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Effect of Aerobic Exercise Versus Vestibular Stimulation on Lipid Profile in Premenstrual Syndrome

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Abstract

Objective: *To determine the effect of aerobic exercise versus vestibular stimulation on lipid profile in premenstrual syndrome .**Subjects and Methods:** Sixty patients with premenstrual syndrome had regular menstrual cycles were participated in this study. Their ages were ranged between 23-30 year. Their body mass index did not exceed 30 kg/ m2. They were not participating in physical therapy exercise program at the last 3 months. Patients with cardiovascular problems, pulmonary problems and endometriosis are excluded from the study. All patients were divided randomly into two equal groups (A&B). Group A: It consisted of thirty patients with premenstrual syndrome. They were treated by aerobic exercises in the form of treadmill training at moderate intensity of 60- 70% of the maximum heart rate, 3 times per week for 2 months. Group B: It consisted of thirty patients with premenstrual syndrome. They were treated by vestibular stimulation, 3 times per week for 2 months. **Outcome measures:** Total cholesterol level, HDL, LDL, triglycerides were assessed for all patients before and after treatment in both groups (A&B). Premenstrual syndrome scale was used to confirm the diagnosis of PMS before study and to evaluate the severity of PMS symptoms for all patients in both groups (A&B) before and after treatment .**Results:** Results revealed that, between groups; pretreatment, there was no significant difference between both groups A and B in total cholesterol, triglycerides, HDL, LDL and premenstrual syndrome scale. While post treatment, there was significant difference between both groups A and B in total cholesterol, triglycerides, HDL, LDL and premenstrual syndrome scale (with favour of group A; more decrease in total cholesterol, triglycerides, LDL and premenstrual syndrome scale and more increase in HDL). **Conclusion:** Aerobic exercise was found to be effective more than vestibular stimulation on lipid profile in premenstrual syndrome, in relieving stress and symptoms of PMS .*

Keywords: *Aerobic exercise - Vestibular stimulation - Premenstrual syndrome - Total cholesterol - HDL - LDL - Triglycerides.*

1. Introduction

Premenstrual syndrome (PMS) is characterized by emotional and physical symptoms that begins at the late luteal phase of the menstrual cycle (5–7 days before menstruation) and ends in the follicular phase (2–4 days after menstruation) [1]. It affects 85% of females of reproductive age. The most common psych emotional and behavioural symptoms are depression, anxiety, irritability, restlessness, anger, confusion and loneliness [2].

Lipid profile is affected in females with PMS. The Total cholesterol level and Triglyceride level is increased while, the High-Density Lipoprotein level is decreased in females with PMS [3].

The vestibular system is not just for maintaining balance and equilibrium or reflexes but also, in advanced functions like improving cognition, improving diabetic condition, reducing stress [4]. Vestibular system stimulation has shown many benefits like decreased self-stimulation, decreased hypersensitivity, increased postural security, increased concentration and attentiveness, increased balance, increased body awareness, calming effects, reduction of abnormal muscle tone [5].

Vestibular stimulation regulates food intake through vagus nerve, insulin, arcuate nucleus, thyroid hormones, HPA-axis and promoting sleep [6]. Vestibular stimulation reduced the symptoms of pain in migraine patients, amputees, and paraplegics. Vestibular stimulation is an effective method of pain relief [7]. It may relieve pain by modulating somatosensory perception, through its connections with thalamic nuclei, its connection with raphe nuclei, and its connection with nucleus tractus solitaries. Vestibular stimulation relieves stress by inhibiting stress axes [8].

Aerobic exercise reduces negative effect on female who exercise regularly. It increases the release of several neurotransmitters including natural endorphins (the natural painkillers), estrogen, dopamine and endogenous opiate peptides, as well as alter the production of hormone secretion, suppressing prostaglandin from being released and raising the estrone–estradiol ratio which acts to decrease endometrial proliferation and shunts blood flow away from the uterus [9].

Aerobic exercise has an effect on lipid profile. It was reported that short term aerobic exercise improves High-Density Lipoprotein (HDL-C) and decreases Triglyceride (TG), Total Cholesterol (TC), Low-Density Lipoprotein-Cholesterol (LDL–C). This may be due to the fact that the decrease in LDL levels could be attributed to the increases in the activity of hepatic triglyceride lipase enzyme during short term physical exercise [10].

As far as the authors are aware, there have been no such research studied the effect of aerobic exercise and vestibular stimulation on lipid profile in premenstrual syndrome. Consequently, the purpose of this study was to determine the difference between the effect of aerobic exercise and vestibular stimulation on lipid profile in premenstrual syndrome, in addition to improving premenstrual syndrome.

Materials and methods:

This study was designed as randomized controlled trial as two groups, pre-post-test (experimental study). Patients were selected randomly from Out Patient Clinic of Gynecology Department, Cairo University in Cairo. Ethical approval was obtained from the Institutional Review Board of the Faculty of Physical Therapy, Cairo University, before starting this study [No: P.T. REC/012/004862]. The study's protocol was explained in detail to each woman who signed an informed consent form before starting this study. This work adhered to the principles outlined in the Declaration of Helsinki for the ethical conduct of research involving human subjects. It was carried out between February 2022 till October 2023.

Participants:

Sixty patients with premenstrual syndrome had regular menstrual cycles were participated in this study to determine the difference between the effect of vestibular stimulation and aerobic exercise on lipid profile in premenstrual syndrome. They were selected randomly from Out Patient Clinic of Gynecology Department, Cairo University in Cairo. Their ages were ranged between 23-30 year. Their body mass index did not exceed 30 kg/ m^2. They were not participating in physical therapy exercise program at the last 3 months**.** Patients with cardiovascular problems, pulmonary problems and endometriosis are excluded from the study.

Sample size calculation:

Based on a pilot study, sample size was calculated according to the significant difference in the mean difference of cholesterol level between aerobic exercise group (7.04 ± 1.22) and vestibular stimulation group (3.55 ± 0.86) in two tailed unpaired t test, with α=0.05, power of 80%, and an effect size of 0.74. So a sample size of 30 women/per group would be required and increased to 35 women to allow for a 15% dropout rate (G Power 301 http:www.psycho.uni-duesseldorf.de)

Randomization:

Randomization was done to eliminate the researches' bias, 60 women were randomly divided into two equal groups (group A and B) through computer generated numbers using SPSS for windows version 23 (USA). The participants were allocated to their groups according to the cards chosen by an external blinded researcher. Women were blinded to which group they were assigned to.

Interventions:

Both groups (A&B) were followed the same medical treatment as prescribed by gynecologist in the form of vitamins only (Calcium citrate, 500 to 1,000 mg daily, and vitamin D, 400 IU daily

Group (A) consisted of thirty patients with premenstrual syndrome. They were treated by aerobic exercises in the form of treadmill training at moderate intensity of 60- 70% of the maximum heart rate,

3 times per week for 2 months. Group (B) consisted of thirty patients with premenstrual syndrome. They were treated by vestibular stimulation, 3 times per week for 2 months.

Aerobic exercise:

Each patient in group A was treated by aerobic exercises on electrical treadmill (AC 150 KG AX, Taiwan), for 30 minutes per session, three sessions per week for 2 months. The program was started with 5 mints (warm up phase) in which each patient walks at 80 m/ min at 0.0% grade and 20 mint of exercise (active phase) on electrical treadmill at speed of 147m/ mint and grade was increased gradually until reached 25% grade at 70% of HR max. This was followed by (cooling down phase) of 5 mints in which the treadmill's speed and grade was decreased to 2 miles/ h and 0.0 % grade.

Vestibular stimulation exercise:

Each patient in group B was treated by vestibular stimulation, twice daily for 2 months. Each patient was advised to attend a session before treatment to better understand values of vestibular stimulation exercises and how to correctly practice them. All exercises were started in exaggerated slow time and gradually increased speed to a more rapid rate. Also, exercises were progressed with eye open then with eye close. Vestibular stimulation exercise program in the form of: Head exercise, Shrug exercise, Lean forward exercise, Change from sitting to a standing position then back again, Throw and catch a ball and Eye exercises.

Outcome measures:

Total cholesterol level, HDL, LDL, triglycerides were assessed for all patients before and after treatment in both groups (A&B). Premenstrual syndrome scale was used to confirm the diagnosis of PMS before study and to evaluate the severity of PMS symptoms for all patients in both groups (A&B) before and after treatment.

Statistical analysis:

Results are expressed as mean ± standard deviation. Test of normality, Kolmogorov-Smirnova test, was performed to measure the distribution of data measured at pre-treatment. Comparison between normally distributed data (variables) in the two groups was performed using unpaired t test. Analysis of covariance (ANCOVA) test was used to compare the pre-treatment values of the two groups and at the same time between post-treatment values on controlling the effect of pre-treatment values. Comparison between pre- and post-treatment data in the same group was performed using paired t test. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value ≤ 0.05 was considered significant.

Results and Discussion

Figure (1) depicts the flow diagram of the patient throughout the study. There were no reported instances of patients experiencing adverse effects or lodging complaints during or following the treatment Figure 1. Flow chart for participant.

General characteristics of the two studied groups:

There was no statistical significant difference between the two groups as regards age (t= -0.628, p= 0.533), weight (t= 0.496, p= 0.622), height (t= -0.354, p= 0.725) and BMI (t= 0.646, p=0.521), respectively (Table 1).

Items	Group A	Group B	Comparison	
	Mean ± SD	Mean ± SD	t-value	P-value
Age (yrs.)	25.80 ± 2.04	26.17 ± 2.47	-0.628	0.533 (NS)
Weight (Kg)	66.70 ± 5.52	66.00 ± 5.41	0.496	0.622 (NS)
Height (m)	159.47 ± 2.11	159.70 ± 2.93	-0.354	0.725 (NS)
BMI (Kg/ m2)	26.16 ± 1.81	25.85 ± 1.87	0.646	0.521 (NS)
Items	**Group A**	**Group B**	**Comparison**	
	Mean ± SD	**Mean ± SD**	**t-value**	**P-value**
Age (yrs.)	**25.80 ± 2.04**	**26.17 ± 2.47**	**-0.628**	**0.533 (NS)**
Weight (Kg)	**66.70 ± 5.52**	**66.00 ± 5.41**	**0.496**	**0.622 (NS)**
Height (m)	**159.47 ± 2.11**	**159.70 ± 2.93**	**-0.354**	**0.725 (NS)**
BMI (Kg/ m2)	**26.16 ± 1.81**	**25.85 ± 1.87**	**0.646**	**0.521 (NS)**

Table (1): Comparison of subject characteristics between group A and B Data are expressed as mean ± SD, NS= p> 0.05= not significant.

Lipid profile:

Results of this study as shown in table (2), within groups; there was a statistically significant decrease in the mean value of cholesterol level, triglycerides, LDL and PMS scale and significant increase in the mean value of HDL when compared with its corresponding value measured at pre treatment in both groups (A&B).

Between groups, pretreatment, there was no significant difference between both groups (A&B) in the mean value of cholesterol level, triglycerides, LDL, HDL and PMS scale. While post treatment, there was a statistically significant difference between both groups (A&B) in the mean value of cholesterol level, triglycerides, LDL, HDL and PMS scale (in favor of group A).

Table (2): Cholesterol value, triglycerides value, Serum high density lipoprotein value, Serum low density lipoprotein value and Premenstrual syndrome scale between and within groups.

		Pre-treatment	Post treatment	Mean difference	% of change	T- value	P- value
		Mean± SD	Mean± SD				
cholesterol value	Group A	172.95 ± 19.31	166.00 ± 18.01	6.95	4.02 ↓↓	22.944	0.001 (S)
	Group B	168.81 ± 22.47	165.09 ± 22.03	3.72	2.20 ↓↓	19.676	0.001 (S)
	F- value	0.585	116.225				
	P- value	0.448 (NS)	0.001 (S)				
triglycerides value	Group A	121.50 ± 20.02	119.40 ± 19.10	2.10 ± 1.74	1.73 ↓↓	-4.724	0.001 (S)
	Group B	116.97 ± 18.43	116.09 ± 18.46	0.88 ± 0.89	0.75 ↓↓	-4.135	0.001 (S)
	F- value	-0.858	…….	-3.095			
	P- value	0.391 (NS)	……..	0.002 (S)			
Serum high density lipoprotein (HDL)	Group A	46.67 ± 1.27	49.43 ± 1.61	-2.76 ± 1.36	5.91 ↑↑	-4.816	0.001 (S)
	Group B	47.08 ± 1.75	48.20 ± 1.45	-1.12 ± 0.91	2.38 ↑↑	-4.319	0.001 (S)
	$Z^{\#}$ value	-0.911	…….	-4.382			
	P- value	0.362 (NS)	……	0.001 (S)			
Serum low density lipoprotein (LDL)	Group A	102.12 ± 11.49	100.18 ± 10.74	1.94	1.90 ↓↓	6.894	0.001 (S)
	Group B	99.88 ± 8.36	99.25 ± 7.88	0.63	0.63 ↓↓	4.377	0.001 (S)
	F- value	0.743	18.931				
	P- value	0.392 (NS)	0.001 (S)				
Premenstrual syndrome scale (PMSS)	Group A	149.57 ± 7.44	136.83 ± 8.31	12.74 ± 5.17	8.52 ↓↓	-4.786	0.001 (S)
	Group B	147.40 ± 9.00	145.23 ± 8.78	2.17 ± 1.90	1.47 ↓↓	-4.218	0.001 (S)
	$Z^{\#}$ value	-1.029	……..	-6.184			
	P- value	0.303 (NS)	……	0.001 (S)			

*** Significant values, data are expressed as mean ± SD, F value= ANCOVA test; t value= paired t test, NS= p> 0.05= not significant; S= p≤ 0.05= significant.**

Discussion

Premenstrual syndrome (PMS) is characterized by clinically significant somatic and psychological manifestations during the luteal phase of menstrual cycle. The exact mechanism causing PMS still remains unclear. The symptoms of premenstrual syndrome are often mild in 75% of the women, but 3–

8% reported to experience moderate to severe symptoms that are associated with substantial distress and functional impairment [11].

Premenstrual syndrome is associated with abnormal sensitivity and excessive response to normal hormonal changes. The severity of PMS varies from one women to another. Diverse body systems such as central nervous system, endocrine, cardiovascular and female reproductive system are associated with symptoms of PMS related to physical, cognitive, emotional and behavioral aspects [12].

The exact cause of premenstrual syndrome is almost unknown, but there were risk factors have been mentioned as the changes of ovarian steroid levels, disorders in the path of renin angiotensin-aldosterone, increased prostaglandins and prolactin, vitamins and mineral deficiencies, age and genetics [13].

The morbidity associated with premenstrual syndrome is often poorly managed. The aims of interventions prescribed for PMS are useful for reducing symptoms and promoting quality of life in women with PMS [14].

This study was conducted to determine the effect of aerobic exercise versus vestibular stimulation on lipid profile in premenstrual syndrome.

Sixty patients with premenstrual syndrome had regular menstrual cycles were participated in this study. They were selected randomly from Out Patient Clinic of Gynecology Department, Cairo University in Cairo.

All patients were divided randomly into two equal groups (A&B). Group A: It consisted of thirty patients with premenstrual syndrome. They were treated by aerobic exercises in the form of treadmill training at moderate intensity of 60- 70% of the maximum heart rate, 3 times per week for 2 months. Group B: It consisted of thirty patients with premenstrual syndrome. They were treated by vestibular stimulation, 3 times per week for 2 months.

Total cholesterol level, HDL, LDL, triglycerides were assessed for all patients before and after treatment in both groups (A&B). Premenstrual syndrome scale was used to confirm the diagnosis of PMS before study and to evaluate the severity of PMS symptoms for all patients in both groups (A&B) before and after treatment.

Results of this study revealed that, within groups; there was a significant decrease in the total cholesterol, triglycerides, LDL and premenstrual syndrome scale; and significant increase in HDL in both groups A and B post treatment.

Between groups; pre treatment, there was no significant difference between both groups A and B in total cholesterol, triglycerides, HDL, LDL and premenstrual syndrome scale. While post treatment, there was significant difference between both groups A and B in total cholesterol, triglycerides, HDL, LDL and premenstrual syndrome scale (with favor of group A; more decrease in total cholesterol, triglycerides, LDL and premenstrual syndrome scale and more increase in HDL).

Cheng et al., [15] stated that serum cholesterol level is higher in women with premenstrual syndrome than women without PMS symptoms and also it was found that there was higher triglyceride level and lower HDL level in women of premenstrual syndrome.

Results of this study can be explained by **Kumar,** [16] who stated that vestibular stimulation regulates food intake through vagus nerve, insulin, arcuate nucleus, thyroid hormones, HPA- axis and promoting sleep.

The results of this study are in line with **Neha et al.,** [17] who proved that vestibular stimulation can be effective on lipid profile in premenstrual syndrome as it was found that there is a significant decrease in total cholesterol level, a slight increase in the HDL level and a slight decrease in the LDL.

Sadanandan et al., [6] concluded that, vestibular stimulation had beneficial effect on the blood lipid profiles of adult male albino rats exposed to high-fat diet for 28 days. The total cholesterol, triglycerides and LDL were found to be reduced by vestibular stimulation with comparison to control group received high-fat diet alone. So, vestibular stimulation promotes direct actions on dyslipidemia.

The results of this study are in line with **Smitha et al.,** [18] who proved that the vestibular stimulation may relieve stress by inhibiting stress axes. As, there was a decrease in depression, stress scores in addition to serum cortisol followed by vestibular stimulation

Florane et al., [19] added that 38 min of galvanic vestibular stimulation decrease the anxiety level of young healthy adult. Galvanic vestibular stimulation represents a promising non-invasive tool to modulate neuronal excitability.

Results of this study agreed with **Minu et al.,** [20] who stated that the vestibular stimulation was effective for management of PMS as a no pharmacological therapy. Twenty female participants of age group 18- 30 years in his research and conventional swing was used to administer vestibular stimulation. The depression, anxiety, and stress scores are decreased after 2 months of intervention. Also, psychological dopamine score and social relationships were increased after intervention.

Also, **Sailesh et al.,** [21] added that the vestibular stimulation may relieve pain by modulating somatosensory perception, through its connections with nucleus tracts solitaries.

Suzuki et al., [22] concluded that vestibular stimulation affected on emotions through its projections to insula, limbic system, the hippocampus, the cingulate gyre and the parabrachial nucleus via cerebellar, brainstem, diencephalic centers and amygdale cells.

Also**, Fasold et al.,** [23] stated that vestibular stimulation affected on emotions through modulating cerebral cortex as the vestibular nucleus acts as a relay station between the central and peripheral nervous system. The vestibular stimulation modulates brain functions by activating somatosensory areas and deactivating the visual areas.

Rappaport and Coffey, [24] concluded that vestibular stimulation affected on emotions through hypothalamus as the lesions of hypothalamus are usually associated with extreme passivity, loss of motivation, excessive eating, drinking and violent behavior.

The results of the study contradicted with **Sai et al.,** [25] who found that there was no significant difference on depression between control and vestibular groups before and after vestibular stimulation, also there was no significant difference on stress between control and vestibular groups when applied on 60 male and female participants to alleviate stress among college students by achieving vestibular stimulation using swings.

The results of the study contradicted with **Saritha et al.,** [26] who concluded that there was an increase in the triglycerides and HDL followed by vestibular stimulation when applied on lipid profile in underweight females and no significant change was observed in total cholesterol and LDL. It may be due to the difference in the type of stimulation that influences the lipid profile.

Rothenbacher et al., [27] found that aerobic exercise can affect the metabolism of blood lipids. Exercise improves serum lipids in patients with hyperlipidemia by lowering serum triglyceride levels, total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) levels, while increasing high density lipoprotein cholesterol (HDL-C) levels.

This could be explained by **Barnett et al.,** [28] who added that improved glycemic control by aerobic exercise is always associated with reduction in serum malondialdehyde, a reliable measure of lipid peroxidation. Aerobic exercise increased the activity of endogenous antioxidants, glutathione peroxidase and decreased low density lipoprotein concentration. The effect of aerobic exercise in lipid profile was equivalent to improvement of all variables HDL, LDL, triglycerides, and total cholesterol.

Results of this study are supported by **Vishnupriya and Rajarajeswaram,** [29] who concluded that moderate and severe intensity aerobic exercise training over 6 weeks reduced menstrual symptoms in females with premenstrual syndrome. So, it is suggested that both intensity and duration of exercise are important for hormonal regulation and anti-oxidant adaptation.

Rapkin, [30] concluded that aerobic exercise may have psychological benefits like improved body image and self-efficacy, which improves self-esteem in females that suffering from premenstrual syndrome as it reduces the amount of leptin in blood to 30- 40%.

Kelly et al., [31] added that aerobic exercise training raises serum progesterone levels. The increase in progesterone may be insufficient to alter the menstrual cycle, but may provide positive benefit to alter mood and decrease stress via neurotransmitter systems e.g., GABA, serotonin modulated by sex steroids.

Also, **Vishnupriya and Rajarajeswaram,** [29] added that the effect of aerobic exercise on pain may be due to release of endorphin. The raise of endorphin levels and reducing the symptoms of adrenal cortisol leads to the improvement of PMS, increased pain tolerance, anxiety, depression.

Vishnupriya and Rajarajeswaram, [29] showed that the reduction in menstrual symptoms by aerobic exercise training may be associated with improved insulin sensitivity and glycemic intake. It was proved that the effect of insulin sensitivity of a single bout of aerobic exercise lasts for 24- 72 hr. So, the frequency of exercise session should be at least three times per week.

Also, **Zahra et al.,** [32] added that there was a significant decrease in physical symptoms of premenstrual syndrome after performing 8 weeks of regular aerobic exercise in patients with premenstrual syndrome

The results of the study contradicted with **Pablo et al.,** [33] who found that there was increase in behavioural changes and water retention in experimental group, as well as there was positive change related on the automatic reactions such as nausea, dizziness, cold sweet and hot flash in experimental group after 8 weeks of aerobic exercise.

The results of the study are contradicted with **Saritas**, [34] who found that there was substantial increase in LDL level with significant decrease in HDL level after 8-week aerobic training program on lipid profile in young men.

Conclusion:

Aerobic exercise was found to be effective more than vestibular stimulation on lipid profile in premenstrual syndrome, in relieving stress and symptoms of PMS.

Author contributions:

The listed authors have made substantial intellectual contributions to the work and have provided their approval for its publication.

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Declaration of conflicting interests:

The author(s) have no conflict of interest to declare.

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Ethical approval:

This was approved by the Ethics Committee of the Faculty of Physical Therapy at Cairo University [No: P.T. REC//012/004862].

Consent:

The procedures of this study were explained to all participants, who signed a consent form before the beginning of the study.

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