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GENERAL GYNECOLOGY

Effect of swimming exercise on premenstrual syndrome

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Abstract

Objective To study the effectiveness of performing swimming on the severity of symptoms of premenstrual syndrome (PMS).

Materials and methods A randomized controlled trial that was conducted on 70 women diagnosed with PMS divided randomly into two equal groups: Group I included women who engaged into exercise and group II controls. Daily Symptoms Report was filled at the start and at end of the study.

Results At the posttreatment evaluation,there was a highly significant difference between the study and control groups regarding anxiety (0 vs. 5), depression (3 vs. 12), tension (3 vs. 12), mood changes (0 vs. 7), feeling out of control (0 vs. 7), weak coordination (0 vs. 10), confusion (2 vs. 9), headache (3 vs. 15), tiredness (4 vs. 12), pains (5 vs. 11), tenderness of the breast (2 vs. 8), and cramps (6 vs. 17) ($P < 0.001$), but no such difference was found regarding irritability, insomnia, crying, swelling, or food craving. Regarding the percentage of symptoms changes, there was a highly significant difference between the study and control groups regarding anxiety (− 33.3 vs. 0), depression (− 79.29 vs. 15.56), tension (− 81.18 vs. − 6.79), mood changes (− 33.33 vs. 0), feeling out of control (− 91.67 vs. 0), weak coordination (− 100 vs. − 9.55), sleeplessness (− 71.43 vs. 0), confusion (− 84.17 vs. − 9.55), headache (− 77.78 vs. − 6.94), fatigue (− 65.69 vs. 0), pains (− 65.83 vs. − 8.93), breast tenderness (− 87.87 vs. 4.55), cramps (− 60.77 vs. 4.55), and swellings (− 55.05 vs. − 8.33), but no such difference was found regarding irritability, crying, or food craving.

Conclusions There is beneficial effect of swimming on most of the physical and psychological symptoms of PMS.

Clinical trial registry no. NCT03264612.

Keywords Swimming · Aerobic exercise · Premenstrual syndrome

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Introduction

Premenstrual syndrome (PMS) is symptoms which is experienced frequently by reproductive-aged women during the late part of the luteal phase of the menstrual cycle. When these symptoms become severe and disabling, it is named as premenstrual dysphoric disorder (PMDD). These symptoms reach around 300 manifestations and include both psychological and physical manifestations. These symptoms may have moderate-to-severe intensity with limitations that need particular considerations in 15% of women [1]. Current studies estimate strict criteria of in 3–8% of menstruating women [2].

Premenstrual syndrome is a collection of psychological, behavioral, and physical manifestations appearing during the late luteal phase of menstruation and disappears after menstruation. These symptoms differ with different cycles and lack of consistent physical or laboratory criteria for its diagnosis [3].

The exact aetiology of these disorders is unclear. Many biological factors were suggested. The most commonly studied factors are sex steroids (estrogen and progesterone) and different neurotransmitters, especially gammaaminobutyric acid (GABA) and serotonin [4].

PMDD is identified in the DSM-5 by the presence of at least five symptoms accompanied by significant psychosocial or functional impairment. PMS refers to the presence of numerous symptoms that are not associated with a significant impairment.

The severe form of PMS is diagnosed by the presence of five of more symptoms including at least one of the four psychological manifestations. These manifestations were included in a record of 17 different psychological and physical ones. These manifestations are markedly felt before menses and subside or felt minimal after its end [5].

The main manifestations of PMS are psychological stress, irritability, depression, mood changes, sleep disturbances, mastalgia, and abdominal distension [6].

Therapy or PMDD and PMS include psychotropic agents, ovulation suppression, and dietary modification [7].

High sugar and caffeine foods and beverages can aggravate premenstrual manifestations in some women. Calcium supplementation can correct deficiency-related symptoms such as muscle cramps [8]. Vitamins such as pyridoxine (vitamin B_6) and vitamin E offer some relieve. Combined Magnesium pyridoxine may decrease anxiety-related premenstrual manifestations [9]. Of nonpharmacologic alternatives to treatment, there is growing evidence assessing efficacies o acupuncture, bright-light therapy, exercise, and omega fatty acids [10].

The benefits of water therapy as with swimming exercise in traditional medical therapy have been detected since the times of ancient Romans and Greeks. The body response to stimulation by heat, cold, water pressure, and water sense itself is carried by nerves of the skin to deep parts of the body leading to immune system stimulation, affecting the secretion of stress hormones, enhancing digestion and circulation, and decreasing pain sensitivity [11].

In swimming exercise, the body weighs only one-tenth of its actual weight relieving the normal gravity pressure on both muscles and joints. The pressure of water on the skin and muscles improves venous return. The massage like soothing effect of water on the skin causes special brain responses with calming of the body. Adding water jets or bubbles of air exaggerates these effects [12].

The American College of Obstetricians and Gynecologists recommended exercise to women to treat disorders related to menstruation, but to prove its effectiveness, good randomized controlled studies are required [13].

It was found that 3 months of aerobic training reduced premenstrual symptoms in sedentary women, so that the American College of Obstetrician and Gynecologists recommends regular physical exercise as nondrug treatments of PMS [14].

This study aimed to find out the effectiveness of performing swimming, as an aerobic exercise, on the severity of premenstrual syndrome.

Materials and methods

A randomized controlled trial that was conducted on 70 women diagnosed with PMS. They were recruited from El Gezira Youth Center and clubs related to Ministry of Sports after full examination at Specialized Sports Medicine Center in Nasr City from April 2016 to May 2017.

Sample size calculation was based on the difference in percent change of depression score between the two study groups after treatment as a primary outcome. The minimal clinical significant percent decrease in depression score in the swimmers group was set at 25% in the presence of negligible change in the control group [15]. Setting the *P* value at 0.05 and power at 80%, and ratio between the two groups at 1:1, 35 participants were needed in each arm. Sample size calculation was done using IBM SPSS Sample Power software, release 3.0.1 (IBM Corp., Armonk, NY, USA).

All females included in our study were virgins. Their age ranged from 18 to 25 years, and their body mass index (BMI) ranged from 18 to 25 kg/m^2. They were clinically and medically stable during the study with regular menstrual cycle of 23–35 day duration.

Exclusion criteria included those with cardiopulmonary or orthopaedic problems, women taking any hormonal drugs or drugs that affect hormones as antidepressants

during the preceding 3 months before participation in the study, and any abnormality in ovulation or those with pelvic inflammatory diseases (PID). Women with endocrine abnormality as thyroid, pituitary, or ovarian disorders were also excluded. The study was approved by Kasr Alainy ethical committee.

Participants were divided randomly using automated Web-based randomization system ensuring allocation concealment into two equal groups: Group I included 35 women who engaged into swimming exercise and group II included 35 women who did not engage into swimming exercise.

Diagnosis of PMS was done based on University of California at San Diego criteria defined as "The presence of one or more of affective and somatic presentation in the premenstrual 5 days in the last three cycles". Affective symptoms included depressive disorder, anger, irritability, anxiety, confusion, and social pulling out. Somatic symptoms included mastalgia, abdominal distension, headache, and limbs swelling. These manifestations fade out from cycle day 4 to cycle day 13 [16].

The symptoms must occur during most menstrual cycles and must interfere significantly with work, social activities, or relationship.

The initial assessment of premenstrual syndrome symptoms was performed in 3 consecutive months, and then, the subjects were referred to the gynecologist to confirm the diagnosis.

The treatment protocol was explained to all participants. An informed written consent form had been signed by each female in both groups before participation in the study. Assessment for all manifestation was carried after 3 months of enrollment.

Complete history evaluation with full examination was applied to all participants before involvement to ensure strict inclusion and exclusion criteria. Pelvic ultrasound was done using Medison X6 ultrasound (Samsung Medison, Seoul, South Korea) machine equipped with a 4–7 MHz transabdominal probe with the woman in supine position and having full bladder to exclude any uterine, ovarian, or other pelvic abnormalities. Laboratory investigations done included complete blood count (CBC), serum prolactin, and thyroid stimulating hormone (TSH) to exclude any other possible causes of symptoms similar to those of PMS [17].

Premenstrual distress questionnaire: reevaluation of test reliability was done. Test validity was claimed depending on that adaptation of an existing famous tool with confirmed validity [18].

Each female sets her experience of 47 manifestations on a 6 point scale separately for the premenstrual, menstrual, and intermenstrual phases of her latest and worst menstrual cycle. Daily Symptoms Report was filled at the start and at the end of the study (before and after performing swimming exercise) (Fig. 1).

The 47 symptoms were intercorrelated and factor analyzed separately for each phase. These factors represent separate, but intercorrelated groups of symptoms were labeled (pain, concentration, behavioral change autonomic reactions, water retention, negative affect, arousal, and control). Scores on these eight clusters were correlated with age [19].

Females in group I were instructed to engage into swimming exercise 30 min daily, three times weekly for 3 months. Exercise was ceased on the first 3 days of menstrual cycle and then resumed afterwards.

The exercise included three stages: warming up, swimming, and cooling down.

Warming up phase involved 5 min of breathing, circulatory, and stretching exercises. Breathing diaphragmatic and costal exercise was performed. Diaphragmatic breathing exercise was performed at a convenient position with full relaxation, then she inspires deeply through the nose, and ballooning her abdomen then expires through the mouth with a sigh and slowly and that was repeated 3–5 times.

Costal breathing exercise was also done at the woman favorable position; then, she inspires deeply through the nose, which opens out her ribs then expires through the mouth with a sigh and slowly and that was repeated 3–5 times.

Circulatory foot and ankle exercises were done by instructing the woman to point her toes up and down, doing isometric calf muscle contractions and knee flexion and extension.

Stretching exercise of neck flexors, extensors, latissimus dorsi, deltoid dorsal fibers, triceps, pectoralis major, supraspinatus, wrist, lumbar extensors, abdominal, lumbar flexors, lumbar rotators, hamstrings, adductor, gluteal, gastrocnemius, hip flexors, tensor fascia latae, and quadriceps muscles were performed during warming up phase.

The second phase of treatment was swimming for 20 min starting with 5 min walking inside the pool around its edges, and then forth and back swimming without reaching fatigue level for 15 min.

The last phase was cooling down phase which was the same exercises of the warming up phase for 5 min (Fig. 2).

Statistical analysis

SPSS version 20.0 was used for data management and data analysis. Median and range described quantitative data. Nonparametric *t* test (Mann–Whitney test) compared medians of the two study groups. Percent change in different score is the difference between the initial score and score after swimming exercise in experimental group and after the same period in control group calculated as a percent from the initial score. For scores that decreased on the average, the signs of change will be negative. *P* value is always two tailed and considered significant at 0.05 level.

Symptoms → Days ↓	Anxiety	Irritability	Depression	Nervous tension	Mood swings	Out of control	Poor coordination	Insomnia	Confusion	Headache	Crying	Fatigue	Aches	Breast tenderness	Cramps	Swelling	Food craving	Daily total score
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
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Figure 1 Daily symptoms report

Severity scoring for each symptom:

0 = No symptom

1 = Minimal or slightly apparent to you

2= Moderate, awareness of symptoms but doesn't affect your daily routine

3= A lot, continuously bothered by the symptom and /or symptoms interferes with your daily routine

4= Severe, symptom is overwhelming and/or unable to carry out your daily routine

Fig. 1 Daily Symptoms Report

Results

The flow chart of the studied population is shown in Fig. 3.

There was no significant difference between the two study groups regarding age and body mass index (Table 1).

All participants were nonsmokers, nonalcohol drinker with high level of education reached college.

At the pretreatment evaluation, there was no significant difference between the study and control groups regarding all symptoms except sensation of swelling which was higher in the study groups (Table 2).

At the posttreatment evaluation, there was a highly significant difference between the study and control groups regarding anxiety, depression, tension, mood changes, feeling out of control, weak coordination, confusion, headache, tiredness, pains, tenderness of the breast, and cramps, but no such difference was found regarding irritability, insomnia, crying, swelling, or food craving (Table 2).

Regarding the percentage of symptoms changes, there was a highly significant difference between the study and control groups regarding anxiety, depression, tension, mood changes, feeling out of control, weak coordination, sleeplessness, confusion, headache, fatigue, pains, breast tenderness, cramps, and swellings, but no such difference was found regarding irritability, crying, or food craving (Table 2).

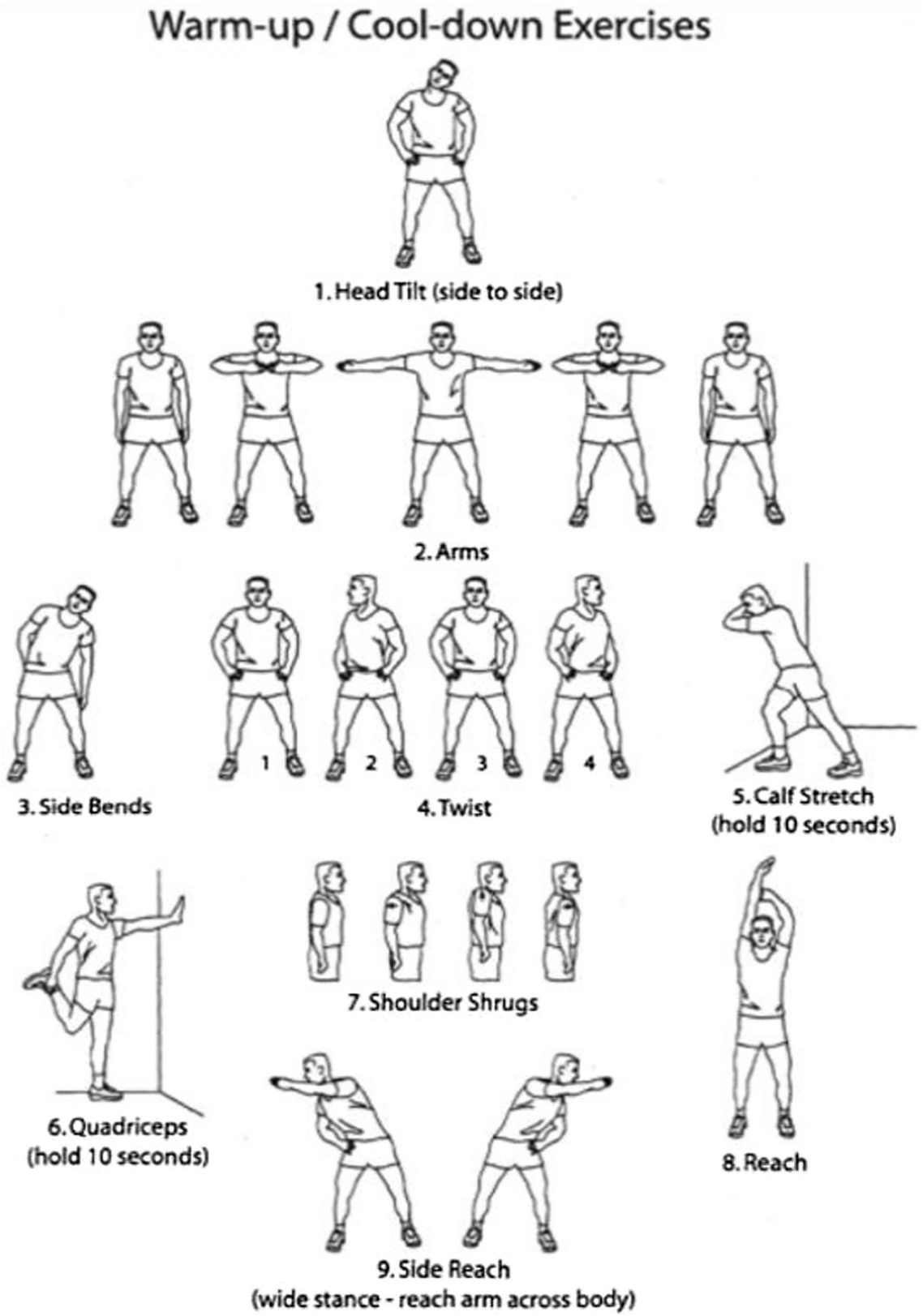

Fig. 2 Warming up and cooling down phases of exercise

Fig. 3 Flow chart

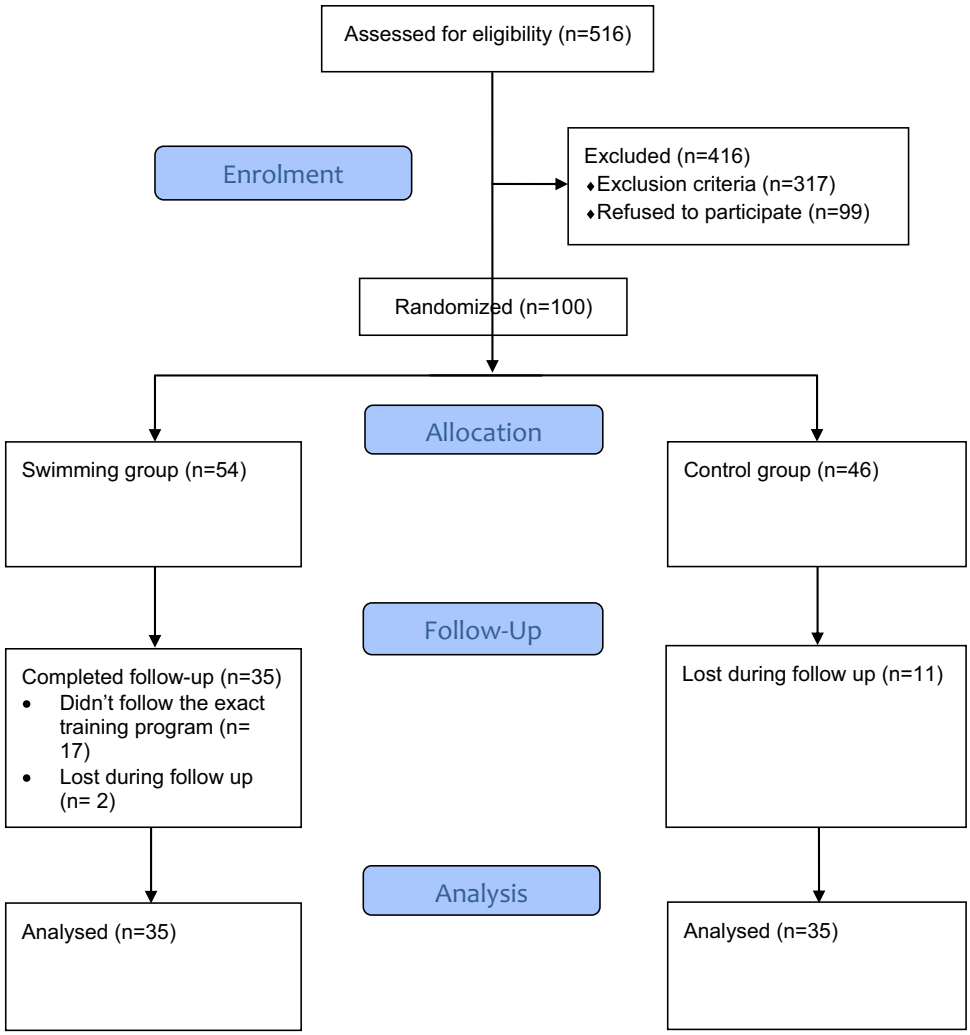

Table 1 Mean values of age and BMI of both groups (A&B)

	Study group $\bar{x} \pm SD$	Control group $\bar{x} \pm SD$	*P* value	Significance
Age (years)	21.1 ± 2.33	21.15 ± 1.66	0.94	NS
BMI (kg/m^2)	21.11 ± 1.21	20.84 ± 1.41	0.53	NS

Discussion

During the premenstrual period, many of the women in their reproductive age experience a variety of physical and emotional symptoms. These symptoms are usually mild except in 5–8% of cases who have moderate or severe manifestations causing functional impairment [20].

Studies confirmed improvement in particular functions with performance of chronic water exercises. Understanding the benefits of chronic exercise in water whether being generalized or improving selective functions must be done [21].

Our study confirmed the beneficial effect of swimming exercise on most of the physical and psychological symptoms of PMS.

Anxiety decreased by 33.3% in swimmers group compared to control group. Depression decreased by 79.29%, while nervous tension decreased by 81.18% in the study group. The results were in line with Darling, who concluded that aerobic exercise as swimming exercise induced positive changes to depression, anxiety, and stress. It is mediated by alterations to neurotransmitters including endorphins [22].

Pablo and colleagues in 2011 subjected 82 women suffering from moderate depression to 8 weeks of swimming training. They found that aerobic exercise reduces symptoms in patients with moderate depression [23]. The effect of swimming on nervous tension can be explained by the fact that aerobic exercise acutely raises serum progesterone level which affects mode positively and diminishes stress and tension via neurotransmitters (as gammaaminobutyric acid and Serotonin) modulated by sex steroids [24].

Table 2 Mann–Whitney *U* test for comparison between pre treatment, posttreatment, and percent of change of median values of premenstrual signs and symptoms of the study and control groups

Scoring system	Study group Median	Control group Median	*P* value	Sig.
Anxiety				
Pretreatment	3	5	0.16	NS
Posttreatment	0	5	0.0001	HS
Percent of change	− 33.3	0	0.0001	HS
Irritability				
Pretreatment	0	0	0.92	NS
Posttreatment	0	0	0.86	NS
Percent of change	0	0	0.98	NS
Depression				
Pretreatment	14	10	0.06	NS
Posttreatment	3	12	0.0001	HS
Percent of change	− 79.29	15.56	0.0001	HS
Tension				
Pretreatment	15	12	0.07	NS
Posttreatment	3	12	0.0001	HS
Percent of change	− 81.18	− 6.79	0.0001	HS
Mood				
Pretreatment	3	6	0.84	NS
Posttreatment	0	7	0.001	HS
Percent of change	− 33.33	0	0.01	S
Feeling out of control				
Pretreatment	5	7	0.88	NS
Posttreatment	0	7	0.0001	HS
Percent of change	− 91.67	0	0.002	HS
Poor coordination				
Pretreatment	11	12	0.46	NS
Posttreatment	0	10	0.0001	HS
Percent of change	− 100	− 9.55	0.0001	HS
Insomnia				
Pretreatment	2	0	0.13	NS
Posttreatment	0	0	0.79	NS
Percent of change	− 71.43	0	0.0001	HS
Confusion				
Pretreatment	10	11	0.55	NS
Posttreatment	2	9	0.0001	HS
Percent of change	− 84.17	− 9.55	0.0001	HS
Headache				
Pretreatment	14	17	0.12	NS
Posttreatment	3	15	0.0001	HS
Percent of change	− 77.78	− 6.94	0.0001	HS
Crying				
Pretreatment	0	0	0.86	NS
Posttreatment	0	0	0.27	NS
Percent of change	0	0	0.26	NS
Fatigue				
Pretreatment	14	12	0.39	NS
Posttreatment	4	12	0.0001	HS
Percent of change	− 65.69	0	0.0001	HS
Aches				
Pretreatment	15	14	0.24	NS
Posttreatment	5	11	0.0001	HS
Percent of change	− 65.83	− 8.93	0.0001	HS
Breast tenderness				
Pretreatment	10	8	0.37	NS
Posttreatment	2	8	0.0001	HS
Percent of change	− 87.87	4.55	0.0001	HS
Cramps				
Pretreatment	15	18	0.88	NS
Posttreatment	6	17	0.0001	HS
Percent of change	− 60.77	4.55	0.0001	HS
Swelling				
Pretreatment	11	7	0.004	HS
Posttreatment	4	6	0.27	NS
Percent of change	− 55.05	− 8.33	0.0001	HS
Food craving				
Pretreatment	0	0	> 0.99	NS
Posttreatment	0	0	0.94	NS
Percent of change	0	0	0.92	NS

According to our results, irritability was not improved after swimming.

Guszkowska in 2004 revealed beneficial effects of aerobic exercise as swimming, in both healthy and subjects with emotional disturbances.

Low and moderate intensity regular aerobic exercises that use large groups of muscles performed for 15–30 minutes a day, 3 times weekly for 10 or more weeks cause the best improvement in manifestaions of PMS.

Anxiety, depression, and mood changes following exercise may be through endorphin and monoamine materials. Exercise helps elevation of body temperature, improves brain circulation and affecting the hypothalamo–pituitary–adrenal axis, and changes the physiological reaction to stresses [25].

Regarding other symptoms, our study proved decrease in mood swings by 33.33%, feeling out of control by 91.67%, poor coordination by 100%, insomnia by 71.43%, and confusion by 84.17% in women within swimming group.

Aerobic exercise performed regularly leads to decreased sympathetic response and hypothalamo–pituitary–adrenal axis reactions and so it helps to decrease anxiety and feeling out of control [26].

Bodnar and Klein stated that the secretion of β-endorphins and increased its receptor binding after acute exercise reduces anxiety and elevates the mood [27].

Ströhle et al. reported a negative correlation between frequency of exercise and sensation of anxiety or confusion [28].

Concerning changes in physical symptoms after performing swimming exercise, we found decline in headache by 77.78%, fatigue by 65.69%, aches by 65.83%, breast tenderness by 87.87%, cramps by 60.77%, and swelling by 55.05%.

Köseoglu et al. reported the benefits of aerobic exercise on headache and demonstrated β endorphin role after 6 weeks of regular swimming exercise [29].

Varkey et al. found that exercise maximized oxygen uptake when compared with other lines of treatments, which leads to headache relief [30].

Rezvani et al. in their study found that aches intensity and length was reduced through 8-week aquatic exercises [31].

Khademi et al. reported a significantly reduced incidence of breast tenderness and general edema among swimmers when compared to non swimmers [32].

They explained that by cyclic sex hormones changes which causes breast tissue swelling and water retention. Muscle contractions during swimming release the fluid trapped within the breast. Improvement of circulation also allows better absorption of the excess fluid.

A study conducted by Abbaspour et al. found that exercise helped to decrease cramps by improving the circulation. Stress worsens cramps and a natural way to decrease stress is through exercise.

During aerobic exercise, the venous return is enhanced through repetitive muscle contractions. The increased venous return increase substances as prostaglandins which decrease backaches and abdominal and pelvic discomfort. Lowered level of norepinephrine as a result of regular exercise helps to decrease both the heart rate and blood pressure at rest [33].

To the best of our knowledge, our study is the first randomized controlled trial to assess the effect of swimming exercise with correct phases with a large sample size on women with PMS. Our study paid attention to both physical and psychological symptoms equally.

The main limitation of our study was the inability to study the long-term effect of swimming and reappearance of symptoms after stopping swimming exercise.

We recommend that extending studies to evaluate the effect of swimming in other obstetrical and gynecological cases are strongly needed, also the effect of swimming in reducing daily living stresses.

Author contributions MMA: data analysis and manuscript writing/editing. AHA: protocol/project development and manuscript revision. HRSS: protocol/project development and manuscript writing/editing. HE protocol/project development. HW: protocol/project development. AIO: data collection. AK: manuscript writing/editing.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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