

COMPARISON OF CARDIAC AUTONOMIC ACTIVITY AND BMI IN DIFFERENT PHASES OF MENSTRUAL CYCLE USING HEART RATE VARIABILITY

Sneha B Shetty*, Sheila R Pai*, Nayanatara AK*, Balachandra Shetty**

ABSTRACT

Aim: The aim of this experiment was to compare the cardiac autonomic activity and BMI in the different phases of menstrual cycle using Heart rate variability.

Context Heart rate variability (HRV) in women has been related independently to endogenous sex hormones, hormone replacement therapy, menopause, menstrual cycle, body mass index (BMI), and physical conditioning .It has become a popular non invasive tool for assessing the activities of autonomic nervous system.

Objectives: The aim of this experiment was to compare the cardiac autonomic activity and BMI in the different phases of menstrual cycle using Heart rate variability

Design: Prospective comparative study during one menstrual cycle.

Study setting A total of 54 female students were selected. The selected students were divided into two Group I (BMI < 20) and Group II (BMI >20) the ECG recording were taken during the 3 phases of menstrual cycle. The analog ECG signal were conveyed through an A/D converter to PC and were analyzed .The frequency domain analysis was done in which the LF, HF and LF/HF components were studied.

Results: In group II (BMI>20) there was a significant increase in the LF/HF ratio in the luteal phase of menstrual cycle when compared to other phases of the menstrual cycle. In group I (BMI < 20) there was no statistically significant difference in LF/HF ratio in the three phases .

Conclusion: Woman between 16-25 years having less BMI had more parasympathetic activity than those with greater BMI. In women with greater BMI cardiac autonomic activity had a predominant sympathetic profile.

INTRODUCTION

The heart is an organ under the influence of the autonomic nervous system for the maintenance of homeostasis, and, in this respect, one of its main characteristics is the constant modification of its rate on beat-to beat basis¹. Also, it should be emphasized that heart rate is a variable that can be measured in a noninvasive manner with minimal error using simple and low-cost equipment. Today, with the aid of digital computers, it has become possible to study beat-to-beat heart rate variability (HRV) obtained from the R-R intervals in the electrocardiogram (ECG) recordings^{2,3,4}. This method has proved to be of great clinical usefulness to evaluate the balance of sympathetic and parasympathetic regulation in several pathological conditions^{5,6,7,8,9,10}. HRV has proved to be a more sensitive tool for the detection of autonomic balance than mean heart rate¹¹

Power spectral analysis of heart rate variability (HRV) has been used as a sensitive index of autonomic nervous activities^{12,13,14,15}. In humans, power spectral analysis of R-R interval variability has revealed that there are two major spectral components: the high frequency (HF) component at the respiratory frequency and the low frequency (LF) component at .03 to .15 Hz. The HF component corresponds to the respiratory sinus arrhythmia and is modulated solely by the parasympathetic nervous system^{14,16,17}, whereas the LF component corresponds to blood pressure oscillations occurring around .1 Hz, (i.e., the Mayer waves) and is jointly modulated by the sympathetic and parasympathetic nervous systems^{18,19}. In addition, the LF/HF ratio is also a useful parameter that reflects the balance of autonomic nervous activities^{20,21}.

Heart rate variability (HRV) in women has been related independently to endogenous sex hormones,

hormone replacement therapy, menopause, menstrual cycle, body mass index (BMI), and physical conditioning²². Physiological effects of menstrual cycle on the autonomic function have been extensively examined²³. Several studies have found variation of symphatho-vagal activities during the menstrual cycle but the results are inconsistent²⁴.²⁵. Few studies have evaluated neurocardiac parameters during the various phases of menstrual cycle²⁶; this would be useful and highly relevant for cardiovascular evaluation of women at higher risk to develop heart disease, thus permitting early intervention.

BMI has traditionally been used to identify individuals who are most likely to be overweight or obese. It is calculated by dividing the weight (kg) by height (meters) squared. Generally high value indicates excessive body fat and consistently relates to increased health risks and mortality²⁷. There is a well recognized relationship between autonomic nervous system function and body habits²⁸. A decrease in parasympathetic nervous system mediated HRV in obesity may in part explain the mortality and morbidity that are associated with the obese state²⁹. Gonadal steroids play a major role in the distribution of body fat. At the onset of puberty women increase their body fat relative to their muscle mass. The distribution of body fat is important clinically in determination of obesity, visceral central adiposity is associated with a greater risk of metabolic & cardiovascular disorders including insulin resistance, type2 diabetes, hypertension & coronary heart disease³⁰. Obesity can be determined by BMI³⁰.

It is questionable that whether in general population low HRV is a consequence of a disease or an indicator of an underlying mechanism for future disease. Several studies suggest that, there are definite changes in the HRV in the different phases of the menstrual cycle³¹ but studies are lagging correlating the cardiac autonomic activity, menstrual cycle and BMI in young females in different phases of menstrual cycle. The present study aims to describe the HRV and assesses its association with BMI, and menstrual cycle in healthy young women in time domain and frequency domain method in different phases of menstrual cycle

MATERIALS AND METHODS:

A total of 54 female students studying their MBBS Course in Kasturba Medical College Bejai, Mangalore were selected. The selected students were in the age group 18-25 years who were having regular, 28-day menstrual cycles for at least 6 months prior to this study. After detailed enquiry of the medical history of the subjects, those with history of smoking, alcoholism, medical illness were excluded. Subjects on oral contraceptive pill, hormonal replacement therapy, drugs that alter the cardiovascular functions were also excluded from the study. Informed written consent was obtained from all participants, and the experiment protocol was approved by Ethics committee of the college.

EXPERIMENTAL PROTOCOL:

The selected students were divided into two group based on their BMI values, Group I (n=25; n denotes the number of individuals in each group) consisted of BMI<20 and Group II (n=29) consisted of individuals having BMI>20.

The ECG recording were taken during the following 3 phases

Menstrual phase (M) – 1st to 5th day of bleeding,

Follicular phase (F) - 6th day to 14th day of menstrual cycle.

Luteal phase (L) - 15th day to 28th day or the next menstrual bleeding.

Heart rate Variability was recorded using Digital data Acquisition system, HRV soft 1.1

VERSION, AIIMS, NEW DELHI. A high quality ECG recording was taken under standardized condition to minimize artifacts. The ECG signal was first analogally recorded & then digitally converted and analyzed in the frequency domain.

The experiments were carried out in the morning in fasting state. Subjects refrained from caffeinated beverages for at least 12 hours prior to the experiments and had completed their evening meal by 9 P.M. they were also instructed to avoid strenuous physical activity from the previous evening. The recordings of ECG of all subjects were

done by the same person of our team in order to avoid any inter-observer error. To quantify heart rate, the analog ECG signal was obtained using lead II to obtain a QRS complex of sufficient amplitude and stable base line. ECG signals were conveyed through an A/D converter to PC and were analyzed offline after visual checking of abnormal ECG. Heart rate variation during normal breathing for a period of 5 minutes was recorded, with subject supine, awake and resting. In the present study, in the frequency domain analysis the two main frequency components that is the low frequency (LF) components (0.04 to 0.15Hz) and the high frequency (HF) components (0.15 to 0.4 Hz) was measured. We have also evaluated and analyzed the ratio LF/HF^{32,33,34,35}.

Statistical analysis: The statistical analysis was done using ANOVA (Analysis of variance), student's unpaired T test, Mannwhitney U test, Tukey's Test. P value was taken as significant at 5 percent confidence level. ($p < 0.05$)

BMI < 20			
	LF	HF	LF/HF
Menstrual	38.5 ± 6.6	61.4 ± 6.63	0.64 ± 0.18
Follicular	39.18 ± 16.86	60.81 ± 16.86	0.76 ± 0.54
Luteal	65.95 ± 1.77	69.70 ± 2.94	0.94 ± 0.04

Table 1: Effect of variation in HRV in the three different phases of menstrual cycle in group I (BMI <20) individuals (n=25)

BMI > 20			
	LF	HF	LF/HF
Menstrual	42.64 ± 23.05	61.05 ± 17.59	0.83 ± 0.79 ^{†††}
Follicular	50.4 ± 17.37	49.59 ± 17.37	1.23 ± 0.66 ^{***}
Luteal	62.74 ± 14.27	37.25 ± 14.27	2.03 ± 1.03

Table 2: Effect of variation in HRV in the three different phases of menstrual cycle in group II (BMI >20) individuals (n=29)

P < 0.0001^{†††} - Menstrual phase compared to Luteal phase

P < 0.0001^{*}** - Follicular phase compared to Luteal phase

	LF	HF	LF/HF Ratio
BMI <20	65.95 ± 1.77	69.70 ± 2.94	0.94 ± 0.04
BMI >20	62.74 ± 14.27	41.11 ± 15.80	2.03 ± 1.03

Table 3: - Effect of variation in BMI on HRV during Luteal phase of menstrual cycle (n=54) in Frequency domain analysis

P < 0.0001^{*}** - Comparison between BMI <20 and BMI >20

RESULTS:

In the present study, the variations of LF, HF, and LF/HF ratio in group I (table 1) showed no statistically significant difference in between the three phases of menstrual cycle. Further in group II (table II) there was a significant increase in the LF/HF ratio in the luteal phase of menstrual cycle when compared to other phases of the menstrual cycle ($P < 0.001$ for both). Analysis of HRV during the luteal phase of the menstrual cycle in between group I and group II (table 3), showed a statistically significant increase in the LF/HF ratio ($P < 0.001$) in group II.

DISCUSSION:

Autonomic regulation of the heart in the normal woman differs during the menstrual cycle. Cardiac autonomic functions can be influenced by multiple factors³⁶. The results of the present study support that BMI plays an important role in the women's cardiac autonomic modulation. Our results clearly demonstrated a significant difference in the autonomic nervous activity in the luteal phase of the menstrual cycle in young females with increased BMI.

Power spectral analysis of HRV has more sensitivity in assessing the slight fluctuation of autonomic activities during menstrual cycle³⁷. Our previous study provides findings that autonomic nervous activities fluctuate during Menstrual cycle. Luteal phase of MC was associated with a significant increase in the LF component and a significant decrease in the HF component, resulting in a high LF/HF ratio. Our findings were in agreement with earlier work who observed that sympathetic nervous activities are predominant in the luteal phase as compared with follicular phase^{38, 39}.

In this study BMI was a major determinant of cardiac autonomic nervous modulation. Women between 16-25 years having less BMI had more parasympathetic activity than those with greater BMI. In women with greater BMI cardiac autonomic activity had a predominant sympathetic profile. LF/HF ratio is the most sensitive indicator of sympathovagal balance⁴⁰. In the present study increase in BMI showed a higher increase in the LF/HF ratio in the luteal phase of the menstrual cycle, this indicated presence of sympathovagal imbalance (SVI).

In summary, this study has shown that women with increased BMI had significant changes in autonomic nerve function that included reduced parasympathetic control and elevated sympathovagal modulation. Even though these women did not come under the obese group, they are more prone to become obese. Clearly more work is needed to explore this relationship at the later age. It is well established that a lower heart rate variability is associated with increased cardiovascular morbidity. Detection of sympathovagal imbalance at an early age based on BMI and necessary life style modification could decrease the incidence of cardiovascular diseases.

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Authors :

1. Sneha B Shetty, Sheila R Pai, Nayanatara AK
Departments of Physiology,
Center for Basic Sciences,
Kasturba Medical College (Manipal University) Bejai,
Mangalore-575004, Karnataka, India.
2. Balachandra Shetty,
Professor,
Department of Medicine, A.J. Institute of Medical Sciences,
Mangalore, Karnataka, India