Original article:

Influence of low BMI on resting heart rate in different phases of menstrual cycle

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ABSTRACT:

Introduction: Menstrual cyclicity is one of the physiological challenges in a normal individual which is accompanied with variations in autonomic functions. Resting heart rate is a non-invasive marker of cardiac health and frequently used during the evaluation of the functional condition of a person . Different factors like hormones, stress, body mass index etc that influence different phases of menstrual cycle also modulate resting heart rate.

Aim & objectives: The aim of this study was to assess the influence of low BMI on resting heart rate (RHR) in different phases of the MC in healthy females.

Methodology: Sixty (60) randomly selected Female subjects of age group 18-25 years were chosen. The study subjects were classified into two groups: Group I - Subjects with BMI in between 18.5 to 24.99 kg/m^2 (n=30, Normal BMI) and Group II - Subjects with BMI < 18.5 kg/m^2 (n =30, Low BMI). The participants made three visits to the laboratory; one in each phase of the cycle (follicular, ovulatory, and luteal). The RHR was evaluated during a 10-min period in the supine position, and was considered the lowest value recorded by the heart rate monitor. Statistically significant difference with an increase in resting heart rate in Low BMI group as compared to normal; maximum in luteal phase of menstrual cycle was obtained.

Results: The results suggests that the imbalance of the ovarian hormones due to low BMI affects the cardiac autonomic activity, indicated by increased resting heart rate .

Key words: Resting heart rate, Body mass index, Menstrual cycle.

INTRODUCTION

Menstrual cyclicity is one of the physiological challenges in a normal individual.[1] Different phases of menstrual cycle are accompanied by variations in autonomic functions upto different degrees. So any factor which causes disruption of the pattern of menstrual cyclicity in an individual shall also be reflected in her autonomic activity.[2]

Heart rate (HR) is modulated by the autonomic nervous system through its sympathetic and vagal branches. The HR control and response follows a well-defined pattern both at rest and during exercise.[3,4,5] This autonomic control is an important indicator of health, because adults with autonomic dysfunction have higher all-cause and cardiovascular mortality rates. [6,7,8,9,10,11,12] Resting heart rate (RHR) is frequently used during the evaluation of the functional condition of a person. The resting values determine have a direct relation to a person's intensity of aerobic training.[13] In addition, the RHR is an independent predictor of mortality.[9,10,12,14] Intrinsic and extrinsic factors can modify the

behavior of RHR, including body temperature.[15,16] During the ovulatory phase of the MC, there is an increase in body temperature[17], which could change the values of RHR. Number of host and environmental factors also influence menstrual patterns like strenuous physical exercise, psychosocial stress, low body fat, endocrine disturbances and lifestyle factors. All these factors may perturb menstruation resulting in autonomic disturbances and thus resting heart rate. Body fat plays a significant role in reproduction and both the extremes of the weight distribution have deleterious effects on menstrual cycle and infertility.[18,19,20] As the population of underweight girls in India is substantial and as mentioned that these girls are more prone for modulation of autonomic system, so the present study is carried out to explore variations in resting heart rate relating different phases of menstrual cycle with body mass index.

Aims & objectives

Aim- To evaluate the influence of low BMI on resting heart rate in different phases of menstrual cycle.

Objectives

1. To assess the effect of low BMI on resting heart rate of young healthy females of normal and low BMI during menstrual, follicular and luteal phases of menstrual cycle.
2. To compare the effect of low BMI on resting heart rate between normal and low BMI females in different phases of menstrual cycle and to find out correlation, if any, between the same.

Methodology

Sixty (60) randomly selected Female subjects of age group 18-25 years were chosen. On the basis of International Classification of underweight, overweight and obesity in adults **,** the study subjects were classified into two groups:

Group I- Subjects with BMI in between 18.5 to 24.99 kg/m^2 (n=30, Normal BMI)

Group II- Subjects with BMI < 18.5 kg/m^2 (n =30, Low BMI)

Known history of diabetes, hypertension, heart disease or any other medical complications and taking medications which might influence their autonomic functions and BMI were excluded. The subjects were also asked to refrain from drinking coffee and alcohol and engaging in physical exercise 8 and 24 hrs, respectively, prior to the assessments. All evaluations were done in the afternoon. Prior to the commencement of the study ethical clearance was obtained from the Institutional Ethical Committee. The participants were informed well in advance about the aims, objectives and protocol of the study and they were asked for their willingness to participate in the same. Those willing to participate in the study were asked to fill the written informed consent form**.**

Procedure

All the subjects were evaluated for the parameters in one sitting. A general physical examination including height and weight and a detailed menstrual history along with subject's physical activity level was obtained. Menstrual cycle characteristics was self-reported.

Subjects were asked to remove clothes except for light personal clothing. Shoes were also removed. Height and weight were recorded to the nearest 0.1 cm and 0.1 kg respectively. Height was recorded

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after the subject was standing erect with the head held in horizontal Frankfurt's plane. BMI was computed from height and weight using standard formula (Weight in kg / height in meters^2).

The time durations for different phases of menstrual cycle is as follow:

1. Menstrual phase: 1st to 5th day of bleeding.
2. Follicular phase: 6th day to 14th day of menstrual cycle.
3. Luteal phase: 15th day to 28th day or the next menstrual bleeding.

In subjects having variations in the duration of menstrual cycle the phases were calculated by considering 14 days duration fixed for luteal phase.

Resting Heart Rate

The participants' RHR was recorded using **RMS POLYRITE D MACHINE** during 10-min in the supine position.

STATISTICAL ANALYSIS

Data was collected in Microsoft Excel; mean, standard deviations of all variables were calculated. Unpaired t-test was performed in both the groups and also for the intra- and inter-phasal comparison of resting heart rate in both the groups.

Pearson (Linear) Correlation was applied to find correlation in BMI and heart rate.

RESULTS

Table 1

Distribution of values of anthropometric parameters in Normal and Low BMI groups

Parameter	Normal BMI (Mean ± SD)	Low BMI (Mean ± SD)	Unpaired T-test	
			t- value	p-value
Age	18.73±.86	18.23±.77	2.37	0.02
Weight	51.8±4.8	40.3±4.7	9.37	0.0001
Height	158.4±5.3	157.08±5.37	0.95	0.34
BMI	20.6±1.51	16.43±1.66	10.17	0.0001
Age at menarche	13.4±1.77	13.63±1.06	0.61	0.54

Above table shows Statistically significant difference in weight and BMI in low BMI group as compared to normal BMI.

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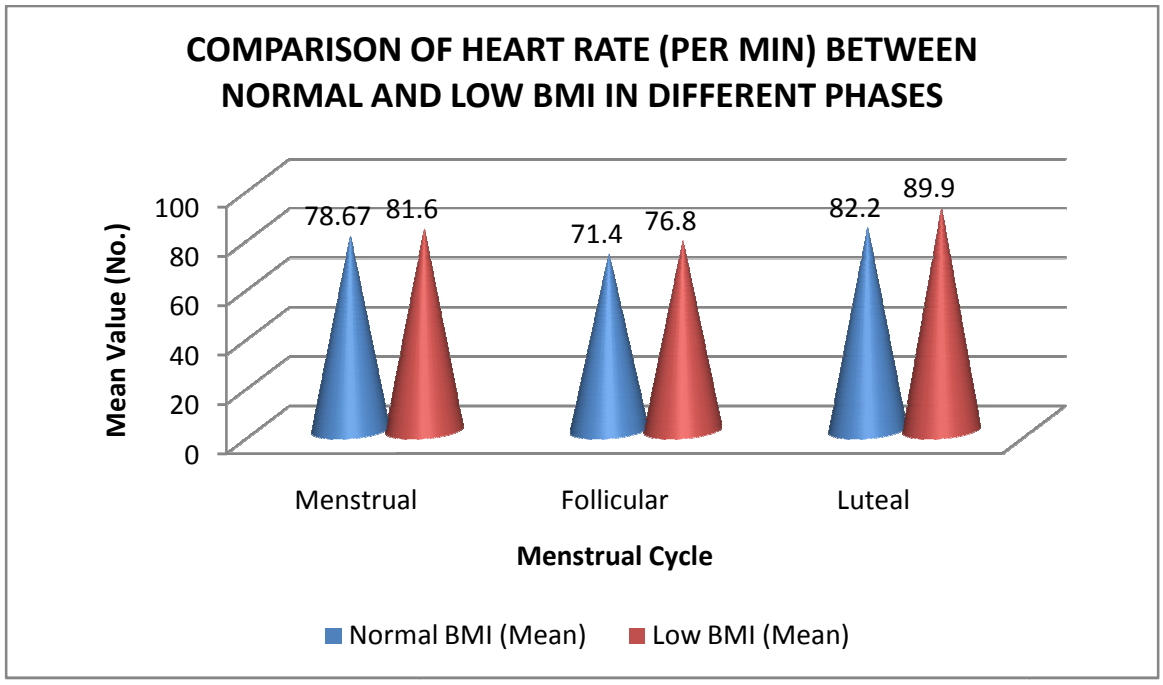
Table 2

Comparison of Resting Heart rate (per minute) between Normal and Low BMI groups in different phases

Menstrual cycle	Normal BMI (Mean ± SD)	Low BMI (Mean ± SD)	Unpaired T-test	
			t- value	p-value
Menstrual	78.67±7.25	81.6±8.42	1.42	0.14
Follicular	71.4±7.08	76.8±8.14	2.7	0.0079
Luteal	82.2±7.28	89.9±6.68	4.2	0.0001

Statistically significant difference with an increase in heart rate in Low BMI group as compared to Normal BMI group; maximum being in luteal phase of menstrual cycle. On applying **Pearson Correlation** the r-value came out to be **Negative(-0.6)** showing significant negative correlation between BMI and heart rate indicating that BMI is inversely proportional to heart rate.



Discussion

It was observed in the present study that resting heart rate varies in different phases of menstrual cycle in relation to BMI. A significant increase in resting heart rate in the luteal phase was found in both the groups. However the lower BMI group showe a

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greater increase in resting heart rateas compared to normal BMI girls

Influence of low BMI on Cardiac Autonomic Control

Individual's body fat content is known as an important variable in influencing the autonomic neural reactivity. The BMI has been reported as the second major determinant of autonomic nervous modulation in an individual while age per se remains the primary determinant.[22] The lower BMI group showed a greater increase in resting heart rate as compared to normal BMI girls. These findings were in consistent with many of the previous studies.[23,24] Jern MK et al[25] observed that heart rate and blood pressure were significantly greater in the luteal phase. Similar were the findings of Palmero F[26] and Yildirir Aylin et al.[27] Our findings are in consonance with these studies. It seems that the alteration in the balance of ovarian hormones might be responsible for the observed changes in the autonomic functions affecting heart rate and blood pressure.

Ishizawa et al[28] and Petretta M et al.[29] in their studies found increased heart rate in thin young low BMI women and according to them it was due to reduced parasympathetic responsiveness and increased cardiovascular sympathetic responsiveness.

Magdalena S et al[30] observed pronounced changes in the heart rate during menstrual cycle with minimum changes in follicular and maximum in luteal phase. According to them change depend on the vagal tone and high estrogen levels in these phases accompanied with decreased sympathetic nervous activity.

On the contrary in others authors[31,32] found no difference in the heart rate variability across the phases of menstrual cycle. Their findings might be due to less number of subjects and different methods used in assessing autonomic activity.

Influence of Menstrual Cycle on Cardiac Autonomic Control

The gonadal hormones fluctuations during the menstrual cycle is associated with significant changes in multiple neuro-humoral homeostatic mechanism of the body.[33] Previous studies have shown that the MC can modify the cardiac autonomic control. Leicht et al.[34] showed that higher values of RHR occur during the ovulatory phase of the cycle in comparison to the follicular and luteal phases. In their study, the authors found a significant correlation between peak estrogen levels and cardiac vagal activity. In addition, Bai et al.[35] demonstrated through HR variability that the high-frequency (HF) components decreased from the follicular phase to the luteal phase while the low-frequency (LF) components, the LF/HF ratio, and RHR increased. According to the authors, the follicular phase is characterized by enhanced vagal activity and the luteal phase is characterized by enhanced sympathetic activity. This istudy is in agreement to our study.

In contrast, Sato et al.[36] observed through power spectral analysis of HR variability that sympathetic nervous activities are predominant in the luteal phase when compared to the follicular phase,however , it didn't change the RHR. In this context, Tanaka et al.[37] demonstrated that baroreflex control of HR is altered during the regular MC in healthy women, but it had no effect on RHR.

The literature shows that high values of RHR increase the risk of mortality. Another practical application of RHR values is during a physical exercise prescription. The RHR is used in the HR reserve equation by Karvonen et al.[38] Therefore, any phenomenon that is likely to influence cardiovascular

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control is an important research question that should be elucidated.

CONCLUSION

We conclude that the alteration in the balance of the ovarian hormones affecting cardiac autonomic activity might be responsible for the increase in resting heart rate. However , BMI is one of the major determinant of cardiac autonomic modulation in females since it affects the levels of ovarian hormones.

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