Whole Boby Vibration and Cancer

https://pubmed.ncbi.nlm.nih.gov/30224596/

Whole body vibration exercise in the management of cancer therapy-related morbidities: A systematic review 2018

The four included studies (2 of them with "high" LE-II and MQ) were performed in patients with different types of cancer (i.e. breast, lung, prostate, solid or hematological), treated with WBV exercise to counteract the cancer therapy-related morbidities. The variables evaluated were muscle activity, subjective rate of perceived exertion, exercise capacity, muscle strength, quality of life, resting urinary incontinence and severity of peripheral neuropathy. Although WBV exercise appears to be a potential treatment procedure of cancer therapy-related morbidities, further additional studies are required to determine specific and tailored protocols to be used in the different stages of the disease.

https://pubmed.ncbi.nlm.nih.gov/35884459/

Yoda1 Enhanced Low-Magnitude High-Frequency Vibration on Osteocytes in Regulation of MDA-MB-231 Breast Cancer Cell Migration. 2022

Low-magnitude (≤1 g) high-frequency (≥30 Hz) (LMHF) vibration has been shown to enhance bone mineral density. However, its regulation in breast cancer bone metastasis remains controversial for breast cancer patients and elder populations. Yoda1, an activator of the mechanosensitive Piezo1 channel, could potentially intensify the effect of LMHF vibration by enhancing the mechanoresponse of osteocytes, the major mechanosensory bone cells with high expression of Piezo1. In this study, we treated osteocytes with mono- (Yoda1 only or vibration only) or combined treatment (Yoda1 and LMHF vibration) and examined the further regulation of osteoclasts and breast cancer cells through the conditioned medium. Moreover, we studied the effects of combined treatment on breast cancer cells in regulation of osteocytes. Combined treatment on osteocytes showed beneficial effects, including increasing the nuclear translocation of Yes-associated protein (YAP) in osteocytes (488.0%, $p < 0.0001$), suppressing osteoclastogenesis (34.3%, $p = 0.004$), and further reducing migration of MDA-MB-231 (15.1%, $p = 0.02$) but not Py8119 breast cancer cells (4.2%, $p = 0.66$). Finally, MDA-MB-231 breast cancer cells subjected to the combined treatment decreased the percentage of apoptotic osteocytes (34.5%, $p = 0.04$) but did not affect the intracellular calcium influx. This study showed the potential of stimulating Piezo1 in enhancing the mechanoresponse of osteocytes to LMHF vibration and further suppressing breast cancer migration via osteoclasts.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6156963/

Feasibility of whole body vibration during intensive chemotherapy in patients with hematological malignancies – a randomized controlled pilot study. 2018

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

Our study is the first proving the feasibility of WBV during intensive/high-dose chemotherapy of hospitalized cancer patients. Additionally, WBV-induced neuromuscular adaptations resulted in functional benefits relevant to patients' autonomy. We believe that WBV can be implemented as an alternative training method during intensive chemotherapy, although the relative benefit compared to conventional resistance training requires more evaluation in future studies.

To generate the best neuromuscular response, exercises were performed within a frequency range of 18–25 Hz and at 3.5-4 mm amplitude [43, 44]. During static exercises, patients were asked to shift their body weight on their forefeet and to maintain a knee angle of approx. Sixty degrees flexion in static position [43]. If patients couldn't maintain the forefoot position throughout the exercise period, we supported their stance position via a heel foam wedge.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8707128/

Physical Exercise with or without Whole-Body Vibration in Breast Cancer Patients Suffering from Aromatase Inhibitor—Induced Musculoskeletal Symptoms: A Pilot Randomized Clinical Study. 2021

Concurrently, muscle strength, physical performance, and quality of life significantly improved in both groups, without significant differences between groups. No dropouts and no side effects were recorded. Both patients and the physical therapist reported a high level of satisfaction with the intervention. Our findings suggest that physical exercise and WBV combination might be a safe therapeutic option for improving the rehabilitative management of patients with AIMSS.

Aromatase inhibitors (AIs) interfere with the body's ability to generate estrogen from androgens by inhibiting the action of the aromatase enzyme [4]. Due to their effectiveness in hormone receptor (HR)-positive breast cancers, AIs represent a backbone therapy, particularly in postmenopausal women [5]. However, AIs administration has been related to common side effects that represent a critical issue in the current literature [6,7]. Moreover, to date, the mechanisms forming the basis for the onset of side effects are far from being fully understood but might be related to the severe estrogen depletion [7]. Among these, AIs-induced musculoskeletal symptoms (AIMSS) are an often underdiagnosed and underestimated complication of this type of treatment [8]. This condition is defined by the presence of painful musculoskeletal disorders during endocrine therapy with AIs [9]. It has recently been estimated that up to 40% of HR+ breast cancer survivors treated with AIs experience AIMSS [10,11,12].

https://www.mdpi.com/2571-631X/6/2/28

Vibration Therapy for Cancer-Related Bone Diseases. 2023

Patients undergoing cancer treatments and/or suffering from metastatic bone lesions experience various skeletal-related events (SREs), substantially reducing functional independence and quality of life. Therefore, researchers are working towards developing new interventions by harnessing the bone's innate anabolic response to mechanical stimulations. Whole body vibration (WBV) has recently gained interest due to its nature of being safe, effective, and easy to perform. In this review, we will summarize the most cutting-edge vibration studies of cancer models and bone-cancer cell interactions. We will also discuss various parameters, including age, vibration settings, and differences between bone sites, which may affect vibration efficacy. Studies have shown that WBV improves bone mineral density (BMD) and bone volume in patients and mice with cancer. WBV also reduces tumor burden and normalizes bone vasculature in mice. At the cellular level, vibration promotes interactions between bone cells and cancer cells, which reduce osteoclastogenesis and inhibit cancer metastatic potential. Hence, WBV could potentially serve as a new intervention or adjuvant treatment to attenuate cancer progression while preserving bone health.

Cancer is a leading cause of death and a critical public health issue. It is mainly driven by unstable genetic mutations in cells, resulting in uncontrolled cell proliferations and eventual metastases to other organs. The occurrence of metastases is the primary cause of treatment failure and cancer-related deaths [1,2,3]. Bones are a common secondary site for the metastases of breast and prostate cancer. Approximately 70% of advanced-stage breast and prostate cancer patients suffer from bone metastases, an unusually high occurrence rate for a secondary site of cancer [1,2]. Although less common, bone metastases can still occur in patients with thyroid, lung, or bladder cancer [3].

Current standard cancer treatments induce severe bone damage in cancer patients [28,29,36] who may already be at a high risk of bone loss due to bone metastases or hormonal fluctuations [10,28]. As such, cancer treatments are often accompanied by the administration of bisphosphonates or denosumab to ameliorate bone loss and fractures. However, long-term and high-dose usage increases bone brittleness and can induce rare but severe conditions, such as osteonecrosis of the jaw [37,38]. Therefore, researchers are working towards developing new interventions by harnessing the bone's innate anabolic response to

mechanical stimulations.
For cancer patients, the cumulative effects of diseases, standard treatments (i.e., hormone therapy, chemotherapy, and radiotherapy), and physical inactivity are detrimental to bones [10,28,29,36]. While cancer-associated SREs could be alleviated by exercise [39,40,41,42,43], it is often physically challenging for bedridden or elderly patients. This paper highlights existing evidence on how vibration, an exercise surrogate, benefits cancer-related bone diseases (Figure 1). WBV has been shown to improve bone quality and quantity as well as enhance bone turnover in patients (Table 1) [51,52,54] and mice (Table 2) [57,58,59] with cancer. Additionally, WBV has demonstrated the ability to reduce tumor burden and normalize bone vasculature altered by cancer metastases in mice (Table 2) [57,58,59]. LMHF vibration has also been shown to promote interactions between bone cells and cancer cells, which ultimately reduce osteoclastogenesis and inhibit cancer metastatic potential (Table 3) [16,17,60].

https://pubmed.ncbi.nlm.nih.gov/36419845/
Reduction of breast cancer extravasation via vibration activated osteocyte regulation 2022
We used a microfluidic co-culture platform that mimics bone-cancer environments to study the impact of vibration on breast cancer extravasation. LMHF vibration activated osteocytes, the primary mechanosensing cells in bones, which reduced cancer extravasation by 43%. We further studied the vibration mechanism by demonstrating the important role of the Piezo1 ion channel in osteocyte mechanotransduction. Chemical activation of Piezo1 enhanced osteocyte inhibition of cancer extravasation under vibration at the early time point. These data indicated that LMHF vibration could inhibit cancer extravasation, suggesting that vibration may suppress bone metastasis in breast cancer patients.

https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/full/10.1002/elsc.201900154
Low-frequency mechanical vibration induces apoptosis of A431 epidermoid carcinoma cells. 2020
Cancer research is increasingly focused on discovering strategies to induce cancer cell apoptosis without affecting surrounding normal cells. One potential biocompatible method is mechanical vibration, which has been developed as part of the emerging field of mechanomedicine. Previous studies of mechanical vibration have employed high-frequency vibration, which damages healthy cells. In this study, we examined the effects of brief (1 h) low-frequency (20 Hz) mechanical vibration on glucose consumption and survival (apoptosis, necrosis, HMGB1 release) of the human epidermoid carcinoma cell line A431. We found that apoptosis, but not necrosis, was significantly increased at 48 h after mechanical vibration compared with cells maintained in static culture. In keeping with this, extracellular release of HMGB1, a necrosis marker, was lower in cultures of A431 cells subjected to mechanical vibration compared with control cells. Glucose consumption was increased in the first 24 h after mechanical vibration but returned to control levels before the onset of apoptosis. Although the precise intracellular mechanisms by which low-frequency mechanical vibration triggers apoptosis of A431 cells is unknown, these results suggest a possible role for metabolic pathways. Mechanical vibration may thus represent a novel application of mechanomedicine to cancer therapy.
We found that mechanical vibration induced an increase in glucose consumption and apoptosis, but not in either HMGB1 release or necrosis, compared with control conditions. Thus, mechanical vibration may represent a potential strategy to induce apoptosis of cancer cells while minimizing cell death by necrosis.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6560364/
The Impact of Vibration Therapy Interventions on Skin Condition and Skin Temperature Changes in Young Women with Lipodystrophy: A Pilot Study 2019
Vibration therapy was a method known back in ancient times. Today, many devices that apply vibrations are accessible, most often with fixed parameters describing the generated vibrations. The impact of vibration on the human body is multidirectional. Among others, vasodilatation is observed, resulting in an improvement in blood and lymph circulation [7], as well as a change in muscle tension through reflex activation [8]. It is also confirmed that vibration therapy exerts an antalgic effect and leads to an increase in muscle mass and bone density [9–11]. One of the results of vibration massage is a rise of temperature within the skin and subcutaneous tissues in the regions covered with the intervention [12]. Many of the enumerated mechanisms can turn out efficient in reducing signs of GL.

https://medivizor.com/blog/SampleLibrary/hodgkin-lymphoma/whole-body-vibration-during-chemotherapy-for-leukemia-and-lymphoma/
Whole body vibration during chemotherapy for leukemia and lymphoma
20 patients with leukemia and lymphoma being treated with chemotherapy were included in the study. One group received vibration therapy. The other group did cycling exercises (control group). Changes in chemotherapy side effects, blood pressure, and heart rate were recorded. Some daily function tests were also measured. These included jump height and time of chair-rising (CRT). Timed up and go (TUG; a test of a person's mobility and balance) was also measured. No changes in blood pressure or side effects were seen between the groups. No worsening in chemotherapy side effects was seen in the vibration treatment group. Jump height in the vibration treatment group increased by 2.3cm. TUG was reduced by 1.3 seconds in the patients with vibration therapy. CRT did not change between groups.
The bottom line
The study concluded that vibration treatment was effective in improving mobility in patients with leukemia and lymphoma receiving chemotherapy

https://pubmed.ncbi.nlm.nih.gov/25153791/
Whole-body vibration in breast cancer survivors: a pilot study exploring its effects on muscle activity and subjectively perceived exertion. 2014
WBV at 20 and 30 Hz revealed lower subjectively perceived exertion and the highest muscle activity and therefore provide the optimal modalities for WBV in breast cancer survivors.

https://pubmed.ncbi.nlm.nih.gov/24965268/
Prostate cancer and occupational exposure to whole-body vibration in a national population-based cohort study. 2014
We found no consistent relationship between WBV and prostate cancer.

https://www.sciencealert.com/scientists-destroy-99-of-cancer-cells-in-the-lab-using-vibrating-molecules
Scientists Destroy 99% of Cancer Cells in The Lab Using Vibrating Molecules. 2023
-used NIR light

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4970889/
Low Intensity Vibration Mitigates Tumor Progression and Protect Bone Quantity and Quality in a Murine Model of Myeloma. 2016
Myeloma facilitates destruction of bone and marrow. Since physical activity encourages musculoskeletal preservation we evaluated whether low-intensity vibrations (LIV), a component of mechanical signaling, could protect bone and marrow during myeloma progression. Immunocompromised-mice (n=25) were injected with human-myeloma cells, while 8 (AC) were saline-injected. Myeloma-injected mice (LIV; n=13) were subjected to daily-mechanical loading (15min/d; 0.3g @ 90Hz) while 12 (MM) were sham-handled. At 8w, femurs had 85% less trabecular bone volume (BV) fraction in MM versus AC, yet only a 21% decrease

in LIV as compared to as compared to AC, reflecting a 76% increase versus MM. Cortical BV was 21% and 15% lower in MM and LIV, respectively, than AC; LIV showing 30% improvement over MM. Similar outcomes were observed in the axial skeleton, showing a 35% loss in MM with a 27% improved retention of bone in L5 of LIV-treated mice as compared to MM. Transcortical-perforations in the femur from myeloma-induced osteolysis were 9× higher in MM versus AC, reduced by 57% in LIV. Serum-TRACP5b, 61% greater in MM versus AC, rose by 33% in LIV compared to AC, a 45% reduction in activity when compared to MM. Histomorphometric analyses of trabecular bone demonstrated a 70% elevation in eroded surfaces of MM versus AC, while measures in LIV were 58% below those in MM. 72% of marrow in the femur of MM mice contained tumor, contrasted by a 31% lower burden in LIV. MM mice (42%) presented advanced-stage necrosis of marrow in the tibia while present in just 8% of LIV. Myeloma infiltration inversely correlated to measures of bone quality, while LIV slowed systemic myeloma-associated decline in bone quality and inhibited tumor progression through the hindlimbs.
Mice assigned to the mechanical loading regimen were subject to LIV (0.3g ± 0.025 @ 90Hz, where 1g = Earth's gravitational field or 9.8m/s2) (38, 47, 51), for 15min/d, 5d/w, while AC and MM groups underwent identical handling and loading protocols as LIV mice but without activation of the platform. Displacements required to produce accelerations at 90Hz are well below 100μm and are barely perceptible to human touch.

https://pubmed.ncbi.nlm.nih.gov/26364870/

Triggering the apoptosis of targeted human renal cancer cells by the vibration of anisotropic magnetic particles attached to the cell membrane. 2015

The present study focuses on a recently proposed approach for cancer cell destruction based on the targeted triggering of cancer cell spontaneous death through the mechanical vibration of anisotropic magnetic micro/nanoparticles attached to the cell membranes at low frequencies (~20 Hz) and in weak magnetic fields (~30 mT). The study was conducted in vitro, on human renal cancer cells with superparamagnetic-like particles. Three types of such particles made of NiFe or magnetite were prepared and characterized (either synthetic antiferromagnetic, vortex or polycrystalline with random grain anisotropy). The triggering of the apoptosis of these cancer cells was demonstrated with NiFe vortex particles and statistically characterized by flow-cytometry studies. The death pathway via apoptosis and not necrosis was identified by the clear observation of caspase activation.

https://www.nature.com/articles/s41557-023-01383-y

Molecular jackhammers eradicate cancer cells by vibronic-driven action. 2023

Through the actuation of vibronic modes in cell-membrane-associated aminocyanines, using near-infrared light, a distinct type of molecular mechanical action can be exploited to rapidly kill cells by necrosis. Vibronic-driven action (VDA) is distinct from both photodynamic therapy and photothermal therapy as its mechanical effect on the cell membrane is not abrogated by inhibitors of reactive oxygen species and it does not induce thermal killing. Subpicosecond concerted whole-molecule vibrations of VDA-induced mechanical disruption can be achieved using very low concentrations (500 nM) of aminocyanines or low doses of light (12 J cm−2, 80 mW cm−2 for 2.5 min), resulting in complete eradication of human melanoma cells in vitro. Also, 50% tumour-free efficacy in mouse models for melanoma was achieved. The molecules that destroy cell membranes through VDA have been termed molecular jackhammers because they undergo concerted whole-molecule vibrations. Given that a cell is unlikely to develop resistance to such molecular mechanical forces, molecular jackhammers present an alternative modality for inducing cancer cell death