STUDY ON THE VARIATION OF BLOOD PRESSURE DURING DIFFERENT PHASES OF MENSTRUAL CYCLE AMONG THE HEALTHY FEMALE STUDENTS OF A MEDICAL COLLEGE IN KATHMANDU, NEPAL.

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ABSTRACT

Blood pressure (BP) can vary in response to different factors such as stress, emotion, body position, and body temperature. This study is aimed to explore BP and heart rate variations in different phases of menstrual cycle, which are not well-documented. A cross-sectional, observational study was conducted on 65 consenting first year undergraduate students of Nepal Medical College, Kathmandu, Nepal. Students' BP was measured in menstrual, follicular and luteal phases which were taken on 2-4 days, 10-12 days, and 22-24 days respectively from the first day of the last menstrual period. Students age range was 18 to 21 years and their BP were within normal limits in all occasions. Their average menstrual cycle length was 28 days. Mean systolic BP were 106.65 ±9.23, 109.45±9.12, and 108.46±8.78 mmHg; diastolic BP were 67.66±8.18, 67.28±8.69, and 64.51±7.75 mmHg; and HR were 73.26±5.85, 72.92±5.6, and 72.8±4.92 per minute in menstrual, follicular, and luteal phases respectively. Compared to other phases, significantly low values were recorded for systolic BP in menstrual phase (p=0.005) and diastolic BP in luteal phase (p=0.001); HR differences were not significant. The significant variations in BP in different phases of menstrual cycle may have implications in antihypertensive treatment in females of reproductive age, requiring considerations in dose adjustments.

KEYWORDS

Blood pressure, heart rate, menstrual cycle, ovarian hormones

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INTRODUCTION

Menstrual cycle is divided into three phases – menstrual, in which the hormones levels wane away; follicular, in which estrogen levels are high; and luteal, in which the corpus luteum releases large amounts of progesterone. Therefore, rhythmic changes occur in the levels of ovarian hormones in the menstrual cycle, especially of progesterone and estrogen.[1,2] The effects of ovarian hormones on the uterine endometrium as well as their contribution to the appearance of secondary sexual characteristics on a female body are established. However, their effect on other organ systems are not well documented.[3] Premenopausal women are at lower risk of developing hypertension and coronary heart disease than men of the same age and thus the cardiovascular risk increases after menopause in women.[4] Changes in blood pressure occurring in young women during different phases of the normal menstrual cycle have been reported inconsistently. Greeenberg *et al* (1985) recorded higher systolic BP at the luteal phase than in other phases.[5] Kelleher *et al* (1986) found a significant increase in systolic BP in a week before menstruation in a similar prospective study.[6] Chapman *et al* (1997) found significant decrease in mean arterial pressure during mid-luteal phase which was associated with a decrease in systemic vascular resistance and increase in cardiac output.[7] But the results of Pai *et al* (2004) and Usha Rani *et al* (2013) contradicted the earlier findings as their studies did not find significant changes of blood pressure during different phases of menstrual cycle.[3,8]

Rylance *et al* (1985) found that natural progesterone when given orally to a group of men and postmenopausal women, caused significant reduction in erect diastolic blood pressure and mean arterial blood pressure when compared to the pretreatment readings, suggesting antihypertensive action of progesterone.[9] Barbagallo *et al* (2001) claimed evidence to the possible mechanism of action of progesterone on blood vessels that it decreases the pressor response of norepinephrine and also modulates the calcium channel.[10]

Thus, the reports on variation of blood pressure during different phases of menstrual cycle are conflicting. Such a study has not been reported on Nepalese population. This study aims to explore blood pressure variation related to menstrual cycle among selected healthy Nepalese female students. Many studies have reported higher mean arterial blood pressure in women taking oral contraceptive pills.[11-12] Knowledge of blood pressure changes during different phases of menstrual cycle may be useful to prevent hypertension in oral contraceptive pills users.

MATERIALS AND METHODS

The study was conducted on the female students of the first phase undergraduate medical/dental program at the Nepal Medical College in a duration of 4 months (September, 2017-November, 2017). Irregular menstrual history, associated menstrual problems such as menorrhagia and dysmenorrhea, premenstrual symptoms, history of use of hormonal preparations including contraceptive pills, hypertension, cardiovascular disorders, diabetes mellitus, thyroid dysfunctions, febrile conditions, and use of any medications at the time of recording were the exclusion criteria.

Participants were advised to avoid high salt diet, heavy strenous exercises, and stressful activities on the day of recording. After getting informed written consent, a detailed menstrual history was obtained. Height was measured using a wall-mounted height scale, with no shoes and cap; weight was measured with a digital weight scale with minimal comfortable clothings. Body mass Index (BMI) was calculated as weight in kilograms divided by square of height in meters (kg/m^2). After appropriate resting time, heart rate (HR) from radial arterial pulse, systolic blood pressure, SBP; and diastolic blood pressure, DBP were recorded from the dominant arm, in sitting position, using mercury sphygmomanometer. Two records were taken for HR and BP, at five minutes gap when they were subjected to informal conversation, and then the average values were used for analysis. All the measurements were done in the afternoon hours between 1 pm – 2 pm, prior to lunch.

The collected data was compiled in Microsoft Excel 2007 worksheet; statistical analysis was carried out using SPSS version 16.0 software. Repeated measures T test using general linear model was used to verify significant differences, level of significance was set at 0.05.

The study was approved by the Nepal Medical College Institution Review Committee.

RESULTS

The study population included 65 students, age ranging from 18 to 21 years (Table 1).
By BMI (kg/m^2) categories, 7 were underweight (10.8%, BMI<18.5), 55 were normal (84.6%, BMI=18.5-24.9), 2 were overweight (3.1%, BMI=25-29.9), and 1 was obese (1.5%, BMI>30)

Table 1: General characteristics of the students (n=65)

Characteristics	Range	Minimum	Maximum	Mean	Std. Deviation
Age in years completed	3.0	18.0	21.0	19.35	0.54
Weight in kilograms	29.0	39.0	68.0	52.26	6.3
Height in centimeters	44.0	124.0	168.0	157.6	6.29
Body mass index (kg/m^2)	14.79	16.42	31.22	21.06	2.53

Average values of the two records of SBP, DBP, and HR at the menstrual, follicular, and luteal phases were compared by multiple variate tests by general linear model for repeated measures (Table 2). The SBP was lowest at the menstrual phase and DBP lowest at luteal phase while HR remained fairly similar in all phases.

Table 2. Blood pressure and heart rate variations in different phases of menstrual cycle (n=65)

	Menstrual phase	Follicular phase	Luteal phase	F value	P value
SBP mmHg	106.65±9.23	109.45±9.12	108.46±8.78	5.871	0.005
DBP mmHg	67.66±8.18	67.28±8.69	64.51±7.75	8.382	0.001
HR bpm	73.26±5.85	72.92±5.6	72.8±4.92	0.400	0.672

The role of BMI as a factor influencing the BP and HR differences was explored and found to be insignificant (F value = 0.189, p=0.643). Considering the narrow range of age (3 years), the effect of age on the BPand HR was not explored.

DISCUSSION

The effects of ovarian hormones on the reproductive system as well as the hemodynamic and blood pressure changes during pregnancy are well known. However, blood pressure changes during different phases of menstrual cycle, in accordance to cyclic changes in the levels of the hormones, are scantilly documented.

Greenberg *et al* (1985) recorded higher SBP at the luteal phase than in other phases.[5] In another study by the same group, DBP was found to be lower at the luteal than in other phases.[5] Our study also observed the lower values of DBP in luteal phase.

Our finding of lower SBP in the menstrual phase compared to other phases is similar to that reported by Kelleher *et al* (1986) where they observed a rise in SBP during mid cycle.[6] Garg *et al* (2014) reported higher SBP as well as DBP in luteal phase than in menstrual phase, and then decrease again in follicular phase.[14]

Studies have established the role of estrogen as a promoter of vasodilation, thus implying that it lowers BP. It acts by stimulating prostacyclin and nitric oxide synthesis and decreasing the productioin of vasoconstrictor agents which are cycloxygenase derived products such as entothelin-1 and angiotensin-II.[15-16] Considering the higher level of estrogen during follicular phase, our finding of higher SBP during this phase seems contradicting.

The other ovarian hormone, progesterone, also exerts protective influence on vasculature and the effects are independent of estrogen effects. Studies by Rylance *et al* (1985) and Regensteiner *et al* (1991) found significant lowering of blood pressure when progesterone was administered in human subjects.[9,13] Rylance *et al* also suggested that progesterone relaxes the vascular smooth muscles by sequestering intracellular calcium.[9] In a study done in rats, Barbagallo *et al* (2001) found that progesterone reversibly and significantly blunted calcium inward currents through L-type calcium channels.[10] The decrease in pressor response of norepinephrine with intravenous injection of progesterone is strong evidence that progesterone is a vasoactive hormone, inhibiting agonist-induced vasoconstriction.[10]

However, in study by done H Park *et al* (2013) a statistically significant association was found between the use of oral contraceptives to systolic and diastolic blood pressure in Korean women using oral contraceptives having a combination of estrdiol and progestin.[17] This finding may direct towards a different action of estrogen and progenterone when they are given in combination than when they are given alone as per the study done by Rylance *et al* 1985, Regensteiner *et al*. (1991) and Barbagallo *et al* (2001).[9,13,10] Further studies are required to excavate the mechanism of actions of estrogen and progesterone alone and when given in combination. These should include larger group of population and wider variation of age group in order solve the dilemma of their action on blood pressure.

Our study included only a smaller group of subjects and the individual variation on the days in context to the different phase of menstrual cycle also could not be demarcated considering the chances of its influence on the blood pressure variation.

In conclusion larger studies need to be conducted to establish the association between progesterone and decrease in DBP during luteal phase of female reproductive cycle. The findings will have roles that may be progestine therapy can be considered during treatment protocols in female patients with hypertension. Clinicians may also suggest special care to pre-menopausal women having low blood pressure due to autonomic dysfunction or postural hypotension, especially a week before their menstrual period.

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