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ORIGINAL ARTICLE

Effects of Aerobic Exercise at Different Intensities in Pre Menstrual Syndrome

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Abstract
Objectives The purpose of this study is to analyze the potential benefits of aerobic exercises at different intensities in the management of pre menstrual syndrome.
Methods The study design is quasi-experimental; sixty-one female subjects were randomly allocated into three groups, Group A (mild intensity), Group B (moderate intensity) and Group C (severe intensity) and the intervention were given for 6 weeks. The study setting was general community settings. The outcome measures were menstrual symptom questionnaire, VO_2 max, forced vital capacity (FVC), maximum voluntary ventilation (MVV) and lipid profile (HDL, LDL, TGL).
Results There is significant decrease in menstrual symptoms in both Groups B and C. However, Group C improved with increased rate of perceived exertion. LDL levels did not change significantly but HDL, TGL, VO_2 max, FVC, and MVV improved significantly in Groups B and C, but remains significantly unchanged in Group A.
Conclusions This study encourages the employment of regular, moderate intensity aerobic exercise as a potential intervention for pre menstrual syndrome.

Keywords Aerobic exercise · Pre menstrual syndrome · Metabolic changes · Menstrual symptoms · Quality of life

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Introduction

Pre menstrual syndrome (PMS) is an array of predictable physical, cognitive, affective and behavioral symptoms that occur cyclically during the luteal phase of the menstrual cycle [1]. Evidence suggests that PMS is not a single condition but a set of interrelated symptom complexes with multiple genotypes, phenotypes or subtypes and several different patho physiologic events that begin with ovulation [2, 3]. Premenstrual symptoms occur in 90% of all women of reproductive age and about 10% are diagnosed as having premenstrual dysphoric disorder [4]. Over 200 premenstrual symptoms have been reported and individuals with underlying disorders such as affective or anxiety disorder may be particularly vulnerable to menstrual triggers but do not show symptomatology at other times because of factor which prevent them from being vulnerable outside of the premenstrual time frame [2, 3].

However, many conditions are also subject to menstrual magnification in which symptoms are triggered or exacerbated by the menstrual cycle. (e.g., include depressive disorders, seizures, migraine headache, allergies and

asthma). Recognizing this phenomenon it is important in distinguishing PMS from chronic underlying conditions [5]. It is reported that behavior changes, criminal behavior, suicide attempts, absenteeism from work, hospital admissions and increased prone to accidents can be aggravated premenstrually [1]. Gannon et al. found that the length of time women had been exercising correlated significantly with lower levels of menstrual symptoms via correction of neuroendocrine abnormality [6]. Keye reported lower levels of anxiety in women who exercised regularly compared with non-exercisers [7] and Schwartz found that women runners reported a decrease in PMS [8]. In a cross sectional study, Timonon reported that of 748 female university students surveyed, 136 students of physical education department has fewer pre menstrual symptoms [9]. Coggen et al. reported that, if the training stimulus is adequate, the majority of the responses are independent of sex and age. This study was conducted to examine the impact of an aerobic exercise program at different intensities on, menstrual symptoms, metabolic control, aerobic capacity and respiratory endurance in girls with pre menstrual symptoms.

Design and Methods

Eighty-six female subjects volunteered to participate in the study from the general community of Puducherry and 61 of 86 met selection criteria. Informed written consent was obtained from all the selected subjects. Samples were divided into Group A ($n = 20$), B ($n = 20$), and C ($n = 21$) using random group allocation software. Of the 61 recruited subjects, two did not complete the program, Group B = 1, C = 1. Six subjects did not have lipid profile investigation Group A = 1, B = 2, and C = 3. Menstrual symptom questionnaires (MSQ) was handed out to the subjects and instructed to fill the questionnaires during three separate occasions (menstrually, premenstrually, intermenstrually). The reliability of the questionnaire is 0.88. A prospective chart of Borg scale was given to the patients for identifying the rate of perceived exertion from day 1 to end of exercise session (Figs. 1, 2, 3, and 4).

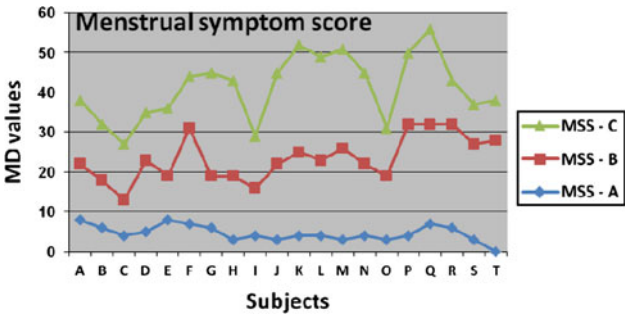

Fig. 1 Mean difference scores of three groups. *A-T* subjects; *MSS* Menstrual symptom score; *MD* Mean difference

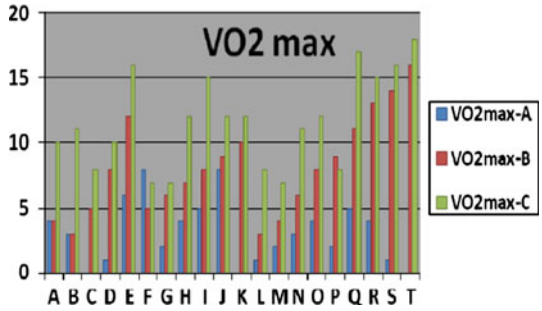

Fig. 2 Mean difference scores of three groups

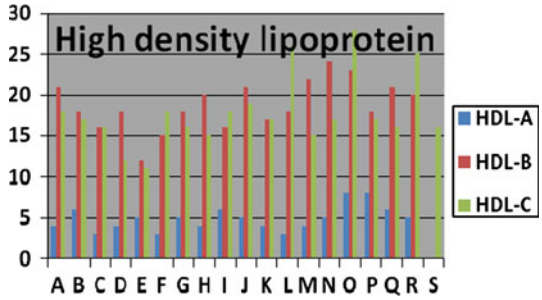

Fig. 3 Mean difference scores of three groups

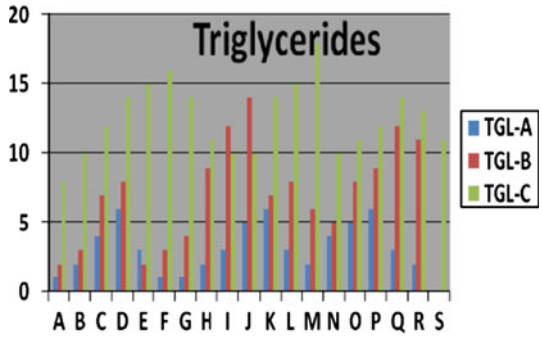

Fig. 4 Mean difference scores of three groups

Subjects were included as per American college of obstetrics and gynecology diagnostic criteria for menstrual symptoms Table 1, with age between 15 and 25 years. Participants were excluded if they have known cardiovascular disorder, thyroid disease, and renal impairment, subjects under medication for any systemic disease, non menstruating girls and pregnant mothers. The mode of exercise chosen for the intervention was aerobic and the training protocol was framed using FIIT's principle for all the recruited subjects. Intensity was calculated using

Table 1 ACOG diagnostic criteria for PMS

Affective symptoms	Somatic symptoms
Depression	Breast tenderness
Angry outbursts	Abdominal bloating
Irritability	Headache
Anxiety	Swelling of extremities
Confusion	
Social withdrawal	

American College of Obstetrics and Gynecology ACOG April 2000

Diagnosis made if there is a report of at least one of these affective and somatic symptoms in the three prior menstrual cycles during the 5 days before the onset of menses

The symptoms must resolve within 4 days of onset of menses and not recur until after day 12 of the cycle

The symptoms must be present in at least two cycles during prospective recording

The symptoms must adversely affect social or work related activities

Karovenen formula as per the aerobic guidelines according to American College of Sport Medicine (ACSM). Group A—mild intensity 35–60% of HRmax, Group B—moderate intensity 60–80% of HRmax and Group C—high intensity 80–90% of HRmax. (HR max = 220—age of the subject). The aerobic exercise includes (1) warm up phase (2) upper body exercise (3) lower body exercise (4) cool down phase. All the exercises were demonstrated and the study group was instructed to continue the exercise at home regularly (4 days/week) and report the changes or discomfort noticed during/after the exercise session. The tools used in this study were (i) spirometer (RMS Helios 401), transducer, disposable cuff, cotton, measuring tape, stop watch, questionnaire copies, and aerobic exercise charts.

Outcome Measures

(1) Menstrual symptom questionnaire (MSQ) is a self-reported instrument, five point Likert scale (Severe/Moderate/Mild/Hardly/No problem). The questions framed as "In relation to your menstrual periods, to what extent the following issues have been problem for you? It consists of eight domains under which 46 symptoms were grouped. The domains in the questionnaire are (i) pain (ii) concentration (iii) behavioral change (iv) autonomic reactions (v) water retention (vi) negative effect (vii) arousal (viii) control. (2) VO2max was calculated using 3 min Step test, (VO2max = 65.81—(0.1847 × Step test pulse beats/min). Subjects were asked to perform each stepping cycle of a four-step cadence, "up–up–down–down" for 3 min. After completion, pulse rate was measured. Recovery heart rate was converted to beats per minute and compared with predicted VO2 max [10]. Forced vital capacity (FVC) and maximum voluntary ventilation (MVV) were analyzed using computerized spirometry (RMS Helios 401). Proper usage of transducer was demonstrated and nose clips were given to the subjects to avoid errors, the results were tabulated and data interpreted. Lipid profile (HDL, LDL and TGL) has been taken as another indicator of metabolic control to analyse the effects of aerobic exercise in girls with PMS.

Data Analysis and Results

The data were collated in Microsoft Excel 2007. Analysis was undertaken using statistical package of social sciences windows version 16 (SPSS Inc., Chicago IL, USA) by a statistician who was blind to identity the three groups. Mean was used as the measure of central tendency and 95% of Confidence Interval was used to express the true population mean. Paired *t* test was used to find the significance of mean within group, while one-way ANOVA was used to find the significance of improvement between groups. Paired *t* test is also used to analyze correlation between VO2max and Borg scale scores for the three groups. The baseline characteristics of the subjects, in three groups were highly comparable the values are computed in Table 2, along with their *P* value and there is no significant difference both within and between the three groups.

The physiological and biochemical variables at baseline and after 6 weeks for Group A, B, and C were shown in Table 3. After 6 weeks of aerobic training, menstrual symptoms scores were decreased significantly in the next menstrual periods in Group B and C, However, Group C improved with increased rate of perceived exertion. The analysis of variance (ANOVA) for the MSQ items reveal that girls who underwent regular, aerobic exercise showed significantly lower levels menstrual symptoms with ($P < 0.05$) in all three groups ($n = 61$). However in examination of each group separately, Group B and C (moderate intensity and severe intensity group) showed significantly decreased level of menstrual symptoms, when compared to Group A. Analysis of individual symptoms under particular domain reveals significant lower levels of pain and concentration in Group A, pain, concentration, negative effect and behavioral change in B and C, but autonomic reactions, water retention, control and arousal did not differ significantly after the intervention by comparing the mean difference values Table 4. Pain and concentration significantly decreased in all the three groups. Muscle stiffness, headache, cramps, backache, fatigue and general aches are the seven items under "Pain". Insomnia, forgetfulness, confusion, lowered judgment, difficulty in concentrating, accidents, and lowered motor coordination are the eight items under "concentration".

Table 2 Baseline characteristic of study subjects

Baseline characteristics	Group A	*P* value	Group B	*P* value	Group C	*P* value	Total
Female (no.)	20		20		21		61
Age							
Range	17–21	>0.05	17–21	>0.05	17–21	>0.05	17–21
Mean	18.68		18.4		18.95		18.677
BMI							
Range	20–31.4	>0.05	20–32	>0.05	20–32.4	>0.05	20–32.4
Mean	24.98		24.61		24.67		24.753
RHR							
Range	62–86	>0.05	70–84	>0.05	68–82	>0.05	62–86
Mean	73.84		75.6		74.6		74.69
BP (systolic)							
Range	110–130	>0.05	110–132	>0.05	110–136	>0.05	110–136
Mean	122.21		123.6		123		122.949
BP (diastolic)							
Range	68–82	>0.05	70.84	>0.05	70–86	>0.05	68–86
Mean	72.31		78		77.9		76.13
MSS							
Mean	185.05	>0.01	201.75	>0.01	196.48	>0.01	177.796
SD	19.23		20.82		21.98		
VO2max							
Mean	24.89	>0.01	23.70	>0.01	24.15	>0.01	24.37
SD	4.41		5.89		4.44		
HDL							
Mean	33.06	>0.01	32.11	>0.01	28.37	>0.01	31.127
SD	9.51		9.49		8.12		
LDL							
Mean	112.78	>0.01	114.61	>0.01	111.95	>0.01	113.090
SD	8.27		10.05		8.95		
TGL							
Mean	86.39	>0.01	87.44	>0.01	93.16	>0.01	81.327
SD	12.33		15.88		13.66		
FVC							
Mean	0.2995	>0.01	0.2710	>0.01	0.2450	>0.01	0.271
SD	0.1305		0.1195		0.1043		
MVV							
Mean	31.63	>0.01	31.30	>0.01	32.15	>0.01	31.694
SD	4.62		5.859		5.71		

BMI body mass index, *RHR* resting heart rate, *BP* blood pressure, *MSS* menstrual symptom score, *HDL* high density lipoprotein, *LDL* low density lipoprotein, *TGL* triglycerides, *FVC* force vital capacity, *MVV* maximum voluntary ventilation

Low density lipoprotein did not change significantly in all the three groups. High density lipoprotein cholesterol and triglycerides improved significantly after 6 weeks in Group B and C, but did not change in Group A. No significant change in peak VO_2 max in Group A, but increased in Group B and C. FVC, MMV significantly increased after 6 week in Group B and C, however no significant change was found in Group A. There is significantly high correlation between the VO_2max and Borg scale scores in Group A mild intensity), B (moderate) and C (severe intensity) with $r = 0.981$, $r = 0.812$, and $r = 0.844$, respectively.

Discussion

Greene has described the symptoms of the premenstrual syndrome as of extraordinary diversity and relevant to every specialty. However, before any medical treatments are commenced, it is still important to confirm that lifestyle has been optimized. This study demonstrated that moderate and severe intensity aerobic exercise training over 6 weeks reduced menstrual symptoms in patients with PMS. However, severe intensity group improved with increased rate of perceived exertion during exercise. The impact of

Table 3 Outcome measures in three groups before and after intervention

Group A			Group B		Group C		*P* value
Pretest		Posttest	Pretest	Posttest	Pretest	Posttest	
MMS	185.05 ± 19.23	180.26 ± 18.46	201.75 ± 20.82	182.95 ± 19.91	196.48 ± 21.98	177.90 ± 20.11	<0.01
VO2 max	24.89 ± 4.41	28.21 ± 4.47	23.70 ± 5.89	31.20 ± 7.06	24.15 ± 4.44	35.25 ± 4.61	<0.01
HDL	33.06 ± 9.51	37.94 ± 9.97	32.11 ± 9.49	50.89 ± 10.73	28.37 ± 8.12	46.11 ± 8.41	<0.05
LDL	112.78 ± 8.27	116.78 ± 8.31	114.61 ± 10.05	118.39 ± 9.72	111.95 ± 8.95	116.63 ± 9.87	<0.05
TGL	86.39 ± 12.33	83.11 ± 11.94	87.44 ± 15.88	80.28 ± 15.67	93.16 ± 13.66	80.63 ± 14.35	<0.05
FVC	0.2995 ± 0.1305	0.5205 ± 0.2244	0.2710 ± 0.1195	0.7525 ± 0.1883	0.2450 ± 0.1043	1.4265 ± 0.3724	<0.01
MVV	31.63 ± 4.62	33.47 ± 4.75	31.30 ± 5.859	36.05 ± 5.84	32.15 ± 5.71	38.25 ± 6.03	<0.01

Table 4 Change scores on 8 domains of menstrual symptom questionnaire in three study groups

Variables	Groups	Pre test mean ± SD	Post test mean ± SD	*P* value
Pain	A	28.32 ± 4.91	26.47 ± 4.86	0.000
	B	28.10 ± 4.14	22.70 ± 4.46	0.000
	C	28.20 ± 4.35	17.85 ± 5.72	0.000
Concentration	A	23.26 ± 4.29	21.74 ± 4.68	0.000
	B	23.35 ± 4.76	18.85 ± 4.03	0.000
	C	31.85 ± 4.86	20.70 ± 6.15	0.000
Behavioral change	A	15.84 ± 2.46	15.37 ± 2.73	0.046
	B	31.75 ± 4.81	25.55 ± 3.89	0.000
	C	16.01 ± 2.51	8.30 ± 3.51	0.000
Autonomic reactions	A	19.84 ± 3.15	18.95 ± 3.58	0.009
	B	16.10 ± 2.22	13.25 ± 1.68	0.000
	C	16.15 ± 2.21	13.20 ± 2.97	0.000
Water retention	A	15.37 ± 2.39	14.74 ± 2.68	0.010
	B	15.35 ± 2.32	12.70 ± 2.34	0.000
	C	15.48 ± 2.33	7.55 ± 3.03	0.000
Negative effect	A	31.89 ± 4.70	31.00 ± 5.10	0.132
	B	31.95 ± 4.45	27.45 ± 4.33	0.000
	C	31.60 ± 4.56	21.65 ± 5.87	0.000
Arousal	A	15.84 ± 2.57	15.42 ± 2.59	0.042
	B	19.90 ± 3.08	16.60 ± 2.66	0.000
	C	19.70 ± 3.13	16.60 ± 3.27	0.000
Control	A	31.63 ± 4.95	30.58 ± 4.90	0.006
	B	14.75 ± 2.47	13.05 ± 2.35	0.000
	C	23.05 ± 4.24	18.95 ± 4.56	0.000

aerobic training at different intensities on PMS has not been fully investigated, but it is suggested that both intensity and duration of exercise are important for hormonal regulation and anti-oxidant adaptation. The onset of symptoms is gradual, there may be a fortnight of lethargy and depression, some 10 days of irritability, a gradual onset of vertigo during last week and finally a severe migraine attack on the last premenstrual day, progressed to more incapacitating symptoms. Maximum fluctuation in hormones occurs during the premenstrual/menstrual phases. Israel found a raised renal threshold for estrogens in patients with PMS and suggests that the cause was not high level of oestradiol in the blood but due to lack of progesterone to act as antagonist [11]. It is not only ovarian hormones which fluctuate, but that those of adrenal cortex (Aldosterone) also exhibit cyclical activity, which is increased in the week preceding menstruation. Aldosterone causes water and sodium retention, potassium depletion (electrolyte imbalance) and hypertension because of insufficient progesterone to act as aldosterone antagonists [12]. Aerobic exercise training acutely raises serum progesterone levels, a response prevented by prolonged fasting before exercise. Such increase in progesterone may be insufficient to substantially 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 [13]. The efficacy of aerobic exercise on pain may be related to release of endorphin, counteracting possible declines in endorphin levels in the luteal phase. Raised endorphin levels have been associated with significant reductions in depression. The disturbed ratio between mineralocorticoid (desoxycorticosterone, aldosterone, water and electrolyte balance) and estrogen on the one hand and progesterone and glucocorticoids (related to stress, anti-allergic, anti-inflammatory and carbohydrate metabolism) on the other hand would go a long way toward explaining the totality of the syndrome. The effects of exercise on hormonal secretions were described in Table 5. The reduction in menstrual symptoms by aerobic exercise training may be associated with improved insulin sensitivity and glycemic control. Reports indicate that the effect of insulin sensitivity of a single bout of aerobic exercise lasts for 24–72 h. Therefore the frequency of exercise session should be at least three times per week.

High density lipoprotein and triglycerides improved significantly in Group B and C. However it is reported that improved glycemic control by aerobic training is always associated with reduction in serum malondialdehyde, a reliable measure of lipid peroxidation. Elosua et al.

Table 5 The effects of exercise on hormone output

Host gland	Hormone	Exercise effects on hormone secretion
Anterior pituitary	Endorphins	Increase with increasing exercise
	Growth hormone (GH)	
	Prolactin	
Posterior pituitary	Vasopressin (ADH)	Increase with increasing exercise
	Oxytocin	Increase with heavy exercise only
Adrenal cortex	Cortisol	Increase with increasing exercise
	Corticosterone	
	Aldosterone	
Adrenal medulla	Epinephrine	Increase with increasing exercise
	Norepinephrine	
Thyroid	Thyroxine	Increase with increasing exercise
	Triiodothyronine	
Pancreas	Insulin	Decreases with exercise
	Glucagon	Increases with exercises
Ovaries	Estrogen	Increases with exercise
	Progesterone	
Kidney	Renin	Increase with increasing exercise

reported that aerobic training increased the activity of endogenous antioxidants, glutathione peroxidase and decreased low density lipoprotein concentration [14]. Kelly et al. reported in a meta analysis that effect of aerobic exercise in lipid profile was equivalent to improvement of all variables (HDL, LDL, triglycerides, and total cholesterol), but after conducting sensitivity analysis, only decrease in triglycerides remained statistically significant which in turn influence the hormonal function.

Results of VO2max, FVC, and MVV proved the beneficial effect of aerobic fitness of these menstruating girls. However, the VO_2max positively correlated with Borg scale scores. The VO2 max does, provide important information on the capacity of the long-term energy system; in addition, this measure has significant physiological cardiovascular, neuromuscular adaptations which in turn regulate hormonal mechanism. Although increase in exercise duration can increase oxidative stress, it also simultaneously induces antioxidant systems. Long-term exercise training can reduce oxidative stress by enhancing antioxidant defence mechanisms. From this study we propose that moderate to severe intensity exercise training over 6 week or above is an effective intervention for reducing menstrual symptoms, and it also enhances the aerobic fitness in the menstruating girls. The aerobic exercises produce a characteristic "training effect", in which the cardiovascular adaptations include reduced heart rate at rest and at submaximal workload, increased work capacity and increased maximal oxygen consumption (VO2 max). The theoretical utility of the study reveals that, if a person has to reach the maximum capacity for aerobic metabolism and adequate hormonal regulation for decrease in menstrual symptoms, it is achieved only by the sufficient dosage of aerobic exercise with appropriately framed protocol. Another finding of this study is that increase in HDL were associated with increase in maximum oxygen consumption (VO2max) in ml/kg/min r value 0.85, $P < 0.05$) and VO2 max positively correlated with rate of perceived exertion (Borg scores). Aerobic exercise may have psychological benefits like improved body image and self-efficacy, which improves self-esteem [15]. The results of this study encourage the incorporation of regular, moderate aerobic exercise as a potential intervention for PMS.

Acknowledgments The authors thank our institute (M.T.P.G and R.I.H.S) for setting the stage for our performance and sincere thanks to the time, effort, and interest shown by the subjects of this study.

Appendix: Menstrual Symptom Questionnaire

In relation to your menstrual periods, to what extent the following issues have been a problem for you?

	Severe problem	Moderate problem	Mild problem	Hardly problem	No problem
PAIN					
1. Muscle stiffness	☐	☐	☐	☐	☐
2. Headache	☐	☐	☐	☐	☐
3. Cramps	☐	☐	☐	☐	☐
4. Backache	☐	☐	☐	☐	☐
5. Fatigue	☐	☐	☐	☐	☐
6. Breast tenderness	☐	☐	☐	☐	☐
7. General aches & pains	☐	☐	☐	☐	☐
CONCENTRATION					
1. Insomnia	☐	☐	☐	☐	☐
2. Forgetfulness	☐	☐	☐	☐	☐
3. Confusion	☐	☐	☐	☐	☐
4. Lowered judgment	☐	☐	☐	☐	☐
5. Difficulty in concentrating	☐	☐	☐	☐	☐
6. Distractable	☐	☐	☐	☐	☐
7. Accidents	☐	☐	☐	☐	☐
8. Lowered motor coordination	☐	☐	☐	☐	☐
BEHAVIOURAL CHANGE					
1. Lowered college or work Performance	☐	☐	☐	☐	☐
2. Stay at home	☐	☐	☐	☐	☐
3. Avoid social activities	☐	☐	☐	☐	☐
4. Decreased efficiency	☐	☐	☐	☐	☐
AUTONOMIC REACTIONS					
1. Dizziness, faintness	☐	☐	☐	☐	☐
2. Cold sweats	☐	☐	☐	☐	☐
3. Nausea/vomiting	☐	☐	☐	☐	☐
4. Hot flashes	☐	☐	☐	☐	☐
WATER RETENTION					
1. Weight gain	☐	☐	☐	☐	☐
2. Skin disorders	☐	☐	☐	☐	☐
3. Painful breasts	☐	☐	☐	☐	☐
4. Swelling	☐	☐	☐	☐	☐
NEGATIVE EFFECT					
1. Crying	☐	☐	☐	☐	☐
2. Loneliness	☐	☐	☐	☐	☐
3. Anxiety	☐	☐	☐	☐	☐
4. Restlessness	☐	☐	☐	☐	☐
5. Irritability	☐	☐	☐	☐	☐
6. Mood swings	☐	☐	☐	☐	☐
7. Depression	☐	☐	☐	☐	☐
8. Tension	☐	☐	☐	☐	☐
AROUSAL					
1. Affectionate	☐	☐	☐	☐	☐
2. Orderliness	☐	☐	☐	☐	☐
3. Excitement	☐	☐	☐	☐	☐
4. Feelings of well-being	☐	☐	☐	☐	☐
5. Bursts of energy, activity	☐	☐	☐	☐	☐
CONTROL					
1. Feeling of suffocation	☐	☐	☐	☐	☐
2. Chest pains	☐	☐	☐	☐	☐
3. Ringing in ears	☐	☐	☐	☐	☐
4. Heart pounding	☐	☐	☐	☐	☐
5. Numbness, tingling	☐	☐	☐	☐	☐
6. Blind spots, fuzzy vision	☐	☐	☐	☐	☐

Thank you for completing this questionnaire

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