

Effect of Yoga on Autonomic Functions and Psychological Status During Both Phases of Menstrual Cycle in Young Healthy Females

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ABSTRACT

Context: Premenstrual stress affects 75% of women of childbearing age and yoga has been found to be beneficial in many psycho-somatic disorders.

Aims: To investigate the effect of integrated yoga on autonomic parameters and psychological well-being during both pre and post phases of menstrual cycle in healthy young female subjects.

Settings and Design: Present study is a randomized control trial and was conducted in the Department of Physiology, Lady Hardinge Medical College, New Delhi, India.

Material and Methods: Fifty apparently healthy females in the age group of 18-20 years were randomized into two groups: Group I (n=25) consisted of subjects who practiced yoga 35-40 minutes per day, six times per week for the duration of three menstrual cycles. Training was given by qualified yoga instructor. Group II (n=25) subjects acted as controls. Following parameters were recorded at the beginning and after completion of three menstrual cycles in all the subjects: Height, weight (BW), Resting Heart Rate (HR), Resting Systolic (SBP) and Diastolic Blood Pressure (DBP), parasympathetic reactivity tests including Expiration-Inspiration Ratio (E: I ratio) and 30:15 ratio, sympathetic reactivity tests including BP changes due to Isometric Hand Grip (IHG) exercise, and Cold Pressor Test (CPT). Assessment of psychological status was done by administering DIPAS (Defense Institute of Physiology and Allied Sciences) inventories of Anger self report scale, Trait Anxiety, Sense of well-being and Depression scale.

Statistical Analysis: Intra-group comparison of physiological parameters was done by using paired 't' test, whereas intra-group comparison of non-parametric data such as scores of anxiety, depression, anger and sense of well-being was done by Wilcoxon signed-rank test. Inter-group comparison of parameters was done by Students 't' test for parametric tests and Mann-Whitney 'U' test for non-parametric tests.

Results: There was significantly higher BW, resting SBP, DBP, sympathetic activity and blunting of parasympathetic reactivity and also, significantly higher scores of anger, depression, anxiety and decreased score of well-being in premenstrual phase as compared to postmenstrual phase in both the groups in initial cycle. There was significantly higher percentage decrease in BW, HR, SBP & DBP in yoga group as compared to control group in both the phases from initial to second and onwards between second and third menstrual cycle. Also, decrease in anger, depression and anxiety and increase in well-being score was significant in yoga group as compared to control group from initial to second and third cycle in premenstrual phase while the change was significant only in depression score in postmenstrual phase.

Conclusion: Our study shows that there was significant alteration of autonomic functions and psychological status in premenstrual phase when compared with postmenstrual phase in young healthy females. Also, regular practice of yoga has beneficial effects on both phases of menstrual cycle by bringing parasympathetic dominance and psychological well-being probably by balancing neuro-endocrinal axis.

Key words: Yoga, Premenstrual stress, Autonomic functions, Psychological status

INTRODUCTION

Premenstrual stress is characterized by physical, psychological, and behavioral changes and is believed to affect 75% of women of childbearing age [1]. Previous studies suggest that functioning of autonomic nervous system during the late luteal phase is altered which could be associated with diverse psychosomatic and behavioural symptoms appearing during premenstrual phase [2]. A growing body of evidence supports the belief that yoga benefits physical and mental health via down-regulation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS) [3]. Yoga is an effective method for improving health in addition to the prevention and management of diseases [4]. Yoga plays an important role in reducing stress, reducing sympathetic activity [5,6], increasing parasympathetic activity [7], decreasing blood pressure [8], improving sense of well-being [9,10], and decreasing anxiety levels [10]. The objective of the study is to evaluate the effect of yoga practice if any, on

autonomic parameters and psychological well-being during both pre and post-phases of menstrual cycle.

MATERIAL AND METHODS

This study was conducted in the Department of Physiology, Lady Hardinge Medical College (LHMC) and Smt. Sucheta Kriplani Hospital (SSKH), New Delhi, India.

Study Design

Prior permission for the present project was taken from the institutional ethical committee. 50 apparently healthy female subjects in the age group of 18-20 years volunteering for the present study and meeting the inclusion criteria of history of regular menstrual cycle, not suffering from any medical or psychiatric illness, not involved in any prior athletic programme or were practicing other forms of yogic exercises including meditation or biofeedback relaxation techniques were selected for the present

study. All the subjects who were unable to perform yoga practices due to any reason were excluded from the study. After taking written informed consent from the subjects, detailed menstrual history was noted and the menstrual phases were calculated as postmenstrual phase means 5th to 10th day of the menstrual cycle and premenstrual phase means 1-7 days prior to the onset of next menstruation.

After taking their initial baseline recordings during both postmenstrual and premenstrual phases of the initial menstrual cycle, they were randomly divided into 2 groups. Group I (n=25) practiced yoga practice and Group II (n=25) with no intervention served as controls. A trained and qualified yoga trainer from Morarji Desai National Institute Yoga (MDNIY), New Delhi, India gave training to Group 1 subjects. This helped us in ensuring regularity and uniformity in Yoga practice. Following yogic techniques were daily practiced in the sequence as mentioned below:

I. YOGIC PRAYER (2 minutes)

II. SUKSHMA VYAYAMA (Micro-exercises) (5 minutes)

1. Griva Sakti Vikasaka: Strengthening the neck
2. Vaksha-sthala Sakti Vikasaka: Strengthening the chest
3. Udara Sakti Vikasaka: Strengthening the abdominal muscles
4. Kati Sakti Vikasaka: Strengthening the muscles of back
5. Skandha tatha Bahu Mool Sakti Vikasaka: Strengthening the muscle of shoulder blades and shoulder joints
6. Jangha Sakti Vikasaka: Strengthening the muscles of thigh
7. Gulpha-pada-prstha-pada-tala Sakti Vikasaka: Developing the strength of ankle and feet

III. Sthula Vyayama (Macro exercises) (5 minutes)

1. Urdhav Gati: This exercise increases blood circulation in the body and strengthens the limbs.
2. Surya Namaskar or 12 postures sun salutation exercise (1 round).

IV. Pranayama (3 minutes)

1. Nadi Shodhan Pranayama

V. Asana (Postures) (20 minutes)

1. Supta Pavana Muktasana
2. Uttanpadasana
3. Bhujangasana
4. Ushtrasana
5. Gomukhasana
6. Ardha-Matsyendrasana
7. Tadasana
8. Shavasana

VI. Dhyana (Meditation) (5 Minutes)

Detailed explanation for the yogic practices is given in Appendix 1. The subjects were taught yogic techniques for nearly 40 minutes in the morning on empty stomach six days a week for a total period of three menstrual cycles. Since according to yogic texts, yogasanas are prohibited during the days of menstruation, hence the students were instructed only to do yogic prayer, sukshma vyayama (micro exercises) and meditation during these days.

Yoga practice was started just after cessation of menstruation in the next cycle (of initial recording) and was denoted as first menstrual cycle of yoga practice and the practice was continued in the second and third menstrual cycles. Control group did not practice yoga. All the recordings were taken in a quiet room at comfortable temperature of 25-28°C. For taking the recordings, the students reported to the Department of Physiology in the morning between 9-10 a.m. at least two hours after taking light breakfast. Following parameters were then recorded in both the groups during postmenstrual and premenstrual phases in initial,

second and third menstrual cycles in the following order:

- Height (cm) and weight (kg)
- Autonomic parameters

A. Resting Heart Rate (HR), Resting Systolic (SBP) and Diastolic Blood Pressure (DBP)

After asking the subject to rest in supine position for 15 min, continuous ECG was recorded by means of ECG machine. The resting HR was calculated by counting number of R waves within one minute period. Blood pressure (BP) was recorded from left brachial artery by mercury sphygmomanometer three times with a gap of 5 minutes each and lowest value was considered as final reading.

B. Parasympathetic Reactivity Tests

1. Expiration-Inspiration Ratio (E:I ratio) is the ratio of longest R-R interval during expiration to the shortest R-R interval during inspiration. The subject breathes deeply and steadily at six breaths per minute. The E: I ratio was calculated from the formula given below:

$$E: I \text{ ratio} = \frac{\text{Longest R-R interval during Expiration}}{\text{Shortest R-R interval during Inspiration}}$$

2. 30:15 ratio: It is the ratio of R-R interval corresponding to the 30th and 15th heart beat upon standing from supine position. It was calculated by following formula:

$$30:15 \text{ ratio} = \frac{\text{R-R interval at beat 30 after assuming erect posture}}{\text{R-R interval at beat 15 after assuming erect posture}}$$

C. Sympathetic Reactivity Tests

1. BP changes due to Isometric hand grip (IHG) exercise: After recording resting BP, IHG exercise was done with Hand Grip Dynamometer (INCO, Ambala, India). The subjects were asked to hold the dynamometer in dominant hand and pull the grip with maximal tension. Three successive trials were performed; the highest value of three contractions was taken as maximum voluntary contraction (MVC). Following this, handgrip was maintained steadily by the subject at 30% of MVC for as long as possible. During this maneuver, both SBP & DBP were recorded every 30 seconds on the non-exercising arm. The maximum rise in SBP and DBP was taken as an index of response to hand grip. While taking the recordings later on at subsequent times (premenstrual phase of initial cycle and postmenstrual and premenstrual phases of second and third cycle) the readings with Hand Grip Dynamometer were taken for the same effort as was taken at the time of the postmenstrual phase of the initial cycle.

2. Blood pressure changes due to cold pressor test: After recording baseline BP recording in sitting posture, subject was asked to immerse her hand in a thermocol box of water (maintained at 4-5°C). BP was recorded from the other arm at 30 sec intervals for a period of two minutes after which subject removed her hand. The maximum rise in SBP & DBP was determined from other arm.

D. Assessment of psychological status

Self report scales for measuring four Psychological parameters: Anxiety, Depression, Anger and Sense of well-being. The questionnaires were developed by DIPAS (Defense Institute of Physiology and Allied Sciences), New Delhi, India. These questionnaires were chosen as they are valid for Indian population, reliable and specific to measure the tested psychological domains. Every item amongst all the questionnaires measures the tested domain on the weighted scores of responses from 0 to 3 ranging from 'never' to 'almost always' response respectively. Questionnaires were scored by adding the weighted (0 to 3) scores of each item.

E. Anger self report scale

It consists of 16 items and was included because it was hypothesized that high levels of stress may lead to increased levels of anger related behaviour.

F. Trait Anxiety

It denotes "relatively stable individual differences in anxiety proneness" and refers to a general tendency to respond with anxiety to perceived threats in the environment and various situations. This questionnaire consists of 40 items and the total score ranges from 0 to 120.

G. Depression

This scale consists of 10 items which takes into consideration variables like depressed mood, guilt, difficulty in sleeping, decision making, work and interests.

H. Sense of well-being

It refers to that positive attribute and questionnaire consists of 50 questions and assesses individual on various aspects of subjective well-being including the ability to develop persons' potential; work productivity and creativity; build strong and positive relationships with others. The lesser the score the better is the sense of well-being. All the parameters were again evaluated during postmenstrual and premenstrual phases of second and third menstrual cycles but not in the first menstrual cycle of yoga practice. The data was recorded and statistically analyzed.

STATISTICAL ANALYSIS

Intra-group comparison of physiological parameters was done by using paired 't' test, whereas Intra-group comparison of non-parametric data such as scores of anxiety, depression, anger and sense of well-being was done by Wilcoxon signed-rank test. Inter-group comparison of physiological parameters was done by using Students 't' test, whereas, the comparison between non-parametric data was done by using Mann-Whitney 'U' test. P value less than 0.05 was considered as significant.

OBSERVATION AND RESULTS

[Table/Fig-1] shows that there was no significant difference in the age, height, weight and duration of menstrual cycle and menstruation between the groups.

[Table/Fig-2] shows that in both yoga and control group during initial cycle, BW, HR, SBP and DBP were significantly higher during premenstrual phase as compared to postmenstrual phase. Also, trend towards significant decrease in BW, HR and SBP from initial to second and third cycle was observed only in yoga group during both phases and significant decrease in DBP was seen in premenstrual phase only.

[Table/Fig-3] shows that there was significantly higher percentage decrease in BW, HR, SBP & DBP in yoga group as compared to control group in both the phases from initial to second and onwards between second and third menstrual cycle.

[Table/Fig-4] demonstrates that increase in SBP IHG and SBP CPT had significantly reduced in 3rd cycle as compared to the initial cycle in both the phases in yoga group. Increase in DBP CPT had significantly reduced in 3rd cycle in yoga group only as compared to the initial cycle in premenstrual phase.

[Table/Fig-5] shows increase in SBP IHG and SBP CPT had significantly decreased in yoga group as compared to control group from initial to 3rd cycle in premenstrual phase. Also, the increase in DBP CPT had significantly decreased in yoga group as compared to control group from initial to 3rd cycle in premenstrual cycle.

[Table/Fig-6] shows that there were significantly higher scores of anger, depression, anxiety and decreased score of well-being in premenstrual phase as compared to postmenstrual phase in both the groups in initial cycle. In yoga group in 3rd cycle, only significant increase was found in anger and depression scores during premenstrual phase. Anger, depression and anxiety scores had significantly decreased and well-being had increased from initial to second and third cycle and from second to third cycle in yoga group only.

[Table/Fig-7] shows that decrease in anger, depression and anxiety and increase in well-being score was significant in yoga group as compared to control group from initial to second and third cycle in premenstrual phase while the change was significant only in depression score in postmenstrual phase.

Parameters	Yoga Group	Control Group
Age (years)	18.6±1.080	18.08±0.759
Height (cm)	154.19±6.79	154.92±5.90
Weight (kgs)†(postmenstrual phase)	51.44±10.24	49.6±8.15
Duration of menstrual cycle (days)	28.6±1.40	29.34±1.45
Duration of menstruation (days)	4.42±1.06	4.46±0.72

[Table/Fig-1]: Distribution of Age, Height, and Duration of menstrual cycle and duration of menstruation in two groups (Mean±SD)

Analysis done by unpaired student 't' test. *p<0.05, **p<0.01, ***p<0.001. † During postmenstrual phase of initial cycle

Postmenstrual phase						
	Yoga group			Control group		
	Initial cycle	2 nd Cycle	3 rd Cycle	Initial cycle	2 nd Cycle	3 rd Cycle
Body weight@ (BW)	51.44±10.24	51.94±9.50	50.72±8.93†††	49.60±8.15	50.58±7.93**	49.16±6.85††
Heart Rate (HR)	79.84±2.94	75.52±3.61***	72.96±3.01***†††	75.72±4.77	77.36±3.45	81.92±2.04***†††
SBP	107.12±5.48	104.16±5.10**	101.92±2.97***†	108.00±7.68	108.80±6.00	110.88±3.06
DBP	72.80±5.42	71.60±5.54	71.36±2.56	74.32±6.42	74.48±5.78	80.88±2.09***†††
Premenstrual phase						
	Yoga group			Control group		
	Initial cycle	2 nd Cycle	3 rd Cycle	Initial cycle	2 nd Cycle	3 rd Cycle
Body weight@	52.28±10.37§§	52.00±9.92	51.32±9.51*††	50.60±8.66§§§	50.94±8.14§	50.44±7.98†††§§
Heart Rate	85.54±5.77§§§	80.40±2.52***§§§	77.36±2.63***†††§§§	86.34±6.17§§§	84.64±3.09§§§	84.08±2.80§§§
SP	115.12±4.59***§§§	108.40±5.54***†††§§	107.52±2.60§§§	114.32±4.42§§§	112.96±4.09*§§§	114.88±4.76§§§
DBP	78.24±4.67§§§	72.56±4.34***	71.52±4.52***†	76.88±6.73	80.80±3.79*§§§	82.72±3.05***†††§

[Table/Fig-2]: Comparison of basal physiological parameters between two groups. Values in mean±SD

Analysis done by One Way ANOVA between cycles, by paired Students 't' test between phases

@ During postmenstrual phase of initial cycle.

* Comparison with initial cycle. *p<0.05, **p<0.01, ***p<0.001

† Comparison with 2nd cycle. †p<0.05, ††p<0.01, †††p<0.001

§ Comparison between premenstrual phase and postmenstrual phase. §p<0.05, §§p<0.01, §§§p<0.001

Postmenstrual phase						
Parameters	% change from initial to 2 nd cycle		% change from initial to 3 rd cycle		% change from 2 nd to 3 rd cycle	
	Yoga	Control	Yoga	Control	Yoga	Control
Body weight (kg)@	+ 1.25 ± 3.54	+ 2.13 ± 3.36*	-0.97 ± 4.56	-0.50 ± 3.76***	- 2.21 ± 1.91	- 2.53 ± 3.50***
Heart rate (bpm)	-5.26±6.22	+2.48±6.94***	-8.45±5.86	+8.58±7.19***	-3.34±1.80	+6.08±5.11***
SBP	-2.65±4.42	+1.31±7.92*	-4.63±5.19	+3.16±7.72***	-1.94±5.11	+2.20±6.23**
DBP	-2.80±8.95	+0.54±7.55	-1.46±7.95	+9.5±9.64***	-1.64±6.23	+10.35±7.83***
Premenstrual phase						
Parameters	% change from initial to 2 nd cycle		% change from initial to 3 rd cycle		% change from 2 nd to 3 rd cycle	
	Yoga	Control	Yoga	Control	Yoga	Control
Body weight (kg)@	-0.34±3.34	+0.88±3.28**	-1.50±4.58	-0.07±3.55***	-1.18±2.11	-0.95±0.93
Heart rate (bpm)	-6.00±5.81	-1.49±6.17**	-9.57±5.56	-2.13±6.20***	-3.77±1.76	-0.60±2.95***
SBP	-5.79±4.14	-1.14±2.79***	-6.50±3.21	+0.57±4.54***	-0.59±4.96	+1.72±3.31*
DBP	-6.97±7.35	+5.90±10.93***	-8.24±8.40	+8.49±11.53***	-1.40±3.18	+2.46±3.14***

[Table/Fig-3]: Comparison of percentage change between groups. Values in mean±SD

Analysis done by unpaired Student 't' test between groups. '+' sign ' indicates increase; '-' sign' indicates decrease. @ During postmenstrual phase of initial cycle. *p<0.05, **p<0.01, ***p<0.001

Postmenstrual phase						
	Yoga group			Control group		
	Initial cycle	2 nd Cycle	3 rd Cycle	Initial cycle	2 nd Cycle	3 rd Cycle
Increase in SBP IHG	22.00±3.78	22.88±5.44	18.00±3.05***†	23.36±9.25	24.40±6.19	24.40±5.13
Increase in DBP IHG	16.00±5.00	14.40±3.82	14.00±3.82	16.00±4.08	16.16±3.91	16.56±2.67
Increase in SBP cold pressor	17.68±7.60	14.56±3.97	14.24±3.71*	18.48±6.41	17.76±6.83	18.84±3.05
Increase in DBP cold pressor	18.00±6.19	16.08±7.10	15.20±5.44	15.20±7.21	15.84±4.72	14.08±3.08
E/I ratio	1.72±0.21	1.70±0.21	1.74±0.29	1.70±0.32	1.53±0.48	1.81±0.46†
30/15 ratio	1.03±0.17	1.04±0.16	1.06±0.13	1.05±0.18	0.98±0.06	1.03±0.08†
Premenstrual phase						
	Yoga group			Control group		
	Initial cycle	2 nd Cycle	3 rd Cycle	Initial cycle	2 nd Cycle	3 rd Cycle
Increase in SBP IHG	24.88±5.71§	22.64±8.49	20.00±4.20***§	24.72±2.99	25.44±6.54	26.32±5.08
Increase in DBP IHG	18.32±7.15	16.00±6.32	15.12±5.00	18.88±3.78§	18.00±6.95	19.04±6.53§
Increase in SBP cold pressor	19.20±4.54	16.88±6.00	15.12±4.98***	20.00±2.88	20.00±3.10	21.04±3.11§
Increase in DBP cold pressor	20.08±4.81	18.00±4.28	17.04±4.55*	17.36±9.25	18.72±8.44	17.64±6.42§§
E/I ratio	1.65±0.17	1.63±0.18	1.61±0.25	1.60±0.25	1.69±0.36	1.60±0.19
30/15 ratio	1.02±0.23	1.03±0.12	1.05±0.12	1.02±0.12	1.03±0.07	1.06±0.13

[Table/Fig-4]: Comparison of basal autonomic parameters between two groups. Values in mean±SD

Analysis done by One Way ANOVA between cycles, by paired Student 't' test between phases. * Comparison with initial cycle. *p<0.05, **p<0.01, ***p<0.001

† Comparison with 2nd cycle. †p<0.05, ††p<0.01, †††p<0.001. § Comparison between premenstrual phase and postmenstrual phase. §p<0.05, §§p<0.01, §§§p<0.001

Postmenstrual phase						
Parameters	% change from initial to 2 nd cycle		% change from initial to 3 rd cycle		% change from 2 nd to 3 rd cycle	
	Yoga	Control	Yoga	Control	Yoga	Control
Increase in SBP IHG	-2.56±30.72	+30.02±95.19	-15.94±20.51	+21.88±59.25*	-7.85±30.90	+8.10±40.48
Increase in DBP IHG	-12.46±90.50	+7.26±37.23	-21.44±149.12	+11.00±36.82	-1.82±31.30	+10.73±38.85
Increase in SBP cold pressor	-7.84±45.58	-7.31±51.75	-12.18±42.95	+27.54±102.66	-5.60±41.50	+22.94±51.93
Increase in DBP cold pressor	-0.25±53.90	+2.74±97.23	-6.41±47.36	-23.40±116.52	-10.74±57.26	-2.43±36.45
E/I ratio	-0.01±16.53	-4.90±37.83	+2.84±22.43	+10.06±33.58	+4.25±23.57	+67.63±188.84
30/15 ratio	+1.52±20.99	-5.07±10.91	+5.23±18.23	-0.91±12.60	+5.13±22.86	+4.65±10.10
Premenstrual phase						
Parameters	% change from initial to 2 nd cycle		% change from initial to 3 rd cycle		% change from 2 nd to 3 rd cycle	
	Yoga	Control	Yoga	Control	Yoga	Control
Increase in SBP IHG	-3.65±51.38	-3.25±25.21	-15.82±22.68	+7.88±23.96**	-2.30±39.60	+7.22±23.79
Increase in DBP IHG	-11.67±96.46	-3.85±60.22	-4.34±85.32	+9.90±61.51	-4.36±51.31	+12.22±35.17
Increase in SBP cold pressor	-9.89±30.98	+1.57±19.72	-18.38±26.17	+6.91±18.83***	-4.68±27.97	+6.46±15.26
Increase in DBP cold pressor	-6.14±29.59	+42.92±138.06	-11.48±29.07	+34.76±102.32*	-4.27±18.37	-2.91±32.31
E/I ratio	-0.70±12.17	+9.74±31.14	-0.93±19.46	+2.07±19.64	-0.63±20.44	-20.88±143.47
30/15 ratio	+5.06±23.13	+2.76±14.10	+7.05±20.89	+3.59±16.79	+4.08±19.31	+1.46±15.21

[Table/Fig-5]: Comparison of percentage change between groups. Values in mean±SD

Analysis done by unpaired Student 't' test between groups. '+' sign ' indicates increase; '-' sign' indicates decrease. *p<0.05, **p<0.01, ***p<0.001

Postmenstrual phase						
	Yoga group			Control group		
	Initial cycle	2 nd Cycle	3 rd Cycle	Initial cycle	2 nd Cycle	3 rd Cycle
Anxiety	40.64±6.22	39.40±6.69	37.24±9.14*†	41.60±5.49	40.24±6.97	38.64±12.76
Depression	6.84±3.10	3.96±2.59***	3.12±2.71***††	6.36±4.13	6.24±4.98	6.074±2.81
Anger	8.84±4.01	7.76±3.53***	7.92±4.29	9.12±4.41	9.04±4.33	8.96±4.65
Well-being	41.72±16.05	39.64±16.07**	37.20±15.17***††	45.60±14.05	44.68±16.50	43.96±14.01
Premenstrual phase						
	Yoga group			Control group		
	Initial cycle	2 nd Cycle	3 rd Cycle	Initial cycle	2 nd Cycle	3 rd Cycle
Anxiety	46.96±5.87§§§	41.48±5.77***§	40.80±5.75***§	46.76±5.33§§§	45.80±6.41§§§	43.88±7.06
Depression	10.72±4.19§§§	5.92±3.76***§§	4.76±2.82***††§§§	9.72±3.89§§	9.56±3.22§§	9.36±2.96§§§
Anger	15.00±5.92§§§	9.52±4.70***§§	8.52±4.15***†	14.32±5.24§§§	14.28±4.89§§§	13.12±4.83§§§
Well-being	53.92±20.35§§§	44.48±17.87***§§	40.24±16.22***†††	51.04±14.89	50.40±18.67	49.76±17.02§

[Table/Fig-6]: Comparison of psychological parameters between two groups. Values in mean±SD

Analysis done by One Way ANOVA between cycles, by paired Student 't' test between phases.

* Comparison with initial cycle. †p<0.05, **p<0.01, ***p<0.001

† Comparison with 2nd cycle. †p<0.05, ††p<0.01, †††p<0.001

§ Comparison between premenstrual phase and postmenstrual phase. §p<0.05, §§p<0.01, §§§p<0.001

Postmenstrual phase						
Parameters	% change from initial to 2 nd cycle		% change from initial to 3 rd cycle		% change from 2 nd to 3 rd cycle	
	Yoga	Control	Yoga	Control	Yoga	Control
Anxiety	-2.75±10.97	-3.10±13.08	-8.27±17.00	-5.88±31.29	-5.94±13.09	-1.30±36.26*
Depression	-46.29±23.51	-49.47±192.38*	-59.79±28.82	-43.31±163.23***	-26.20±43.14	79.57±212.98**
Anger	-11.40±13.22	41.93±189.51	-3.31±81.30	-12.39±61.99	-31.39±166.31	-26.33±121.16
Well-being	-5.36±9.79	-3.94±48.91	-10.87±13.88	-0.53±25.59	5.98±10.55	4.76±33.54
Premenstrual phase						
Parameters	% change from initial to 2 nd cycle		% change from initial to 3 rd cycle		% change from 2 nd to 3 rd cycle	
	Yoga	Control	Yoga	Control	Yoga	Control
Anxiety	-11.05±11.60	-1.73±11.50**	-12.95±7.49	-5.43±16.27*	-0.93±13.21	-3.49±13.78
Depression	-46.72±20.75	-13.52±55.53***	-56.85±19.80	-18.48±82.63***	-19.48±26.06	-6.65±53.21*
Anger	-36.68±19.92	-5.08±33.73***	-42.28±19.78	-2.64±34.91***	-4.89±28.48	-4.84±24.22
Well-being	-17.50±12.43	-0.65±27.54**	-25.15±14.09	1.08±39.81**	9.72±8.28	5.81±454.15

[Table/Fig-7]: Comparison of percentage change between groups. Values in mean±SD

Analysis done by unpaired Student 't' test between groups.

†+ sign † indicates increase; †- sign † indicates decrease.

*p<0.05, **p<0.01, ***p<0.001

DISCUSSION

There was no significant difference in the baseline parameters of the both groups. Therefore, these groups can be considered comparable for the study. Our results demonstrate that there was significantly higher resting HR, SBP & DBP in both yoga and control groups in the premenstrual phase when compared with postmenstrual phase in all the three cycles. Our findings are in agreement with previous studies which have found higher sympathetic activity during premenstrual phase [11]. There was significant rise in SBP and DBP in response to IHG and CPT in pre menstrual phase in both the groups in initial cycle indicating sympathetic over reactivity and although not significant, lesser E: I ratio and 30:15 ratio signify decrease in parasympathetic activity. Therefore, our study shows altered autonomic balance during initial menstrual cycle in all the study subjects. Also, the present study shows significantly higher anxiety, depression and anger scores and decrease in sense of well-being score during premenstrual phase compared with postmenstrual phase in all the three cycles. Our findings are in agreement with previous studies which have demonstrated that females have higher levels of anxiety, depression, symptoms of irritability, mood swings and anger during premenstrual phase [12-14].

There was significant increase in body weight from postmenstrual phase to premenstrual phase during the initial cycle both in yoga and control group before beginning of the study and our findings are consistent with previous scientific reports which found similar results. With yoga practice, significant decrease in body weight was observed from initial to second and third cycle and even between second and third cycle in premenstrual phases. No such trend was observed in control group. Increase in body weight can be attributed to sodium retention [15], increased aldosterone levels [16], increased estrogen level [17] or decreased progesterone levels with unopposed estrogen action [18]. The decrease could be attributed to decrease in salt and water retention due to yoga practice, because in control group no such continuous trend in weight was observed. However, Inter-group comparison revealed no significant change in body weight between yoga and control group.

With practice of yoga by Group 1 subjects, HR, SBP and DBP showed a significant decreasing trend in second and third menstrual cycles both during postmenstrual and premenstrual phases with no change being observed in control group. Significant decrease in resting HR, SBP & DBP during the premenstrual phase of second and third cycles depicts effectiveness of yoga

in decreasing sympathetic activity. Our findings are similar to previous studies which have reported decrease in BP with the yoga practice [7,19,20].

Sympathetic reactivity: Increase in DBP due to IHG and CPT assesses the sympathetic reactivity [21]. With yoga practice, there was decreasing trend in the rise of both SBP & DBP during IHG from initial to second and third cycle both during postmenstrual and premenstrual phases. Significant decrease in the rise of only SBP was observed from initial to third cycle both in postmenstrual and premenstrual phase ($p < 0.001$). Also, yoga group depicted decreasing trend in the increase of both SBP and DBP during CPT from initial to second and third cycle both during postmenstrual to premenstrual phase. Significant decrease in the rise of SBP and DBP in CPT was observed from initial to third cycle both in postmenstrual to premenstrual phase. Control group did not show any significant change. This suggests decrease in sympathetic reactivity both during postmenstrual and premenstrual phase in yoga group. Our results are in close agreement with the previous studies of yogic practices as reported by Khanam et al., [22] who noted a decrease of 10 mmHg rise ($p < 0.05$) in DBP in IHG even after seven days of yoga practice. Madanmohan et al., [23] in a study on ten normal adults who practiced shavasana for seven days reported significant blunting of CPT induced increase in HR and BP suggesting that shavasana reduces a load on the heart by blunting the sympathetic response. Udupa et al., [7] reported significant decrease in sympathetic reactivity in subjects practicing pranayama for 3 months. The reduction in rise in BP response to IHG and CPT in subjects practicing yoga suggests decrease in exercise induced stress to the cardiovascular system.

Parasympathetic activity: Heart Rate Variability with Deep Breathing difference (E:I ratio) & HR changes from supine to standing (30:15 ratio) are considered as a measure of cardiac vagal function [24]. The increase in the HR that occurs during inspiration (sinus arrhythmia) results from decreased cardiac vagal activity [25]. During inspiration, impulses in the vagi from stretch receptors in the lungs inhibit the cardio inhibitory area in the medulla oblongata. No significant change in the E:I ratio was found from initial to second and third cycle either in premenstrual phase or in postmenstrual phase in both the groups. Intra-group comparison study between yoga and control group recorded no significant change in E:I ratio due to yoga practice.

Similar results have been found by Khanam et al., [22] with yoga practices in patients of Bronchial Asthma, where they have indicated no change in parasympathetic reactivity which is decreased in these patients.

In response to orthostatic stress the rapid increase in the heart rate at 15th beat is due to abrupt vagal inhibition followed by a relative bradycardia which is maximal at 30th beat and the normal ratio is ≥ 1.04 [24,25]. No significant changes in 30:15 ratio were found in both the groups from the initial cycle to the second and third menstrual cycle in postmenstrual to premenstrual phase. Inter-group study of E:I ratio between yoga and control group also did not show any significance between the two groups. This suggests no change in cardiac vagal activity with this test during the study period due to yoga practices.

At rest, normally, there is a moderate amount of tonic discharge in the cardiac sympathetic nerves, but there is a good deal of tonic vagal discharge called vagal tone; whereas the sympathetic vasoconstrictor fibers to most vascular beds have some tonic activity [26]. In the present study we have observed a significant decrease in resting heart rate, systolic blood pressure and diastolic blood pressure with yoga practice both during postmenstrual and premenstrual phase. These findings point towards either an increase in vagal tone or a decrease in sympathetic tone.

On the other hand, considering no change in parasympathetic

reactivity, and a significant decrease in sympathetic reactivity, there is a possibility that a decrease in resting heart rate, systolic and diastolic blood pressure in second and third menstrual cycle both during postmenstrual and premenstrual phases are by sympathetic manipulation, suggesting decrease in sympathetic dominance, more so in the premenstrual phase.

Psychological parameters: With the practice of yoga, significant decrease in anxiety, depression and anger scores and improvement in sense of well-being was recorded from initial to second and third menstrual cycle both in premenstrual and postmenstrual phases. No significant change was observed in control group. Therefore, our study demonstrates that regular yoga practice improves psychological status of the subjects. Our results are in agreement with previous study which found regular yoga practice by medical students lead to decrease in anxiety and depression levels, reduction in examination stress and an increase in optimistic outlook of the students who practiced yoga [9].

The mechanism by which yoga reduces premenstrual stress in the subjects cannot be deciphered from the present study but it can be hypothesized that it may have occurred due to better resting autonomic tone towards parasympathodominance and improved autonomic reactivity to the stress. Yogasanas are low intensity usually non-strenuous exercises which affect HPA axis positively bringing down sympathetic stimulation and significantly decreasing the release of catecholamines. Also, yoga-based practices have been found to correct under activity of the parasympathetic nervous system (PNS) and GABA systems in part through stimulation of the vagus nerves, the main peripheral pathway of the PNS [27]. As integrated yoga practice includes aspects of exercise (asanas), breath manipulation (pranayama) and relaxation (meditation), effects of yoga are multi-dimensional and have immediate down-regulating effect on both SNS / HPA axis response to stress [28]. Regular practice of meditation has also been documented to reduce sympathetic activity, balance neuro-endocrine axis and decrease stress and anxiety levels [29].

CONCLUSION

Our study shows that premenstrual stress significantly alters autonomic function and psychological status of young females and regular practice of yoga beneficially affects both phases of menstrual cycle by improving parasympathetic activity and bringing equanimity of mind.

LIMITATIONS OF THE STUDY

In the present study, it was not possible to attempt double blind conditions. It was also not possible to assess bio-chemical parameters like Vanillyl mandelic acid (VMA), metanephrines etc to substantiate the findings obtained during the study. Further studies are needed for longer period and larger sample size to document whether the autonomic and psychological changes are permanent in the practitioners. However, no significant clinical side effects (confusion, CVS accidents etc) occurred with yoga practice during the study.

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