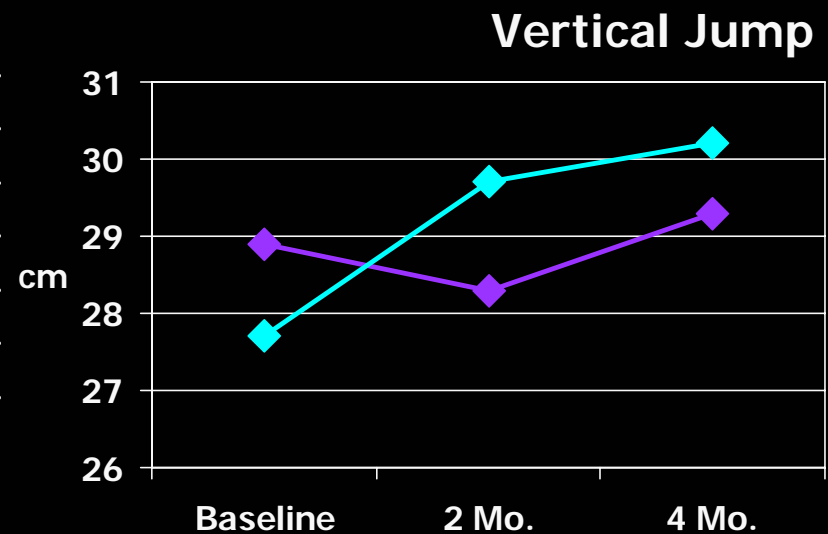
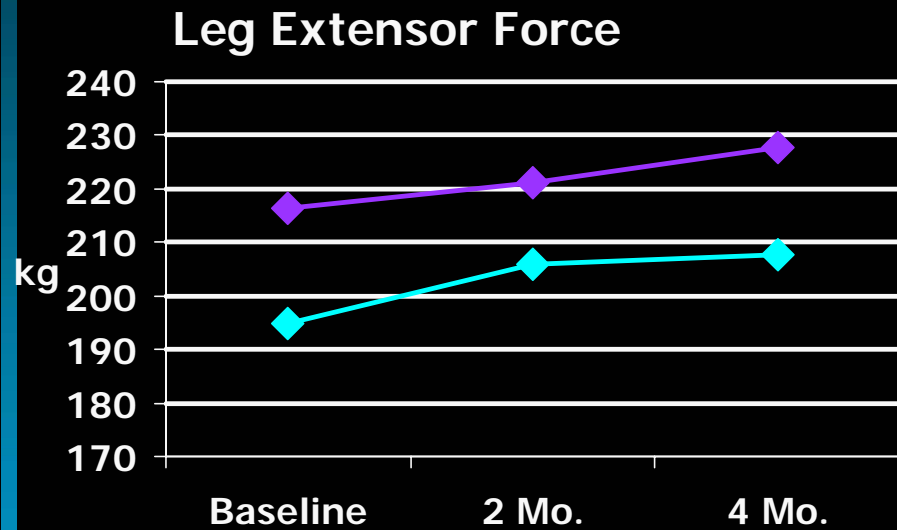
Long-Term Effects of WBV

- Torvinen studied physical performance effects of a 4-month WBV program in 56 young adults who trained 2-4 min., 3-5 times/week, in various positions
- Platform vibration amp. = 2 mm; frequencies ranged from 25 to 40 Hz; est. acceleration force = 2.5 – 6.4 g

Torvinen et al, *Med Sci Sports Exerc*, 2002,34:1523:1528

Changes in Muscle Strength

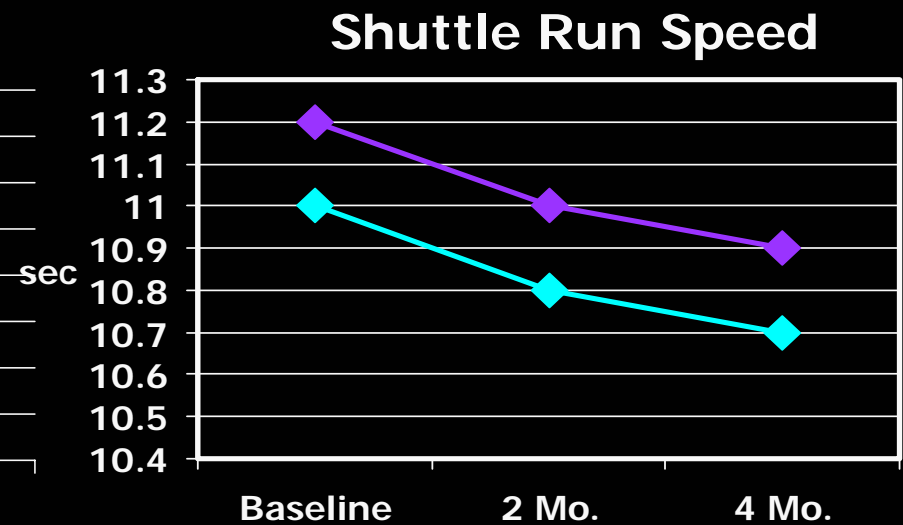
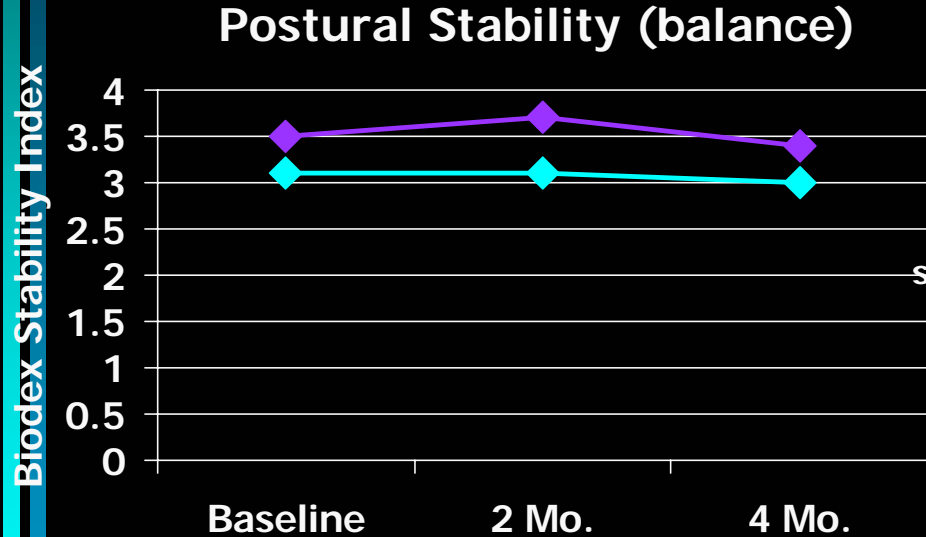
◆ CONTROL ◆ VIBRATION



Torvinen et al, *Med Sci Sports Exerc*, 2002,34:1523:1528

Changes in Motor Performance

—◆— CONTROL —◆— VIBRATION



Torvinen et al, *Med Sci Sports Exerc*, 2002,34:1523:1528

Changes in Bone

- Torvinen continued study for a total of 8 months; results presented at ASBMR meeting in Sept. 2002
- Bone mass, structure, and strength of tibia measured with pQCT; BMD in other sites measured with DEXA
- No significant change reported in BMD or bone biomarkers
- Overall 7.8% improvement in vertical jump but no other performance benefits

Summary of Rubin's work on vibration and bone

- Has used 10-20 min. of low-magnitude (0.2-0.3 g), high-frequency ($\sim 20-90$ Hz) vibration with various animal models
- 2 pilot studies with humans
- Conducting bedrest studies for NASA

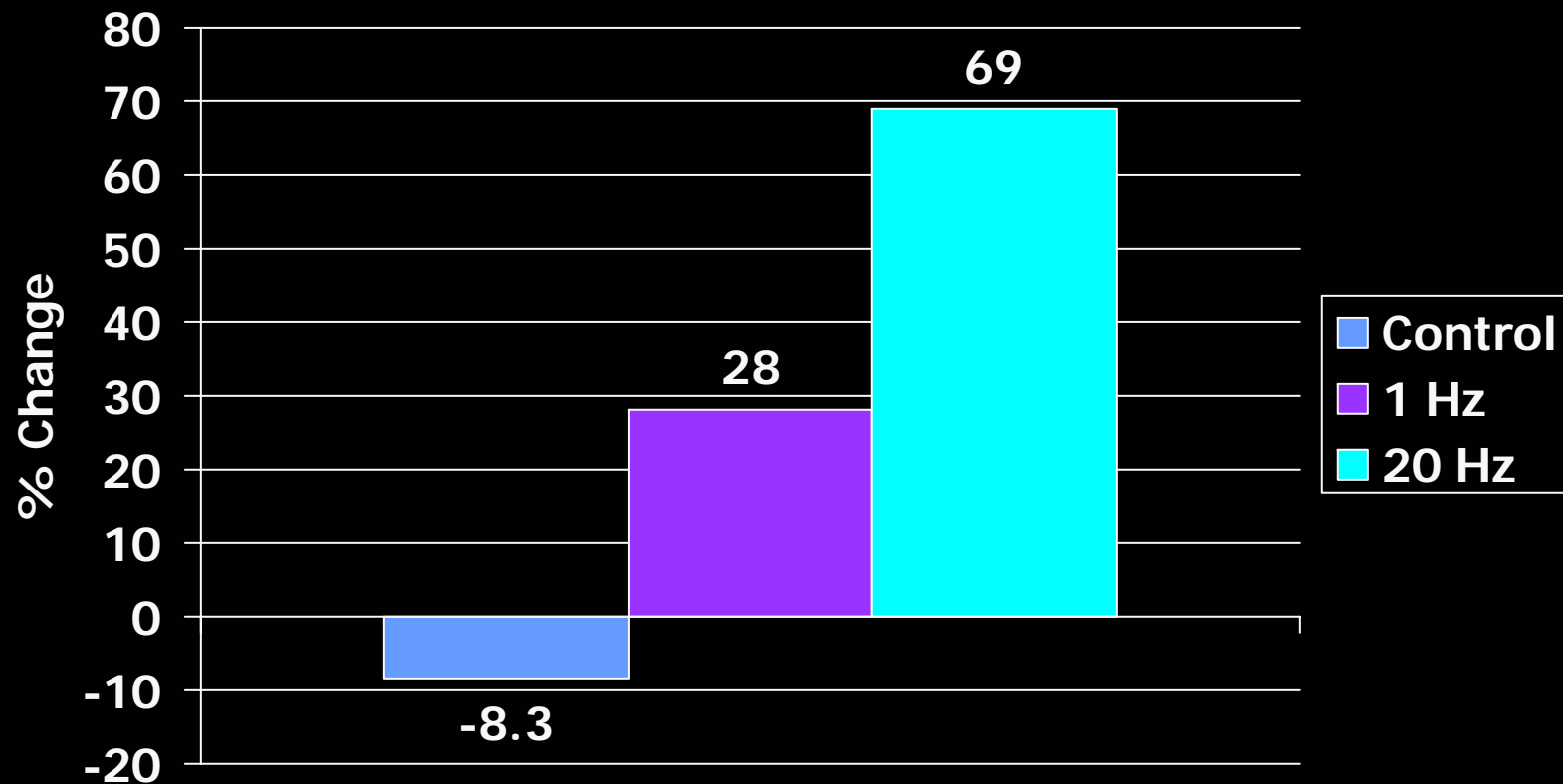


Percent differences in bone parameters for vibrated vs. control sheep (after 1 yr.)

Total bone density	+ 6.5%	Trabecular density	+ 34.2%
Total bone volume	+ 32%	Trabecular number	+ 45%
Bone formation rate	+ 113%	Mineralizing surface	+ 144%

Rubin, et al, *Nature*, 2001, 412:603-604

Percent of Bony Ingrowth @ 8 wks. (titanium implant in turkey ulna)



Rubin & McLeod, *Clin Orthop Rel Res*, 1994, 298:165-174

Rubin's overall findings suggest:

- Doubling of bone formation rates
- 25% increase in strength of trabecular (vs. cortical) bone
- Inhibition of disuse and post-menopausal bone loss
- Postulated relationship between age-related sarcopenia and osteoporosis

Rubin et al, *Drug Discov Today*, 2001, 6(16):848-858
(overview of work; has numerous other publications)

Other animal studies of bone loss

- Fleiger, et al (1998) studied ovariectomized rats vibrated at 50 Hz, 2 g, 30 min./day for 12 weeks; vibrated rats demo. significantly **less bone loss** than sham & non-vibrated rats
- Oxlund, et al (2003) compared vibration frequencies in ovariectomized rats and found that 45 Hz **increased bone formation and inhibited resorption** the most and preserved biomechanical strength of bone.



Human Pilot Studies: Prevention of bone loss in postmenopausal women

- RCT of 67 postmenopausal women in US who underwent 20 min./day WBV for 1 year (vs. placebo)
- Placebo group lost 3.8% in spine and 5.5% in femur
- WBV group **only lost 1.0% in spine and 1.5% in femur**

Rubin et al, *Bone*, 1998, 23:S174 (abstract)



Human Pilot Studies: Treatment of low BMD in disabled children

- RCT on 20 British children with disabilities (e.g., CP) who underwent 10 min./day WBV for 6 mo. (vs. placebo)
- Observed net gains in trabecular BMD in subjects exposed to WBV
 - +3.8 mg/nl in spinal vertebrae
 - +18.2 mg/nl in proximal tibia

Ward et al, *J Bone Miner Res*, 2001, 16:S1, #1148

Effect of WBV on Lumbar BMD in osteoporotic women

- Iwamoto et al, compared alendronate (Fosamax) to combined meds-WBV in 50 post-menopausal women with osteoporosis
- WBV group used Galileo platform @ 20 Hz, once a week x 4 min. for 12 months
- No sig. difference in BMD but back pain was ↓ more in WBV group.

Iwamoto et al, Aging Clin Exp Res, 2005, 17(2):157-163.

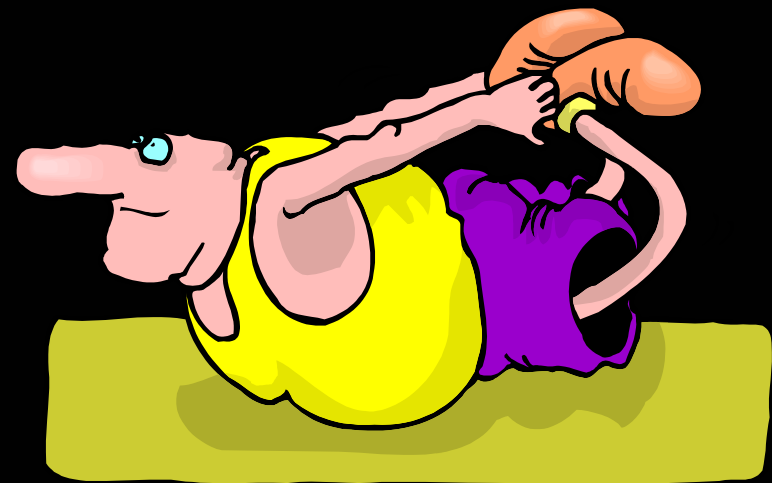
Effect of WBV on Back Pain

- Rittweger compared effects of WBV and isometric exercise on lumbar strength, pain, and disability ratings in 60 patients with chronic LBP
- Used Galileo platform: amp. = 6 mm @ 18 Hz; progressed from 4 to 7 min.
- Twice a week x 6 weeks, then weekly

Rittweger et al, *Spine*, 2002, 27(17):1829-1834

Effect of WBV on LBP

- Subjects demonstrated significant, but comparable **reductions in pain and disability ratings**.
- Exercise group demonstrated greater increases in lumbar extension torque than vibration group.
- Vibration did not aggravate pain or limitations in any subjects.



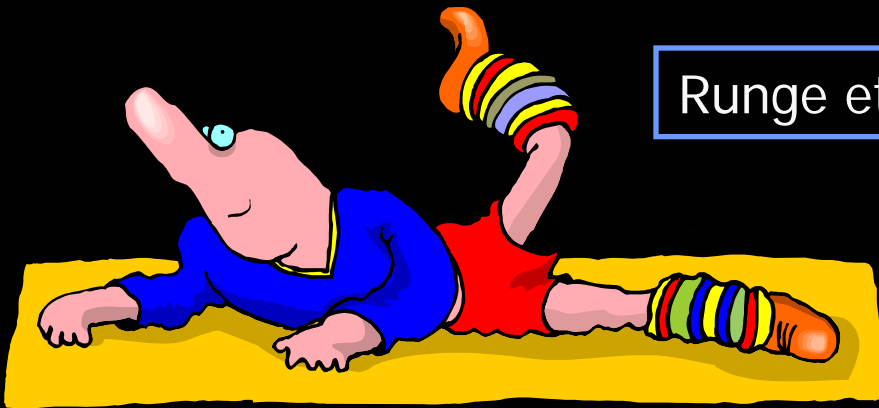
Geriatric Studies

- Runge conducted a crossover study involving 34 older adults in Germany who underwent 6 min. of WBV 3 times/week x 6 months
- Used Galileo platform: amp. = 7-14 mm @ frequency of 27 Hz
- Preliminary data (n=19) – chair rise time decreased by 18% in WBV group; no adverse effects reported

Runge et al, *J Musculoskel Neuron Interact*, 2000, 1:61-65

Effect on Urinary Incontinence

- Runge, et al are also investigating the effects of WBV on incontinence in older adults; no published studies yet
- Hypothesized mechanism is strengthening of pelvic floor muscles via activation of the stretch reflex



Runge et al, *Der Hausarzt*, 2002, 2:56-61

Effect on Fall Risk

- Bruyere et al, conducted a RCT to compare effects of 6 weeks of WBV + PT vs. PT alone in 42 NH residents.
- WBV group had significantly greater improvements in balance & gait (based on Tinetti test and TUGT) as well as QOL ratings.

Bruyere et al, *Arch Phys Med Rehabil*, 2005, 86(2):303-307

Fall and Fracture Prevention

- Iwamoto et al, enrolled 25 older women in a 3-mo., weekly exercise program that included WBV (using Galileo), one-legged standing, and half-squats.
- Step length, knee ext. strength, and OLST ↑ significantly, but no change in walking speed or hip flexor strength.
- No adverse effects reported.



Iwamoto et al, *Keio J Med*, 2004, 53(2):85-89

Effect on Postural Control

- van Nes, et al studied short-term postural changes in 23 stroke patients who received 4, 45-sec. bouts of WBV (Galileo platform @ 30 Hz).
- Small, significant improvements in sway velocity (AP) and weight-shifting accuracy in most subjects.
- No adverse effects reported.



van Nes et al, *Am J Phys Med Rehabil*, 2004, 83:867-873

Effect on Postural Control

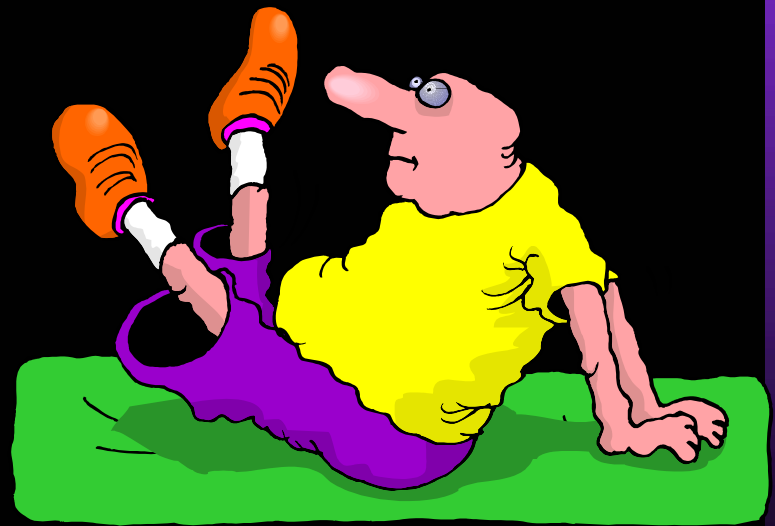
- Schuhfried, et al studied effects of low-frequency (2.0-4.4 Hz) WBV in 12 patients with multiple sclerosis; 6 assigned to WBV and 6 received placebo.
- WBV group's **postural sway and TUGT improved**, but not their functional reach. Improvements persisted 1-2 weeks.
- No adverse effects reported.

Schuhfried et al, *Clin Rehabil*, 2005; 19:834-842

There is fertile ground for
more research...

Potential benefits for children with CP

- Pilot study being conducted at Hardin-Simmons University (Abilene, TX) to determine effects of WBV exercise on children with spastic diplegia.
- Will assess changes in muscle tone, posture, and functional balance.
- Funded by the Texas Physical Therapy Foundation (ML Garret & MR Hinman, investigators)



Potential benefits of WBV for children with spastic diplegia

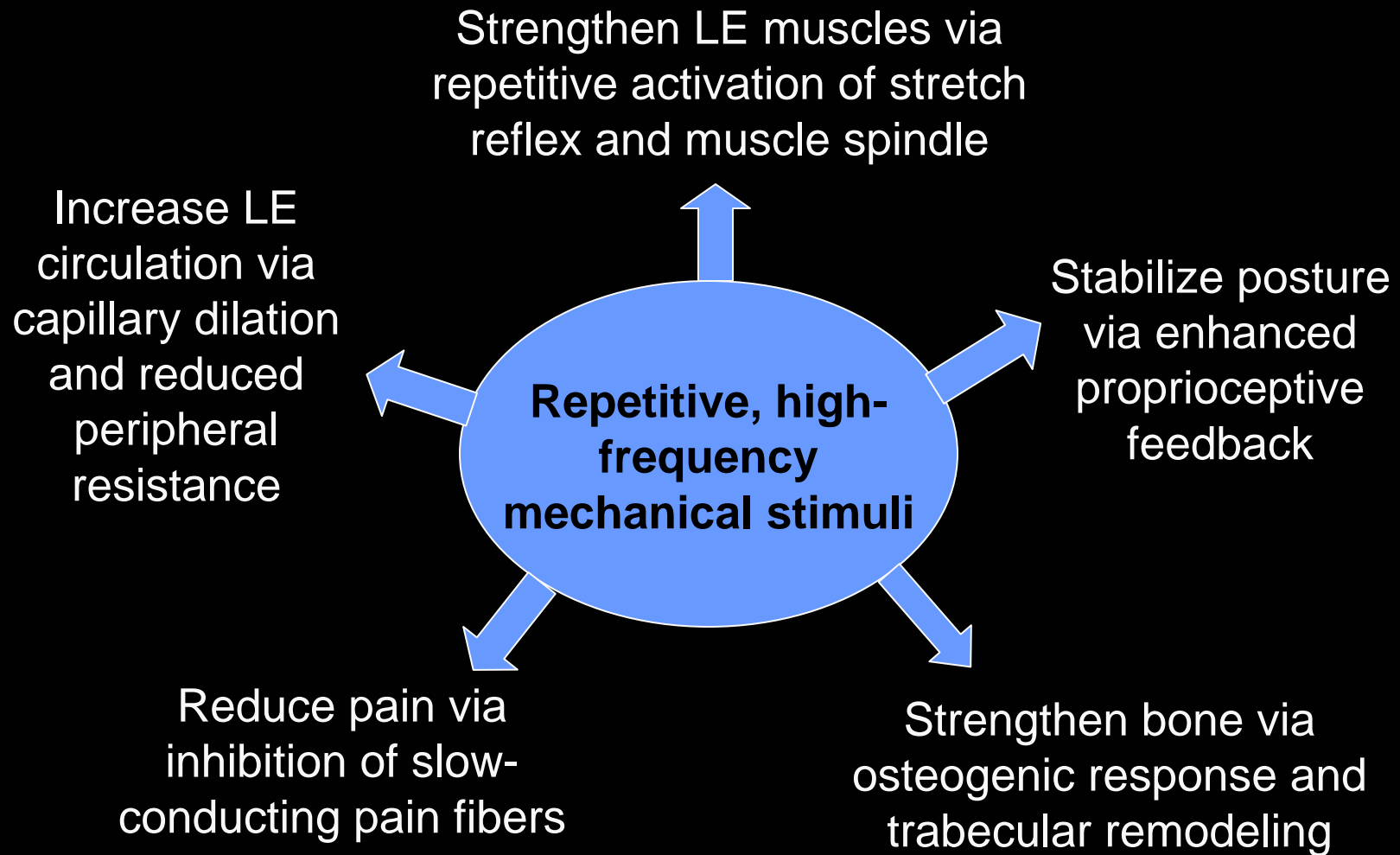
↓ LE muscle

tone via
fatigue
and
inhibition of
H-reflex

Repetitive,
high-frequency,
mechanical
stimuli

↑ postural
stability
via
proprioceptive
feedback

Potential benefits of WBV post-burn



Potential benefits for young athletes

Build bone to prevent osteoporosis in later life

**Repetitive, high-frequency,
mechanical stimuli**

Augment muscle strength and power
without over-stressing joints



Potential benefits for people with peripheral vascular disease and/or neuropathy

- Compare effects on extremity circulation with more traditional exercise approaches such as walking.
- Can repetitive vibratory stimulus also improve sensation?



We invite your input and
collaboration with this work!

Contact:

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