



# Effect of Whole-Body Vibration Versus Weight Bearing Exercises on Osteoporosis in Breast Cancer Patients after Chemotherapy

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## Abstract

The purpose of this study was to assess the impact of whole-body vibration (WBV) compared to weight-bearing exercises upon bone mineral density (BMD). The methods of evaluation were Bone mineral density as well as the T-score mean. A total of 45 breast cancer patients who had undergone chemotherapy and were experiencing osteoporosis were randomly assigned to three groups. Group (A) were given a regimen of WBV for a duration of 20 minutes, three times a week, over a period of two months, in addition to drug therapy consisting of vitamin D pills as well as calcium. Group (B) engaged in weight-bearing aerobic activity on a treadmill for 20 minutes, three times per week, for a duration of two months. Additionally, got pharmacological therapy in the form of vitamin D supplements as well as calcium. Group (C) were given drug therapy (vitamin D supplements as well as calcium) only. The findings demonstrated that the combined use of WBV, treadmill weight bearing exercises, as well as drug therapy had a more significant impact on enhancing BMD among breast cancer patients undergoing chemotherapy, compared to the use of drug therapy alone. It could be concluded that the application of both WBV as well as treadmill weight-bearing exercises yielded similar results among breast cancer patients who had osteoporosis following chemotherapy, as demonstrated by a substantial rise in both the bone mineral density, or BMD, as well as mean T-score.

**Keywords:** Whole body vibration, Treadmill weight bearing exercises, Bone mineral density, T-score and Osteoporosis.

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## 1. Introduction

Chemotherapy has the potential to harm the bone marrow, leading to a reduction in the synthesis of white blood cells, platelets, as well as red blood cells. Cardiotoxic cytostatic drugs such as anthracyclines as well as bleomycin can lead to a decrease in cardiac output, resulting in a compromised blood supply to the muscles [1-20]. Osteoporosis is a condition that affects the entire body and specifically the skeletal system. It is defined by a decrease in bone density and the deterioration of the structure of bone tissue, resulting in bones being more prone to fracture. Osteoporosis is defined by a decrease in BMD, which leads to a higher likelihood of experiencing fractures. Fractures primarily caused by osteoporosis can be influenced by both intrinsic variables (such as genes & hormones) as well as extrinsic factors (such as lifestyle choices) [2,7,13,15,17]. Whole-body vibration (WBV) involves putting one's body through its paces on a vibrating platform. WBV refers to a particular type of vibration that, instead of vibrating just one part of the body, spreads

throughout the whole body. [10,11,14,19]. Both the prevention and treatment of osteoporosis should include weight-bearing aerobic exercises along with muscle-strengthening exercises. To maintain and strengthen bones, regular physical activity, especially weight-bearing exercises, is believed to supply the mechanical stimulus, or "loading" that is so vital. There is strong evidence that regular weight-bearing exercise in childhood and adolescence increases peak bone mass and supplies the mechanical stimulation, or "loading," necessary for bone health maintenance and reduced bone loss rates in adulthood [3,8,16,18]. Typically, clinicians and physical therapists follow these procedures to diagnose Osteoporosis: BMD is commonly assessed by measuring it in the hipbone, spine, and forearm. Bone densitometry, a technique that utilizes low-dose X-rays, is employed to assess BMD. BMD is expressed in mg/cm<sup>2</sup> and represents the mean concentration of bone mineral in the scanned areas during the imaging examinations. [3,8,16].

## 2. Materials and methods

### 2.1. Study design

This study had forty-five breast cancer patients who had undergone chemotherapy and were experiencing osteoporosis. The participants, aged between 35 and 55 years, were chosen from the National Cancer Institute. The patients were grouped into three groups of equal size: Group A, consisting of fifteen breast cancer participants, underwent a treatment regimen of WBV for 20 minutes, three times per week, over a period of two months. Additionally, they got prescription medication in the form of vitamin D supplements plus calcium. Group B consisted of fifteen breast cancer participants, they were given weight-bearing exercises for 20 minutes, three times per week, for two months. Additionally, they got prescription medications in the form of vitamin D supplements plus calcium. Group C: Fifteen breast cancer participants, consisting of vitamin D supplements plus calcium. The measurements were taken prior to commencing the treatment as an initial record, and at the second month following therapy as a final record. A follow-up was undertaken after a period of two months.

### 2.2. Instrumentation

Absorptiometry (DXA) is a clinically validated method for evaluating BMD. It was used as a measurement tool in this investigation. The primary use of this equipment is in the diagnosis and treatment of osteoporosis and various diseases with abnormal BMD, as well as in monitoring the efficacy of treatment for these conditions. Regarding Whole-body vibration (WBV) device which has frequency 30HZ with intensity 5 mm for 20 mins 3 times / week, Participants were advised to avoid eating for two hours prior to the session. Also, participants were told to wear whatever made them feel comfortable. After a brief period of rest from 10 to 15 min., the participants began the exercise program. To exclude any potential impact of shoe-induced vibration dampening, subjects were observed while barefoot. They stood on a force platform that caused lateral vibrations throughout their bodies. An electronic treadmill, the Kettler-marathon type No. 7899-800, manufactured in Germany (for weight bearing exercises), was set to the subject's preferred walking speed, during treadmill training, the participant can adjust the machine's speed as well as inclination and monitor the exercise parameters displayed on the display. The aluminum-pertinax running deck, shock absorbers, and general shock-damping design, along with the pharmacological therapy (calcium as well as vitamin D supplements), make it possible to run comfortably without experiencing joint or back pain. [4,5,13,17].

### 2.3. Procedures

#### 2.3.1. Evaluation

DEXA measures the patient's bone density before starting the program as well as at the end of the problem. This test quantifies the calcium content in bone, usually focusing on the hip and lower spine regions. The technologist who did the exam was qualified and responsible for making sure the patient was comfortable and safe, getting them ready and putting them in the right position, placing the areas of interest for BMD measurements, keeping an eye on the patient throughout the measurements, and getting the measurements that the supervising doctor ordered. A postero-anterior (PA) scan of

both hips was part of a standard DXA test. The positioning as well as soft-tissue-equivalent devices that the manufacturer sent were used correctly and reliably. A patient's T-score was determined by comparing their measured BMD to the mean BMD of healthy young adults who were matched for ethnicity and gender. Then, the SD of this difference was expressed relative to the young adult population: According to the following equation, a normal T-score is defined as  $T > -1.0$ , osteopenia is defined as  $-2.5 < T < -1.0$ , while established osteoporosis is defined as  $T < -2.5$  in the context of 1 or more fragility fractures [2,4,5,13,21].

$$T\text{-score} = \frac{\text{Measured BMD} - \text{Young adult mean BMD}}{\text{Young adult population SD}}$$

#### 2.3.2. Treatment procedures

Patients were advised to refrain from eating two hours before their treatment session to facilitate the WBV apparatus processes. Comfortable clothing was also advised for the subjects. Prior to beginning the exercise session, subjects rested for ten to fifteen minutes. So that their shoes wouldn't dampen the vibration, the subjects walked around barefoot. While standing on the force platform, the entire body oscillated laterally. The following procedures, however, while using an electronic treadmill (a type of weight-bearing exercise): The treatment lasted for two months, with each session lasting twenty minutes of exercise performed three times weekly. These exercises were divided into 3 components as follow:

##### 2.3.2.1 Warm up phase

Gentle stretches for every muscle group, followed by 5 minutes of walking at the slowest speed on the treadmill.

##### 2.3.2.2. Active phase

When the patient came in for treatment, they were fully informed about the reason for the treatment and how it would help them physically and therapeutically. For purposes of comparison, all of the patients' prior measurements were recorded before the treatment began. Ten minutes is the duration. Training intensity: the first two weeks were 50–55% of maximum heart rate (MHR), the second two weeks were 55–60%, the third weeks were 60–65%, and the last two weeks were 65–70% of MHR, all based on the (Karvonen formula);  $MHR = 220 - \text{Age}$ .

##### 2.3.2.3. Cool down Phase

Gentle stretches for every muscle group, followed by 5 minutes of walking at the slowest speed on the treadmill. [2,6,9,15,18,19].

#### 2.3.3. Data analysis

The age groups were compared using an ANOVA test. The Shapiro-Wilk test was used to ensure that the data followed a normal distribution. To ensure that the groups were similar to one another, we used Levene's test to check for homogeneity of variances. To compare BMD and T score among the three groups, a one-way analysis of variance was performed. Subsequent multiple comparisons were tested with post hoc tests with Tukey's test. To compare each group's pre-, post-I, as well as post-II measurements, we used a one-way ANOVA using repeated

measures methodology. All statistical tests were set to have a significance level of  $p < 0.05$ . All of the statistical analysis was carried out using SPSS version 25 for Windows, which is a program developed by IBM SPSS in Chicago, IL, USA. (Flow chart of the study).

### 3. Results and discussion

#### 3.1. Subject characteristics

Forty-five patients with osteoporosis received chemotherapy and took part in this investigation. They were between the ages of 35 and 55. The mean  $\pm$  SD age of group A, B & C were  $47.40 \pm 5.88$ ,  $47.33 \pm 5.72$  as well as  $47.27 \pm 5.49$  years respectively. There was no substantial difference regarding age among groups ( $p > 0.05$ ).

#### 3.2. Effect of treatment on BMD and T-score

##### 3.2.1. Within group comparison

There was a substantial improvement in BMD as well as T-score at post I in addition post II contrasted with pretreatment for the three groups ( $p < 0.001$ ). There was no substantial difference in BMD as well as T-score between post I in addition post II for the three groups ( $p > 0.05$ ). The percent of change in BMD as well as T-score regarding group A was 41.85% & 46.07% respectively, regarding group B was 43.67% & 44.17% respectively whereas in group C was 18.56 and 25.68% respectively (Table 1).

##### 3.2.2. Between group comparison

There was no substantial difference among groups pretreatment ( $p > 0.05$ ). There was a substantial improvement in BMD as well as T-score of group A in addition group B contrasted with group C at post I ( $p < 0.001$ ) as well as post II ( $p < 0.01$ ). There was no substantial difference in BMD as well as T-score among group A and group B at post I as well as post II ( $p > 0.05$ ). (Table 2).

#### 3.3. Ethical approval

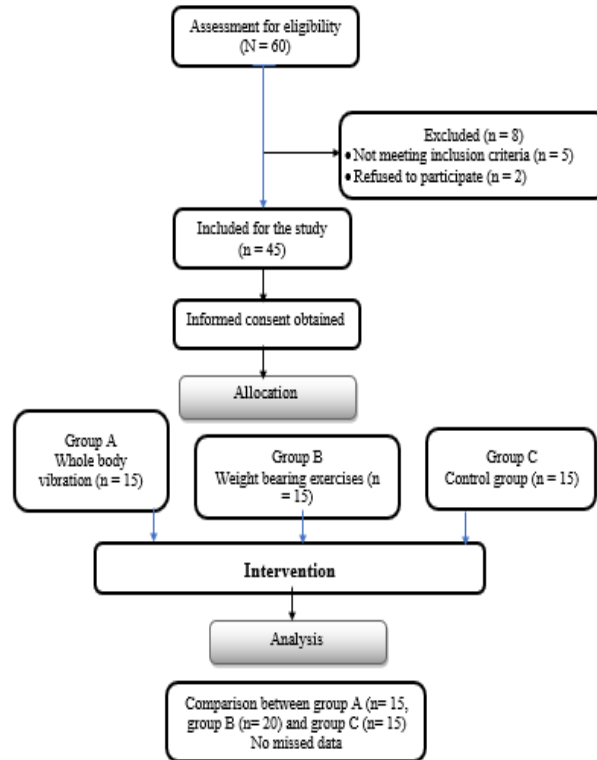
The examination identified with human use has agreed to all the significant national guidelines and institutional approaches have pursued the fundamentals of the assertion of Helsinki and have been endorsed by the Ethics Committee of the Faculty of Physical Therapy, Cairo University (NCT05970250).

#### 3.4. Informed consent

Informed consent has been obtained from all individuals included in this study. Osteoporosis is a condition that affects the bones and is characterized by low bone mass as well as deterioration of bone tissues. It is most common among elderly women and men. The disease progresses slowly over time and often does not cause noticeable symptoms [2,7,13]. Osteoporosis has been observed in post-menopausal women as well as elderly men who have been exposed to smoking for an extended period of time. These groups have been found to have deficits ranging from 0.5 to 1.0 SD. Furthermore, a correlation has been shown between cigarette smoking along with reduced bone density during the period of youth and early adulthood. Smokers typically have a lower body weight compared to non-smokers. Additionally, smokers tend to consume more alcohol, engage in less physical activity, experience nutritional deficiencies, and undergo menopause at an earlier age than non-smokers. In addition to their tobacco

intake, these features significantly elevate the risk of Osteoporosis among many smokers [2,7,13,17,21]. Whole-body vibration platforms facilitate the training of several skeletal muscles as well as elicit varied physiological responses in the body. The effects are utilized in sports, physical fitness, aesthetics, rehabilitation, as well as medicinal therapy. There have been numerous peer-reviewed publications published on the impact of WBV, with a significant number of research studies undertaken annually. The platform is subjected to upward vibrations in order to counteract the force of gravity, so it is referred to as "hyper-gravity". High Energy Linear Machines have the capacity to exert a force on the muscles that is up to 6 times more than (6G) during the upward phase. This means that the person using the machine is effectively weight training by utilizing their own body mass. [4,10,12,14,19]. The results of the current investigation revealed that there were not any substantial differences in the initial measurements of both BMD as well as T-score average of the hip bone among the average values of the three groups. The initial study group found a substantial and statistically significant improvement in the average values of both BMD as well as T-score mean of the hip bone following the implementation of WBV as well as prescription medication (specifically, vitamin D supplements as well as calcium) compared to the pre-application results. The findings from the second study group showed a substantial and statistically significant improvement in the average values of both BMD as well as T-score mean of the hip bone following the implementation of treadmill weight-bearing exercises as well as prescription medication (specifically, vitamin D supplements as well as calcium). Application of WBV and treadmill weight bearing exercises have profitable effects and mostly equivalent in improving the BMD in cases of osteoporosis in breast cancer patients after chemotherapy as evidenced by the highly significant increase in BMD and T-score mean. Substantial differences, among the first study group (WBV as well as prescription medication) in addition the control group (prescription medication only), between the second study group (Weight bearing exercises group) in addition the control group (Only drug therapy application), as well as between the first study group (Whole body vibration group and drug therapy application) and the second study group (Weight bearing exercises group) were nearly equivalent in increasing the BMD as well as T-score mean were in line with those observed as well as documented by Ballard et al., 2011; Bonnick, 2009; Candus, 2009; Chadeaux et al., 2021; cho et al., 2009; Costantino et al., 2018; Dalsky et al., 2006; Dubyak, 2008; Fethke et al., 2018; Odano et al., 2022; Shadloo et al., 2021 and Sierra-Guzmán et al., 2018. [3-10].

People with osteoporosis should think about three different exercises strategies: 1. An exercise program to prevent osteoporosis; 2. An exercise program for osteopenia; and 3. An exercise program for progressive osteoporosis. [3]. It is advisable to adhere to a moderate exercise regimen that primarily consists of weight-bearing exercises and resistance or strength training. For the maintenance of healthy bones, it is essential to engage in regular exercise from a young age. In conjunction with sufficient vitamin D and calcium, physical activity is crucial for the development of bone mass. Increases in physical activity induces a greater "load" or force on the bones [5].



**Figure 1:** Flow chart showing the experimental design of the study

**Table 1:** Mean BMD and T-score pretreatment, post I and post II of group A, B and C

	Pre treatment	Post I	Post II	p-value		
	mean ± SD	mean ± SD	mean ± SD	Pre vs post I	Pre vs post II	Post I vs post II
<b>BMD (gm/cm<sup>2</sup>)</b>						
<b>Group A</b>	0.497 ± 0.093	0.704 ± 0.057	0.705 ± 0.058	0.001	0.001	1
<b>Group B</b>	0.490 ± 0.101	0.701 ± 0.054	0.704 ± 0.055	0.001	0.001	0.19
<b>Group C</b>	0.501 ± 0.068	0.592 ± 0.047	0.594 ± 0.049	0.001	0.001	0.36
	<i>p &gt; 0.05</i>	<i>p &lt; 0.001</i>	<i>p &lt; 0.001</i>			
<b>T-score</b>						
<b>Pre treatment</b>	-2.941 ± 0.225	-1.624 ± 0.498	-1.586 ± 0.444	0.001	0.001	0.78
<b>Post I</b>	-2.966 ± 0.198	-1.680 ± 0.477	-1.656 ± 0.463	0.001	0.001	0.10
<b>Post II</b>	-2.886 ± 0.247	-2.212 ± 0.348	-2.145 ± 0.385	0.001	0.001	0.25
	<i>p &gt; 0.05</i>	<i>p &lt; 0.001</i>	<i>p &lt; 0.001</i>			

SD, Standard deviation; p-value, Level of significance

**Table 2:** Comparison of BMD and T-score between groups A, B and C.

	BMD (gm/cm <sup>2</sup> )				T-score			
	Post I		Post II		Post I		Post II	
	MD	p value	MD	p value	MD	p value	MD	p value
<b>Group A vs group B</b>	0.003	0.98	0.001	0.99	0.056	0.93	0.07	0.89
<b>Group A vs group C</b>	0.112	0.001	0.111	0.001	0.588	0.002	0.559	0.003
<b>Group B vs group C</b>	0.109	0.001	0.110	0.001	0.532	0.006	0.489	0.009

**MD, mean difference; p-value, level of significance**

Exercise is crucial throughout a woman's lifespan, especially as she ages. Regular physical activity confers advantages to cardiovascular health and skeletal strength, aids in weight management, enhances general emotional and psychological state, and uplifts mood [6]. Physical inactivity in women significantly increases their susceptibility to coronary heart disease, being overweight, having elevated blood pressure, or diabetes, and it also directly impacts the structure along with geometrical properties of their bones, leading to osteoporosis [7]. It was stated that there are three primary varieties of WBV platforms available on the market, each functioning through distinct mechanisms and possessing distinctive characteristics. The vibration oscillation magnitude is defined as the peak-to-peak displacement of the identical magnitude. Amplitude, as defined, refers to the maximum magnitude of oscillation from the position of equilibrium. Animal studies have demonstrated that low to moderate intensity exercise has a beneficial impact on bone mass, however high intensity exercise may hinder bone formation. Studies on humans have also demonstrated that engaging in high-intensity exercise has a detrimental effect on BMD. The body experiences acceleration forces as a result of mechanical stimulation. The application of these pressures induces muscular elongation, which is then detected by the muscle spindle, a tiny anatomical structure within the muscle [14]. One study found that people who took 1500 mg of calcium supplements daily and engaged in weight-bearing exercise (such as walking, running, or stair climbing) three times a week for 22 months saw improvements in bone density. The majority of the increase in lumbar BMD was noted to happen within the first 9 months, according to this study as well. Improvements persisted, but at a slower pace, beyond the 99th month [15]. Walk Tall is an uncomplicated as well as comprehensive exercise regimen designed to restore posture, strengthen bones, and improve balance. The outcomes are truly remarkable! As the program advances, the focus is on enhancing the back extensors, which are the deep layer of muscles responsible for supporting the body against the pull of gravity [16]. Vibrations can be transmitted to a person via particular devices. A good example of this is when a hammer strike transfers shock vibrations along the limb, whereas a vibration platform that is custom-made distributes pure vibrations throughout the entire body.

Consequently, vibration can have both advantageous and detrimental impacts on individuals and their overall well-being. On the contrary, exposed muscles become necrotic when subjected to high frequency, prolonged vibration. The extent of vibration's impact on an individual is dependent upon the quantification factors and duration of vibration exposure. For instance, compared to a state of inactivity, the gravitational forces pushing on the body were around 1.5 to 1.7 times stronger [18]. Workplace vehicle operators, particularly those operating buses and trucks, are subject to WBV, and they also encounter positive and negative gravitational forces in the horizontal and vertical planes when their vehicles move. Applying stress on passive structures which include bones, ligaments, as well as joints. WBV is particularly well-suited for individuals who are challenging to train due to factors such as advanced age, disease, disorders, excessive weight, or injury. Moreover, it is particularly well-suited for professional athletes seeking to stimulate as well as strengthen their muscles while minimizing strain on joints as well as the remaining parts of the physical system [19]. In certain settings, whole-body vibration has been utilized for the purpose of physical fitness. Researchers have used vibration platforms to have subjects either stand still or move about, doing things like squats and squats with a weight. In addition to lowering body fat, WBV has been found to raise levels of testosterone and growth hormone. From a practical standpoint, WBV enhanced the strength and power of the leg muscles [20]. Findings of this research confirm the expectation that application of both WBV as well as treadmill weight bearing exercises had a large and nearly equal impact on enhancing BMD among breast cancer patients undergoing chemotherapy, as seen by the substantial rise in both BMD as well as T-score mean [21].

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#### Disclosure statement

No author has any financial interest or received any financial benefit from this research.

**Conflict of interest**

No potential conflict of interest relevant to this article was reported.

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