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Effects of whole-body vibration exercise on sleep disorders and clinical parameters in children with Down Syndrome: a pilot study

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Down Syndrome (DS), the most common genetic disorder worldwide. Children with DS have sleep disorders and the physical activity (PA) seems to be effective in minimizing the sleep disturbance. Whole-body vibration exercise (WBVE) is a security modality of PA. The aim of this pilot study is to evaluate the effect of WBVE on sleep quality in DS individuals. Data were collected in February 2021 from 3 children aged between 5 and 7 years of both sexes, the guardians signed the Free and Informed Consent Form (FICF) and answered two questionnaires on sleep disorders in children before the intervention and one week after the intervention. The heart rate (HR), respiratory rate (RR), blood pressure (BP) and oxyhemoglobin saturation (SpO2) were also verified before and after the intervention. The assessment of sleep quality was through Reimão and Lefevre infant sleep questionnaire (QRL) and Sleep disturbance scale in children (SDSC). The HR and BP have been checked by the automatic BP monitor, OMRON, model HEM7113, Brazil; the SpO2 checked by finger oximeter, Medical Rossmax model SB100, Taiwan; and the RR by the number of respiratory incursions for 1 minute. The parameters used during the WBVE were 2.5mm peak-to-peak displacement, 5Hz frequency, 1 time/week, each session consisted of 5 series (30 seconds/ vibration, 1 minute/rest) and in sitting position on the base of the vibrating platform with the feet resting on the floor and the hands were resting on the knees. The DS individuals showed an improvement in sleep patterns, decreasing the number of nocturnal awakenings and movement during sleep. Considering the findings of this pilot study, it is possible to suggest that acute effect of WBVE was effective in improving sleep quality in children with Down syndrome.

WBV contributions in cerebral palsy children's motor function

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Introduction: Whole body vibration (WBV) has been used to treat individuals with sensorimotor disorders. Cerebral palsy (CP) consists of an injury to the central nervous system that results in postural and kinetic changes in the individual, and his sensory-motor impairment varies according to the brain region affected. Hypomobility in these individuals reduces the ideal mechanical load for good musculoskeletal development and, consequently, limits function.

Purpose: to correlate exposure to WBV in individuals diagnosed with CP at different degrees of impairment and to analyze the possible benefits of such intervention.

Methods: Data collection was carried out in databases, using articles published between 2009 and 2019 that addressed the effectiveness and tolerance of whole body vibration in individuals diagnosed with cerebral palsy. An analytical bibliographic review of the publications was carried out.

Results and discussion: There is evidence that the WBV protocol is considered viable, safe and tolerable for participants with CP. This form of intervention has conferred benefits such as improved ankle proprioception (benefiting reactive balance, acquisition and adaptation of movement), improvement of gait variables, postural control, reduction of fracture risk by increasing the cortical bone area and improvement of gross motor coordination. If the vibratory stimulus is applied constantly, it can generate a neuroplasticity mechanism (in sensory, somatic and motor pathways) through the activation of mechanoreceptors. Muscle strength and mass can also increase, as the vibration incites motor units that were previously inert, inducing the muscle activation reflex (through the excitation of motor neurons) and potentiating the electromyographic activity during the stimulus.

Final Considerations: The stimuli received by the WBV also contribute to the modulation of tone, reducing spasticity and stimulating muscle and kinetic control, promoting an improvement in vestibular (static and dynamic balance) and neural function in children with CP.

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Whole Body Vibration combined with Interval Rehabilitation in Children with Ataxia

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Background: Physiotherapy, including vibration-assisted therapy, has been proven to be effective for patients with ataxic cerebral palsy. Herewith, we studied the effect of vibration-assisted home-training combined with interval rehabilitation on the motor function of children with congenital ataxia.

Patients: 45 children (mean age 7.7 years, SD 4.70) with ataxia, having received a six-month home-based side-alternating whole body vibration therapy combined with intensive, goal-oriented, functional rehabilitation intervals, were included in the study, classified according to the progressive or non-progressive ataxia character.

Method: Retrospective analysis of the prospectively collected data of the registry of the Cologne rehabilitation program "Auf die Beine". Motor abilities have been assessed prior to the intervention (M0), after six months of home-training (M6) as well as in a follow-up six months later (M12). We performed a gait analysis, a one-minute walking test (1-MWT), and the Gross Motor Function Measure (GMFM-66).

Results: The GMFM-66 improvement (M6-M0 vs M12-M6) was statistically significant with median improvement of 2.4 points (non-progressive) and 2.9 points (progressive) respectively, and clinically relevant. The 1-MWT improvement was statistically significant and clinically relevant for non-progressive ataxia.

Conclusions: Intensive interval neuromuscular functional training, supplemented with vibration assisted home-training has led to significant motor function improvement in patients with progressive, as well as in patients with non-progressive ataxias.

Is early vibration therapy intervention effective in toddlers with cerebral palsy?

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Background: Early years are a crucial period for the development of individuals with cerebral palsy (CP), the most common cause of motor disability in childhood. Previous studies have demonstrated that early interventions (e.g. physiotherapy, treadmill training, and conductive education) promote motor development in children with CP. Vibration therapy (VT) is a promising weight-bearing exercise modality to the early rehabilitation of children with CP and has been reported to have a positive effect on motor function, mobility, muscle strength, and bone density in older children.

Aim: The purpose of this pilot study was to evaluate the feasibility, safety, and efficacy of the VT in toddlers ages 2-4 years with cerebral palsy (CP)

Methods: A prospective, single-group, repeated-measures design was conducted in 10 children (mean age 42.6±10.9 months; 4 boys) with cerebral palsy GMFCS level I-III. Participants underwent 12 weeks of control period followed by 12 weeks of home-based side-alternating VT at 20 Hz for nine minutes per session, four days a week. Assessments were conducted at the baseline (T0), after the control period (T1), and after VT (T2) and included gross motor function measure (GMFM-66), dual-energy X-ray absorptiometry, 10-meter run test (10MRT), balance (Leonardo Mechanography plate), muscle strength (hand-held dynamometry), and quality of life (PedsQL).

Results: VT was well tolerated, with no side effects, and a high compliance level at 92.4%. After 12 weeks of VT period, participants demonstrated improvements in the total GMFM-66 score (+8.2 points; p=0.015), knee extension strength (+0.8 kg; p=0.03), and total lean mass (+602 g; p=0.047) as well as in bone mineral density in total body (+0.015 g/cm^2; p=0.048) and legs (+0.021 g/cm^2; p=0.017) with no changes in these parameters over the control period. There were no observed effects on balance, 10 MRT, total body bone and leg mineral content, and quality of life (total score).

Conclusion: A 12-week home-based VT was feasible and safe in toddlers ages 2-4 years with CP. VT was associated with improvements in motor function, total and leg bone mineral density, muscle strength, and total lean mass.

Clinical rehabilitation impact: VT has the potential to be incorporated in the early rehabilitation plan of toddlers with CP to optimize their development.

Effect of an interval rehabilitation program with home-based, vibration-assisted training on the development of muscle and bone in children with cerebral palsy – an observational study

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Background: Cerebral palsy (CP) is the most common cause of physical impairment in children. In children with CP, lesser muscle and bone growth compared to healthy children were reported. The aim of this study was to evaluate the effect of an intensive rehabilitation program including physiotherapy in combination with six months of home-based, vibration-assisted training on muscle and bone growth in children with CP.

Methods: The subjects were children with CP, who participated in the rehabilitation program. Muscle mass was quantified by appendicular lean mass index (App-LMI) and bone mass by total body less head bone mineral content (TBLH-BMC) assessed by Dual-energy X-ray absorptiometry (DXA) at the beginning of the rehabilitation and one year later. To assess the functional muscle-bone unit, the relation of TBLH-BMC to TBLH lean body mass (TBLH-LBM) was used.

Results: The study population included 128 children (52 females, mean age 11.9±2.7). App-LMI assessed in kg/m^2 increased significantly after the rehabilitation program. The age-adjusted Z-score for App-LMI showed no significant change. TBLH-BMC assessed in gram increased significantly. The Z-scores for TBLH-BMC decreased lesser than expected by the evaluation of the cross-sectional data at the beginning of the rehabilitation program. The parameter (TBLH-BMC)/(TBLH-LBM) did not change relevantly after 12 months.

Conclusions: Muscle growth and to a lesser extent bone growth could be increased in children with CP. The intensive rehabilitation program including vibration-assisted training seemed to have no direct effect on the bone, but the bone anabolic influence seemed to be only mediated through the muscle

Immediate effects of whole-body vibration exercise on the hormonal parameters and oxidative biomarkers in sarcopenic older people: controlled and randomized clinical trial

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Sarcopenia is a progressive and widespread disease of skeletal muscle that is associated with a greater likelihood of adverse outcomes, including falls, fractures, physical disability, mortality. The whole-body vibration exercise (WBV) was recently introduced as a non-pharmacological complementary therapeutic strategy for sarcopenic older people. Thus, the present study aims to evaluate the immediate effect of WBV exercise on hormonal parameters and oxidative biomarkers during dynamic squatting exercise with and without WBV in sarcopenic older people. A crossover randomized controlled trial involving non-sarcopenic (NSG=22) and sarcopenic (SG=22) individuals who underwent both intervention protocols: squats with and without WBV. The exercise protocol was 40 Hz and 4 mm, with eight sets of 40s of exercise and rest. The participants were evaluated by Dual Energy Radiological Absormetry (DXA) and anthropometric measures. Peripheral blood samples were collected before and after the situations (with and without WBV). The variables, assessed at moments baseline and after a session in both groups, were serum concentrations of cortisol, the activity of superoxide dismutase (SOD) and catalase (CAT), and concentrations of thiobarbituric acid (TBARS) and power iron-reducing antioxidant

Figure 1. Immediate hormonal and oxidative biomarkers responses in the situations with and without whole-body vibration in non-sarcopenic and sarcopenic groups. Data are means and standard deviation. Two-way ANOVA for repeated measures and Post Hoc Bonferroni. Difference between the mean values at rest between groups (a # b); *difference between "rest". TBARS: concentrations of thiobarbituric acid; FRAP: power iron-reducing antioxidant; CAT: catalase; SOD: superoxide dismutase.

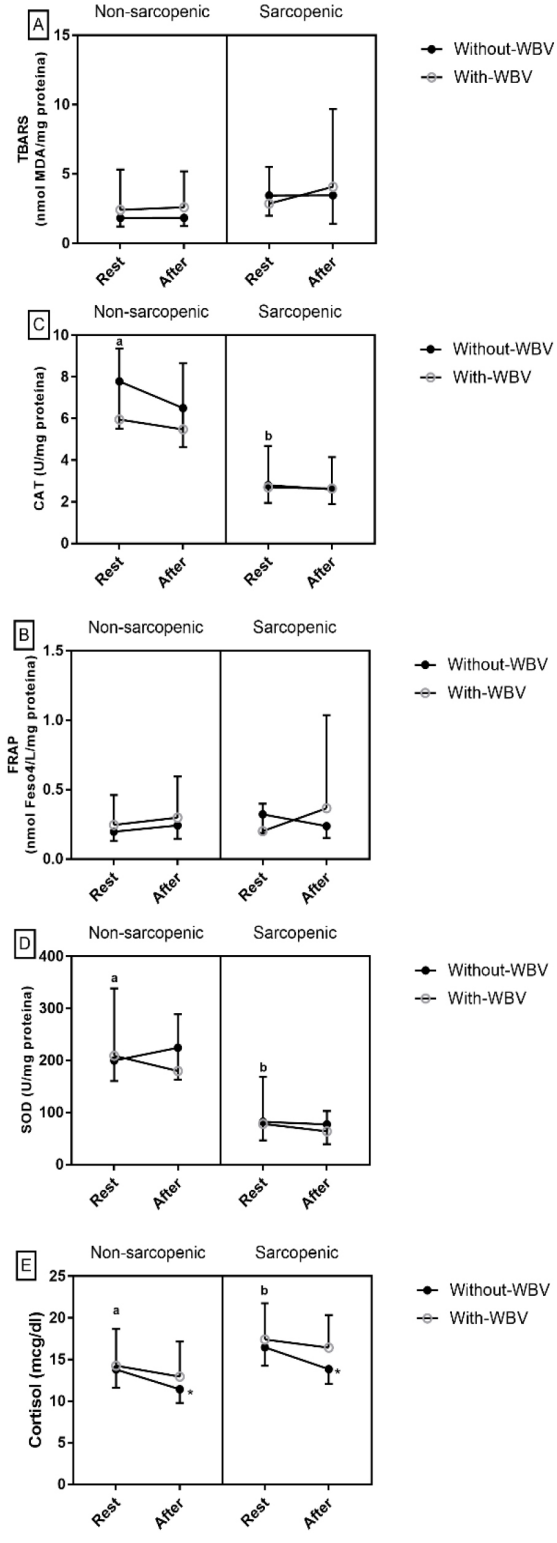

Table 1. Values are means (95% CI. TBARS: concentrations of thiobarbituric acid; FRAP: power iron-reducing antioxidant; CAT: catalase; SOD: superoxide dismutase. Experimental design in randomized blocks (between-intervention, within-intervention, interaction analyses). Two-way ANOVA (2 intervention x 2 moments), in both groups (non-sarcopenic and sarcopenic). F values. **Post Hoc* Bonferroni.

				p	F	p	F	p	F
Δ Cortisol, mcg/dl	Without-WBV	-2.30 (-3.60 – -1.17)	-2.60 (-3.84 – -1.41) *	0.78	0.01	**0.03**	4.99	0.64	0.22
	WBV	-1.30 (-2.52 – -0.09)	-0.97 (-2.19 – 0.24)						
Δ TBARS (nmol MDA/mg protein)	Without-WBV	0.00 (-1.63 – 1.64)	0.02 (-1.62 – 1.66)	0.54	0.38	0.41	0.69	0.53	0.41
	WBV	1.22 (-0.42 – 2.85)	0.18 (-1.46 – 1.82)						
Δ FRAP (nmol Feso4/L/mg protein)	Without-WBV	-0.03 (-0.19 – 0.14)	0.02 (-0.15 – 0.19)	0.92	0.01	0.27	1.22	0.68	0.18
	WBV	0.11 (-0.06 – 0.27)	0.08 (-0.09 – 0.25)						
Δ CAT (U/mg protein)	Without-WBV	-0.20 (-2.19 – 1.78)	-1.28 (-3.27 – 0.69)	0.46	0.56	0.63	0.23	0.74	0.11
	WBV	-0.06 (-2.05 – 1.92)	-0.47 (-2.46 – 1.51)						
Δ SOD (U/mg protein)	Without-WBV	-4.97 (-52.26 – 42.32)	9.79 (-37.50 – 57.08)	0.87	0.03	0.39	0.76	0.44	0.61
	WBV	-7.01 (-54.35 – 40.23)	2.73 (-76.77 – 17.81)						

(FRAP). The variables were presented as means and 95% confidence intervals. The t-independent test (parametric variables) or the Mann-Whitney test (non-parametric variables) were used to compare the groups at the baseline. Multivariate analysis to identify the effect and interaction through ANOVA two-way repeated measures (groups x moments) and ANOVA two-way (groups x intervention) with post hoc Bonferroni test. The level of significance adopted was 5%. The mean age, body mass index (BMI), lean mass, were respectively [Non-Sarcopenic: 72,0 (68.9-75.2); 24.9 (23.8-26.0), 40.1 (36.9-43.3)] and [Sarcopenic: 71.6 (68.1-75.2); 21.3 (20.4-22.2), 33.9 (30.9-36.9)]. There were differences between BMI (p=0.0001) and lean mass (p=0.013). As for relative skeletal muscle index (RSMI), when stratified by sex, men and women with sarcopenia presented 6.5 kg/m^2 (p <0.000) and 5.2 kg/m^2 (p<0.000) respectively. The SG showed higher concentrations of serum cortisol (p=0.0384) and reduced values of antioxidant enzymes SOD (p<0.0001) and CAT (p=0.0003) when compared to NSG. However, in SG there was a significantly greater reduction in serum cortisol levels after the exercise without WBV (p<0.03) when compared to the exercise with WBV. The addition of WBV did not promote differences between groups for oxidative biomarkers. Thus, we conclude that the parameters adopted in the WBV exercise were insufficient to modify the blood concentrations of cortisol and oxidative biomarkers in sarcopenic older people.

The Role of Dentin Matrix Protein 1 (DMP1) in Low-Magnitude High-Frequency Vibration Accelerated Osteoporotic Fracture Healing

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Introduction: Low-magnitude high-frequency vibration (LMHFV) has been proven to enhance osteoporotic fracture healing significantly and shorten bedrest period. Previous studies showed that LMHFV improved stem cell recruitment and angiogenesis. Recent studies also showed that vibration increased osteocytes number and modified their morphology. Osteocytes, making up 90% of bone cells , are responsible for mechano-sensing. LMHFV could alter osteocyte lacuno-canalicular network (LCN) and facilitate fracture healing. DMP1 in osteocytes is responsible for maintaining LCN and mineralisation. This study aims to investigate osteocyte-specific DMP1's role in enhanced osteoporotic fracture healing in response to mechanical loading.

Methods: Bilateral ovariectomy was done on 6-month-old female SD rats to induce osteoporosis. Metaphyseal fracture was created at left distal femur using oscillating micro-saw after internal fixation with screws and 6-hole T-shape plates. Rats were randomised to five groups: (1) DMP1 KD, (2) DMP1 KD + vibration (VT), (3) Scramble + VT, (4) vehicle control + VT, or (5) vehicle control, where KD stands for knockdown done by injection of shRNA into marrow cavity 2 weeks before surgery. Assessments included weekly X-ray, Micro CT and immunohistochemistry on DMP1, E11 and sclerostin at week 1, 3 and 6 post-fracture.

Results: DMP1 KD significantly impaired vibration enhanced fracture healing as shown by comparing KD + VT group to vehicle control + VT group or scramble + VT group. The X-ray relative opacity showed less tissue growth (p=0.012) at week 6 (Figure 1) and bone volume fraction decreased after DMP1 KD (p=0.034) at week 3 (Figure 2). DMP1 KD also significantly altered the expression level of osteocyte specific DMP1, E11 and sclerostin during the healing process. DMP1 KD + VT group showed no significant difference in fracture healing process and osteocyte specific protein expression compared to KD only group (Figure 3).

Figure 1. Radiography of healing outcome at week 6 post-fracture. Red arrows indicate the fracture site and the degree of bridging of the gap. Relative opacity of all groups at week 1, 3 and 6 post-fracture.

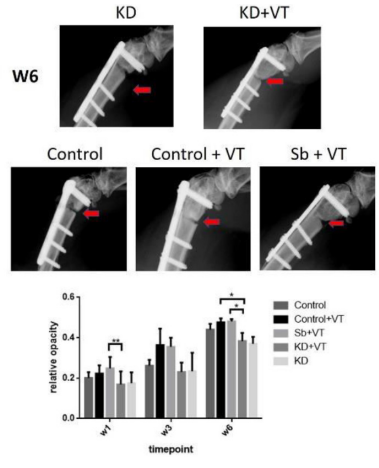


Figure 2. Bone volume fraction (BV/TV) increased steadily toward week 6. Significant difference was achieved at week 3 in Sb+VT compared to KD+VT.

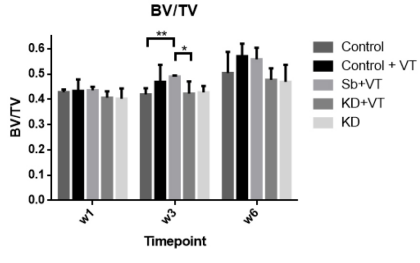
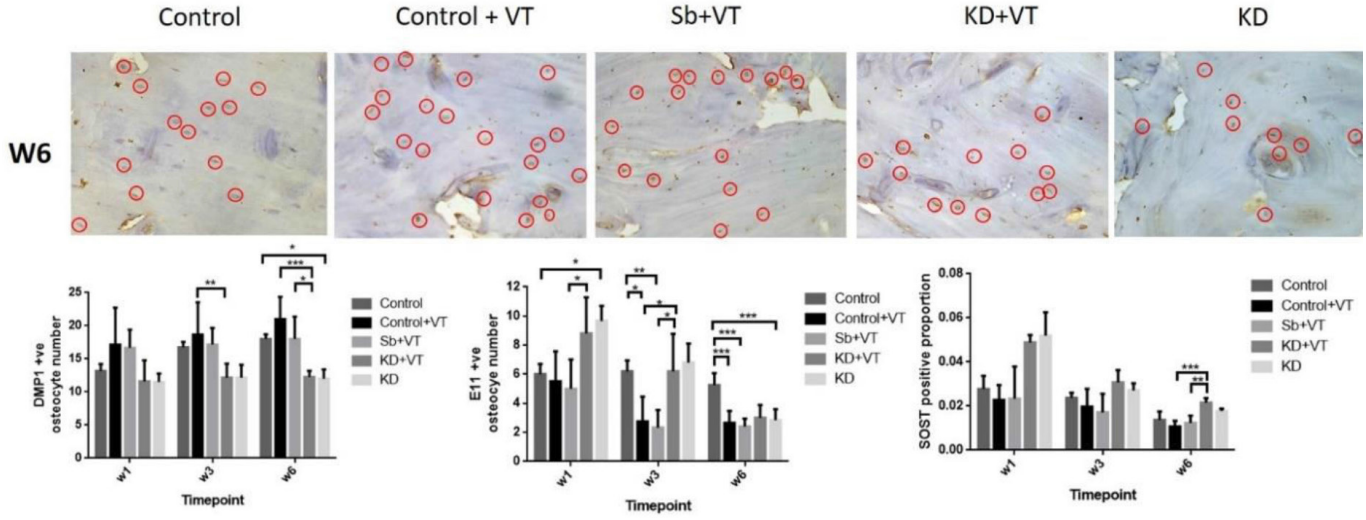


Figure 3. Representative images of immunohistochemical staining showing the region of interest (ROI) for quantification of positive signals (red circles). Significantly decreased DMP1 positive osteocytes in KD groups showed successful knockdown of DMP1. E11 expression in KD+VT group was significantly higher than Sb+VT group at both week 1 and 3, indicating delayed fracture healing. Vibration induced suppression of SOST was not seen in KD groups. SOST expression was significantly higher in KD+VT group than VT and Sb+VT groups at week 6.



Discussion: The lower bone volume fraction and relative opacity in DMP1 KD groups indicated that knockdown of DMP1 was associated with poorer fracture healing process compared to non-knockdown groups. E11 expression increased under DMP1 deficiency indicating that there were more pre-mature osteocytes and fracture healing was still in early stage. Also, DMP1 KD abrogated the effect of LMHFV in suppressing sclerostin expression level. Previous studies showed that DMP1 and E11 expression level would increase after application of LMHFV. However, the similar results in both knockdown groups with and without vibration showed that blockage of DMP1 would negate LMHFV-induced enhancement on fracture healing.

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WBV and nervous system: Clinical effects

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Introduction: The whole body vibration (WBV) activates the central nervous system (CNS) through receptors present throughout the body. Studies indicates a relation between WBV and several positive neurophysiological alterations, offering efficiency and praticality in the treatment of various neurological pathologies.

Purpose: To review the neurophysiological effects caused by WBV, relating them to the clinical effects in neurological disorders.

Methodology: Review of analytical literature. Data collection was performed in databases such as Google Scholar, Scientific Electronic Library Online (SciELO) and National Library of Medicine (PubMed). Only articles published between 2014 and 2019 were used (except for classical data and/or historical) that approached the neurological effects and/or the clinical applications of WBV use.

Results and discussion: WBV in different amplitudes, frequencies and duration causes neurophysiological adaptations that increase proprioceptive excitatory discharges of the somatososensory cortex, vestibular system and thalamus activation. It is observed an activation of the α motor neuron that helps muscle hypertrophy consequently leading to an increase in strength. In addition, the vibration reduces the release of neurotransmitters to motor neurons, decreasing the amplitude of the H reflexes; related to the activation of corticospinal and intracortical mechanisms. Such changes associated with peripheral mechanisms - improved perfusion and activation of muscle reflex - are related to improvement in muscle strength, spastic hypertonia, hypomotility, impaired posture and balance. Clinically, WBV improves sequels from neurological diseases, especially in those patients prevented from performing traditional physical exercises. In the treatment of multiple sclerosis (MS), for example, WBV (26 Hz) showed an improvement in the production of muscular torque, in the sitting and standing test and in other mobility tests. Patients with spinal cord injury also improved isometric strength after use of the WBV and presented significant resourcefulness in the walk test of 8 meters and in the SARA scale of ataxia. Cerebral palsy patients showed improvement in concentric, eccentric work and peak eccentric torque in the weakest limb, in addition to improving the score in several mobility tests. Patients with stroke as well as MS patients, improved the isometric, eccentric and isokinetic extension of the legs and also showed reduced spasticity. Individuals with Parkinson 's Disease showed an improvement in posture and balance.

Final considerations: WBV acts positively in the improvement of neurological pathologies such as multiple sclerosis, spinal cord injury, stroke, cerebral palsy and Parkinson's disease. The clinical effects most cited as positive are: increased strength of the lower limbs; reduction of spasticity; improvement of balance, postural control and motor function.

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Understanding the molecular basis of the effects of WBV on Parkinson's Disease pathology at a cellular level

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Background: Whole-body vibration (WBV) has shown to have positive effects on both the brain and the muscular system, which makes it a potential treatment for Parkinson's Disease (PD). A major limitation for the use of WBV in PD is the lack of an optimal WBV protocol. To provide a rationale for such an optimal protocol, it is crucial to determine the underlying mechanism of PD which is most sensitive to WBV. The genetic architecture of PD suggests that Leucine rich repeat kinase 2 (LRRK2) plays an essential role in PD pathogenesis and literature strongly suggests that LRRK2 mediates this role via the immune response. Several studies show the beneficial anti-inflammatory and immune-related effects of WBV.

Aim: Characterize the cellular role of LRRK2 and the molecular effect of WBV on LRRK2-mediated signaling and PD in general. We approach this via phagocytosis uptake since literature indicates the role of LRRK2 in phagocytosis. We will determine if WBV reverses the negative effects of LRRK2 mutation in phagocytosis. We will use cellular models from all kingdoms of life, as well as an animal model.

Methods: To characterize the potential of WBV to reverse the pathogenic changes caused by the PD related mutations (LRRK2), we are using Dictyostelium discoideum and its Roco4 null mutants to establish an optimal protocol for WBV. Dictyostelium discoideum Roco4 has the same domain topology as LRRK2 and is a model to study the structural and biochemical characteristics of the LRRK2 kinase model. Literature indicates that there is a defect in phagocytosis uptake in Roco4 mutants. We are using this defect as a readout to see the impact of various WBV protocols on the LRRK2 pathway.

Dictyostelium discoideum and its ROCO4 mutant are fed bacteria, yeast, and zymosan beads to induce uptake. The uptake is quantified visually using confocal microscopy and by taking the Optical Density readout of the number of bacterial cells taken up and the growth is measured by counting the number of cells. The experiments will be performed with and without vibration intervention at 30 Hz, for different time periods and directionality.

Expected outcome: We expect to see that Roco4 null cells have a defect in phagocytosis, in comparison to wild-type control cells and to see if WBV reverses or improves the defect. If this works then our next step would be to use the same WBV intervention protocol in other organisms like bacteria, murine and mammalian cell lines.

Effects of single session of Whole-Body Vibration on cardiac troponin I (cTnI), echocardiographic and ambulatory electrocardiographic (Holter) parameters of healthy non-athletic dogs

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The Whole-body vibration (WBV) has beneficial effects on the cardiovascular system in human patients and can be beneficial in dogs and cats rehabilitation. Studies should be conducted to obtain better scientific evidence and effective protocols in domestic animals. This study investigated the effects of WBV on cardiac troponin I (cTnI), echocardiographic and ambulatory electrocardiographic (Holter) parameters of healthy non-athletic dogs. Fourteen male crossbreed dogs aged between 27 and 96 months were submitted to a single session of WBV session by using a vibrating platform that delivered a vortex wave circulation. All dogs were submitted to single session of WBV with a frequency of 30 Hz [peak displacement (Dpeak)]= 3.10 mm) for 5-min, followed by an increase to 50 Hz (Dpeak=3.98 mm) for 5-min and finishing with a frequency of 30 Hz (Dpeak=3.10 mm) for 5-min, without rest. For cTnI measuring, blood samples were obtained from a jugular vein at 5 min before (5PRE) WBV session, 1 min (1POST), 30 min (30POST), 60 min (60POST), 120 min (120POST), 360 min (360POST), 12 h (12hPOST), and 24 h (24hPOST) after WBV. The echocardiographic parameters were measured at 5PRE, 1POST, 12hPOST, and 24hPOST, and the ambulatory electrocardiographic (Holter) parameters at following time-points: 5PRE, 1POST, 120POST, 360POST, 12hPOST, and 24hPOST. Dogs weighing tried to sit after 3-min at a frequency

of 50 Hz. Regarding the dog's behavior, 71% of them remained calm after the WBV session. There were no significant variations in cTnI values, and significant variations were identified in the thickness of the interventricular septum and thickness of the left ventricle-free wall values: GI<GII at 5PRE. The diameter of the left atrium values showed a difference: GI<GII at 5PRE and 1POST; and a decrease in GII between 5PRE and 1POST. Several ambulatory electrocardiography (Holter) parameters demonstrated significant differences between both groups and time-points. A single session of WBV at frequencies of 30 and 50 Hz during 15-min by using a vibrating platform that delivered a vortex wave circulation did not induce significant changes in cTnI values, echocardiographic and ambulatory electrocardiographic (Holter) parameters in healthy non-athletic dogs.

Acute effects of whole-body vibration exercise on flexibility in individuals with chronic obstructive pulmonary disease: preliminary findings

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Background: Chronic obstructive pulmonary disease (COPD) is a preventable, common and treatable disease and is characterized by air limitation due to alveolar changes that result in persistent respiratory symptoms. According to the World Health Organization (WHO), the number of deaths caused by tobacco reaches 8 million people per year, seven million from direct smoking and one million non-smokers who have been exposed to smoking. Respiratory symptoms are dyspnoea, one of the most debilitating, coughing, discharge and the most common non-respiratory symptoms are loss of muscle mass, weakness, reduced mobility. In order to reduce the pulmonary and non-pulmonary symptoms of COPD, pulmonary rehabilitation is indicated as a non-pharmacological, multidisciplinary approach in which the patient has several therapies, including support to change their lifestyle, guidance and the inclusion of physical exercise in their daily practice.

Methods: Fifteen COPD Individuals performed a single session of whole-body vibration exercises, sitting in an auxiliary chair in front of a side alternate vibrating platform. The parameters used were frequency 25 Hz, amplitude 2.5 mm, rest time 1 minute, work time 1 minute. Flexibility was assessed by the anterior trunk flexion test, the cardiovascular parameters were assessed by the measurement of heart and respiratory rate and by diastolic, systolic and mean arterial pressure. The data were analyzed with appropriate statistical tests using the Graph Prism software. Ethics Committee: agreement number: CAAE 49219115.3.0000.5259 and ReBEC under number RBR-72dqtm.

Results: The preliminary findings indicate an improvement (decrease), but not significant, in the anterior trunk flexion (14.00±11.32 cm before and 12.63±10.87 cm after; p=0.3692) and there were no significant differences in cardiovascular parameters.

Discussion: Exercise is recommended as a non-pharmacological treatment for patients with COPD and WBV exercise is an approach that does not stress the cardiovascular system and has been shown to be safe training in this population, showing an improvement in flexibility with a small number of participants.

Conclusion: The WBV exercise is a safe technique and is indicated as an exercise modality for frail population. More studies are needed to assess the acute effects on flexibility of COPD patients with a large number of individuals.

Cardiopulmonary responses during dynamic squatting exercise with and without wholebody-vibration in adolescents

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Background: Whole-body vibration (WBV) has been widely used as a therapeutic resource in pediatric rehabilitation. However, the cardiopulmonary responses are still unknown.

Objective: To investigate the intensity of dynamic squatting exercise with and without WBV in healthy adolescents to characterize cardiorespiratory responses.

Methods: Two experimental sessions were performed (squatting exercises with and without WBV) where the measurements of the VO2 measured breath by breath by a portable gas analysis system, and heart rate (HR) measured using an HR monitor. The protocol consisted of performing squatting exercises (8 sets of 40 seconds, with 40 seconds of rest between sets) with a frequency of 40 Hz and amplitude of 4 mm or without vibration (same protocol with the platform off), separated by at least 1 day. Twenty-five adolescents (14.1±1.7 years), 10 girls and 15 boys participated in the study. Inclusion criteria were age between 12 and 18 years old of both sexes and normal weight according to BMI. Exclusion criteria were to present chronic or acute neurological, orthopedic, respiratory, cardiac, and endocrine disease and no self-reported contraindication for WBV.

Results: There was a significant increase of the VO2 during both protocols in relation to the rest with significantly higher values during squatting with-WBV (p<0,01). Also, significant difference in HR was found in both protocols in comparison to corresponded rest with significantly higher values during squatting with-WBV (p<0,01). The predicted HR max for age in adolescents, determined by the equation HRmax=208-(0.7 x age), was 198 bpm. Rest, squatting without vibration, and squatting with WBV were 42, 50, and 56 % (with means of 83; 99; 110 bpm respectively) of the HRmax predicted for age. About the perceived exertion, the protocol with-WBV showed significant values compared with the protocol without-WBV with a mean score of 15.12±1.7 (level hard of exertion), and the protocol without-WBV showed a mean score of 8.48±1.7 (between extremely light and very light exertion) (p<0,01). Moreover, WBV was able to reach 24.7% of adolescents' VO2max, considering the mean values of VO2max.

Conclusion: Squatting associated with WBV was considered a light-intensity exercise tolerated by healthy adolescents. This study provided valid results of the effectiveness of this training modality and could be used as a tool to define the energy consumption spent, besides characterizing adolescents for such protocol.

Oscillatory whole-body vibration improves exercise capacity and physical performance in pulmonary arterial hypertension: a randomised clinical study

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Objective: In patients with pulmonary arterial hypertension (PAH), supportive therapies may be beneficial in addition to targeted medical treatment. Here, we evaluated the effectiveness and safety of oscillatory whole-body vibration (WBV) in patients on stable PAH therapy.

Methods: Twenty-two patients with PAH (mean PAP≥25 mm Hg and pulmonary arterial wedge pressure (PAWP)≤15 mm Hg) who were in world health organization (WHO)-Functional Class II or III and on stable PAH therapy for≥3 months, were randomised to receive WBV (16 sessions of 1-hour duration within 4 weeks) or to a control group, that subsequently received WBV. Follow-up measures included the 6-min walking distance (6MWD), cardiopulmonary exercise testing (CPET), echocardiography, muscle-power, and health-related quality of life (HRQoL; SF-36 and LPH questionnaires).

Results: When compared to the control group, patients receiving WBV exhibited a significant improvement in the primary endpoint, the 6MWD (+35.4±10.9 vs −4.4±7.6 m), resulting in a net benefit of 39.7±7.8 m (p=0.004). WBV was also associated with substantial improvements in CPET variables, muscle power, and HRQoL. The combined analysis of all patients (n=22) indicated significant net improvements versus baseline in the 6MWD (+38.6 m), peakVO2 (+65.7 mL/min), anaerobic threshold (+40.9 mL VO2/min), muscle power (+4.4%), and HRQoL (SF-36 +9.7, LPH −11.5 points) (all p<0.05). WBV was well tolerated in all patients, and no procedure-related severe adverse events (SAEs) occurred.

Conclusions: WBV substantially improves exercise capacity, physical performance, and HRQoL in patients with PAH who are on stable targeted therapy. This methodology may be utilised in structured training programmes, and may be feasible for continuous long-term physical exercise in these patients.

Trial registration number NCT01763112; Results.

Whole-body vibration training versus conventional balance training in patients with severe chronic obstructive pulmonary disease (COPD) – a randomized, controlled trial

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Background: Whole-body vibration training (WBV) performed on a vibration platform can significantly improve physical performance in patients with chronic obstructive pulmonary disease. It has been suggested that an important mechanism of this improvement is based on an improvement in balance. Therefore, the aim of this study was to investigate the effects of WBV compared to conventional balance training.

Methods: 48 patients with severe COPD (FEV1: 37±7 %predicted) and low exercise performance (6-minute walk distance (6MWD): 55±10% predicted) were included in this randomized controlled trial during a 3-week inpatient pulmonary rehabilitation. All patients completed a standardized endurance and strength training program. Additionally, patients performed 4 different balance exercises 3x/week for 2 sets of 1 minute each, either on a vibration platform (Galileo) at varying frequencies (5-26 Hz) (WBV) or on a conventional balance board (BAL). The primary outcome parameter was the change in balance performance during a semi tandem stance with closed eyes assessed on a force measurement platform. Muscular power during a countermovement jump, the 6MWD, and 4-meter gait speed test (4MGST) were secondary outcomes. Non-parametric tests were used for statistical analyses.

Results: Static balance performance improved significantly more (p=0.032) in favor of WBV (path length during semi-tandem stand: -168±231 mm vs. +1±234 mm). Muscular power also increased significantly more (p=0.001) in the WBV group (+2.3±2.5 W/kg vs. -0.1±2.0 W/kg). 6MWD improved to a similar extent in both groups (WBV: 48±46 m, p<0.001 vs. BAL: 38±32 m; p<0.001) whereas the 4MGST increased significantly only in the WBV-group (0.08±0.14m/s^2, p=0.018 vs. 0.01±0.11m/s^2, p=0.71).

Conclusions: WBV can improve balance performance and muscular power significantly more compared to conventional balance training.

Effect of whole-body vibration exercise on anterior trunk flexion and perceived exertion in patients with chronic obstructive pulmonary disease: an acute intervention

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COPD is often associated with extrapulmonary comorbidities with significant secondary consequences, especially in skeletal muscle, with regard to functional changes. Regular physical activity can prevent physical disabilities and avoid problems in functional capacity in individuals with COPD. Whole-body vibration exercise (WBVE) is considered a type of physical activity that improves muscle strength and power, flexibility, and other health conditions.

Objective: To analyze the effect of WBVE on anterior trunk

flexion (ATF) and perceived exertion (PE) in patients with Chronic Obstructive Pulmonary Disease (COPD).

Methods: Fifteen COPD patients underwent anterior trunk flexion and subjective perceived exertion before and after a session of WBVE, sitting in an auxiliary chair in front of a side alternate vibrating platform. The parameters used were frequency 25 Hz, amplitude 2.5 mm, rest time 1 minute, work time 1 minute. Flexibility assessment was performed using the AFT test and PE was performed using the Borg rating of perceived exertion scale. The data have a normal distribution and belong to the same group of individuals (they are parametric and paired). Data evaluation was performed using the Shapiro Wilk normality test. Ethics Committee: agreement number: CAAE 49219115.3.0000.5259 and ReBEC under number RBR-72dqtm.

Results: In the effort perception scale (EPS), there was no significant difference (p=0.12) between EPS begin 10.07±2.78 (6-15) and EPS final 9.13±2.44 (6-13) showing that WBVE can be a safe activity to the COPD patients.

Conclusion: The ATF of individuals with COPD can be improved through physical activity using WBVE. In addition, the perception of effort unchanged in these individuals may suggest that this modality is a safe therapeutic strategy and easy to adapt for this population

Effects of whole-body vibration on neck circumference in patients with Metabolic Syndrome - preliminary results

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Metabolic Syndrome (MSy) is composed of risk factors that favor the onset of cardiovascular diseases and type 2 diabetes mellitus. MSy is directly related to the deposition of visceral fat and insulin resistance, considerably increasing the risk of cardiovascular diseases and mortality. Studies show that the increase in neck circumference (NC) may be a finding independent of other metabolic risk factors, once considered a determinant of upper body obesity and because it is closely related to changes in blood pressure and MSy. Whole-body vibration (WBV) has been used for management of obese individuals and with MSy and is commonly recommended because it is a safe method because it has a low mechanical impact, besides being a low cost and good adherence method, being a good treatment suggestion for individuals with MSy. The assessment of the effects of WBV on the NC of individuals with MSy has not yet been reported. The hypothesis of this work is that the WBV can promote the reduction of NC in individuals with MSy.

Material and Methods: This project corresponds to a randomized, cross-sectional, blinded study. Twenty-six individuals diagnosed with MSy (6 men and 20 women, with 57.08±11.31 years of age, 87.49±15.35 kg of body mass, 161.29±8.82 m in height and 33.6±4.58 kg/m^2 of body mass index) were recruited at the Hospital Universitario Pedro Ernesto (HUPE) and Policlínica Piquet Carneiro (PPC), in the Universidade do Estado do Rio de Janeiro (UERJ), divided into two groups: I) 14 in the Fixed Frequency Group (FFG) and II) 12 in the Variable Frequency Group (VFG). Individuals from both groups underwent 6 weeks of intervention, twice a week, totaling 12 sessions, held in an alternating vibrating platform (VP) (Novaplate, Fitness Evolution, São Paulo, Brazil). The individual was positioned barefoot, with knee flexion at 130° on the base of the VP. The peak-to-peak displacement was 2.5, 5 and 7.5 mm in each sequence. In both groups, from the 1st to the 4th session, 3 sequences were performed, from the 5th to the 8th session, 4 sequences and from the 9th to the 12th session, 5 sequences. During the protocol, individuals performed static and dynamic squats, with one session being static and the other dynamic (alternately). In VFG, the frequency of 5 Hz was used in the 1st session, increasing 1 Hz in each session, totaling 16 Hz in the last session. One minute of vibration was performed with squat and 1 minute without vibration and without squat in each peak-to-peak displacement. The working time used was one minute of vibration and one minute of rest. In the FFG, the frequency of 5Hz remained unchanged in all sessions. The working time used was 10 seconds of vibration and 110 seconds without vibration in each peak-to-peak displacement, being 1 minute with squat (dynamic or static) and 1 minute of rest. The WBV intervention was performed in the Laboratório de Vibrações Mecânicas e Práticas Integrativas (LAVIMPI), PPC/UERJ. NC and BMI were measured before and after the intervention.

Results: The preliminary results of this investigation demonstrated that the use of WBV generated by vibrations produced on a vibrating platform with low frequency (from 5 to 16 Hz) in individuals with MSy significantly reduced (p<0.05) the NC in the VFG (38.65±3.32 before, 37.56±2.90 after, p=0.01). The intervention with FFG did not produced significant result (37.20±3.43 before, 37.29±4.26 after, p=0.65).

Conclusion: The findings of this study suggest that the WBV exercise applied in a 12 sessions can benefit individuals with MSy.

Whole-body vibration exercises could be a strategy to improve body composition and health metabolic in obese individuals? Preliminary results

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Obesity can be considered as a worldwide epidemic that can lead to considerable problems for the health of the individual and has major cost implications associated with both its prevention and treatment. The pathogenesis of obesity includes the balance between calories consumed and energy expenditure. Obesity is often classified according to body mass index (BMI) and Individuals with obesity are more susceptible to the development of cardiovascular (CVD) diseases, stroke, several types of cancers and increased risk for complications from COVID-19. Waist circumference (WC) is an anthropometric measure that measures central fat and may reflect the accumulation of fat in the abdominal region. Metabolic abnormalities in obese individuals appear to be related to ectopic and visceral fat supporting reports that metabolically harmful phenotypes may be associated with patterns of body fat distribution unhealthy over the Years. The transition from metabolically healthy to unhealthy phenotypes has been linked to a higher BMI or WC. The most premature deaths due to CVD events may be attributable to impaired lifestyle patterns associated with body fat concentration. In this context lifestyle choices such as exercise and proper diet have been shown to be related to metabolic health benefits. Whole-body vibration exercise (WBVE), that has been used in obese individuals, is performed through the transmission of the mechanical vibration (produced by vibration platform-VP) to the whole body of the individual. Biomechanical parameters, the time of intervention (rest and working time) and the position of the individual need to be established according to the aim of the intervention and clinical conditions of the individual. Cross-sectional study approved by ethical committee (CAAE 19826413.8.0000.5259 and ReBEC RBR-2bghmo) includes individuals of both sexes, with obesity and excludes individuals with functional disability or severe illness that did not permit the position on the VP during the protocol. WBVE was performed by 6 weeks, static and dynamic squatting, twice a week, from 18 to 30 minutes, frequency from 5 to 16 Hz and peak to peak displacement from 2.5 to 7.5 mm, using side-alternating VP. The bioelectrical impedance analysis and the evaluation of WC were performed before and after 6-weeks. The statistical analysis was mad using Graph Prism software. Preliminarily, 7 individuals (58.75±12.06 years and 34.43±4.02 (kg/m^2) BMI, finished the 6-week protocol, and the data are presented in mean and standard deviation with p-value: WC before 110.1±10.44 cm and after 107.6±10.57 cm (p=0.02) and trunk fat percentage (TFP) before 45.80±2.42% and 44.83±2.90% (p=0.03). Data demonstrate significant reduction in the WC and TFP of studied individuals after 6-week of WBVE. The changes that were found can contribute to metabolic health of these individuals, however, these are the preliminary results and are necessary more studies to promote better comprehension and to confirm these findings.

Could whole-body vibration exercise modify the uric acid concentration in individuals with metabolic syndrome? Preliminary results

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Background: Metabolic syndrome (MSy) is a major worldwide public health issue and is defined as a cluster of cardiovascular risk factors, such as obesity with increased body waist circumference, dyslipidemia associated with high serum triglycerides and low HDL cholesterol, elevated blood pressure, and impaired glucose tolerance (manifested as a type of insulin resistance). Other commonly associated characteristics include nonalcoholic fatty liver disease, microalbuminuria, and hyperuricemia (high uric acid [HUA]). HUA levels are independent markers of increased cardiovascular disease risk, in this context the impaired uric acid metabolism may result in an increased incidence of MSy. Present-day changes in living patterns, such as increased alcohol intake, high-calorie diets, decreased physical activity, as well as increased sedentary behavior, are causes of the increased prevalence of HUA. Regular exercise significantly less the excess mortality risk associated with elevated serum uric acid. In this context, it is suggested that whole-body vibration exercises (WBVE) would be a useful alternative to the management of MSy individuals. In the WBVE, the individual is exposed to mechanical vibrations produced by a vibrating platform (VP) and the vibrations are transmitted to the whole body. The aim of this study was to evaluate the serum uric acid concentration of individuals with MSy before and after WBVE.

Methods: Twenty-four of MSy individuals were allocated in a Fixed Frequency (FF) and Variable Frequency (FV) group. A side-to-side alternating vibrating platform was used. The parameters used were 5 to 16 Hz (frequency), 2.5, 5, and 7.5 mm (peak-to-peak displacement), 1 minute of work time, and 1 minute of rest. This protocol was performed in a squat static and dynamic position, per 6 weeks, twice a week. Samples of blood were collected and the concentrations of uric acid were determined before the first session and after the last WBVE session. The data were analyzed with appropriate statistical tests using the Graph Prism software. Trial register: CAAE 19826413.8.0000.5259 and RBR-2bghmo.

Results: No significant difference was observed in the individuals of the FF (5.46±0.97 mg/dL before and 5.11±0.69 mg/dL after; p=0.438) and FV groups (5.19±1.15 mg/dL before and 5.22±1.09 mg/dL after; p=0.071) comparing before and after WBVE to the concentration of HUA.

Discussion: Considering the findings with a small number of individuals exposed to WBVE, which is a low-intensity exercise, the results suggest that WBVE, with the biomechanical parameters used in the protocols, does not modify the uric acid concentration.

Conclusion: Physical exercise is indispensable for maintaining the health of individuals with MSy, however further studies are needed to learn about the application of whole-body vibration and the better protocol for your utilization related to uric acid concentrations in this population.

Effects of Whole body vibration exercise on serum enzymes abcivites in diabetic wistar rats

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Whole-body vibration (WBV) is well-known as an alternative form of exercise generated in an individual that is in contact with the base of a vibrating platform due to the transmission of mechanical vibration (MV) to a body. WBV is used as an intervention to the management of various clinical disorders, including, diabetes. Diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin. Type-1 diabetes mellitus (T1DM) is characterized by deficiency of insulin production due to the destruction of beta-pancreatic cells. The evaluation of the influence of WBV on T1DM serum enzymes is relevant to try identifying the underlying mechanisms. Therefore, the consequences of the WBV intervention in Wistar rats with T1DM on the serum enzymes activities are reported. To analyze the effect of WBV on serum enzymes (aspartate aminotransferase-AST, alanine aminotransferase-ALT, alkaline phosphatase-AP, amylase-AMS, lipase-LIP) on T1DM Wistar rats. The protocols were approved by the Ethics Committee from University of Rio de Janeiro, protocol CEUA/006/2019. Eighteen male Wistar rats (n=6/per group, 250-350 g, 3-4 months) were separated into three groups, Healthy Control (CON), Diabetic Control (DC) and Diabetic+Vibration (D+VBR). For diabetes induction, Aloxana monohydrate at the dose of 170 mg/kg diluted in saline (NaCl 0.9%) was used. The glucose was measured in a sample of blood collected from the tail with a glycosimeter. The rats were considered diabetic with glucose above 200 mg/dl. The D+VBR group was submitted to MV (frequency of 50 Hz and amplitude of 0.78 mm) exposed to 4 sessions of 30s, separated by 1-min rest period (each session), performed for 5-weeks. Results were expressed as mean±SD. After 5-weeks of the interventions no statistical difference was found when compared the serum enzyme levels of the animals of DC and D+VBR group. But, it was possible to observe changes on enzyme markers levels in CON group (1.55±0.13 [ALT]; 4.92±0.99 [ALP]; 16.16±0.01 [AMS]; 0.16±0.01 [LIP]) compared to DC (1.98±0.31 [ALT]; 16.83±6.63 [ALP]; 14.44±1.90 [AMS]; 0.18±0.01 [LIP]) and D+VBR group (2.02±0.51 [ALT]; 11.05±5.06 [ALP]; 12.39±1.86 [AMS]; 0.19±0.02 [LIP]). As, in general, an increase of the concentrations of the studied enzymes would be related to impairments of liver and kidneys, the present findings indicate that the 5-weeks of the WBV intervention would induce protection (no changes were found) in diabetic Wistar rats. Although, changes in comparison between healthy and T1DM rats were verified

Whole Body Vibration in Adolescent Idiopathic Scoliosis

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Objective: The aim of this study was to evaluate the effect of physiotherapeutic scoliosis specific exercises (SSE) combined with SSE on a side-alternating whole body vibration platform (WBV) as a home-training program in girls with adolescent idiopathic scoliosis (AIS).

Methods: This study was an investigator blinded randomized controlled trial, which has been previously published. Participants: 40 female AIS patients aged 10 to 17 years, wearing a brace and performing regular PSSE were randomly assigned to two groups. The intervention group performed an additional home-based PSSE program on a WBV platform for 6 months. Exercises were standing, sitting and two different kneeling positions (each 3 minutes) five times per week. The control intervention was regular PSSE (treatment as usual). Main Outcome Measure(s) were the Cobb angle measured at start and after six months by MRI. A clinically relevant effect was estimated at a change of 5°. The onset of menarche was documented for sub-group analysis.

Results: The major curve (MAC) in the WBV group decreased significantly by -2.3°(SD±3.8) (95% CI-4.1 to -0.5; P=.014) compared to the difference in the control group of 0.3° (SD±3.7) (95% CI-1.5 to 2.2; P=.682). The difference between groups was significant (p=.035). Clinical relevance for MAC: In the WBV group 20% (n=4) improved by ≥5°, 75% (n=15) stabilized and 5% (n=1) deteriorated. In the control group 0% (n=0) improved, 89% (n=16) stabilized and 11% (n=2) deteriorated. Subgroup analysis showed the clinically largest change in the 'before-menarche' sub-group.

Discussion: This pilot study showed that an additional home-based PSSE performed on a sWBV platform for six months counteracts the progression of scoliosis in girls with AIS wearing a brace; especially before the onset of the menarche. A study protocol on a confirmatory trial on PSSE on a WBV platform in young girls with idiopathic scoliosis before prescription of a brace will be discussed.

Analysis of the pain level during 5-week of whole-body vibration exercise: preliminary findings

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Introduction: Knee osteoarthritis (KOA) is a degenerative disease which mainly affects the articular cartilage, with multiple risk factors including trauma, overuse, and genetic predisposition occurring most frequently in individuals aged over 50 years. Pain is one of the main symptoms, which can lead to limitations on daily activities. Currently, there is no cure for KOA. Pharmacological and

non-pharmacological approaches aim to reduce pain and improve the functional capacity. The whole-body vibration exercise (WBVE) has been suggested as a non-pharmacological intervention for KOA individuals being an effective way of reducing pain levels in individuals with KOA.

Objective: To analyze the level of pain in KOA patients over 60 years old during 5 weeks of WBVE.

Ethics Committee: This study was approved by the local ethics committee (CAAE-19826413.8.0000.5259) and the clinical trial was registered (RBR-7dfwct).

Methods: The WBVE protocol was performed twice a week for 5 weeks in a side-alternating vibratory platform (VP). The Individuals were instructed to (i) sit in an auxiliary chair in front of the VP, (ii) place the feet on the VP basis (barefoot), (iii) knees in a comfortable bending position between 100-120º, (iv) hands resting on the knees to facilitate the transmission of vibration to the whole body. The individuals were instructed to maintain this position in each peak-to-peak displacement (D) (2.5, 5 and 7.5 mm) for 3 minutes with 1 minute of rest between the bouts. The frequency varied from 5 up to 14 Hz and the peak acceleration (a_{Peak}) between 0.12 to 2.95 g. The pain level was assessed through the Numeric Rating Scale (NRS) before and after each session of WBVE.

Results: In general, a reduction on the pain level was observed before and after WBVE in any of the 10 sessions. But the statistical analysis was not performed due to the small number of the sample (six individuals over 60 years old).

Conclusion: This work showed the result of the daily assessment of the level of pain before and after 10 sessions of WBVE. As only 6 individuals were evaluated, it is required a larger sample size to confirm or refute this finding.

The evaluation of the effects of whole-body vibration exercise on sleep quality in knee osteoarthritis elderly woman: preliminary findings

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Introduction: Knee osteoarthritis (KOA) involves the joint as a whole, including articular cartilage degradation, bone remodeling, osteophyte formation and synovial inflammation. KOA plays a prominent role, being considered the main cause of chronic pain and progressive disability to work, greatly influencing the quality of sleep. Exercise is an intervention that has been used to the management of KOA individuals.

Objective: The aim is to evaluate effects of whole-body vibration exercise (WBVE) on sleep quality in elderly woman with KOA. Methods: Randomized clinical study conducted with fourteen elderly women with KOA, grade from 1 to 5 (Ahlbäck Scale), 69.36±7.08 years, allocated into two groups: i) control group (n=8) and ii) WBVE group (n=6), recruited in the Setor de Ortopedia e Traumatologia of Hospital Universitário Pedro Ernesto, Rio de Janeiro, Brazil, from September 2019 to March 2020. The participants were subjected to of mechanical vibrations generated in an alternating vibrating platform (VP) sitting in a chair in front of the VP, in a comfortable position, with bare feet standing on the base of the VP, arms extended, and hands on the knees using frequency: 5 to 14 Hz, peak-to-peak displacement: 2.5 to 7.5 mm, Peak acceleration: 0.12 to 2.95 g. The participants performed two days/weekly for five weeks, in three bouts (3 min of working time and 1 min of rest time and 11 min of total time). Participants of the CG were submitted to the same protocol as WBVEG, but with the VP turned off. Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS) were used to evaluate the sleep quality this participants before the first and after the last session.

Results: Considering PSQI, no significant difference was observed in the participants of the CG (10.13±4.58 before and 8.12±2.90 after, p=0.09) and WBVE (5.83±3.31 before and 7.00±2.37 after, p=0.50). Considering ESS, no significant difference was observed in the participants of the CG (7.12±6.20 before and 8.37±4.93 after, p=0,27) and WBVE (9.67±7.17 before and 11.00±5.86 after, p=0.54). Conclusion: Considering the PSQI and ESS, no significant evidence was found in sleep quality of participants with KOA. The current study has limitations that should be considered when interpreting the findings, such as the small number of participants and different degrees of radiological impairments in the knee

Muscular performance is improved by long-term whole-body vibration in comparison to a traditional training program

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The current study aimed to explore the effect of long-term whole-body vibration (WBV) in comparison to traditional training on muscular performance. Thirty healthy physical education students were randomly allocated into a Vibration Group (VG, n=13), which underwent a whole-body vibration training program with external load, and a Traditional Group (TG, n=17), which received the same training program without a vibration load. The study was composed of pre-test assessments, a 4-week intervention phase, and post-test assessments. During the intervention phase, the VG and TG performed three training sessions per week, including six sets of 30-sec squats with external loads. Assessments included: Maximal isometric muscle strength; Power (assessed by squat jump); Reactive strength (assessed by counter-movement jump and drop

jump); and Muscular endurance. The results revealed significant improvements in all measured variables among the participants in the VG from the pre- to post-tests (p<.05). Among the TG participants, significant differences between the pre- and post-tests were found only in the squat jump and the counter-movement jump (p<.01). A significant Group X Time interaction was found in the drop jump test, implying greater improvement in the VG following the intervention. The findings suggest that it would be beneficial for athletes to train with WBV to improve different strength and performance components, rather than traditional resistance training, which has the disadvantage of being very specific and time-consuming.

Whole-body vibration training as a minimal preventive intervention in workplace health promotion: experience from practical studies and a best practice project

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Introduction: Whole-body vibration training (WBVT) is more and more subject of scientific research and frequently used in practice. Previous research has shown that WBVT is an effective and safe preventive intervention, i.e. for older and/or unfit people[1]. To date, a few studies show an effectiveness and safety of WBVT using sinus like and random vibrations in healthy white and blue-collar employees as well as in employees with chronic low-back pain[2].

Methods: Three randomized controlled trials on the preventive use of WBVT for healthy white-collar employees as well as white-collar employees with chronic low-back pain were conducted. Besides, we gained experience in the implementation of WBVT in the second largest German company in the water management sector with around 2250 employees. In addition, we applied two long-term research projects on the accuracy of signals applied from the devices used for WBVT.

Results: Previous results show that WBVT is a safe workplace-based sports activity that is easily integrated into operational processes. Positive effects of such an intervention were found on the muscular capacity of the lower extremities and the trunk[3-5]. Besides, positive effects on the pathology of chronic low-back pain, the quality of life, the daily physical activity and the amount of sick days were found[3]. Regarding the accuracy of the applied signals of WBVT-devices, a negative influence of regular use was found[6]. In addition, the implementation of WBVT in the second largest German company in the water management sector shows that WBVT is also effective and safe for blue-collar employees.

Discussion: Our results and experiences underline, that WBVT is an effective and safe minimal preventive intervention in workplace-health promotion for healthy blue- and white-collar workers as well as for employees with chronic low-back pain.

Our findings suggest that WBVT can be used as an effective and safe part of a multimodal preventive intervention, especially if combined with cardiovascular exercise. To date, a structured analysis on the cost effectiveness of WBVT in the corporate setting is still missing. Future studies should consider this aspect.

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Whole body vibration training: an exercise intervention for the brain?

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Background: Whole-Body Vibration (WBV) is known as an exercise modality in which subjects are exposed to vibrations through a vibrating platform. Exercise can stimulate the brain and contribute to increased physical and mental health. Recent findings have shown that WBV can also stimulate the brain (see [1] for review). The underlying brain mechanism of WBV partly overlaps with active exercise, e.g. the release of neurotrophic factors. However, WBV has its own, specific contributions. For example, skin receptors detect the vibration, and transfer this information to various parts of the brain. The frequency of the platform is transferred 1:1 to the brain, potentially influencing network oscillation (e.g. by synchronization). WBV positively affects neuroinflammation, and stimulates neuronal activity and neurotransmitter release. Numerous brain disorders are accompanied by faulty levels of neurotransmission and neuronal activity as well as increased levels of neuroinflammation. Hence, WBV has the potency to counteract these deficits. However, the WBV results in both human and animal studies typically show a large amount of individual variation, suggesting the existence of "responders" and "non-responders". Most likely, this is due to the lack of tools and insights how to make WBV interventions more personalized. Still, the so-called "Big Five" variables of WBV experimental designs need to be optimized for brain stimulation: vibration amplitude, vibration frequency, method of application, session duration/frequency, and total intervention duration[2]).

Results: A literature overview will be given about the state of affairs of WBV influencing brain functioning.

Conclusions: Based on a neurobiological point of view, we are of the opinion that WBV training has the potential to be a suitable "NeuroExercise" intervention once the underlying mechanisms are better understood, and clinical relevance is enhanced. More translational research using animal models and cell cultures are needed to further our insights in how WBV affects the brain. Given the often large individual variation in effectiveness of WBV to stimulate the brain, more research is needed to understand the origin of this variation.

Implications: Once WBV is better tailored to serve as a "NeuroExercise" intervention, it will be an additional cost-effective tool for many brain-related issues. It will be especially helpful for subject that are not able or willing to participate in active exercise. It may also serve as a stepping stone towards more active exercise.

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Whole body vibration improves hippocampal dependent memory, anxiety-like behavior and motor performance in aged rats

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Background: Recent preclinical studies have shown that moderate aerobic exercise produces benefits on brain health, cognitive functions and behavior, as well on motor performance. In addition, exercise is a meaningful intervention to prevent prevalence of diseases associated with aging and it contributes to successful healthy aging. Whole body vibration (WBV) provides a passive form of stimulation by mechanical vibration platforms. WBV has been considered to be an alternative of physical exercise for aged individuals. However, effects of WBV in the context of cognitive functions, behavior and motor performance have not yet been investigated in aged rats.

Methods: In order to better understand the behavioral, cognitive and motor adaptations induced by WBV, our experiment assessed the effects of long-term WBV intervention on a battery of behavioral and motor tests. 18 months old male and female Wistar rats underwent a 5 weeks long WBV intervention (10 minutes per day, 5 times per week; frequency of 30 Hz and amplitude of 50-200 micron). After 5 weeks, behavioral and motor performance in the open field, novel and spatial object recognition, grip hanging and balance beam tests were investigated.

Results: Rats that underwent vibration treatment spent more time in the outer wall zone of open field arena. In addition, increased number of rears was detected in the vibrated male animals compared to pseudo treated male animals. Whereas spatial memory was improved by vibration treatment, object memory was not affected. Both grip strength and motor coordination were significantly improved by vibration treatment.

Conclusion: In accordance with the literature, our results indicate that long-term WBV training has beneficial effects on depression-like behavior, on cognitive capabilities like spatial memory, as well as in improvements of neuromuscular adaptation in 18 months old rats. Therefore, WBV seems to be comparable with active exercise interventions and has the potential to battle against age-related cognitive and motor decline. However, further preclinical experiments are still needed to reveal and determine the role of the underlying molecular and cellular pathways. These insights can then be used to optimize specific aspects the WBV protocol (e.g. the "Big Five"; see [1]).

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Short-term effects of side-alternating Whole-Body Vibration on cognitive function of young adults

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Background: Whole Body Vibration (WBV) is worldwide used in rehabilitation and sport to stimulate muscle function and balance. More recent research in rodents and humans revealed that WBV is also beneficial for cognitive functions. However, the optimal WBV conditions are not established yet. Studies in young adults and children consistently found significant but small acute effects on selective attention and inhibition after WBV with vertical vibrations (30Hz frequency, 1 mm peak-to-peak displacement) in sitting position. Acute effects under other conditions (e.g., side-alternating vs. vertical vibrations, standing vs. sitting position) are currently unknown. The aim of our study was to determine the short-term effects of side-alternating Whole-Body Vibration in standing and sitting position on cognitive function of young adult.

Methods: Subjects were 60 healthy young adults (mean age 21.7±2.0 years, 72% female). A Galileo side-alternating vibration plate was used. Frequency was verified at 27 Hz with a dominant peak-to-peak displacement in Z-direction of 1.39 mm measured at the medial side of the feet on the plate. A balanced cross-over design was used. In two different sessions, the same participants stood on the plate in 30-45 degrees squat position or were seated in front of the plate with the feet on the plate and the hands on the knees. In each session alternated three WBV and three control conditions were offered for two minutes. After each condition selective attention and inhibition was measured with the color-word interference card of the Stroop test.

Results: In sitting position, we found a significant, but small improvement in Stroop test performance after WBV vs. control condition (33.4±6.0s vs. 33.9±6.0s; $t(59)=2.29$; $p(\text{two-tailed})=0.026$; Cohen's $d=0.08$ performance after WBV vs. control condition was not significantly different.

Conclusions: Alternating WBV in sitting position appears beneficial for cognitive function. However, in agreement with prior studies with vertical WBV while sitting on the plate, the short-term effect was small. We did not find beneficial effects for the standing position. This

may be related to fatigue after two minutes WBV in squat position. An alternative explanation may be that the dominant mechanism is sensory stimulation via the Meissner corpuscles and that during standing the Meissner corpuscles are insufficient triggered since in this condition the hands are not vibrated. The density of Meissner corpuscles is highest in the hands. Sitting on the plate instead of in front of the plate may enhance the beneficial effect of side-alternating WBV.

WBV treatment enhances motor and cognitive functions in senescent rats

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Introduction: Acceptable quality of life during aging requires the preservation of mobility and a healthy brain aging process. Since aging is often hampered by motor, cognitive and psychosocial constraints, this may limit the option for active physical training. Hence, different forms of 'passive' exercise may provide an alternative for actual physical exercise. For that, whole body vibration (WBV) was compared to low frequency pulsed electromagnetic field stimulation (EMF) and treadmill running, regarding effects on motor abilities and cognition.

Methods: Senescent rats (30-32 months of age) were assayed following chronic WBV training (6 weeks long, treatments 5x per week, 2x 5 min sessions per day; Marodyne LivMD). The effects of WBV were compared to (1) chronic active treadmill exercise training and (2) another passive type of exercise treatment modality, the low frequency pulsed electromagnetic field (EMF) stimulation (Sanza, Santerra Co.) of the same duration, i.e. 6 weeks using old rats of the same age. Behavioral tests: open-field (O-F) measuring psychomotility, vertical and horizontal movement activities; novel object recognition (NOR); novel place recognition (NPR) assaying attention, discrimination. Long-term memory was obtained in a passive avoidance task. Measurement of bioenergetic parameters, both frequency and energy transfer were carried out for reproducibility reasons.

Results: All types of trainings increased rearing activity in O-F, but EMF stimulation appeared most effective. Horizontal activity (walking) was not influenced by WBV, nor by EMF. In case of treadmill active exercise, however, the walking activity sharply increased. In this active test the over-stimulated movement is the forced walking itself, thus, this effect shows that a repetitively stimulated movement easily engraved in old age. WBV may decrease anxiety, since the treated rats paid more visits to the central area of O-F. WBV enhanced the differential attention in NOR and NPR. Similarly, EMF and active exercise also enhanced NOR (NPR was not measured). Long-term memory consolidation and retrieval in the passive avoidance test was slightly improved by WBV, while the EMF stimulation also caused a moderate improvement in this spatial learning test, based on long-term memory consolidation.

Conclusions: WBV in the senescent age of rats enhances psychomotility, reduces anxiety and increases differential recognition of objects and place. Therefore, WBV may provide a promising alternative for physical activity regarding mental health at older age.

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Whole-body vibration as a therapeutic intervention for sleep deprivation: An exploratory study

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Background: Sleep deprivation (SD) is considered to be a modern plague on society. The repercussions of SD not only render individuals inept to maintain a functionally- and socially demanding life but also increase the risk of developing certain diseases. Studies have shown that a brief period of SD negatively impacts spatial memory; intriguingly, engaging in regular active exercise prior to one night of SD did not alter spatial memory. However, as not every individual is able to engage in active exercise, passive exercise – namely, whole-body vibration (WBV) – could be an alternative. WBV involves a vibrating device that stimulates mechanoreceptors in the skin and consequently the brain. As such, WBV could be implemented at one's convenience due to its straightforward design principle; e.g., in the seat or arm of a desk chair.

Methods: Male C57BL/6J mice will be divided into 4 groups (n=10): pseudo-WBV (placed on a platform without vibrations), WBV (sinusoidal vibration of 30 Hz, 1.9 g-force & amplitude of 0.05 mm), pseudo-WBV + SD, and WBV + SD. All groups will receive two daily sessions of 10 minutes for five days for a total of five weeks of their respective treatments. After the acquisition trial of the object location memory task (OLM), the mice will be sleep deprived for 6 hours via the gentle stimulation method. After 24 hours, the integrity of the animals' spatial memory will be investigated.

Expected results: It is postulated that pseudo-WBV + SD would score the lowest on the OLM task, WBV would score the overall highest, and WBV + SD would not be significantly different from pseudo-WBV.

Objective: This study could provide an innovative and non-invasive intervention to counteract the behavioral and cognitive drawbacks of SD. Therefore, the aim is to elucidate whether regular passive exercise could offset the negative effects of SD on learning & memory.

Whole body vibration improves Alzheimer's disease pathology in the J20 mouse mode

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Background: Alzheimer's disease (AD) is a complex neurodegenerative disease and the core cause of dementia in elderly populations. The main hallmarks of AD include extracellular amyloid beta (Aβ) accumulation (APP-pathology), neuroinflammation as well as a deficiency in neurotransmitters and growth factors. Whole body vibration (WBV) as a passive form of exercise, might provide an alternative for active physical training. It seems to mimic the wide range of beneficial effects of active exercise, but its effects

on AD pathology are still unknown. Therefore, this study aims to investigate the effects of WBV on early AD pathology.

Methods: Six months old male J20 mice and their wild type (WT) littermates were used to investigate the effect of WBV on Alzheimer's pathology and the healthy brain. Both J20 and WT mice underwent vibration (30 Hz) or pseudo vibration (0 Hz) treatment on a vibration platform. The vibration intervention consisted of 2x10 minutes low amplitude WBV sessions per day, five days per week for five weeks. After these five weeks, the balance beam test was used to assess motor performance. Brain tissue was collected to quantify immunomarkers of neuroinflammation, Aβ deposition as well as levels of neurotransmitters and growth factors.

Results: At this young age J20 have a limited number of plaques. However, current data indicates a tendency of lower plaque load (in hippocampus, corpus callosum and cortex regions), as well as decreased neuroinflammation (in hippocampal subregions CA1, CA3, DGI and Hilus) in vibration treated J20 animals compared to their pseudo vibration controls. The balance beam showed a tendency of improved motor performance in vibration treated WT animals compared to their pseudo vibration controls.

Conclusion: In accordance with the literature, an early plaque load and increased neuroinflammation were detected in J20 mice at the age of 5-6 months. The improvement in motor performance after vibration in WT mice is also in accordance with the literature. This data indicates that WBV may have a beneficial effect on the early progression of AD. As this research is still in progress, immunostainings for microglia (CD68), GFAP, BDNF and ChAT have been conducted, but data from these immunostainings still needs to be obtained. We expect that WBV will restore neurotransmitter and neurotrophic factor levels in the J20 mice. We also expect that WBV could have an even stronger effect in middle-aged J20 mice having a higher plaque burden.

Whole body vibration added to treatment as usual is effective in adolescents with depression

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Background: There is growing evidence for the effectiveness of exercise in the treatment of adult major depression.

With regard to adolescents, clinical trials are still scarce. Due to the inherent symptoms of depression (lack of energy, low motivation to exercise), endurance training forms could be too demanding especially in the first weeks of treatment. We hypothesized that an easy-to-perform passive muscular training on a whole body vibration (WBV) device has equal anti-depressive effects compared to a cardiovascular training, both administered as add-ons to treatment as usual (TAU). Secondly, we presumed that both exercise interventions would be superior in their response, compared to TAU.

Methods: In 2 years 64 medication-naïve depressed inpatients aged 13–18, were included. Both exercise groups fulfilled a supervised vigorous training for 6 weeks. Depressive symptoms were assessed by self-report ("Depressions Inventar für Kinder und Jugendliche" - DIKJ) before intervention and after weeks 6, 14 and 26.

Results: Compared to TAU, both groups responded earlier and more strongly measured by DIKJ scores, showing a trend for the WBV group after week 6 (p=0.082). The decrease became statistically significant for both intervention groups after week 26 (p=0.037 for ergometer and p=0.042 for WBV). Remission rates amounted to 39.7% after week 6 and 66% after week 26, compared to 25% after week 26 in TAU.

Conclusions and limitations: The results provide qualified support for the effectiveness of exercise as add-on treatment for medication-naïve depressed adolescents. The study underlines the equal effectiveness of a rather passive WBV-treatment compared to endurance training in treatment of adolecent depression. This is of particular importance given the diminished drive of this clientele. The present results are limited by the not randomized control group and the lack of an active placebo-intervention to filter out the unspecific factors as for instance attention or expectations. Another limitation is the limited number of subjects.

Towards updated guidelines for reporting on Whole Body Vibration research

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Background: Whole-Body Vibration (WBV) is an exercise modality or prophylaxis/treatment method in which subjects are exposed to vibrations through a vibrating platform. The vibrations are defined by their direction, frequency, magnitude, duration and number of daily bouts. Subjects can be exposed while performing exercises, hold postures, sitting or lying down.

Worldwide, WBV has attracted significant attention and the number of studies is rising consistently. To interpret, compare and aggregate studies, correct, complete and consistent reporting of WBV specific data (e.g., WBV parameters) is critical. Specific reporting guidelines aid in accomplishing this goal. There was a need to evolve existing guidelines because of continuous developments in the field of WBV research including but not limited to new outcome measures regarding brain function, cognition or neuroinflammation, modified design of WBV plates and attachments (e.g., mount a chair on a plate) or comparisons of animal and cell culture studies with human studies. As an international group of experts, we collaborated with the purpose to update and further develop reporting guidelines, which can be used additional to general guidelines like the Consort Statement or ARRIVE.

Methods: We used EQUATOR (Enhancing the QUALity and Transparency Of health Research) methodology and had several face-to-face and online meetings, registered at EQUATOR, performed two Delphi studies for WBV research in respectively humans[1] and animals/cell cultures and wrote an extensive guidelines document.

Results: We developed separate checklists for human and animal/cell cultures WBV research including respectively 26 and 24 items related to device, vibrations, administration, general protocol and participants. In addition, for each item we wrote extensive explanations and examples how to report.

Conclusions: The guidelines extend and progress prior guidelines considerably. More aspects of WBV research are covered, explanations and examples are given and items specific for preclinical animal and cell cultures WBV research are included now thus providing new insights in how to report WBV research.

Implications: The guidelines can aid researchers, peer-reviewers and editors to improve the quality and stimulate harmonization of reporting about WBV studies. The guidelines are suitable for both (clinical) human studies and preclinical animal and cell culture studies and can be used next to general reporting guidelines. The guidelines do not include recommendations regarding the design of the WBV protocol and should be used in a non-rigid way with an eye for the large variability in WBV studies.

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Medical Applications of Whole Body Vibration (WBV) – Review

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Introduction: The research on the physiological effects of Whole Body Vibration (WBV) has gained prominence since the space race. Currently, studies on the subject are focused on the body performance and functionality although positive results are seen in the recovery of certain pathologies.

Purpose: to identify the clinical applications of WBV in different Medical fields.

Methodology: analytical literature review. Data collection was performed in databases such as Scientific Electronic Library Online (SciELO) and National Library of Medicine (PubMed). Articles published between 2010 and 2019 were used (except classic and/or historical data) that studied the use of WBV in medical interventions. Animal studies, non-systematic literature reviews and research that addressed WBV without clinical medical application were excluded. 10 articles were selected (1 meta-analysis and 9 experimental studies).

Results: The findings showed the use of WBV in Neurology, Orthopedics, Dermatology, Pulmology and Endocrinology. In Parkinson's disease, WBV emerges as a resource for functional rehabilitation, as vibration provides proprioceptive information to the Central Nervous System inducing reflex muscle activation. It also modifies the activation of the corticospinal tract by managing intracortical inhibition and activating sensory inputs in the primary motor cortex. In patients recovering from a stroke, multiple sclerosis, amyotrophic lateral sclerosis, cerebral palsy and spinal cord injury, the oscillatory waves generated by vibrational stimuli are captured by peripheral receptors causing the illusion of movement, stimulating neural plasticity. In Orthopedics, results focus on metabolism and bone mineral density, on improving gait and muscle performance, with increased strength and prophylaxis of hypotrophy in dysfunctional muscles; improvement in balance and functional capacity. Dermatological benefits involve changes mainly in the cutaneous and connective tissue, providing good aesthetic results. Research in pulmology indicates the removal of bronchial secretion through thixotropy. In the endocrinological field, decreased insulin resistance was observed, being indicated for patients with type 2 Diabetes Mellitus. The same principle of improved glucose metabolism was linked to weight loss, especially visceral adipose tissue, a key element of the metabolic syndrome, an important risk factor for cardiovascular diseases.

Final Considerations: Although in small number, studies on the medical application of WBV are observed in several clinical specialties. And even if there are, as in any treatment, contraindications; its prescription, associated with other therapies, is growing and deserves more research.

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Predicting human hand-arm vibration syndrome pathogenesis from animal vibration-injury research

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Hand-arm vibration syndrome (HAVS) is a vasospastic (vibration white finger), neurodegenerative (peripheral neuropathy) and musculoskeletal disease generated in workers by long-term hand contact with high magnitude vibration in the 30-250 Hz frequency range. Humans cannot feel vibration above 1000 Hz. This neurophysiological observation led to calculating the risk for HAVS with a frequency-weighted formula (European Standard ISO 5349). Unfortunately, this formula eliminates the very high acceleration energy from frequencies above 1250 Hz up to 50 kHz emitted as shockwaves from percussive impact tools. Although recognized clinically a century ago, the pathogenic mechanisms in humans remain poorly understood. Our rat tail vibration data permit discussion of plausible processes for HAVS. Vascular, neural and connective tissue cells are all injured by vibration. Injury of one promotes structural and functional injury of the others. A major unanswered question is "what occurs when the early signs of transient vasoconstriction and numbness and/or tingling become permanent HAVS disease". One hypothesis is that the tremendous regenerative capacities of these tissues account for the long latency between first exposure and permanent disease which onsets when these capacities are exhausted. The relevance of this discussion to stepping onto a vibrating platform for exercise and rehabilitation is that workers standing on vibrating platforms develop vibration white toe and neuropathy, and the sports/clinical vibration platforms have the capacity to replicate the magnitudes and frequencies linked to HAVS in the workplace.

Changes in muscle power following a combined exercise program supplemented with whole-body vibration training in patients with fibromyalgia syndrome: A Randomized Controlled Trial

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Introduction: Skeletal muscle power is a strong predictor of functional capacity and health[1]. Fibromyalgia is associated with diminished muscle power[2].

Objective: To determine whether an 8-week exercise programme supplemented with whole-body vibration improves muscle power in women with fibromyalgia.

Design: Randomized controlled trial.

Patients: Forty-six participants diagnosed with fibromyalgia (aged 58±8 years old, height 157±6 cm, weight 72±10 kg).

Methods: Participants were randomly assigned to: (i) an exercise (EX) group (n=15) which performed twice-weekly exercise sessions (aerobic exercise, strengthening, and flexibility); (ii) an exercise (WBV+EX) group (n=15) with the same exercise therapy as EX, combined with 3 whole-body vibration training sessions a week (bilateral squats: 6–9 sets of 30 s with 45-s recovery between sets; and unilateral squat: 4–7 sets of 30 s, 30 Hz–4 mm); and (iii) a usual-care control (CON) group (n = 16). Power output was assessed with the back-squat exercise following an incremental load protocol. Changes in power output were examined using a one-way analysis of variance (ANOVA).

Results: One-way ANOVA showed significant differences among groups in power output changes (P=0'049). The changes in power experienced by WBV+EX, EX, and CON were 13'7±25'8 W, 21'2±37'7 W, and -18'7±27'1 W respectively. Post hoc analysis showed significant differences between WBV+EX and CON (P=0'035), and between EX and CON (P=0'021), but not between WBV+EX and EX (P=0,577).

Conclusion: The results show that both, a traditional exercise programme supplemented with whole-body vibration training (WBV+EX) and a traditional exercise programme only (EX), improved muscle power in women with fibromyalgia. This may represent a key factor for improving functional capacity in this patient group.

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Effects of Whole body vibration on cutaneous wounds healing in health adult rats

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The whole-body vibration (WBV) leads to increase angiogenesis and tissue granulation formation, and is linked to increasing pro-angiogenic growth factors. The authors evaluated whether WBV accelerates cutaneous wound healing in adult health male rats submitted to WBV. Fifty-four adult health male Wistar rats weighing between 301.0 and 389.0 grams were used. A full-thickness skin defect of 3.14 cm^2 was performed on the dorsal region of all rats under anesthesia. Rats were randomly divided into three groups encompassing 18 rats each according to treatment with saline solution 0.9% (G1), ointment composed with allantoin and zinc (G2), and saline solution 0.9% and the rats submitted to a single WBV by using a vibrating platform that delivered a vortex wave circulation (G3). All treatments were performed each 24 h during 21 days The WBV sessions were performed at same period of the day after 30 min of acclimation on top of the vibrating platform (turned off). Rats were placed inside of polyvinyl chloride pipes and fixed with polypropylene adhesive tape at the top of the vibrating platform during the WBV session. These pipes had an opening on their bottoms to allow rats' paws to touch the vibrating platform. The G3 Group was submitted to WBV protocol of single daily session at 40 Hz (3.37

mm peak displacement) for 30 min. Six rats in each group were subjected to euthanasia at seven days (7 dpw), 14 (14 dpw), and 21 days (21 dpw post wounding (21 dpw) for morphometric and morphological analysis of their wounds. The smallest wound area and the highest wound recovery percentage were recorded in rats of G3 group. The wounds of G3recorded the lowest wound depth at the 21dpw. There was identified a mononuclear inflammatory cell in rats of G3 at 7dpw, whereas rats of G1 and G2 groups presented majority of polymorphonuclear inflammatory cells in all evaluated time-points. Neovascularization was present in all time-points in G1 and G2 groups. Wounds of G3 group did not show neovascularization at 14 dpw and 21 dpw. Fibroplasia was identified in all times-point in rats of G1 and G2 groups, and only on 7dpw in rats of G3 group. Whole-body vibration (40 Hz, 30 min, daily) session by using a vibrating platform that delivered a vortex wave circulation improved cutaneous wound healing in health adult rats.

Whole-body vibration training increases antioxidant biomarker in woman with fibromyalgia

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Fibromyalgia (FM) syndrome is a chronic disorder characterized by generalized and persistent musculoskeletal pain that predominantly affects women. The pathophysiology of FM is still controversial, but evidence points to oxidative stress as a relevant event in the pathogenesis of FM resulting in an imbalance between oxidative and antioxidant factors, favoring marked production of reactive oxygen species. Previous work of our team showed the immediate effect of a single session of whole-body vibration (WBV) improving antioxidant defense biomarkers towards a greater adaptation to the stress response in FM women. In this sense, remains a gap about WBV training, representing the sum of single sessions, on biomarker of antioxidant defense in women with FM. The aim of our work was to investigate WBV training on catalase (CAT), one of the primary defenses against reactive oxidative stress, in women with FM. The data were reported as mean and standard error and two-way ANOVA followed by Scheffé's post-hoc comparisons tests were used. The level of statistical significance was set at 5%. Forty women with FM were randomized into an intervention group (IG), receiving 6 weeks of WBV training, or a control group (CG) with no intervention. CAT blood level was evaluated at baseline and after the training period in both groups. The analyses revealed that the groups were similar at baseline, and the WBV training increased CAT in the follow-up compared to the baseline (IG baseline 2.71+0.45 U/mg prot; IG follow-up 4.07+0.33 U/mg prot; $p<0.05$) and to the CG group (CG baseline 2.63+0.15 U/mg prot; CG follow-up 2.83+0.27 U/mg prot; $p<0.05$). Our results indicate WBV taining improves biomarkers related to the antioxidant primary defense in women with FM.

Whole body vibration restored brain collagen after surgery; associations with neuroinflammation and neurogenesis

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Background: Peripheral surgery can induce neuroinflammation and decreased neurogenesis, associated with postoperative cognitive dysfunction. Neurons are thought to be protected by a collagen-containing perineuronal net (PNN). Whole body vibration (WBV) may affect collagen formation. We hypothesize that WBV after surgery can prevent neuronal damage by restoring collagen in the PNN, associated with preserved neurogenesis and reduced neuroinflammation.

Methods: Adult male Wistar rats underwent major abdominal surgery. One day later, WBV (10 minutes twice a day) or physical exercise by treadmill running (30 minutes a day) started. Two weeks later, rats were sacrificed and brains were dissected and processed for (immune)histochemistry. Collagen positive areas in the hippocampus were analyzed in Sirius Red stained sections, while neuroinflammation and neurogenesis were measured in IBA-1- and Double Cortin stained sections, respectively.

Results: Within the hippocampus, most pronounced effects were seen in the CA1 region. Surgery significantly decreased CA1 collagen level (23.9±1.3 versus 28.9±1.2%), which was fully prevented by WBV (29.0±1.5%). WBV significantly increased neurogenesis (4.29±0.21 versus 3.55±0.14 in control surgery rats). Accordingly, surgery increased CA1 microglia activity (5.4±0.5 versus 4.0±0.3%), which was partly restored by WBV (4.7±0.4%; $p<0.1$). Effects of physical exercise did not reach statistical significance.

Conclusion: WBV after surgery restored the surgery-induced decline in hippocampal collagen content. As this effect coincided with reduced neuroinflammation and improved neurogenesis, we suggest that WBV could prevent neuronal dysfunction after surgery by improving neuronal protection

Co-application of oral magnesium supplementation and low-magnitude, high-frequency vibration treatment attenuates sarcopenia via PI3k/Akt/mTOR pathway

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Introduction: Sarcopenia which is coded recently in the International Classification of Disease, Tenth Revision (ICD-10) Clinical Modification (CM), is characterized by the gradual loss of muscle mass, muscle strength, and muscle quality in aging. Sarcopenia is a muscle disease (muscle failure) rooted in adverse muscle changes that accrue across a lifetime. The pathogenesis of sarcopenia is quite complicated, and anabolic and catabolic process play important roles in the development of sarcopenia. Currently limited options were offered to counter muscle failure during sarcopenia, except for lifestyle therapies like healthy nutrition and exercise training, combined treatment of exercise and nutritional supplements (protein, vitamin D, creatine, amino acid and so on) showed some promising effects on muscle regeneration. Although community-based, well-rounded exercise programs have been proven to improve muscle

mass and functional fitness, their efficacy in reversing sarcopenia has not been documented. Furthermore, the beneficial effects of a combination of well-rounded exercise and protein supplementation in improving body composition, physical function, and oxidative stress among sarcopenic elderly has yet to be determined. As reported in previous studies, Low-Magnitude, High-Frequency Vibration (LMHFV) and dietary Mg both showed positive effects on muscle metabolism, increase muscle mass and physical performance in elderly patients. Also, LMHFV and Mg were reported to have potential relationships with muscle hypertrophy pathway, suggesting some underlying mechanism of LMHFV and Mg on muscle maintenance may exist through medicating anabolic and catabolic process during sarcopenia. This study aims to assess comprehensively the combined effect of dietary nutrition intake (Mg) and mechanical loading to attenuate age-related loss of skeletal muscle mass, power, and strength directly through physiological mechanisms.

Methods: Senescence-accelerated mouse P8 (SAMP8) mice at month 6 were randomized into control (Con), vibration (VIB), Mg or Mg+VIB groups. The mice in the VIB group were given LMHFV (0.3 g, 35 Hz, 20 min/day, 5 days/week) treatment. Mg was administered to animals through oral gavage of 0.2 ml Mg solution in water at the dosage of 98 mg/ml/day, 5 days/week. Both LMHFV and Mg supplement were given in the Mg+VIB group. *Ex-vivo* functional assessment, immunohistochemical staining of myofibers (myosin heavy chain expression) and Dual Energy X-ray Absorptiometry (DXA) measurements were performed at month 0,2,3,4 post-treatment for all groups. *In vitro*, C2C12 myoblasts were cultured on 30mm dishes and divided into 10 groups in this study: (1) control, (2) LMHFV only, (3) Mg only, (4) Mg+LMHFV, (5) Mg+Rapamycin, (6) Mg+LY294002, (7) LMHFV+Rapamycin, (8) LMHFV+LY294002, (9) Mg+LMHFV+Rapamycin (10) Mg+LMHFV+LY29402. The transcriptional expression levels of IGF1, myoD, Myf4, Myf5, myogenin, FOXO-3, MuRF1 and MAFbx were assessed by qPCR; the translational level of p85, Akt, pAkt, mTOR, eIF4EBP1, S6K1, myoD and myogenin were detected by Western Blot. Data analysis was done with one-way ANOVA, and the significant level was set at $p \leq 0.05$.

Results: *In vivo*, at late stage in month 3 and 4, lean mass percentage and appendicular lean mass percentage in VIB groups were higher than control group. The mice in the VIB, Mg and combination groups showed significantly higher muscle strength and contractibility at month 3 (Figure 1). In MHC staining, the combination group showed showed significantly fewer type I muscle fibers and more type IIa and IIb muscle fibers than the control group at 2 (Figure 2). Also the combination group could highly increase the expression level of myoD, Myf-5, Myf-6, and myoG at month 2. Mg and combination groups increased mTOR, p85, Akt, pAkt translational expression significantly at month 3 and 4 (Figure 3). *In vitro*, co-application of Mg and LMHFV did not show synergistic effect for increasing myotube formation. With the inhibition of PI3k/Akt/mTOR, both LY294002 and Rapamycin groups showed significantly lower myotube formation compared with Mg and LMHFV groups. Western blot results further substantiated the findings. Inhibition of p85 and mTOR abolished the enhancement effects of treatments.

Discussion and Conclusion: In this study, the results showed that LMHFV treatment could effectively increase muscle mass and enhance muscle function in SAMP8 sarcopenia mice, particularly showing dominant effect on muscle mass compared with other treatment groups. Oral Mg supplements did not show any changes in muscle mass, but could continuously increase muscle function and enhance type II muscle hypertrophy and suppress type I muscle fiber atrophy during sarcopenia. LMHFV or Mg treatment could enhance muscle proliferation and stimulate muscle growth by increasing MyoD and Myf5 expression via PI3k/Akt/mTOR pathway, but suppressing MAFbx and MuRF1 *in vivo* and *in vitro*. Combined treatment of LMHFV and Mg could show an addictive effect on suppressing type I fiber atrophy but increasing type II muscle hypertrophy, and no synergistic or addictive effect was shown on muscle contractile function, *In vitro*, Combination of LMHFV and Mg could enhance myoblast differentiation with acute effect on Myf5 and Myf6, inhibit upregulation of MAFbx and MuRF1 via PI3k/Akt/mTOR pathway, which was consistent with LMHFV or Mg individually.

Significance/Clinical Relevance: The combined treatment of Mg and LMHFV could be potential resolution on sarcopenic muscular changes, targeting muscle atrophy related PI3K/Akt/MTOR pathway.

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Figure 1. *Ex-vivo* functional test results at month 2,3,4 post treatments.

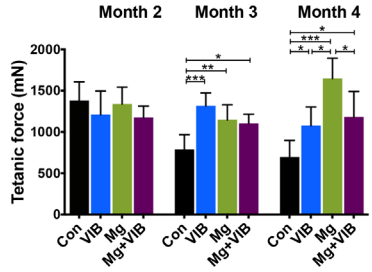


Figure 2. IHC staining at month 2,3,4 post treatments.

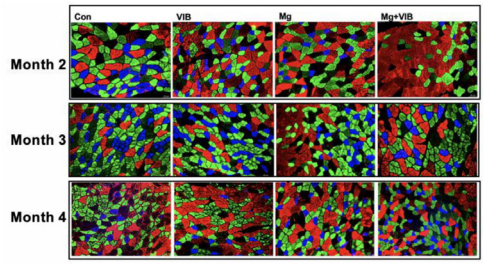
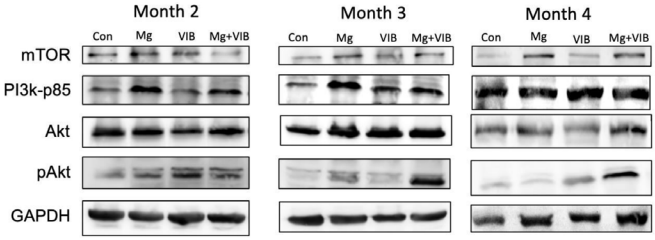


Figure 3. WB results of PI3k/Akt/mTOR at month 2,3,4 post treatments.



Evaluation of ultrasound data from the MARES Sinusoidal Perturbation Protocol for the analysis of vibration-induced changes in fascicle length and pennation angle as a function of vibration frequency and muscular preload

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Introduction: In the body, periodic stretching and shortening cycles of the muscle-tendon complex occur during vibration exposure. This is accompanied by cyclic changes in fascicle length (FL) and pennation angle (PEN). However, little is known about the extent to which stretching and shortening depends on muscular tension and frequency. Therefore, the main aim of this study was to get an insight into vibration induced responses of FL and PEN at different frequencies and constant-force contractions. In addition, the influence of long-term bed rest on FL and PEN excursion was evaluated as well as the changes in static muscle architecture at different levels of contraction.

Methods: 23 subjects performed the sinusoidal perturbation protocol before and after 60 days of bed rest. Countermeasure groups were iAG group (6 x 5 min centrifuge drive per day), cAG group (1 x 30 min centrifuge drive per day) and control group (no centrifuge drive). Ultrasound sequences of gastrocnemius medialis (GM) were recorded while superimposing a series of 10 vibration frequencies (4-16 Hz) onto different levels of contraction (isometric plantar flexion at 0, 25, 50 and 75% MVC). The Response of FL and PEN was evaluated using a semi-automated tracking software (UltraTrack) and custom-made R-scripts. By means of perievent histograms the alteration of fascicle architecture was determined and expressed as excursion relative to the initial FL or PEN value (before the vibration sets in). Linear mixed effects models with all possible interaction terms were constructed and stepwise simplified. Significant effects were followed up by a-priori defined treatment contrasts. Reference level of contrast was 4 Hz, 0% MVC, control group and baseline data.

Results: Excursion of FL and PEN was statistically significant smaller when muscle was contracted (FL: $P<0.001$ for 25 and 50% MVC, $P<0.01$ for 75% MVC; PEN: $P<0.001$ for 25% MVC and $P<0.01$ for 50% MVC). From 7 to 10 Hz there was a significant increase in excursion for pre-tensioned GM, especially for FL. After bed rest, excursion was significantly greater at 9 and 10 Hz vibration ($P<0.05$) for FL and at 8 Hz, 10 Hz ($P<0.01$) and 9 Hz ($P<0.05$) for PEN, respectively.

In static muscle architecture, there was a statistically significant decrease in FL ($P<0.001$, all contraction levels) and an increase in PEN ($P<0.05$ for 25 % MVC, $P<0.001$ for 50 and 75% MVC) by increasing contraction level. Minor changes occurred in muscle thickness (MT).

Conclusions: The main finding of this study was a significant resonance effect at 7–10 Hz vibration in contracted muscle. Resonance was even more evident after bed rest. No changes in the resonant frequency range were apparent across the levels of contraction. This is possibly due to an equivalent increase in damping properties and stiffness in the muscle as muscle activity elevates. It is also conceivable that the increase in excursion is a consequence of resonance within the natural tremor frequency. It is possible that the induced vibration causes the physiological tremor to resonate. However, the exact cause of this resonance effect is still unknown.

Whole Body Vibration, an effective intervention strategy for postoperative recovery?

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Background: Physical exercise (PE) is associated with physical and mental improvement in many conditions. One of these conditions is recovery from surgery. Progression of (neuro)inflammation, changes in neurotrophic pathways and neurotransmitters levels like the 5-HT system are implicated to play an important role in therapeutic effects of PE. Low intensity whole body vibration (WBV) is a type of sensory stimulation, which may provide a passive alternative (passive exercise) for PE, but effects of WBV on the post-surgical recovery have not yet been investigated.

Methods: Three months old male Wistar rats were subjected to standard abdominal or radio telemetry (HD-S10) transmitter surgery. After surgery, animals underwent WBV (2x10 minutes/day, frequency of 30 Hz and amplitude of 200-250 micron) or treadmill running (30 min/day, 50–70% of Vo2 max) for 2 weeks. Cognition, mood and motor performance were evaluated during the 2nd week. Baseline values of heart rate, body temperature and blood pressure were obtained by telemetry transmitters. After two weeks of training, acute hypotensive, bradycardia and hypothermic responses to the selective 5HT1A receptor agonist F15599 (0,25 mg/ml) were assessed.

Results: Running exercise after surgery, but not control surgery or WBV after surgery, significantly increased anxiety–like behavior and decreased exploration in the Open Field. Cognitive flexibility was impaired in control surgery rats and normalized by running as well as WBV. Short-term memory and long-term learning/memory were not affected. Grip strength was improved by running, but not by WBV, after surgery. Both WBV and running attenuated the F15599-induced bradycardia and hypothermic response compared to controls, while a marginal hypotonic responses were induced only by running exercise, indicating decreased 5-HT1A receptor functionality.

Conclusion: Our data indicated that effects of WBV after surgery on cognition and 5HT1A stimulation are comparable with those seen after physical exercise. Exercise, but not WBV, declined unprompted exploration activity but improved muscle strength. Despite the absence of muscle improvement, WBV may provide a safe alternative for physical exercise in recovery after surgery.