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Effect of whole body vibration versus resistive exercise on premenstrual symptoms in adolescents with premenstrual syndrome

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Abstract

Background: Premenstrual syndrome (PMS) is a cyclic disorder that affects social activities, interpersonal relationship, and educational productivity of adolescents. Therefore, this study aimed to compare the effect of whole body vibration (WBV) and resistive exercise on premenstrual symptoms in adolescents with PMS.

Methods: Sixty adolescents, aged 16–19 years and with body mass index $> 19.9 \text{ kg/m}^2$, participated in the study. They were randomly assigned to three groups equal in number. Control group received magnesium (Mg) (250 g) and vitamin B6 supplementation once daily. Resistive exercise group received the same supplementations and resistive exercise for three times/week, while the WBV group received the same supplementations and WBV training three times/week for 12 weeks. Premenstrual syndrome questionnaire (PMSQ) was used to evaluate premenstrual symptoms, including anxiety symptoms (PMS-A), depression symptoms (PMS-D), craving symptoms (PMS-C), hyperhydration symptoms (PMS-H), other symptoms, cramp, and low back pain.

Results: Pair-wise comparison test revealed a significant decrease ($p = 0.000$) in PMS-A, PMS-C, PMS-D, PMS-H, other symptoms, cramp, and low back pain of the resistive exercise group and WBV group after treatment. However, there was only a significant decrease in PMS-C ($p = 0.03$) of the control group after treatment. Post hoc test showed no significant difference ($p > 0.05$) between the resistive group and WBV group in all PMS symptoms after treatment.

Conclusions: Passive muscular training using WBV has a similar effect to resistive exercise on premenstrual symptoms that affect the quality of life in adolescents with PMS.

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Keywords: Whole body vibration, Resistive exercise, Premenstrual syndrome, Adolescents

Background

Premenstrual syndrome (PMS) is a common, recurrent, and heterogeneous disorder in women during reproductive age [1, 2]. The prevalence of PMS is 29.8% in adolescent females [3].

PMS is characterized by intense physical, cognitive, behavioral, and somatic symptoms in the luteal phase of the menstrual cycle [1, 4]. These symptoms affect normal activities, interpersonal relationships, social activities, work efficiency, and educational productivity [5, 6].

The specific causes of PMS are still unknown. However, various biosocial and psychological risk factors have been proposed. They include abnormal serotonin

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functions, exercise habits, smoking, the use of alcohol, and the women's sensitivity to variation in steroid hormone concentrations [7].

Treatment options of PMS include the use of psychotropic agents, Gonadotropin-releasing hormone agonists, and oral contraceptives [7]. However, some agents showed addictive symptoms and significant adverse effects such as dizziness, drowsiness, and insomnia [8–10].

Several studies [11–14] reported that aerobic exercise improved physical and psychological symptoms in non-athlete girls with PMS. The effects of the resistive exercise on muscle performance [15], anxiety [16], and depression among both healthy and patients are well-established. Also, whole body vibration (WBV) showed improvements in depression in adolescent patients [17] and mood state in swimmers [18]. However, their effects on PMS are still unknown.

In recent years, there is a focus on finding cost-effective therapeutic approaches with minimal side effects to treat PMS [19]. Therefore, this study aimed to investigate the effect of WBV training and resistive exercise on PMS. The hypothesis of the study was that both WBV training and resistive exercise would have a similar effect on physical and psychological symptoms of PMS.

Methods

Sixty sedentary young females participated in the study. A gynecologist referred patients according to the following criteria: age ranged from 16 to 19 years, body mass index was $> 19.9 \text{ kg/m}^2$, they experienced regular menstrual cycles, and did not participate in any type of physical exercise. They complained of recurrent psychological and physical symptoms associated with their menstrual cycles. PMS was confirmed using the PMS questionnaire.

The exclusion criteria included a history of chronic depression, pelvic pathology, pelvic inflammatory diseases, endometriosis, cardiac diseases, thyroid diseases, taking antidepressant drugs, oral contraceptive pills or gonadotropin-releasing hormone agonists, or smoking.

Each participant and the parents of the participants < 18 years signed a consent form at the starting of the study.

Participants were randomly distributed to three groups using computer-generated random numbers. The allocation was concealed in sequentially numbered opaque envelopes. The control group received magnesium (Mg) (250 mg) and vitamin B6 once daily [20]. The resistive exercise group received the same supplementations and participated in the resistive exercise for three times/week, while the WBV group

received the same supplementations and participated in WBV training three times/week. The study course duration was 12 weeks.

The sample size was calculated based on the changes of the anxiety symptoms score [13]. A sample size equal to 20 per group was sufficient to produce a medium effect size of 0.73 at a power equal to 80% and an alpha level of 0.05 (two-tailed).

It was a randomized controlled trial. The study design, assignment, and intervention followed the CONSORT statement.

Premenstrual syndrome questionnaire (PMSQ)

The PMSQ is a valid and reliable method to confirm the diagnosis of PMS. It consists of five subscales, which includes PMS-anxiety symptoms (PMS-A), PMS-depression symptoms (PMS-D), PMS-craving symptoms (PMS-C), PMS-hyperhydration symptoms (PMS-H), and a subscale of other symptoms, as well as two symptoms in the first two days of the menstruation (cramps and backache). PMS-A symptoms include anxiety, irritability, mood swing, and nervous tension. PMS-D symptoms include depression, crying, forgetfulness, confusion, and insomnia. PMS-C symptoms include appetite increase, headache, fatigue, dizziness or fainting, and palpitation. PMS-H symptoms include fluid retention, weight gain, breast tenderness, and abdominal bloating. Other symptoms include oily skin, acne, diarrhea, constipation, backache, hives, and weakness or radiation down thighs. The researcher gave all participants full instructions about the items of PMSQ and asked them to fill the questionnaire at two consecutive months before starting the study to confirm the diagnosis of PMS. All participants experienced premenstrual symptoms score 50% greater than the postmenstrual score and showed moderate to severe impairment in one or more subscale at two consecutive menstrual cycles [21]. The participants also filled the questionnaire after 12 weeks of the study course to investigate the effect of the treatment.

Whole body vibration program

All participants in the WBV group performed the WBV training on a vibrating device (Confidence Vibration Plate Power Plus, China), which produced a lateral peak-to-peak oscillation. They stood on the WBV platform with a 150° knee angle during the exposure minute. They started the training with three sets of 1 min separated by a 1-min resting period and a vibration amplitude of 1 mm. They added one set every session until they performed 10 sets of WBV. The frequency started at 20 Hz, which was increased gradually by 2 Hz every 2 weeks. They

performed WBV training for three sessions/week for 12 weeks [22].

Resistive exercises program

The resistive exercise started with a 5–10-min warm-up phase and ended with a 5–10-min cool-down phase. These phases consisted of stretching exercises for the upper and lower limbs. The exercise circuit for the upper limb consisted of exercise to the shoulder and elbow joints. The exercise circuit for the lower limb consisted of exercise to the hip and knee joints. One repetition maximum (1-RM) was determined for a given exercise. Then, the weight lifted was 60 to 70% of 1-RM. All participants performed each exercise for 3 to 4 repetitions; they increased repetitions gradually until 12 repetitions. Each participant rested 2 min between each exercise. The total session duration was 40 min [23].

Statistical analysis was conducted using SPSS for Windows, version 22 (SPSS, Inc., Chicago, IL). Homogeneity of covariance was tested. The normality of data was detected using the Shapiro-Wilk test. 3×2 mixed design multivariate analysis of variance (MANOVA) was used to analyze the dependent variables within and between groups. Tukey's honestly significant difference (HSD) post hoc test was used to detect the differed group. Alpha level was set at 0.05.

Results

Baseline characteristics, including age, height, weight, and body mass index (BMI), revealed no significant difference ($p > 0.05$) between all groups, as shown in Table 1.

Mixed design MANOVA showed a significant difference ($p = 0.000$) between the control group, resistive exercise group, and WBV group in all PMS symptoms after treatment, as presented in Table 2. Pair-wise comparison test revealed a significant decrease ($p = 0.000$) of all symptoms in the resistive exercise group and WBV group, and only in PMS-C ($p = 0.03$) of the control group after treatment.

As presented in Table 3, post hoc test showed significant decreases between the control group and

both the resistive exercise group and WBV group in PMS-A ($p = 0.000$, $p = 0.001$ respectively), PMS-C ($p = 0.000$), PMS-D ($p = 0.001$, $p = 0.009$), PMS-H ($p = 0.003$, $p = 0.000$ respectively), other symptoms ($p = 0.000$), cramp ($p = 0.000$, $p = 0.03$), and low back pain ($p = 0.000$), in favor of the resistive exercise group and WBV group. However, there was no significant difference ($p > 0.05$) between the resistive exercise group and WBV group in all PMS symptoms after treatment (Fig. 1).

Discussion

PMS is associated with psychological and physical symptoms that interfere with educational, personal, and social activities [3]. So this study aimed to investigate the effect of WBV training and resistive exercise on premenstrual symptoms. The findings of the study show that both WBV training and resistive exercise are effective to a similar degree in decreasing anxiety, depression, craving symptoms, hyperhydration symptoms, other symptoms, cramp, and low back pain in adolescents with PMS.

These findings were consistent with a previous study, which reported that regular exercisers showed significantly lower levels of negative mood states, impaired concentration, behavior change, and pain than non-exercisers across the menstrual cycle [24]. Other studies reported that aerobic exercise improved the total score of PMS symptoms [12], physical symptoms [13, 14], anxiety, and depression-related symptoms [13] in girls with PMS compared to the non-exercise group.

There is a poor understanding of the etiology of PMS, so that, there is no clear physiological explanation for the observed findings. Changes in mood may be due to the effect of estrogen and progesterone on the serotonin, γ -aminobutyric acid, and dopamine systems [25].

Physical activity, including the resistive exercise, has neuroimmunomodulatory effects, increases neurotrophins [26] and the level of β -endorphins [27], decreases the sympathetic response, affects hypothalamic-pituitary-adrenal axis reactions, and improves the serotonin system; all of these responses may decrease anxiety and depression [28]. However, the effect of WBV training on hypothalamic-pituitary-adrenal axis activity and neurotrophin expression is still under investigation [29].

Also, the cognitive-behavioral theory may explain the improvement of mood and depression after exercise. Exercise can distract from intrusive thoughts and yield positive thoughts decreasing depression [30]. Moreover, exercise improves body image and self-efficacy, which can affect self-concept and self-esteem [31].

Table 1 Baseline characteristics of the participants in all groups

Variable	Control group	WBV group	Resistive group	<i>p</i> -value
Age	17.9±1.16	17.7±1.17	17.3±1.41	0.31
Height	155.75±5.23	158.25±5.85	157.40±6.51	0.40
Weight	55.4±5.89	56.45±4.07	57±5.34	0.37
BMI	22.55±1.18	22.51±1.51	22.93±0.84	0.72

BMI body mass index

* $P < 0.05$ is significant

Table 2 The mean and standard deviation of PMS symptoms for all groups

Variable	Timing	Control group	WBV Group	Resistive group	Group-Time interaction	
					F-value	p-value
PMS-A	Before	9.05±2.85	9.10±1.07	8.85±2.70	62.15	0.000*
	After	9.20±2.58	4.70±1.59	4.20±1.64		
	p-value	0.37	0.000*	0.000*		
PMS-C	Before	9.90±1.33	8.60±1.98	9.25±2.36	33.65	0.000*
	After	9.40±1.27	4.80±1.82	4.95±0.76		
	p-value	0.03*	0.000*	0.000*		
PMS-D	Before	9.95±2.76	10.45±2.01	10.30±2.15	42.39	0.000*
	After	9.55±2.08	5.45±1.63	4.90±1.51		
	p-value	0.18	0.000*	0.000*		
PMS-H	Before	7.95±1.05	6.40±3.21	7.25±2.91	10.72	0.000*
	After	8.05±1.14	3.80±1.70	4.70±1.80		
	p-value	0.16	0.001*	0.000*		
Other symptoms	Before	12.95±1.95	11.70±1.71	12.45±2.28	49.99	0.000*
	After	12.90±2.17	8.70±2.31	7.30±1.34		
	p-value	0.85	0.000*	0.000*		
Cramp	Before	2.45±0.51	2.20±0.41	2.15±0.67	8.17	0.001*
	After	2.40±0.50	1.90±0.30	1.35±0.74		
	p-value	0.33	0.01*	0.001*		
Backache	Before	2.90±0.30	2.65±0.48	2.70±0.57	23.37	0.000*
	After	2.90±0.30	2±0.00	1.75±0.55		
	p-value	0.33	0.01*	0.001*		

PMS-A premenstrual syndrome anxiety, PMS-C premenstrual syndrome craving symptoms, PMS-D premenstrual syndrome depression, PMS-H premenstrual syndrome hyperhydration symptom, WBV whole body vibration

*P<0.05 is significant

Increased serum aldosterone, prostaglandin E2, and deficiency of vitamin B6 and Mg are factors that may cause some physical symptoms such as swelling, weight gain, headaches, and breast pain [32]. Physical activities can decrease serum aldosterone and trigger sodium and water reabsorption [33], which in turn may improve physical symptoms found in the present study. Also, previous studies reported that improved prostaglandins in response to aerobic exercise helped to reduce back pain and abdominal discomfort in females with dysmenorrhea [34, 35]. The effect of resistive exercise and WBV on prostaglandin, in cases of dysmenorrhea or PMS, is still unknown. However, it seems that the improvement of the blood flow and the decrease in the mental and physical stress may explain the improved low back pain and abdominal cramp in response to resistive exercise and WBV training.

Previous studies reported that a combination of Mg and vitamin B6 induced a reduction of mild premenstrual anxiety-related symptoms [20] and the mean score of PMS [36] compared to a placebo group in women with PMS. However, in the present study, it

showed improvement in the craving symptoms only. The contradiction between the results of the studies may be due to the difference in the inclusion criteria and the differed dose of Mg and vitamin B6 supplementations.

Serotonergic antidepressants and Gonadotropin-releasing hormone agonists are used for treating severe symptoms of PMS. However, they may cause adverse effects, including nausea, asthenia, fatigue, and sexual dysfunction [8]. Also, prolonged use increases cardiovascular and osteoporosis risks [9] and increases the need for hormone add-back therapy to counteract their hypoestrogenic effects [10]. Both types of exercises used in the present study are simple and easy to perform as home training and could avoid the previous side effects.

However, this study was limited to the assessment of the premenstrual symptoms using a self-reported questionnaire, which was administered in the participants' second language. However, full instructions were given to all participants to ensure accurate answers to the questionnaire items. Also, the underlying mechanisms of the improvement are still

Table 3 The mean difference between groups for all PMS symptoms

Variable	Compared groups	MD	SE	p-value	95% CI
PMS-A	Control- Resistive exercise group	2.60	0.64	0.000*	1.30-3.89
	Control - WBV group	2.22	0.64	0.001*	-3.89- - 1.30
	Resistive exercise group- WBV group	-0.37	0.64	0.56	-1.66-0.91
PMS-C	Control - Resistive exercise group	2.62	0.46	0.000*	1.50-3.74
	Control - WBV group	3.02	0.46	0.000*	1.90-4.14
	Resistive exercise group- WBV group	0.40	0.46	0.66	-0.71-1.51
PMS-D	Control-Resistive exercise group	2.15	0.58	0.001*	0.71-3.58
	Control - WBV group	1.80	0.58	0.009*	0.36-3.23
	Resistive exercise group - WBV group	-0.35	0.58	1	-1.78-1.08
PMS-H	Control - Resistive exercise group	2.02	0.58	0.003*	0.57-3.47
	Control - WBV group	2.90	0.58	0.000*	1.44-4.35
	Resistive exercise group- WBV group	0.87	0.58	0.42	-0.57-2.32
Other symptoms	Control - Resistive exercise group	3.05	0.57	0.000*	1.62-4.47
	Control - WBV group	2.72	0.57	0.000*	1.30-4.14
	Resistive exercise group - WBV group	-0.32	0.57	1	-1.74- 1.09
Cramp	Control - Resistive exercise group	0.67	0.14	0.000*	0.32-1.03
	Control - WBV group	0.37	0.14	0.03*	0.02-0.73
	Resistive exercise group - WBV group	-0.30	0.14	0.12	-0.65- 0.05
Backache	Control - ES group	0.67	0.11	0.000*	0.40-0.94
	Control - WBV group	0.57	0.11	0.000*	0.30-0.84
	ES - WBV group	-0.10	0.11	0.64	-0.37- 0.17

CI confidence interval, MD mean difference, PMS-A premenstrual syndrome anxiety, PMS-C premenstrual syndrome craving symptoms, PMS-D premenstrual syndrome depression, PMS-H premenstrual syndrome hyperhydration symptom, SE standard error, WBV whole body vibration
 *P<0.05 is significant

unknown. Therefore, there is a need for further studies to investigate the effect of the resistive exercise and WBV on the endorphin, prostaglandin, serotonin, and steroid hormones and their relationship to the improved symptoms. Another limitation is that the physical fitness of the participants was not objectively measured in this study. The last limitation is the duration of the study, so there is a need for long duration and follow-up studies to investigate

the long-term effect of WBV training and resistive exercise on PMS.

Conclusion

Passive muscular training on the WBV device has similar physical and psychological effects compared to active exercise using resistive exercise in adolescents with PMS.

Abbreviations

PMS: Premenstrual syndrome; PMS-A: PMS-anxiety symptoms; PMS-D: PMS-depression symptoms; PMS-C: PMS-craving symptoms; PMS-H: PMS-hyperhydration symptoms; WBV: Whole body vibration

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Authors' contributions

AE contributed to the concept, design, definition of intellectual content, literature search, clinical part, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing, and manuscript review. HA contributed to the literature search, data analysis, statistical analysis, manuscript preparation, manuscript editing, and manuscript review. DO contributed to the literature search, data analysis, statistical analysis, manuscript preparation, manuscript editing, and manuscript review. The authors have read and approved the final manuscript.

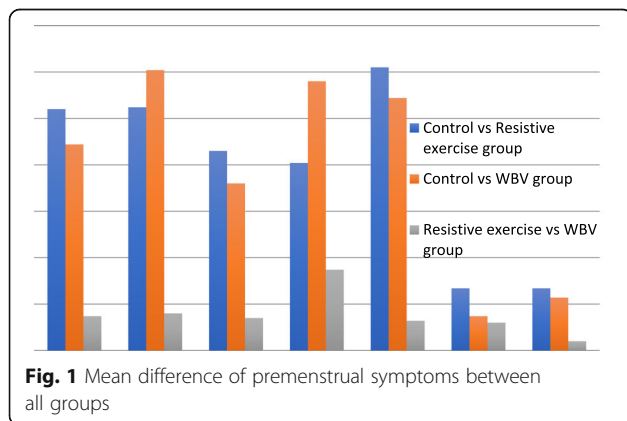


Fig. 1 Mean difference of premenstrual symptoms between all groups

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Availability of data and materials

The dataset generated during the current study are available from the corresponding author on a reasonable request.

Ethics approval and consent to participate

The research has been approved by the Research Ethics Committee, Faculty of Physical Therapy, Cairo University, and written consent form has been provided by each patient who participated in this study.

(Trial registration: PACTR, PACTR201908589835132. Registered 26 June 2019-retrospectively registered, <https://pactr.samrc.ac.za/TrialDisplay.aspx?TrialID=8214>)

Consent for publication

Not applicable

Competing interests

Not applicable

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