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Research Article

EVALUATION OF THE IMMEDIATE EFFECT OF ANULOM VILOM PRANAYAMA ON AUTONOMIC FUNCTIONS DURING PRE-MENSTRUAL PERIOD IN YOUNG UNMARRIED FEMALES

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ABSTRACT

Objective: Pre-menstrual stress (PMS), or pre-menstrual tension, comprises the recurring cyclic manifestation of a cluster of distressing physical, psychological, or behavioral alterations during the luteal phase of the menstrual cycle. Nearly, 80% of women do experience some type of pre-menstrual changes during their reproductive period. Until date, only non-pharmacological interventions, such as aerobic exercises, relaxation, and meditation are helpful in relieving pre-menstrual symptoms.

Methods: During the first stage of the study, descriptive questionnaire method was used, to know the prevalence of PMS among the subjects. At the second stage, the method used was observational design and it was used before and after the yoga test. Subjects were selected for observational study based on the past menstruation period and included baseline and post-yoga tests to know the immediate effects of Anulom Vilom Pranayama on autonomic functions during the pre-menstrual period among unmarried females. The effect of Anulom Vilom Pranayama on autonomic functions in unmarried females on the PMS, health-related quality of life, and related physiological variables were examined. The statistical analysis was done by the SPSS 9 (the Statistical Package for the Social Science) software.

Results: A highly significant improvement was observed in frequency domains of HRV, with an overall marked reduction in the LF/HF ratio. Significant improvement in the E/I ratio was noted after Anulom Vilom.

Conclusion: The results of this study demonstrate that Anulom Vilom Pranayama training significantly improves selected variables among unmarried females. Even a single session of Anulom Vilom pranayama is beneficial in reducing PMS.

Keywords: Pre-menstrual stress, Anulom Vilom, Deep breathing, Autonomic, Yoga.

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INTRODUCTION

One in three women suffers from discomforting symptoms before their periods. Pre-menstrual period is a period between 1 and 7 days before the start of menstruation. PMS, or pre-menstrual tension, comprises the recurring cyclic manifestation of a cluster of distressing physical, psychological, or behavioral alterations during the luteal phase of the menstrual cycle. These disruptions often impede the social, familial, or occupational activities of females [1].

PMS is commonly found in women who are in between 25 and 45 years of age, especially in the ones who have a positive family history of PMS and depression. According to an estimate, 80% of women do experience some type of pre-menstrual changes during their reproductive period [2,3].

The female sex hormones, estrogen, and progesterone start falling down after ovulation. The brain gets affected with changing levels of neurotransmitters and brain chemicals. Serotonin and dopamine are such neurotransmitters. Sleep, motivation and mood are affected by these chemicals. Irritability, sadness, sleep problems, anxiety, and food cravings can occur because of the decreased levels of serotonin and dopamine. These all are common symptoms of PMS [4].

Until date, there is no definite pharmacological treatment of PMS but non-pharmacological interventions, such as aerobic exercises, relaxation, and meditation are helpful in relieving pre-menstrual symptoms [5].

PMS constitutes one among the myriad stressors impacting the body under various stressful circumstances. During this period, an autonomic imbalance ensues within the body, characterized by heightened sympathetic activity alongside diminished parasympathetic activity. This has been confirmed by studies [6].

The tests which are used to know the autonomic imbalance are autonomic function tests, which are described below [7].

1. Tests for sympathetic functions
   a) QT: QS2 ratio
   b) Sympathetic skin response
   c) Cold pressure response
   d) Hand grip test (isometric exercise)
2) Tests for parasympathetic functions:
   a) Standing test
   b) 30:15 ratio
   c) Valsalva ratio
   d) Tachycardia ratio
   e) Deep breathing test

The beat-to-beat variation found in the heart rate (under resting condition) is called as heart rate variability (HRV). Some factors, such as the circadian rhythm, exercise, and environmental factors are known to affect it. The rate at which the primary pacemaker, the sinoatrial node, sends out electrical signals is the deciding factor for the heart rate and its beat-to-beat variation. The beat-to-beat variation occurs by continuous changes in the sympathetic and parasympathetic outflow of

the heart. HRV is influenced by vagal activity to a large extent. Hence, this is a sensitive indicator of the autonomic system.

It reflects the regulatory influences of the two divisions of the autonomic nervous system (i.e. sympathetic and parasympathetic divisions) on the cardiovascular system. In stress, there occurs an increase in low-frequency HRV power which reflects an increase in sympathetic stimulation. On the other hand, activation of parasympathetic efferent increases HRV [6].

HRV is a good and reliable indicator of psychological stress. The limbic system mediates the effects of stress on the hypothalamus, resulting in variations in HRV by affecting the autonomic nervous system. HRV denotes the changes in the duration of heartbeat intervals, indicating the heart's adaptability to diverse environmental and physiological factors [8].

Quantification of HRV is done by two methods: Time domain and Frequency domain. Frequency domain analysis is a complex analysis technique that shows how much of a signal lies within one or more frequency bands (ranges).

Frequency domain HRV metrics include:
- High-Frequency power (HF): denotes the frequency activity within the 0.15–0.40 Hz
- Low-Frequency power (LF): denotes the frequency activity spanning the 0.04–0.15 Hz.

LF/HF Ratio: a measure quantifying the balance between LF and HF components. This ratio is considered as the indicator of the equilibrium between the functions of the two divisions of ANS [9].

Parasympathetic activity (E: I Ratio using deep breathing test)
Sinus arrhythmia is the normally found variation in heart rate (HR) with inspiration and expiration. With inspiration, the HR increases while with expiration, the HR decreases. The vagal nerve supply to the heart mediates this phenomenon. Hence, this test checks the integrity of parasympathetic functions. The variation of more than 18 beats/min is normal and the increased value denotes the increased vagal tone [10].

AIMS AND OBJECTIVES

To study the immediate effect of Anulom Vilom Pranayama during pre-menstrual period on:
1. Frequency domain analysis on HRV (using Physio Pac HRV analytic equipment)
2. Parasympathetic activity (E: I ratio using deep breathing test)

METHODS

Study design
Interventional study.

This study was conducted in the Department of Physiology, Shree Guru Gobind Singh Tricentenary Hospital, SGT University at Chandu Budhera, Gurugram.

Design of the study- During the first stage of the study, descriptive questionnaire method was used, to know the prevalence of the PMS among the subjects. At the second stage, the method used was observational design and it was used before and after the yoga test that was totally based on the inclusion and exclusion criteria. 200 girls, between the age group of 18–25, were taken for this study. Subjects were selected for observational study based on the past menstruation period and had included baseline and post-yoga tests to know the immediate effects of Anulom Vilom Pranayama on autonomic functions during the pre-menstrual period among unmarried females. The effect of Anulom Vilom Pranayama on autonomic functions in unmarried females on the PMS, health-related quality of life, and related physiological variable were examined.

Sample description
In this study, 180 unmarried females between the age of 18–25 years who participated in this study according to their own will (assuring they all meet the inclusion criteria). In the pro forma, their age, height, weight, and body mass index (BMI) were recorded.

BMI was calculated as follows: weight (kilograms)/height^2 (meters).

Those subjects were excluded from the study who were found to be unable to do the yoga asanas because of any reason.

Written informed consent was taken from the subjects, along with detailed menstrual history. Then pre-menstrual phase was calculated as 5 days before the start of the next menstruation. If the day of investigation happens to be a holiday/Sunday, then the successive working day for the study was finalized.

Participants were well informed before carrying out the study, about the purpose of the study and all the steps involved. Subjects were explained about their role in the study. Participants were assured of withdrawal from the study at any time they wished and their information would be kept confidential. Informed written consent was taken from each and every participant. The approval to carry out the study was taken from the Institutional Ethical Committee.

Inclusion criteria
1. Unmarried females aged 18–25 years.
2. History of regular menstrual cycle.
3. Should not have used any contraceptive pills.

Exclusion criteria
1. Medical or psychiatric illness.
2. Undergone any prior athletic program. Meditation or biofeedback relaxation techniques.

Equipments
- Aneroid Sphygmomanometer
- Height measuring tape
- Weight measuring instrument
- A clock or stopwatch
- Physio Pac HRV analytic equipment

Tools used
The following tools were used to collect data for dependent variables:
1. To measure PMS, the tools used were: the Moos Menstrual Distress Questionnaire (MMDQ) constructed by Rudolf. H. Moos (1968) revised 4th Edition, 2010 (Purchased Questionnaire) was used for measuring pre-menstrual syndrome (Moos, 2010).

Scales of MMDQ: psychological symptoms, pre-menstrual problems, emotional affect, and scoring was based on yes, no, and sometimes.

2. The tools used for the measurement of Physiological Variables:

The tool used for measuring resting heart rate (RHR): Physio Pac HRV analytic equipment was used to measure RHR.

MMDQ: MMDQ (Moos, 2010) is a standardized form constructed by Rudolf. H. Moos (1968). Basically, MMDQ has three columns that were self-reporting by itself to measure symptoms that were linked with menstrual, pre-menstrual, and intermenstrual stages. A description of symptoms classified into two categories (15 items) was included in the questionnaire.

Description of the test
One of the regular methods to know and examine the cyclic pre-menstrual period is MMDQ. The MMDQ was one of the best choices to analyze the behavioral and affective responses of girls. MMDQ is a questionnaire having 15 items and that is used for examining and

treating the menstrual and pre-menstrual symptoms on a level of present/absent.

Administration of the test

The MMDQ was answered by unmarried females before the Anulom Vilom was performed. Based on their previous month's menstrual cycle experiences, they had to fill out this questionnaire. MMDQ forms were checked and the respondents were asked to complete any missing items. If a student did not answer any item on any scale, it was replaced with the mean score of all the answered items.

Scoring and interpretation

The individual's responses for the pre-menstrual phase were recorded. Participants were asked to present the severity of each symptom as none, mild, moderate, strong, or severe on the basis of present/absent.

DESIGN OF THE STUDY

The design of this study is shown in Fig. 2.

Statistical analysis

With the help of the SPSS (the Statistical Package for the Social Science) software, the statistical analysis was done. All the data were expressed as Mean±SD of the mean. The $p<0.05$ was taken to be significant. The $p<0.01$ was taken to be highly significant. The $p<0.001$ was taken to be very highly significant.

Method of collection of data

180 Volunteer unmarried females were selected, taken into account the inclusion criteria and exclusion criteria. A separate ID was denoted for each volunteer. A brief history of volunteers was taken and filled in the information chart. Subjects were explained about the whole procedure, including how to do Anulom Vilom Pranayama in detail. They were also motivated before the start of the study. Their detailed menstrual history was noted. The subjects were asked to report on the day, 5 days before the next expected menstruation cycle. The subject was asked to take a very light breakfast, 2 h before reporting for the study. She was asked to reach the Department of Physiology, at 10:00 am sharp on the specific day/date. The pro forma that included the other parameters: Age, weight, height, and BMI were filled by all the subjects. The temperature of the room was adjusted in the comfortable zone (25–28°C). After reaching the recording room, the subject was made to relax and have rest, for about 10 min. A demographic questionnaire and a questionnaire on PMS namely MMDQ was given to the subjects. The physiology of menstruation and the definition of PMS, along with the symptoms of PMS listed in the questionnaire were explained to the subjects. Then they were assured about the non-disclosure of their information.

Steps of Anulom Vilom Pranayam

This was a very easy and simple Pranayama in which the subject firstly was made to sit in padmasana, keeping her hands on her knees, and closing her eyes. Then she was asked to close her right-sided nostril with the right thumb and inhale gradually through her left nostril to allow the maximum air to be filled in the lungs. Then her right thumb was removed from the right nostril and her right middle finger was used to close the left nostril and the subject would exhale through her right nostril. After that, she was to inhale through the left nostril only and this process was repeated for 20 min. After Anulom Vilom Pranayama was over, the following recordings were again recorded.

In this study, Physio Pac HRV analytic equipment was used for HRV recording and analysis. HRV was measured over any length of recorded ECG in the supine position, for 10 min of ECG recorded to get the sympathetic and parasympathetic tone.

Expiration-inspiration ratio (E: I ratio)

In the lying down position, ECG lead settings were done. The baseline HR of the subject was recorded. Then she was instructed to take a deep breath at about six breaths/min, which would take around 5 s each of inspiration and expiration. Throughout the period of deep breathing, the recording of ECG in lead II was taken. Marker was used to denote the start of the inspiratory and expiratory phases.

Thereafter, during expiration, the longest R-R interval and during inspiration, the shortest R-R interval with each respiratory cycle

Psychological symptoms	Cognitive symptoms	Physical symptoms
Irritability	Forgetfulness	Breast tenderness
Mood swings	Decreased concentration	Bloating
Depressed mood		Fluid retention
Crying spells		Constipation
Low self-esteem		Hot flashes
Anxiety		Headaches
Sleep disturbance		Musculoskeletal discomfort
Increased appetite		Acne
		Rhinitis
		Palpitations

Fig. 1: Classification of PMS symptoms[2,3]

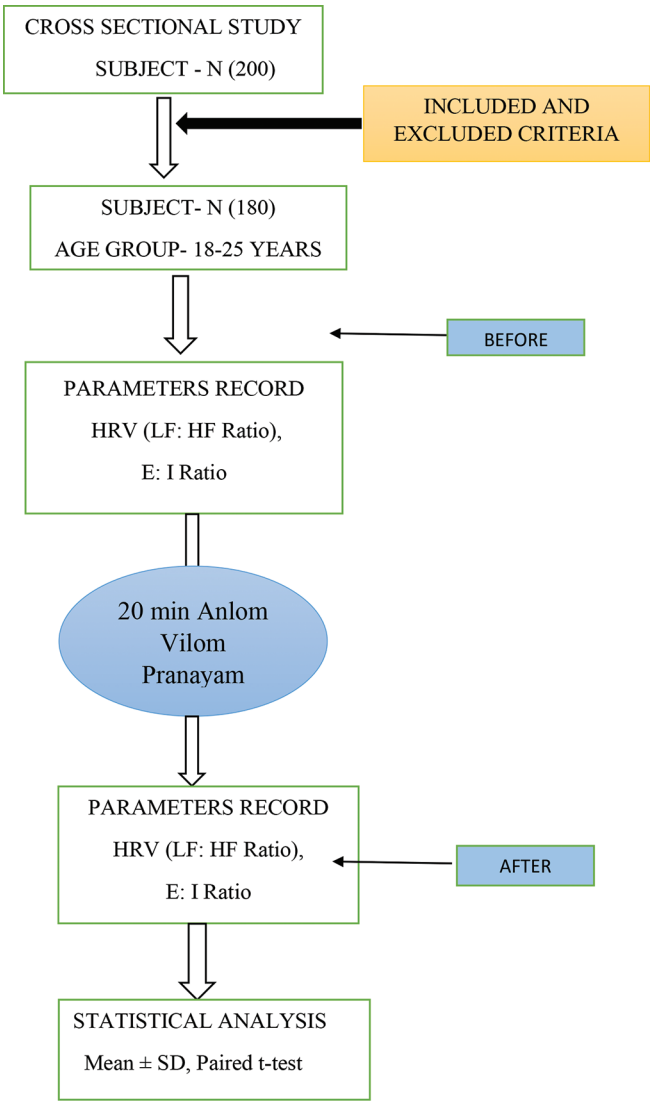

Fig. 2: Study design

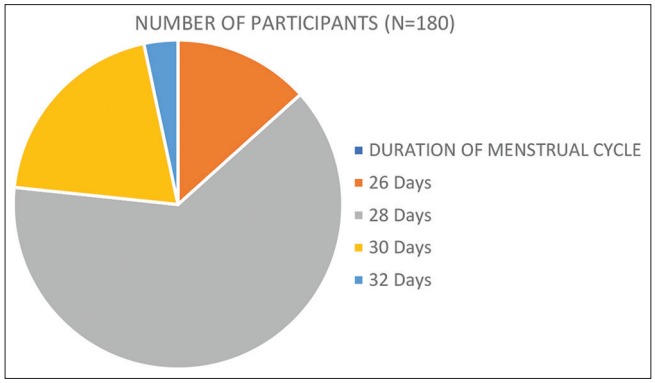

Fig. 3: Pie chart depicting the distribution of the subjects depending upon the duration of menstrual cycle

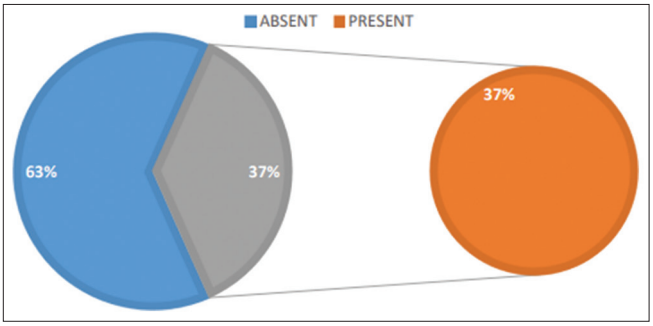

Fig. 4: Pie of pie chart depicting the distribution of the subjects depending upon the dysmenorrhoea present or absent

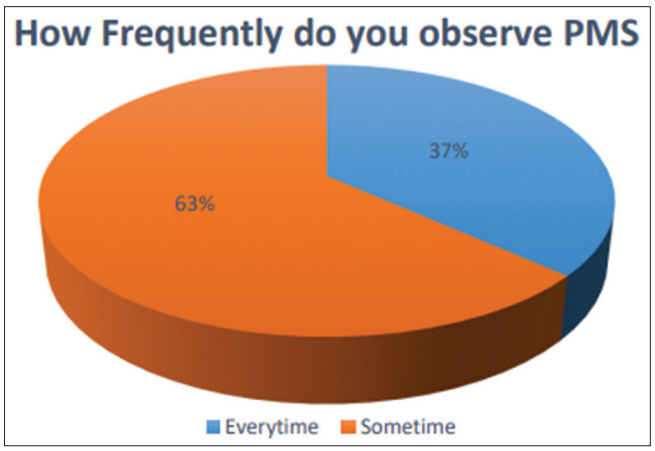

Fig. 5: 3D Pie chart depicting the distribution of the subjects depending upon the frequency of PMS

Table 1: Distribution of the subjects depending upon their age group

Age group	No. of subjects	Percentage
18–20 years	77	42.77
21–23 years	90	50.00
24–26 years	13	7.22

were calculated. The formula for the calculation of the E: I ratio was:

E: I Ratio= Longest R-R interval during the expiratory phase/Shortest R-R interval during the inspiratory phase.

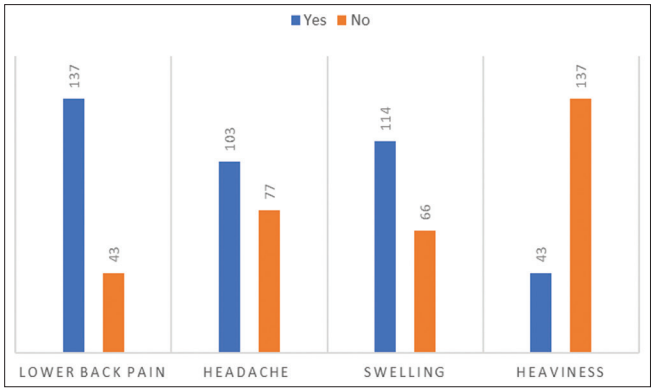

Fig. 6: Clustered column graph depicting the distribution of subjects depending upon the premenstrual symptoms

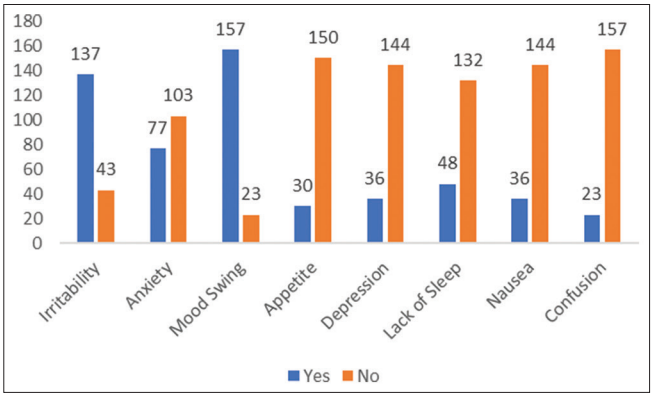

Fig. 7: 3D Clustered column graph depicting the distribution of subjects depending upon the psychological symptoms

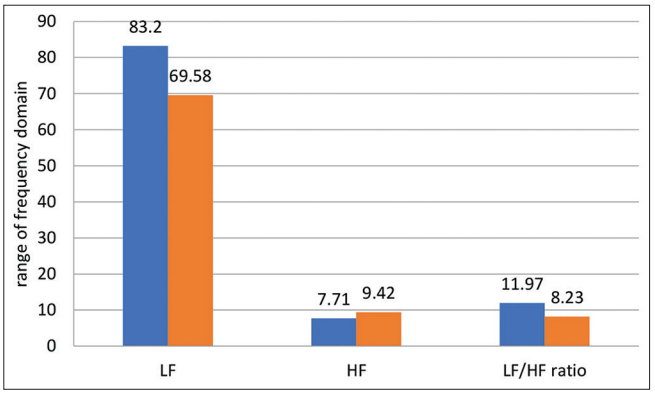

Fig. 8: 3D Combined clustered column graph showing the mean values of frequency domains before and after anulom vilom

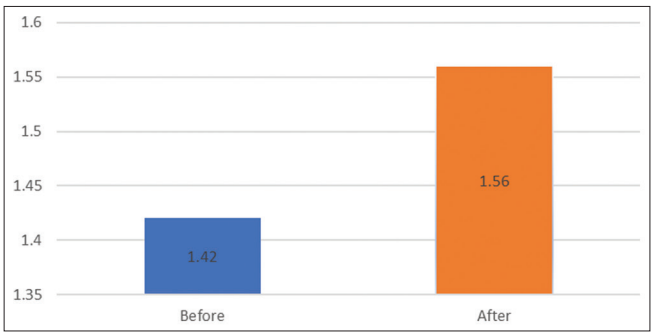

Fig. 9: 3D Clustered column graph showing the mean values of E/I ratio before and after anulom vilom

Table 2: Distribution of the study participants according to the menstruation flow

Menstruation flow	Number of participants (n=180)	Percentage
Heavy	18	10
Low	36	20
Normal	126	70

Table 3: Comparison study before and after Anulom Vilom Pranayama effects on LF, HF, and LF/HF ratio parameters

Frequency domain	Mean±SD (before)	Mean±SD (After)	t-value	p-value
LF	83.2±9.64	69.58±11.36	7.21	<0.001
HF	7.71±3.10	9.42±3.29	4.59	<0.001
LF/HF ratio	11.97±3.42	8.23±2.98	7.5	<0.001

LF: Low frequency; HF: High frequency

Table 4: Depicting the comparison study before and after Anulom Vilom Pranayama effects on E: I ratio parameter

Deep breathing test	Mean±SD	t-value	p-value
E: I Ratio (Before)	1.42±0.05	11.61	<0.001
E: I Ratio (After)	1.56±0.06		

OBSERVATIONS AND RESULTS

Present study was conducted on 180 out of 200 unmarried females. Table 1 shows the distribution of subjects according to age, Table 2 shows distribution according to the menstrual flow. Table 3 shows comparison study before and after Anulom Vilom Pranayama effects on LF, HF, and LF/HF ratio . Table 4 depicts the comparison study before and after Anulom Vilom Pranayama effects on E: I ratio parameters.

Figs. 1-9 shows Classification of PMS symptoms, study design, Pie chart depicting the distribution of the subjects depending upon the duration of menstrual cycle, 3D Pie chart depicting the distribution of the subjects depending upon the frequency of PMS, Clustered column graph depicting the distribution of subjects depending upon the pre-menstrual symptoms, 3D Clustered column graph depicting the distribution of subjects depending upon the psychological symptoms, 3D Combined clustered column graph showing the mean values of frequency domains before and after Anulom Vilom, 3D Clustered column graph showing the mean values of E/I ratio before and after Anulom Vilom , respectively. A highly significant improvement was observed in frequency domains of HRV, with an overall marked reduction in the LF/HF ratio. Significant improvement in the E/I ratio was noted after anulom vilom.

DISCUSSION

Frequency domains analysis

The present study conducted an analysis of frequency domain variables. A highly significant improvement was observed in these domains, characterized by a substantial decline in LF and a corresponding increase in HF components. Consequently, there was an overall marked reduction in the LF/HF ratio. These findings align with previous studies by Chandla *et al*. and Shinba *et al*. (2020), wherein a three-month practice of yoga demonstrated similar results. These results signify a shift towards parasympathetic activity, indicating the impact of slow breathing pranayama on sympatho-vagal balance [11,12] Shinba *et al*. (2020) also noted an increase in the LF domain, suggesting that yoga induces autonomic modulation, thereby normalizing LF [11].

Another study by Landen *et al*. (2004) evaluated time and frequency domain variables concerning PMDD (premenstrual dysphoric disorder). It was observed that during the follicular phase, supine HF was lower in PMDD subjects compared to controls [13]. Tinju (2020) observed augmentation in sympathetic activity during the secretory phase and a corresponding rise in vagal activity during the proliferative phase, attributed to fluctuating sex hormone levels [14].

Deep breathing test

Deep Breathing Test is well explained upon the point of respiratory sinus arrhythmia, whereby the heart rate increases during inhalation and decreases during exhalation. Significant improvement in the E/I ratio was noted after Anulom Vilom, consistent with findings by Kanjoia *et al*. regarding alterations in autonomic function and psychological status during the pre-menstrual phase in contrast to the post-menstrual phase. Regular yoga practice demonstrated beneficial effects by promoting parasympathetic-dominance and balancing the neuro-endocrinal axis [5].

Seebauer *et al*. evaluated variations in respiratory sinus arrhythmia (RSA) across the menstrual cycle and concluded that different patterns of RSA fluctuations occur depending on the average heart rate level [15]. Chanting the OM Mantra along with Anulom Vilom Pranayama aids in reducing perceived stress (Kumar *et al*., 2020) [16]. In addition, Yoga asanas combined with pranayama techniques are more effective in improving pain, severity of the pain, and quality of life in primary dysmenorrhea compared to either Yoga asanas or pranayama alone (Aggarwal *et al*., 2020) [17,18]. Yoga also decreases the anxiety level and improves the vital signs in women having pre-menstrual syndrome (Ghaffarilaeh *et al*., 2019) [19]. Baat *et al*. (2018) similarly concluded that exercise significantly improves PMS [20].

CONCLUSION

The results of this study demonstrate that Anulom Vilom Pranayama training significantly improves selected variables among unmarried females. It can be inferred that even a single session of Anulom Vilom Pranayama is beneficial in reducing PMS, evident through significant changes in the autonomic nervous system by causing variations in the activity of its two divisions. Further research on daily Anulom Vilom Pranayama during the pre-menstrual phase may elucidate its efficacy in alleviating physical, psychological, and behavioral symptoms of PMS as an adjunct therapy.

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