Original Article

Correlation of perceived stress with monthly cyclical changes in the female body

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Abstract

Background: Women are liable to stress-related disorders as female sex hormone, estrogen has been indicated to be protective against stress disorders. The hormone level varies with different phases of menstrual cycle. Moreover, postmenopausal women are at risk for stress-related disorders. So this study was done to correlate the different phases of menstrual cycle with the perceived stress in different phases of monthly cycle. **Methods:** This study was conducted in the Department of Physiology, Shri Guru Ram Rai Institute of Medical and Health Sciences (SGRRIMHS), Dehradun. Four hundred girls in the age group of 18–26 years were selected for the study. The Perceived Stress Scale (PSS) questionnaire was circulated via Google forms after briefing them about the study. Informed consent was also taken. The menstrual history of the subjects was enquired by one-to-one interaction. The participants completed the PSS questionnaire twice in the same cycle. Data collected were statistically analyzed, using Independent *t*-test and Chi-square test and point biserial correlation test. **Result:** The analysis showed strong statistical association of PSS with two phases of menstrual cycle. The PSS score was higher in the late luteal and menstrual phase, while it was less in the late follicular phase ($P < 0.05$). **Conclusion:** The decreased oestrogen levels in the late luteal & menstrual phase are strongly associated with perceived stress in our study. Hormonal changes in the monthly cycles are related with stress, behavioral shift and many other physical changes in females. This information to the family physicians would be beneficial in counseling the females regarding various changes occurring during the menstrual cycle.

Keywords: Early follicular phase, estrogen, late luteal phase, perceived stress

Introduction

The monthly periodic changes in the rate of secretion of the female hormones and consequent physical and physiological changes in the ovaries and other sexual organs are called a female monthly sexual cycle or menstrual cycle.[1] The menstrual cycle begins from the time of bleeding (which is the first day of the cycle) and ends with the start of a time of the next menstrual bleeding.[2] Menstrual cycle is said to be normal if the cycle interval is of 21–35 days, with the duration being 2–7 days.[3]

The menstrual cycle is divided into three phases – follicular (proliferative), luteal (secretory) and menstrual phase. The various hormones responsible for the menstrual cycle vary during the cycle. Luteinizing hormone, progesterone and estrogen hormones are at lowest physiological levels, while the follicle stimulating hormone levels begin to increase at the beginning of the menstrual phase. There is an increase in the estrogen levels of the follicular phase.[4]

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Menstruation has various biological, social and psychological aspects associated with it. The menstrual cycle is regulated by hypothalamus pituitary adrenal axis. Female reproductive steroids are mainly affecting the hypothalamic–pituitary–adrenal axis, which in association with the autonomic nervous system forms the stress system, which regulates the homeostatic mechanism of the body.[5] Higher perceived stress is correlated with menopausal symptoms and menstrual dysregulation. However, the menstrual cycle is affected by weight loss/weight gain, overindulgence of exercises, medical conditions such as polycystic ovarian disease, and stress can also have troublesome effects on a woman's normal menstrual cycle.[3]

Premenstrual symptoms (PMS) is an assembly of symptoms including anger, anxiety, mood swings, depression, fatigue, decreased concentration, breast swelling and tenderness, general aches, and abdominal bloating. These symptoms occur in the late luteal phase of the menstrual cycle, ease off during menses, and are usually absent once the bleeding stops.[6,7]

PMS have been linked with perceived stress and perceived stress anticipates the premenstrual syndrome.[8] Higher perceived stress can be linked with menopausal symptoms[9,10] and menstrual irregularities[3,11] and may play a role in mental health disturbances and, thus, may compromise the daily lives of women, and reduce the performance of the female students.[7,12]

Perceived stress is the feelings or thoughts a person experiences in a given period of time. The rhythm of a menstrual cycle is the gauge of the reproductive functions of females, which is prone to derangement from day-to-day stress, insomnia, anxiety, and depression. The female reproductive system is influenced by stress which can be attributed to the linkage of two axes – the hypothalamic–pituitary–gonadal (HPG) and hypothalamic–adrenal axes.[13-15] The stimulation of Hypothalamus Pituitary Ovarian (HPO) axis modifies the ovarian hormone levels and stimulates the sympathetic nervous system.[7,16] The hormonal variations that take place during the menstrual cycle influence physiological and psychological symptoms in women. So, the present study was done to: (1) measure the perceived stress across two phases of the menstrual cycle (i.e., the late luteal + menstrual phase and late follicular phases + early luteal phase), (2) analyze the consociation between the Perceived Stress Scale (PSS) scores and the phases of the menstrual cycle, and (3) analyze the consociation between PSS and age of menarche, Body Mass Index (BMI), PMS, and dysmenorrhea. We hypothesized that women in their late luteal phases and menstrual phase would have more perceived stress score as compared to their own scores in the late follicular phase. And the increased score is also related to dysmenorrhea, PMS. This study will be useful for family physicians as they would be able to counsel females that the various symptoms and stress the females' experience are related to their hormone levels, and these symptoms should not interfere with their daily activities.

Material and Methods

Study design and population

This study was conducted in SGRRIMHS, Dehradun. Girls of age group 18–27 years with regular menstrual cycles were selected.

Inclusion criteria

(1) Age between 18 years and 27 years, (3) unmarried females, and (4) subjects without medication for PMS.

Exclusion criteria

(1) Any hormonal treatment for Polycystic Ovarian Syndrome (PCOS), fibroids, or any other gynecological disorder (2) if on any anti-anxiety pills

Ethical approval

Ethical approval from Institution Ethics committee (SGRR/IEC/03/23) was taken. Informed consent was taken when the participants were called for one-to-one interview.

Data collection

The participants were asked to complete a questionnaire comprising demographic details, menstrual history, and PSS, which was circulated via Google forms. Anthropometric data with menstrual history were also collected by one-to-one interaction with the participants.

The participants completed the form in both the phases – late follicular phase and late luteal phase. Cycle length was calculated as the number of days between the first day of the last menstrual period (LMP) and the onset of the next bleeding. The average cycle length of 25–35 days was considered a regular cycle.

The menstrual cycle is divided into three phases:[1]

- Menstrual phase – Days of bleeding (1–4 days)
- Follicular phase – Days 5–14 days
- Luteal phase – Days 15–28 days.

For our study, we classified the menstrual cycle into two phases-

- Menstrual + Late luteal phase (days 21 till days of bleeding)
- Late follicular phase (Days 11–20 days).

In the menstrual history, we enquired about the age of menarche, length of the cycle, LMP, dysmenorrhea, number of bleeding days, PMS (headache, bloating, anxiety, mood swings, depression, acidity, irritability), number of pads used, type of bleeding (average, heavy, or with clots).

Anthropometric data were collected in the clinical physiology laboratory with the weighing scale, and height was measured by Stadiometer. BMI was calculated with the formula—weight (kilograms) divided by the square of height (meters). The participants were categorized on the basis of WHO classification, as shown in Table 1.

Perceived stress was measured with the help of Cohen's PSS. The questionnaire was distributed twice – (1) Late follicular phase + early luteal phase (11–21 days) and (2) late luteal phase + menstrual phase (22 + 10 days) to the girls.

The PSS is the most widely used psychological instrument for measuring the perception of stress. It is a measure of the level to which situations in one's life are appraised as stressful.[18] PSS scoring is a Likert-type scale; for each question, 0, 1, 2, 3, and 4 scores were given. PSS scores are calculated by: (1) reversing responses of items 4, 5, 7, and 8 (e.g. – for 0 = 4, 1 = 3, 2 = 2, 3 = 1, and 4 = 0) and (2) summing across all scale items. The scores lie between 0 and 40. Higher scores indicate a higher level of stress. The final scores range between (i) 0–13 – low stress, (ii) 14–26 – moderate stress, and (iii) 27–40 high stress.[19]

We categorized the subjects as low stress with scores <13, and the scores of >14 were considered as high scores. Data of three students out of 400 were removed due to incomplete data of PSS. Data from the remaining 397 participants were analyzed.

Statistical analysis

Data processing and analysis were done with the help of a computer using the SPSS for Windows version 24.0 program. Data are expressed as mean ± SD. Paired student's *t*-test was used to compare the perceived stress level between the two phases of menstrual cycle. Chi-square test was used to compare the patterns of menstrual to PSS**,** dysmenorrhea, PMS, and BMI. *P* value of < 0.05 was considered significant.

Result

Out of 400 participants, only 397 participants completed the study. A comparison of PSS score with the phases of menstrual cycle was done for 397 participants, while other features of menstrual cycle were compared for 400 participants.

The data of demographic profile and menstrual history are summarized as mean ± SD in Tables 2 and 3.

A menstrual cycle pattern is shown in Table 3. It is evident that the age of menarche in 281 (70.25%) participants is 10–13 years and in only 3 (0.75%) participants the age of menarche is 17–19 years.

Various PMS observed in subjects are shown in Table 4. It was observed that symptoms like anger, mood swings, irritability, and anxiety were prominent.

PSS score in all the participants is shown in Table 5, while Table 6 depicts the association between the two phases of menstrual cycle and PSS score. Out of all the participants, 268 (67%) participants have moderate stress. In Table 6, it is shown that 277 participants have moderate and 111 participants have severe stress in the late luteal phase. It shows strong statistical significance.

Table 1: WHO Body Mass Index (BMI) classification[17]

BMI (Kg/m^2)	Nutritional status
<18.5	Underweight
18.6–24.9	Normal
25–29.9	Preobesity
>30	Obesity

Table 2: Demographic profile of the participants (*n*=400)

Demographic variables	Mean±SD
Age (years)	20.73±1.9
Height (m)	1.58±0.06
Weight (kg)	59.21±10.7
BMI (kg/m^2)	23.64±5.19

Table 3: Menstrual cycle pattern of the participants

Menstrual history		*n* (%)
Age at menarche	7–9 years	2 (0.5)
	10–13 years	281 (70.25)
	14–16 years	114 (28.5)
	17–19 years	3 (0.75)
Cycle length (days)	25–28 days	195 (48.75)
	29–35 days	158 (39.5)
	>35 days	47 (11.75)
Duration of bleeding (days)	2–5 days	340 (85)
	5–7 days	14 (3.5)
	7–10 days	46 (11.5)
Flow of blood	Less than normal	14 (3.5)
	Normal	316 (79)
	Heavy	52 (13)
	Heavy with clots	15 (3.75)

Table 4: Frequency of various premenstrual symptoms in the study subjects

Symptoms	*n* (%)
Anger	94 (23.5)
Irritability	40 (10)
Mood swings	251 (62.75)
Anxiety	68 (17)
Breast tenderness	29 (7.25)
Bloating	59 (14.75)
Fatigue	34 (8.5)
None	6 (1.5)

Table 5: Perceived stress scale score in the participants (*n*=400)

PSS score	Number (%)
Low (0–13)	59 (14.75)
Moderate (14–26)	268 (67)
High (27–40)	73 (18.25)

The percentage of participants having moderate to severe perceived stress is more than subjects with low stress (67%).

When the perceived stress scores in the late luteal phase and the late follicular phase in study participants were compared, it

showed strong statistically significant association (P value < 0.05), as shown in Table 6.

Age of Menarche and BMI: The age of menarche was significantly associated with BMI. More is the BMI early the female attains menarche. This relationship is shown in Table 7.

PSS scores and dysmenorrhea

The point biserial correlation revealed that there was a statistically significant correlation between dysmenorrhea and PSS (r = 0.78241, P value < 0.00001. N =397) indicating that high stress score are associated with the presence of dysmenorrhea.

PSS scores and premenstrual symptoms

There was a statistically significant correlation observed between the presence of PMS and the PSS score (r = 0.1236, P value < 0.013, N = 397).

This study result also shows that the increase in the flow of blood during menstruation is significantly related to stress levels, as shown in Table 8. The result shows that the increase in the flow of blood during menstruation is significantly related to stress levels.

Table 6: Comparison of PSS scores in late follicular & late luteal phase (*n*=397)

Phase of menstrual cycle	Mean±SD	*P*
Late follicular phase	20.25±4.46	<0.00001*
Late luteal phase	23.62±5.48	

*Paired *t* test

Table 7: Association of age at menarche with BMI

BMI	Age at menarche			*P*
	10–13 years (*n*)	14–16 years (*n*)	17–19 years (*n*)	
Under weight	13	11	1	<0.05*
Normal	171	68	1	
Preobesity	84	22	2	
Obesity	12	13	1	

*Chi-square test, the result is significant at P<0.05

Table 8: Association of PSS and menstrual bleeding (low to heavy flow) (*n*=397)

Amt. of bleeding	low stress (>13)	moderate to high stress (>14)	*P*
Less flow	1	13	<0.00001*
Average flow	14	306	
Heavy flow	46	3	
Heavy with clots	1	13	

*Chi-square test

Discussion

In the present study, moderate to severe score was observed in 341 subjects (85.2%), out of 400 participants, irrespective of the phase of the menstrual cycle, i.e. 341 subjects experienced high perceived stress. Regarding the late follicular phase, 370 (93.1%) participants had severe stress, while in the late luteal phase + menstrual phase, 388 (97.7%) participants had severe stress. The consociation was statistically significant.

The results of our study match up with earlier studies, which also testify that increase in perceived stress is associated with late luteal phase.[9] Also, numerous PMS like irritability, depression and anxiety symptoms, bloating, sleep disturbances, breast tenderness, fatigue, and anger are also associated with luteal phase.[10,20] The follicular phase is consociated with fewer physical and psychological symptoms.[21] This observation also supports that the late luteal phase and the menstrual phase may be associated with higher perceived stress.

Normal monthly cyclical changes that occur may cause alterations in physical sensations and experiences. These changes can be confused, and as a result causes increase perceived stress among women higher in health anxiety.[22] Increased stress in the luteal phase as indicated by our PSS scoring in Tables 5 and 6 can be credited to ovarian hormones acting on the HPO axis. HPO axis, in turn, affects the stimulation of sympathetic nervous system leading to altered neurotransmitters and other brain functions.[16]

The increase in stress levels in luteal and menstrual phases can also be explained by the study, which shows that there is a significant vagal activity in the follicular phase and high sympathetic activity in the luteal phase.[23] The increase in vagal activity at ovulation was influenced by estrogen which peaks just before the ovulation, while the elevated sympathetic activity during the second phase of the cycle can be attributed to the reduced estrogen level and raised progesterone levels.[24]

The following studies also reinforce and demonstrate our observation of increased perceived stress in luteal and menstrual phases. Cognitive stressors bring a greater sympathetic response in the luteal phase of the cycle, making the females perceive the luteal phase of the menstrual cycle as mentally and physically tasking.[23] The late follicular phase has higher estrogen levels, which have a protective effect against psychosis and so period of menstruation or postpartum period where the estrogen levels are low, which are more prone to psychosis.[25,26] Many studies have implicated the role of cortisol, which is the hormone responsible for stress. The researchers have observed that due to the increased stress, cortisol level increases as there is activation of the Hypothalamic Pituitary adrenal (HPA) axis. It may be possible that estrogen hormone influences the activation of HPA axis and, thus, increase stress. However, cortisol levels were not affected by menstrual cycle phases during the day time.[9]

Another study done on nonrodent species observed that cortisol modulates female gonadal hormones. They observed that cortisol has inhibitory effects on the HPG axis, and it is postulated that the effects of perceived stress on estradiol may be mediated by cortisol.[27,28] The study by Roney and Zachary[28] also proposed that self-perceived stress is consociated with reduced estradiol levels.

Another study proposes that stress causes the progesterone to change into cortisol, thus, escalating the stress response and

weakening the emotional processing.[29] Both the above studies confer our observation of increased stress in the late luteal phase.

Stress has also been implicated in premature menopause as it stimulates the hypothalamic pituitary adrenal axis.[30] Female gonadal hormones affect the HPA axis which in association with ANS forms the stress system which regulates homeostatic mechanism of the body.[5] Therefore, it is essential to identify the females who experience stress in the menstrual cycle so that proper measures can be taken, and the quality of life of the females in the reproductive age group as well as in postmenstrual phase can be improved.

The role of hormones responsible for menstruation in stress and eventually causing other related disorders has also been shown by the following study, which suggests that alterations in hormone levels in the different phases of the menstrual cycle can increase the stress and lead to unhealthy eating habits. This would further lead to physical and psychological distress.[31,32]

The following studies also corroborate our findings of higher stress levels related to low estrogen levels. The study on suicidal behavior and menstrual cycle observed that symptoms of psychiatric disorders improve with high-estradiol phase of the menstrual cycle.[20,33] Low estrogen was linked to increased risk of Post-traumatic stress disorder (PTSD)[34] and higher estradiol levels are protective against subjective distress.[35] The primary care providers can identify the vulnerable female population and improve the psychological health by providing appropriate advice and treatment as they are the first point of contact. By timely intervention of the physicians, various psychological derangements can be avoided.

Majority of the participants had mood swings as the most common PMS as shown in Table 4. Women who experience considerable amount of premenstrual distress are likely to have higher sympathetic activity in late luteal phase as compared to women with few or none symptoms.[36] The PMS predict the increase in the perceived stress.[37] Similar observations were also made by the present study in which 341 participants, who had moderate to severe stress, also experienced more number of PMS including mood swings, anger, fatigue, depression which was found to be statistically significant. Similar findings of increased stress with severity of the premenstrual symptoms in luteal and menstrual phases were also reported by these studies.[8,38]

It is well established that stress raises cortisol levels. The rise in cortisol levels is linked to estrogen dominance, and this relationship justifies the PMS that occur in the luteal phase, wherein a peak is seen in both stress and PMS.[39,40]

Previous studies also observed a significant association between the stress score with heavy menstrual bleeding,[16] days of bleeding, and dysmenorrhea as observed in our study. (Chi-square statistic is 28.08, P value < 0.00001.)

But contrary to our study, no correlation was established between stress and menorrhagia, cycle length, or dysmenorrhea. Their observation might be due to less sample size (n = 100).[3,41]

In our study, dysmenorrhea was strongly correlated with PSS indicating that higher the PSS, higher the chances of dysmenorrhea, which is consistent with the observations of the study on Chinese women, and[2] study on female medical students.[42,43]

The limitations of our study are the study population can be more generalized with diverse and clinical populations. We collected the data across single menstrual cycle in single subject, but measuring the data across multiple menstrual cycles in single subject can give more valuable information. These observations can be established by hormone assay in saliva with the PSS. The salivary assay would make the procedure noninvasive.

Conclusion

The present study done on 397 female subjects and PSS was recorded in the two phases of menstrual cycle. We observed that PSS is strongly associated with late luteal and menstrual phases. This association is related to decreased estrogen levels in the luteal phase (late) and the menstrual phase. The present study also observed that menorrhagia, dysmenorrhea, and PMS are linked with severe stress, and the consociation is statistically significant. Normal cyclical changes across the menstrual cycle may cause oscillations in physical sensations and experiences which are related to hormonal variations over the menstrual cycle. These cyclical fluctuations in stress, behavior, and physical sensations should be known to family physicians and primary care providers. So they are able to manage the stress and mitigate the PMS in such females. This would improve the quality of life, reduce the absenteeism of the female students, and increase the work productivity.

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Conflicts of interest

There are no conflicts of interest.

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