Effect of the Whole Body Vibration versus Aerobic Training on Liver Function in Obese Adult Women

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ABSTRACT

Background: There is lack of awareness of the efficacy of whole body vibration and aerobic training on liver function in obese adult women in Egypt. **Purpose:** The aim of the study was to show the difference of the whole body vibration and aerobic training on liver function in obese adult women. **Subjects and Methods:** Forty obese adult women were enrolled in this study, they were recruited from the relatives of the patients from the out-patient clinic of faculty of physical therapy, Cairo University and from the out-patient clinics of Bolaq El-Dakrour hospital, Cairo, Egypt. Their age ranged from 35 - 45 years with body mass index (BMI) between 30 – 34.9 kg/m^2 (Class I obesity), the waist/hip ratio) less than one and they were assigned randomly into two groups of equal number (A and B). Group (A) includes 20 obese adult women who received diet advices (to prevent increasing weight) and aerobic training in form of treadmill training while group (B) received includes 20 obese adult women who received the same diet advices of group (A) and whole body vibration exercises (vibration frequency was set to 30 Hz then increased gradually to 35 Hz, then the subject took about 20 minutes to fulfill a training session). The participated subjects in this study were assessed by liver enzyme test (alanine transaminase (ALT) (SGPT)) and anthropometric measurement (waist/hip ratio). They were evaluated before and after the treatment program about three sessions per week for eight weeks. **Results:** The obtained results revealed significant differences of all measured variables before and after treatment in the two groups. Statistical significant difference was also found in post-treatment values of all measured variables when compared between the two groups in favor of group (A) and the percentage of improvement of ALT was 11.86 % and waist/hip ratio was 3.66 %. **Conclusion:** Aerobic training in form of treadmill training and whole body vibration exercise can be added to the physical therapy program.

Keywords: Whole body vibration; Aerobic training; Liver function; Obese adult women.

INTRODUCTION

Overweight and obesity are defined as abnormal or excessive fat accumulation. In adults, the World Health Organization (WHO) defines obesity as a Body Mass Index (BMI) greater than or equal to 30 kg/m2, and for children aged between 5–19 years, obesity is considered two standard deviations above the WHO Growth Reference median **(WHO, 2021).** Approximately 340 million children and adolescents worldwide were classified as overweight or obese in 2016 and the prevalence is dramatically increasing **(Deal et al., 2020).**

Obesity has also been associated with a spectrum of cancer types (colon, breast, endometrium, kidney, esophagus, stomach, pancreas, gallbladder and liver function diseases) and together with insulin resistance, represents a risk factor for developing hepatocellular carcinoma **(Bechmann et al., 2012).**

Whole body vibration (WBV) is a novel exercise modality that has previously shown to improve muscle strength and mass via a mechanical stimulus generated by a vibrating platform, stimulating muscle spindle activity and, consequently, increasing muscle mass and strength **(Cardinale et al., 2016).** Improvements in muscle strength have been observed in young overweight/obese women after WBV training (WBVT) 3 times a week for 6 weeks as well as 2 times a week for 10 weeks **(Milanese et al., 2013).**

The WBV is a training modality, has emerged as a useful exercise method for improving overall health. In fact, previous studies have reported that WBVT alone improves body composition, muscular strength, and cardiovascular health concurrently. Also, WBVT is suitable for special populations such as the elderly and diseased populations who cannot perform traditional resistance or aerobic exercise training **(Park et al., 2015).**

Aerobic exercise training relies primarily on skeletal muscle’s utilization of oxygen through aerobic respiration to produce energy, in the form of adenosine tri-phosphate or Adenosine triphosphate (ATP) **(Patel et al., 2017).** The gold-standard for measuring physiologic adaptation to aerobic training is maximal aerobic capacity, VO2max, a measure of cardiorespiratory fitness. VO2 is a strong independent predictor of lifestyle-mediated reductions in intrahepatic fat in Nonalcoholic Fatty Liver Disease (NAFLD) **(Kantartzis et al., 2019).**

Aerobic exercises such as walking and swimming, cause harder breathing and faster heart beating than occur at rest. Benefits of doing aerobic exercise include strengthening the heart and improving circulation, lowering blood pressure, and helping to control blood sugar and weight **(Bidonde et al., 2017).**

Similarly, a recent 16-week study of supervised exercise training in NAFLD found that exercise-mediated improvements in VO2 max and liver fat occurred in the absence of weight loss; both were reversed after 12 months of exercise cessation **(Pugh et al., 2016).** Changes in VO2 max and aerobic training-mediated improvements in NAFLD are theoretically linked. Thus, VO2 max may serve both as a predictive biomarker of the exercise response and a biomarker of NAFLD disease severity **(Glass et al., 2017).**

SUBJECTS AND METHODS

Study design and participants:

Forty obese adult women were enrolled in this study, their age ranged from 35 - 45 years and were recruited from the relatives of the patients from the out-patient clinic of faculty of physical therapy, Cairo University and out-patient clinics of Bolaq El-Dakrour hospital, Cairo, Egypt. The study design was a comparative study and the time length of this study was from November 2021 to March 2022 with ethical approval of faculty ethical committee (P.T.REC/012/003458). The participated subjects in this study were assessed by liver enzyme test (alanine transaminase (ALT) (SGPT)) and anthropometric measurement (waist/hip ratio) and were evaluated before and after the treatment program about three sessions per week for eight weeks.

The participated subjects were enrolled based on the following inclusion and exclusion criteria:

(A) Inclusion criteria:

Forty obese adult women of age between 35 – 45 years, all participants would be clinically and medically stable and the BMI of all participants was more than 30 – 34.9 kg/m^2 (Class I obesity).

(B) Exclusion criteria:

The potential participants would be excluded if they meet one of the following criteria:

Recent myocardial infarction, complex ventricular arrhythmia or heart block, cerebro-vascular disease, visual and/or auditory defects, significant tightness and/or fixed deformity of lower limbs, neurological disorders that affect balance or mentality (e.g. epilepsy), congenital or acquired lower limb deformities in the lower limbs and cardiopulmonary dysfunction.

- **Methods:**

A) Evaluation:

1- Liver function tests (LFTs):

It is one of the most commonly requested screening blood tests. Whether for the investigation of suspected liver disease, monitoring of disease activity, or simply as 'routine' blood analysis, these tests can provide a host of information on a range of disease processes. Commonly test used to check liver enzymes in obesity is Alanine transaminase (ALT) (SGPT) **(Das, 2014).**

B- Anthropometric measurements:

It assess the composition of the body includes waist/hip ratio **(Casadei and Kiel, 2021).**

B) Treatment:

Raatz et al., (2008), stated that diet advices would be instructed to prevent any methods that may increase liver enzymes or total body weight and follow up of those adults weekly by phone, the advices include:

1) Eat a variety of vegetables.

2) Eat a variety of fresh fruits.

3) Include whole grains.

4) Eat a variety of protein foods.

5) Choose low-fat dairy products.

9) Drink much water.

Also, it was other foods would be limited include:

1) Vegetables with added fat.

2) Fruit with added sugar.

4) Carbohydrates high in fat and sugar.

5) Protein foods with added fat.

6) High-fat protein foods.

7) High-fat dairy products.

8) Unhealthy fats.

Forty obese adult women who met the previous criteria would be randomly assigned in to two groups of equal number (A and B) according to the following:

Group (A):

This group includes 20 obese adult women who received diet advices and aerobic training in form of treadmill training about 3 times per week for 8 weeks with intensity 1.5 Kilometers/hour **(Ibrahim and Abdelbasset, 2020).**

The subject completed treadmill training under three conditions in 1 min training cycles. For 15 s of each minute the subject could hold on to the railings with both hands, for the next 15 s with one hand, and finally with no hands on the handrails for 30 s. Each subject repeated this procedure for 30 min **(Muir et al., 2018).**

Group (B):

This group includes 20 obese adult women who received the same diet advices of group (A) and whole body vibration exercises about 3 times per week for 8 weeks **(Ibrahim and Abdelbasset, 2020).**

The total body vibration exercise session is about 30 min; started with an initial 5 minute warming up phase, and then subjects exercised on a horizontal swinging platform with amplitude of 2 mm (Viberogym professional). Vibration frequency was set to 30 Hz then increased gradually to 35 Hz, then the subject took about 20 minutes to fulfill a training session and the vibration frequency was decreased gradually from 35 Hz to 30 Hz as cooling down at the ending 5 minutes by the end of training session. During vibration session, the subjects were bare foot to eliminate any damping of the vibration caused by foot wear. They were positioned on platform with knee slightly flexed with feet placed apart on the board. Subjects encouraged working isometrically against the swinging platform **(Klaus et al., 2007).**

Statistical analysis:

The data were collected and analyzed through two types of statistics by using SPSS version 17 as follows:

-Descriptive statistics:

The mean and standard deviation of each group were calculated for each parameter.

- Mean (X) = summation of x / number of x.
- Standard deviation (SD) = root square of variance.

-Inferential statistics:

- Comparing mean values between pre and post of each parameter within each group was done by paired t-test.
- Comparing mean values of each parameter between the two groups before and after three months of treatment program was done by unpaired t- test.
- The probability in this study was < 0.05%.

RESULTS

A) Demographic data of the subjectsts in groups (A and B):

The obese adult women participated in this study were classified into two groups of equal number;

Group (A): includes 20 women with $\overline{X}$ ± SD value was of age was 38.01 ± 3.11, with $\overline{X}$ ± SD value was of height was 1.62 ± 0.02, with $\overline{X}$ ± SD value was of weight was 84.6 ± 3.94 and with $\overline{X}$ ± SD value was of BMI was 32.37 ± 1.16 **(table 1).**

Group (B): includes 20 women with $\overline{X}$ ± SD value was of age was 38.4 ± 3.38, with $\overline{X}$ ± SD value was of height was 1.63 ± 0.04, with $\overline{X}$ ± SD value was of weight was 85.45 ± 4.59 and with $\overline{X}$ ± SD value was of BMI was 32.22 ± 1.34 **(table 1).**

Table (1): Mean values of age, height, weight and BMI of groups (A and B).

Variable	Groups	$\overline{X}$ ± SD	t-value	p-value
Age (years)	Group (A)	38.01 ± 3.11	0.39	0.699
	Group (B)	38.4 ± 3.38		NS
Height (m)	Group (A)	1.62 ± 0.02	1.14	0.266
	Group (B)	1.63 ± 0.04		NS
Weight (km)	Group (A)	84.6 ± 3.94	0.63	0.534
	Group (B)	85.45 ± 4.59		NS
BMI (kg/m^2)	Group (A)	32.37 ± 1.16	0.37	0.715
	Group (B)	32.22 ± 1.34		NS

$\overline{X}$: Mean. SD: Standard Deviation. t-value: Paired and Un-paired t- test value. p-value: Probability value. S: Significant.

B) Measured variables included:

1- Alanine transaminase (ALT) (SGPT) (u/l):

(a) Pre and post- treatment mean values of alanine transaminase (ALT) (SGPT) (u/l) in groups (A and B):

The results of group (A) revealed that, pre- treatment $\overline{X}$ ± SD value was 63.1 ± 4.67, while that of post- treatment was 38.8 ± 4.31. The significant difference was revealed (p= 0.0001) when comparing between pre and post- treatment mean values and % of change = 38.51 % (table 2) (figure 1).

The results of group (B) revealed that, pre- treatment $\overline{X}$ ± SD value was 62.8 ± 4.99, while that of post- treatment was 43.4 ± 4.5. The significant difference was revealed (p= 0.0001) when comparing between pre and post- treatment mean values and % of change = 30.89 % (table 2) (figure 1).

Table (1): Pre and post- treatment mean values of alanine transaminase (ALT) (SGPT) (u/l) in groups (A and B).

	Group (A)		**Group (B)**	
	Pre- Treatment	**Post- Treatment**	**Pre- Treatment**	**Post- Treatment**
$\overline{X}$ **± SD**	63.1 ± 4.67	38.8 ± 4.31	62.8 ± 4.99	43.4 ± 4.5
MD	24.3		19.4	
% of change	38.51 %		30.89 %	
t-value	17.1		28.6	
p-value	0.0001		0.0001	
Level of Significant	S		S	

$\overline{X}$: Mean. Pre: Before treatment. Post: After eight weeks of treatment.

SD: Standard Deviation. MD: Mean Difference. % of change: Percentage of change. t-value: Paired t- test value. p-value: Probability value. S: Significant.

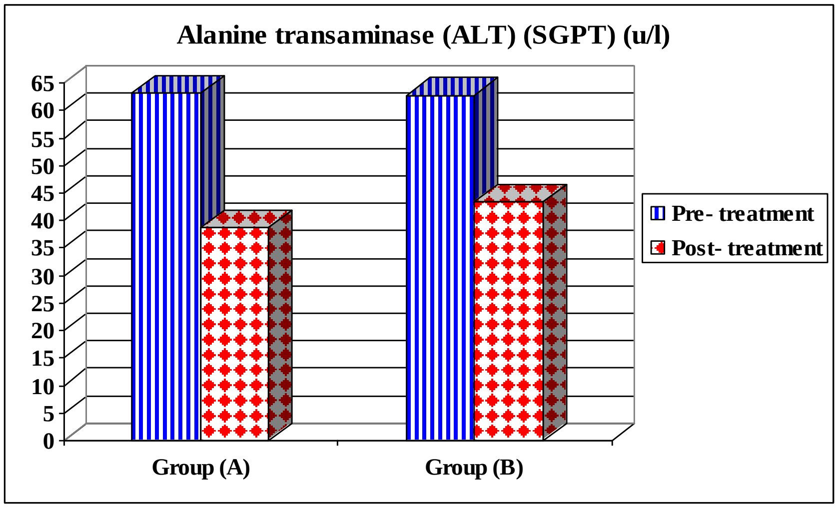

Figure (1): Pre and post- treatment mean values of alanine transaminase (ALT) (SGPT) (u/l) in groups (A and B).

(b) Pre and post- treatment mean values of alanine transaminase (ALT) (SGPT) (u/l) between groups (A and B):

According to unpaired t-test (table 3) and (figure 2), when comparing the two groups (study and control) before treatment, the $\overline{X} \pm$ SD values were 63.1 ± 4.67 and 62.8 ± 4.99 respectively which indicated no significant difference (p= 0.845), while comparing the two groups after eight weeks of treatment, the $\overline{X} \pm$ SD values were 38.8 ± 4.31 and 43.4 ± 4.5 respectively which indicated a significant difference (p= 0.00)2 in favor of group (A) (MD= 4.6) and % of change was 11.86 %.

Table (3): Pre and post- treatment mean values of alanine transaminase (ALT) (SGPT) (u/l) between groups (A and B).

Two Groups	Alanine transaminase (ALT) (SGPT) (u/l)			
	Pre- treatment		Post- treatment	
	Group (A)	Group (B)	Group (A)	Group (B)
$\overline{X} \pm$ SD	63.1 ± 4.67	62.8 ± 4.99	38.8 ± 4.31	43.4 ± 4.5
MD	0.3		4.6	
% of change	–		11.86 %	
t-value	0.2		3.3	
p-value	0.845		0.002	
Level of Significant	NS		S	

$\overline{X}$: Mean. Pre: Before treatment. Post: After eight weeks of treatment.

SD: Standard Deviation. MD: Mean Difference. % of change: Percentage of change. t-value: Paired t- test value. p-value: Probability value. S: Significant. NS: Non Significant.

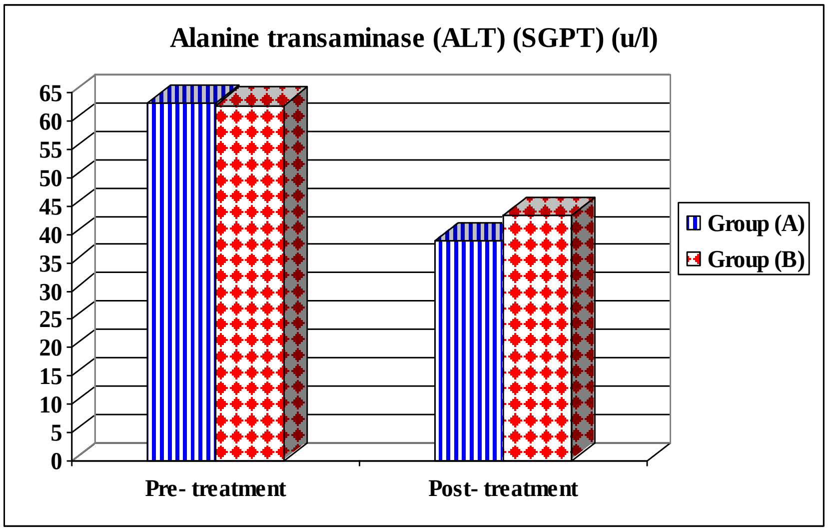

Figure (2): Pre and post- treatment mean values of alanine transaminase (ALT) (SGPT) (u/l) between groups (A and B).

<u>2- Waist/hip ratio:</u>

(a) Pre and post- treatment mean values of waist/hip ratio in groups (A and B):

The results of group (A) revealed that, pre- treatment $\overline{X} \pm$ SD value was 0.87 ± 0.01, while that of post- treatment was 0.82 ± 0.02. According to unpaired t-test, the significant difference was revealed (p= 0.0001) when comparing between pre and post- treatment mean values (MD= 0.05) (table 4) and (figure 3) and % of change = 5.75 %.

The results of group (B) revealed that, pre- treatment $\overline{X} \pm$ SD value was 0.86 ± 0.01, while that of post- treatment was 0.85 ± 0.2. According to unpaired t-test, the significant difference was revealed (p= 0.001) when comparing between pre and post- treatment mean values (MD= 0.01) (table 4) and (figure 3) and % of change = 1.16 %.

Table (4): Pre and post- treatment mean values of waist/hip ratio in groups (A and B).

Waist/hip ratio	Group (A)		Group (B)	
	Pre- treatment	Post- Treatment	Pre- Treatment	Post- Treatment
$\overline{X}$ ± SD	0.87 ± 0.01	0.82 ± 0.02	0.86 ± 0.01	0.85 ± 0.2
MD	0.05		0.01	
% of change	5.75 %		1.16 %	
t-value	10.93		3.71	
p-value	0.0001		0.001	
Level of Significant	S		S	

$\overline{X}$: Mean. Pre: Before treatment. Post: After eight weeks of treatment.

SD: Standard Deviation. MD: Mean Difference. % of change: Percentage of change. t-value: Paired t- test value. p-value: Probability value. S: Significant.

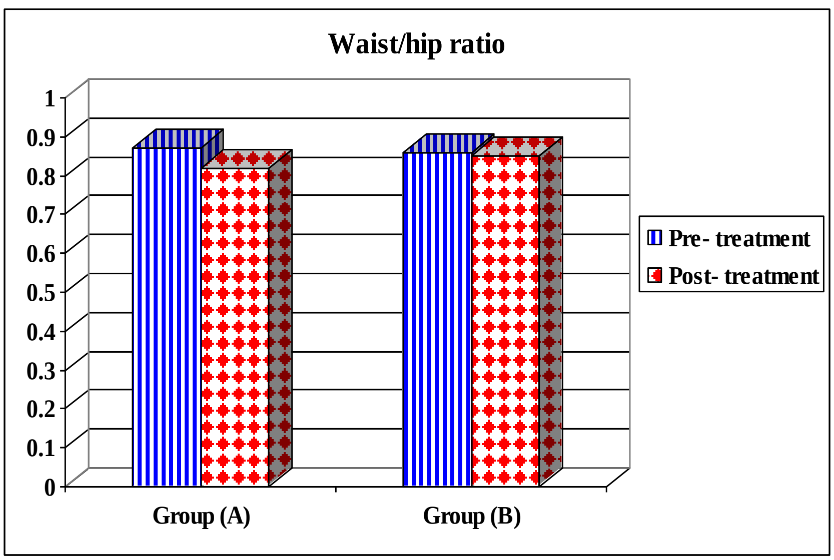

Figure (3): Pre and post- treatment mean values of waist/hip ratio in groups (A and B).

(b) Pre and post- treatment mean values of waist/hip ratio between groups (A and B):

According to unpaired t-test (table 5) and (figure 4), when comparing the two groups (study and control) before treatment, the $\overline{X} \pm SD$ values were 0.87 ± 0.01 and 0.86 ± 0.01 respectively which indicated no significant difference (p= 0.767), while comparing the two groups after eight weeks of treatment, the $\overline{X} \pm SD$ values were 0.82 ± 0.02 and 0.85 ± 0.2 respectively which indicated a significant difference (p= 0.0001) in favor of group (A) (MD= 0.03) and % of change was 3.66 %.

Table (5): Pre and post- treatment mean values of waist/hip ratio between groups (A and B).

Two Groups	Waist/hip ratio			
	Pre- treatment		Post- treatment	
	Group (A)	Group (B)	Group (A)	Group (B)
$\overline{X}$ ± SD	0.87 ± 0.01	0.86 ± 0.01	0.82 ± 0.02	0.85 ± 0.2
MD	0.01		0.03	
% of change	–		3.66 %	
t-value	0.3		4.03	
p-value	0.767		0.0001	
Level of Significant	NS		S	

$\overline{X}$: Mean. Pre: Before treatment. Post: After eight weeks of treatment.

SD: Standard Deviation. MD: Mean Difference. % of change: Percentage of change. t-value: Paired t- test value. p-value: Probability value. S: Significant. NS: Non Significant.

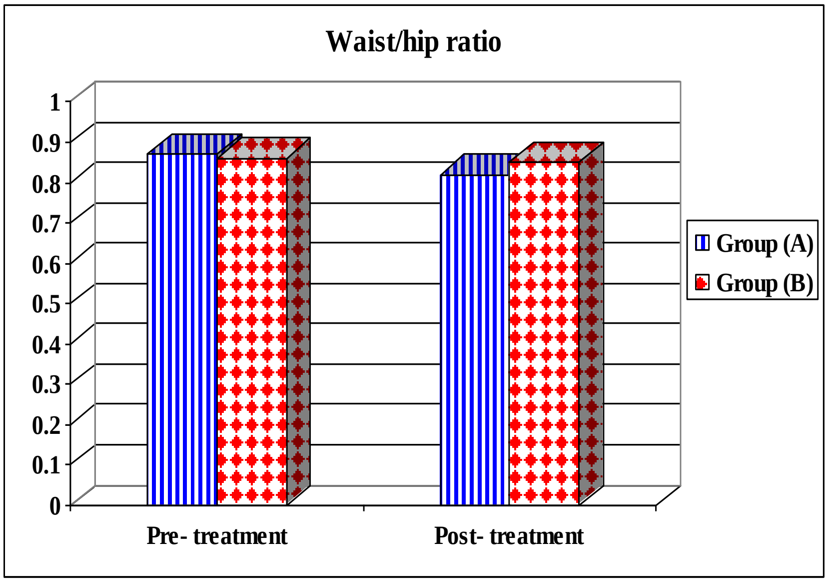

Figure (4): Pre and post- treatment mean values of waist/hip ratio between groups (A and B).

DISCUSSION

Regular exercise, along with physical activity and diet, is well documented as the most effective intervention for the preventive and therapeutic treatment of chronic and adult diseases **(Pedersen et al., 2015).** Exercise exerts different effects depending on not only individual characteristics such as age, gender, and disease, but also exercise characteristics such as frequency, intensity, type, and time **(Slater et al., 2019).** However, exercise is an intervention without side effects and cost burden for chronic diseases, and the effects of exercise are mainly positive **(Luan et al., 2019).**

When comparing between the pre and post- treatment results of group (A) revealed a significant difference that comes in agreement with **Hallsworth et al., (2011)** who stated that aerobic exercise has been shown to increase intramyocellular triacylglycerol synthesis, while decreasing the accumulation of fatty acid metabolites and suppressing the proinflammatory state associated with insulin resistance. Subjects with a BMI $\geq$ 25 kg/m^2, aerobic training is more efficient in reducing body weight, waist circumference and fat mass as well as in increasing $VO_{2\ max}$ uptake when compared to resistance training respectively **(Schwingshackl et al., 2013).**

The results of group (A) are accepted with **Angulo, (2012)** who stated that a reduction of 5% or more of original weight by diet control and regular exercise for 3 months was associated with improvement in total cholesterol and ALT levels. He reported also that, calorie restriction and regular aerobic exercise for 30 minutes a day for 3 months resulted in normalization of liver biochemistry (ALT and AST) in patients with nonalcoholic steatohepatitis. Also, 1% reduction in body weight can improve ALT by 8.1 %.

Also, **Wong et al., (2014)** found that weight reduction in obese patients of 10% from the baseline weight has been shown to reduce ALT levels and hepatomegaly. However weight loss should be gradual as losing more than 1.6 kg per week has been shown to potentially worsen steatohepatitis and result in gallstones. Weight loss may be achieved through an exercise and diet program; aerobic exercise improves insulin resistance independent of weight loss, while calorie restricted diets reduce weight and diets low in saturated fat and high in fiber reduce insulin resistance.

The results of present study in group (A) are confirmed with **Croniger, (2012)** who stated that, liver markers are an effective way to assess accumulation of fat in the liver, and by far the most commonly used of these methods. ALT values correlate positively with liver fat proportions. ALT appears to have associations with both hepatic insulin resistance and later decline in hepatic insulin sensitivity.

When comparing between the pre and post- treatment results of group (B) revealed a significant difference that comes in agreement with **Liu et al., (2016)** who demonstrated that the hepatic effects of WBV were correlated with reductions in sterol regulatory element binding protein 1c (SREBP1c), a transcription factor that regulates genes involved in cholesterol metabolism. Although it is possible that the effects of WBV on glycemic control and hepatic lipids might be mediated by a shared mechanism, this possibility remains speculative and will require targeted manipulation of SREBP1c and other pathways associated with WBV effects on the liver **(McGee-Lawrence et al., 2017).**

The WBV can positively affect body composition by reducing body fat accumulation and serum leptin **(Milanese et al., 2013).** It was reported that WBV combined with endurance training could significantly increase resting energy expenditure for the improvement of body composition **(Wilms et al., 2012).** Vibration exercise was attracted a lot of attention as an exercise modality, which elevates metabolic rate and activates muscular adaption that could be a potential method for weight reduction **(Cochrane, 2012).** The physical performance regarding to vibration exercise was focused on neuromuscular functions or strength evaluation **(Novotny et al., 2014).**

The results of the present study on group (B) are accepted with **Oh et al., (2019)** who stated that WBV improve systemic glucose, fatty acid metabolism, and adipokines to cause adipose tissues in the liver to contribute to hepatic steatosis producing energy to, in turn, reduce ectopic fat deposition in the liver. WBV also alleviates hepatic stiffness and inflammatory effects when applied the study on hepatic steatosis and its underlying pathophysiology in 25 patients with NAFLD. Seventeen patients with NAFLD were designated as a control group. After WBV exercise, body weight in the study group decreased by only 2.5% compared with the control group.

The results of group (B) are agreed with **Oh et al., (2014)** who evaluated WBV results in obese patients with non-alcoholic fatty liver disease by analyzing physical condition, liver and metabolic function, liver fat content, skeletal muscle, and quality of life in relation to health. The results found were that WBV reduced body adiposity, showing a significant reduction in liver fat and lipid content, and on the occurrence of abnormalities shown in results of liver function tests. Also, WBV combined with a hypocaloric diet improved body composition, insulin resistance, glucose regulation, and adiponectin levels to a greater extent compared with dieting alone **(Belloa et al., 2014).**

In the present study, the null hypothesis was rejected which stated that there would be no effectiveness of the whole body vibration and aerobic training on liver function in obese adult women.

Conclusion:

It was concluded that aerobic training in form of treadmill training and whole body vibration exercise can be added to the physical therapy program and aerobic training was more effective than whole body vibration in enhancing liver function in obese adult women.

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