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The effect of whole-body vibration training on selected breast cancer risk factors in obese postmenopausal women: A randomized controlled trial

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ABSTRACT

Menopause is associated with various hormonal changes leading to many complications such as obesity, hot flashes and increased liability for breast cancer, that intractably alter female quality of life. This study was conducted to determine the effect of whole-body vibration training (WBVT) on body mass index and serum prolactin concentration, as risk factors for breast cancer and severity of hot flashes in obese postmenopausal women. A prospective, randomized, parallel group, active controlled study with a 1:1 allocation ratio was carried out. A total of 40 obese postmenopausal women (aged 50 to 60 years, postmenopausal for at least 3 years, with a body mass index BMI between 30-39.9 kg/m2) were randomly assigned into two equal groups (group A and B). Group A (WBVT, n = 20) received WBVT, 3 sessions per week for 3 months, while group B (control group, n = 20) was asked to retrain their usual lifestyle pattern. They were all instructed about healthy dieting. Statistical analysis was performed utilizing SPSS for windows, version 18 (SPSS, Inc., Chicago, IL). The results of our study showed that there was a statistically significant reduction in all measured variables in group A in post-study ($p < 0.05$), while the control group (B) showed a non-statistically significant decrease in these variables in comparison to the pre-study ($p > 0.05$). Comparison of the two groups after treatment showed a statistically significant decrease in the measured variables, in favor of the study group A ($p < 0.05$). From the obtained results, it was concluded that whole body vibration is effective in decreasing BMI and waist circumference, in addition to reducing serum prolactin concentration and the severity of hot flashes in obese postmenopausal women. Therefore, it could be used to decrease the risk of breast cancer in obese postmenopausal women.

KEYWORDS

Whole Body Vibration; Breast Cancer; Menopause

1. INTRODUCTION

Menopause is a physiological process characterized by spontaneous cessation of menstrual cycle lasting at least 12 months. It usually occurs in women aged 45 – 55 years (Emara et al., 2013). Quality of life is greatly influenced by menopausal symptoms which affect postmenopausal women more than pre- and peri-menopausal women (Ibrahim et al., 2015).

An estimated 75–85% of women experience some or all symptoms of menopause, including fatigue, sleep problems, mood disturbances, cognitive difficulties, musculoskeletal pain, headaches, increased adiposity, and vasomotor disturbances (hot flashes and night sweats) (MacLennan, 2009). Increased adiposity, as measured by high body mass index, is associated with more severe menopausal symptoms. In addition, obese women have a higher risk of developing breast cancer after menopause (Ibrahim et al., 2015).

The relation between BMI and breast cancer risk is probably due to increased concentrations of bioavailable estradiol, leading to stimulation for estrogens formation by aromatization in the fat tissue, conversion of hormones in fatty tissue and a decrease in the serum concentration. This is likely to explain the higher risk of breast cancer in overweight post-menopausal females (Key et al., 2003).

Vasomotor manifestations or "hot flashes" are the most common complaint that affect up to 80 percent of menopausal women, frequency of flashes is greatly affected by female culture and ethnicity. Many to most women suffer from severe symptoms, but only about 20 to 30 percent of women seek medical attention for treatment (Randolph et al., 2005).

Menopause is also related to atherogenic changes, as it causes an increase in cardiovascular disease risk factors (Gokce et al., 2003) and decreases aerobic capacity compared with premenopausal period (Shechter et al., 2009). This initially may be due to a decline in endogenous estrogen concentration, and likely further exacerbated by increased body mass index and reduced physical activity levels (Harvey et al., 2005; Bergström et al., 2001).

Post-menopausal women recorded a high serum prolactin concentration; however, they have a significant chance of normalizing their prolactin levels. Serum prolactin levels rise transiently after several physiological states including pregnancy, breast-feeding, exercise, meals, sexual intercourse, minor surgical procedures, general anesthesia, other forms of acute stress and menopause (Mancini et al., 2008).

Prolactin causes inhibition of gonadotropin-releasing hormone (GnRH) leading to inhibition of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) secretion causing amenorrhea, hot flashes, and vaginal dryness (Thapa & Bhusal, 2022). Prolactin may exacerbate cell proliferation and inhibit apoptosis in breast cancer, in mice, prolactin may enhance tumorigenesis and increase cell motility, metastasis and neoplastic revascularization (Carver et al., 2009).

Dopamine considered as regulatory hormone for prolactin production, it suppresses prolactin release, so the more dopamine there is, the less prolactin is produced. Prolactin itself enhances the release of dopamine, so this provides a negative feedback loop (Gonzalez-Iglesias et al., 2008).

Estrogen is another vital controller of prolactin and has been shown to increase the production and secretion of prolactin from the pituitary gland. In addition to dopamine and estrogen, numerous hormones can alter the level of prolactin hormone circulating in the body as thyrotropin-releasing hormone, oxytocin and anti-diuretic hormone (Steinmetz et al., 1997). Prolactin concentration level can be reduced by physical activity which also can alter circulating sex hormone levels in postmenopausal females (Kraemer et al., 1998).

Prolonged exposure to sex steroid hormones is considered a risk factor for breast cancer that can be controlled by physical activity, additionally it can restrict exposure to insulin and insulin like growth factors, and prevention of overweight and obesity which in turn influence the production of estrogens. Hence, exercises considered as potentially promising preventive measure against breast cancer (Shi et al., 2004).

Whole-body vibration training (WBVT) is a promising adjunct intervention therapy for management of obesity, as there is little evidence that it can reduce body mass index and enhances muscles strength (Zago et al., 2018). In the initial stage of obesity management, WBVT is highly recommended because it allows a mild joints stress, deconditioning for an obese patient with poor motivation because it achieves its target without provoking an excessive fatigue. In addition, Passive vibrations do not involve voluntary movement and need a lower contribution of central command, so WBVT is as effective as aerobic and resistance exercise in reducing body adiposity and increasing muscle strength. Finally, WBVT is an effective method to enhance vascular health promotion and prevention in young obese female (Figueroa et al., 2015).

WBVT has been considered as a successful alternative exercise modality as resistance exercise for its ability in increasing force and power, providing capacity in skeletal muscle, enhancing bone mineral density, improving cardiopulmonary capacity, reducing body adiposity and moderating the deficit of the relative muscle strength (Paineiras-Domingos et al., 2017). Unfortunately, the effect of resistance exercise on prolactin has not been broadly studied (Hackney & Saeidi, 2019).

So, this study was conducted to evaluate the effect of whole-body vibration training on BMI, waist circumference, serum prolactin concentration and hot flashes in obese postmenopausal women.

2. METHODS

2.1. Study Design and Participants

This was a prospective, randomized, parallel group, active controlled study with a 1:1 allocation ratio. Recruitment began after approval was received from Ethics Committee of the Faculty of Physical Therapy, Cairo University. Also, this study was recorded in clinical trial.gov: NCT04708093.

Forty obese postmenopausal women participated in this study. The age of the patients ranged from 50 to 60 years, they were postmenopausal for at least 3 years, and their body mass index BMI ranged between 30-39.9 kg/m^2. They were selected from the outpatient clinic of Bab-Elsharea Hospital and participated in the study after reading and signing an informed consent form before data collection.

Participants were screened by the gynecologist before inclusion, through full obstetrical examination to exclude women with musculoskeletal or cardiovascular or neurological disorders that interfere with physical activity, diseases or medical conditions that may elevate the prolactin concentration as hypothyroidism, polycystic ovary syndrome, cirrhosis, chronic renal failure, epileptic seizures, stress and after surgical procedures. They were also excluded if they took medications that may elevate or lower prolactin concentration or either participate in any exercise program before the study by six months.

2.2. Randomization

The participants were randomly allocated to Group A (WBV, n=20) and Group B (Control Group, n=20) by an independent person who selected blindly from sealed envelopes containing numbers created by a random number generator. The randomization was limited to permuted blocks to ensure the equality.

2.3. Evaluation Procedures

All participants were evaluated before and after the end of the study program as follows:

- Physical characteristics was measured including height and weight to calculate the BMI that was taken while being pare foot and wearing light clothes.
- The waist circumference was measured midway between lower ribs and iliac crest from standing position, after that, each woman was asked to refrain from the following before blood draw: exercise for 24 hours and food as well as drink other than water for 12 hours.
- A blood sample of 5 cm3 was obtained from radial vein, centrifuged for 5 min at 4000 rounds per minute and serum was collected into Epindorf tubes. It was analyzed to determine serum prolactin level before and after the end of the study, hot flashes evaluated by dairy card as the number of hot flashes (day and night) and its severity were recorded daily by the woman herself (Mohamed et al., 2015).

2.4. Treatment Procedures

In Group A (study group), the WBVT was applied while women were comfortably standing with the knees slightly flexed (at approximately 20°) to prevent vibrations causing side effects such as dizziness from the vibration transmitted to the head. Then, firmly grasp device handles, vibration was delivered for 1min, with a 1min rest period between each vibration set, which was repeated ten iterations. It was conducted using frequency of 30 Hz and amplitude of 0-2 mm and 50 m/s speed (Melo et al., 2019). These sessions continued 3 times per week for 3 months.

Women in Group B (control group) were asked to do their routine activities and to participate only in biochemical and physiological assays. All women in both groups were instructed about healthy dieting.

2.5. Statistical Analysis

Statistical analysis was performed utilizing SPSS for windows, version 18 (SPSS, Inc., Chicago, IL). Before the final analysis, data were evaluated for normality assumption, homogeneity of variance, and the existence of extreme records. This exploration was done as a pre-essential for parametric calculations of the analysis of difference, and the paired t-test was used to compare the data before the start and after the end of the study. The level of significance was set at $p < 0.05$.

3. RESULTS

The results showed that there was no statistically significant difference between women ages in both groups (A and B) (49.78±2.24) and (50.2±1.7) respectively. There was a statistically significant reduction (11.6%) in post-study BMI compared to pre-study in group A, while there was no statistically significant reduction (1.62 %) of BMI at post-study compared to the pre-study program in group B. There was no statistically significant difference between groups A and B in the pre-study, while the post-study results were statistically significant between both groups, in favor of group A (Table, 1).

Table 1. BMI results for both groups (A and B) before and after the study program.

		Group (A)	**Group (B)**	**t- value**	**p- value**
BMI (kg\m2)	Pre-study	36.10±3.59	34.63±3.29	1.35	0.18 (NS)
	Post-study	31.91±2.09	34.06±3.04	2.61	0.01 (S)
	t- value	6.04	1.34		
	p- value	0.00 (S)	0.19 (NS)		

The results of Table 2 show that there is a statistically significant reduction of 5.87% of waist circumference at post-study compared to the pre-study in group A ($p < 0.05$). There was no statistically significant reduction (0.6%) of waist circumference at post-study compared to pre-study in group B ($p > 0.05$) and there was also no statistically significant difference between the results of groups A and B at pre–study ($p > 0.05$), while in post-study there was a statistically significant difference between both groups, in favor of group A ($p < 0.05$) (Table, 2).

Table 2. Waist circumference results for both groups (A and B) before and after the study program.

		Group (A)	**Group (B)**	**t- value**	**p- value**
Waist Circumference (cm)	Pre-study	102.80±8.38	103.10±8.29	0.11	0.91 (NS)
	Post-study	96.78±7.80	102.48 ±8.65	2.19	0.03 (S)
	t- value	4.9	1.01		
	p- value	0.00 (S)	0.33 (NS)		

As for the serum prolactin concentration results, there was a statistically significant reduction (32.61 %) of serum prolactin at post-study compared to pre-study in group A ($p < 0.05$), while there was no statistically significant reduction (7.44 %) of serum prolactin at post-study compared to pre-study in group B ($p > 0.05$). Also, there was no statistically significant difference in serum prolactin level between groups at pre-study ($p > 0.05$), while post-study results revealed a statistically significant difference, in favor of group A ($p < 0.05$) (Table, 3).

Table 3. Serum prolactin concentration results for both groups (A and B) before and after the study program.

		Group (A)	**Group (B)**	**t value**	**p value**
Serum prolactin (ng/ml)	Pre-study	11.19±2.63	10.21±1.81	1.37	0.18(NS)
	Post-study	7.54± 2.89	9.45±2.59	2.19	0.03 (S)
	t- value	8.48	1.98		
	p- value	0.00 (S)	0.06 (NS)		

The severity of hot flashes tested by Chi-Square Tests, revealed no statistically significant difference between groups before study ($p > 0.05$), while after study there was a statistically significant difference between the two groups, in favor of group A ($p < 0.05$). The percentage of women with hot flashes in group A after treatment was (47.7% none, 45.7% mild, 6.6% moderate, 0.00% severe), while the percentage of women with hot flashes in group (B) after treatment was (6.9% none, 39.8% mild, 33.0% moderate, 20.3% severe).

4. DISCUSSION

The present study was conducted to determine the effect of whole-body vibration training (WBVT) as a feasible and safe type of exercise that is greatly endured by obese fatty individuals on the body mass index and serum prolactin concentration as risk factors for breast cancer and severity of hot flashes in obese postmenopausal females (Tamini et al., 2020).

Whole-body vibration training (WBVT) has become increasingly popular as a type of safe training. It involves the conduction of a vibratory stimulus to the whole body as opposed to local stimulation of specific muscle groups (Merriman & Jackson, 2009).

The results of our study showed that there was a statistically significant reduction in all measured variables in group A in post-study ($p < 0.05$), while the control group (B) showed a non-statistically significant decrease in these variables in comparison to the pre-study ($p > 0.05$). Comparison of the two groups after treatment, showed a statistically significant decrease in the measured variables, in favor of the study group A ($p < 0.05$).

Our results were in accordance with the study by Melo et al. (2019), which recorded a reduction in body fat composition and improvement in some physiological functions as oxygen saturation, bone mineral density and arterial profile. So, WBV is considered as a safe tool in the management of obesity and its complications. Thus, the more the muscle and bone is activated during the vibration period, the better the physiological changes provided to the patient.

Also, Vissers et al. (2010) reported that aerobic exercise along with WBVT in chronic form, in addition to a dietary control (low calorie diet), can greatly assist bringing down body adiposity. Exposure to vibrations stimulate the central sympathetic nervous system, whose innervation of white adipose tissue provokes lipolysis, likewise, WBVT enhances glycemic control by improving insulin effect and glucose regulation, improving glycemic control is vital in postmenopausal female, whose hormonal changes lead to insulin resistance leading to elevation in body mass index (Zago et al., 2018).

Also, this study is supported by Bellia et al. (2014) who founded a 35% rise in insulin sensitivity, after two months of WBVT, additional effects on metabolic adjustments showed an increase of adiponectin and an inhibition of leptin release hence decreasing body adiposity in female after cessation of menstruation. As the fat tissue is the source of prolactin production in postmenopausal period so reducing body fats could greatly decrease prolactin concentration level (Hoehn & Marieb, 2007).

Paineras-Domingos et al. (2017) recorded that the WBVT has been recognized as an effective alternative exercise modality to physical exercises as it simulates high impact exercise for its ability in increasing force and power, magnifing capacity in skeletal muscle, elevating bone mineral density and enhancing cardiovascular endurance. Mastorakos et al. (2005) also stated that regular physical activity causes adaptive decrease in growth hormone profile and serum prolactin concentration.

Increasing body fitness may cause an adaptive response lowering circulating prolactin concentration level. This theory is supported by animal models stated that regular exposure to a specific stressor may lead to decrease in prolactin concentration level over time (Martí & Armario, 1998).

Training stress slows down the loss of dopamine in the brain as exercise induce a general stress response including stimulation of the neuroendocrine system, characterize by release of central opioids that stimulate dopamine secretion which inhibit prolactin secretion. As prolactin is inhibited by activation of the dopamine D2 receptor, increased prolactin secretion may occur due to reduced dopamine D2 receptor availability in the brain so improvement of deficit dopamine D2 receptor-mediated neurotransmission and/or decreased circulating leptin/estrogen levels might be involved in lowering prolactin levels (Santos-Silva et al., 2011). Elevating body fitness was related to decreased prolactin concentrations in postmenopausal female. This could reflect the adaptive response of prolactin to the physical stressors (Martí & Armario, 1998).

Regarding the results of severity of hot flashes, these came in accordance with Tartibian et al. (2009) who stated that physical training lower serum FSH level and vasomotor manifestation (hot flashes). In this way, the specialists should apply procedures to lower vasomotor manifestation by changing way of life from sedentary to training in order to help postmenopausal women general health.

Results of this study were in accordance with Stojanovska et al. (2014) who stated that physical training has been evaluated as an alternative treatment option for easing menopausal symptoms as mental, vasomotor, physical and sexual symptoms that affect female quality of life overall. Our results are also consistent with Lee et al. (2003) who conducted a study to determine the effects of regular aerobic exercises on decrease serum FSH level and vasomotor symptom and recommended that many strategies should be applied to alleviate vasomotor manifestation by altering lifestyle from sedentary to physically active lifestyle to enhance postmenopausal somatic health.

Finally, WBVT is reported to be a safe, feasible and non-impact form of exercise, that can decrease body fat, furthermore suitable and endured by obese individuals and is able to enhance physical abilities and both muscle strength and flexibility, these changes are hardly achieved with the other traditional training exercises requiring a more elevated level of agility (Tamini et al., 2020). Whole body vibration training is an intervention designed to stimulate muscular response particularly for obese postmenopausal female. The literature related to this subject is controversial, heterogeneous, indistinguishable despite the prospect of a major clinical impact (Fratini et al., 2016).

5. CONCLUSIONS

From the obtained results, it was concluded that whole body vibration is effective in decreasing BMI and waist circumference, in addition to lowering serum prolactin concentration and reducing the severity of hot flashes in obese postmenopausal women. Therefore, it can be used to decrease the risk of breast cancer in obese postmenopausal females and to allow better quality of life.

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AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

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