

Variation in pulmonary function tests parameters in different phases of menstrual cycle in healthy female medical students

Abhilasha Mishra, RB Kamal

Department of Physiology, MLN Medical College, Allahabad, Uttar Pradesh, India.

Correspondence to: Abhilasha Mishra, E-mail: abhilashaabhi09@gmail.com

Received June 3, 2015. Accepted July 4, 2015

ABSTRACT


Background: Menstrual cycle is a physiological process that occurs in women. It is characterized by periodic vaginal bleeding owing to the shedding of uterine mucosa, which has its own effect on various systems and metabolisms. **Aims and Objective:** To understand the variations in respiratory parameters in different phases of the menstrual cycle. **Materials and Methods:** This study was conducted on the selected female medical students of MLN Medical College, Allahabad, Uttar Pradesh, India. Fifty-five healthy female volunteers within the age group of 18–24 years who revealed a regular menstrual cycle of 28 ± 3 days were selected. We analyzed various pulmonary function parameters on three different phases of menstrual cycle (menstrual phase, 2nd day; proliferative phase, 12th day; and secretory phase, 22nd day). **Result:** In pulmonary function tests parameters, forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) increased in the mid-secretory phase ($p < 0.001$); FEV1/FVC ratio was higher in the mid-secretory phase ($p = 0.026$); and peak expiratory flow rate (PEFR) was also higher in the secretory phase ($p = 0.001$). These values were the lowest in menstrual phase and lower in the proliferative phase when compared with the secretory phase. **Conclusion:** This study was a moderate attempt to determine the regular variations in different pulmonary function tests parameters, during different phases of menstrual cycle in normal healthy female subjects and evaluate various conflicting reports on female subjects.

KEY WORDS: Menstrual Cycle; Pulmonary Function; Proliferative Phase; Secretory Phase

INTRODUCTION

Female reproductive phase comprises the menstrual cycle, which is an integral part of their lives. A normal menstrual cycle is dependent on the fluctuation in the ovarian hormones (estrogen and progesterone) during the different phases of menstrual cycle—menstrual, proliferative, and secretory

phases. The characteristic rhythmic changes in the rate of secretion of ovarian hormones produce corresponding changes not only in the reproductive system but in other organ systems as well. It is suggested that lung functions exhibit not only diurnal variations but also show changes dependent on the different phases of menstrual cycle.^[1] Women, for largely unknown reasons, are increasingly becoming more affected with inflammatory lung diseases such as asthma, chronic obstructive pulmonary disease, and cystic fibrosis and are experiencing excess morbidity and mortality from these disorders after adjusting the smoking factor. It is being increasingly recognized that about one-third to half of the women experience the worsening of asthma symptoms during the premenstrual or menstrual phases of their menstrual cycle.^[2] Although men have a higher prevalence of chronic obstructive pulmonary disease (COPD) than women, the

Access this article online	
Website: http://www.njppp.com	Quick Response Code:
DOI: 10.5455/njppp.2015.5.0306201554	

National Journal of Physiology, Pharmacy and Pharmacology Online 2015. © 2015 Abhilasha Mishra. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

increased rates of cigarette smoking in female subjects in the last decade have been associated with the steadily increasing rates of COPD in female subjects.^[3]

Even in cases in which cigarette smoking is implicated, women develop COPD after smoking fewer number of cigarettes per lifetime (i.e., less pack-years of smoking) and are two to three times more likely to experience hospitalization than are male patients.^[4]

These epidemiologic data suggest that female gender is a significant risk factor for morbidity and mortality in inflammatory lung diseases and that sex hormones may be important in their pathogenesis, although the mechanisms by which they act may differ between these disorders. Some of the investigators also proposed to supplement progesterone hormone along with other bronchodilators and found better results in female patients with bronchial asthma and acute exacerbations.^[5]

Thus, the information on the effect of sex hormones on lung functions are controversial and, hence, require further evaluation so as to enable the physicians to formulate better treatment regimes. Therefore, this study was attempted to observe the variation in pulmonary functions during different (menstrual, proliferative, and secretory) phases of the menstrual cycle in healthy adult female subjects.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, MLN Medical College, Allahabad, India, after obtaining the clearance of ethical committee. This study was conducted during the period between 2014 and 2015, in healthy female undergraduate medical students volunteers aged between 18 and 24 years with the normal menstrual cycle of 28 ± 3 days. The study protocol was explained to the subjects, and oral and written informed consent was obtained. The age, height, and weight of the participants were recorded following which all the samples were taken between 10 a.m. and 12 p.m. to avoid diurnal variations. A demonstration was given to the subjects before performing the test. The first sample was taken on the 2nd day of onset of menstruation (menstrual phase), the second sample was taken during the 12th day of proliferative phase, and the third sample was collected during the 22nd day of secretory phase. Pulmonary parameters were recorded by spirometer, Spiroexcel PC-based pulmonary function tests.

Peak expiratory flow rate (PEFR), forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and FEV1/FVC of each subject were recorded in sitting position. The subjects were asked to take in a deep breath and exhale forcefully into the tube by closing the nostrils. Three recordings were done for each test in the time interval of 2 min, and the best of three was taken for consideration; the values were expressed in liters/minute.

Inclusion Criteria

This study included healthy north Indian undergraduate female medical students of MLN Medical College, Allahabad, India, with the age group of 18–24 years who showed regular menstrual cycles.

Exclusion Criteria

Contraceptive pills users, lactating women, and cases with history of diabetes mellitus, cardiovascular abnormalities, psychiatric illness, irregular periods, heavy dysmenorrhea, oligomenorrhea, polymenorrhea, and relevant pathology were excluded from this study.

Statistical Analysis

The data were summarized as mean \pm SD (standard deviation). The groups were compared by one-way analysis of variance (ANOVA), and the significance of mean difference between the groups was done by Tukey's post hoc test. A two-tailed ($\alpha = 2$) p value less than 0.05 ($p < 0.05$) was considered statistically significant. Analyses were performed on STATISTICA (Windows version 6.0) software.

RESULT

This study compared the changes in pulmonary function test parameters during the different phases of the menstrual cycle in the participants. A total of 55 subjects, aged between 18 and 24 years, were selected. The pulmonary function test parameters of each subject were measured at menstrual phase (2nd day), proliferative phase (12th day), and secretory phase (22nd day) and compared statistically. The comparative outcome measures of pulmonary function test parameters of the three periods (menstrual phase, proliferative phase, and secretory phase) are summarized below.

Table 1: Pulmonary function test parameter levels (mean \pm SD, $n = 55$) at three different phases of menstrual cycle in undergraduate female medical students

Parameters	Menstrual phase	Proliferative phase	Secretory phase	F (2,162 DF)	p
FVC (L)	2.74 \pm 0.43	3.02 \pm 0.45	3.09 \pm 0.49	8.81	<0.001
FEV1 (L)	2.42 \pm 0.89	2.78 \pm 0.48	2.89 \pm 0.53	7.61	0.001
PEFR (L/s)	5.81 \pm 1.25	6.69 \pm 0.67	6.54 \pm 1.26	10.13	<0.001
FEV1/FVC (%)	91.39 \pm 8.00	94.83 \pm 6.66	92.57 \pm 5.10	3.74	0.026

Table 2: For each parameter, comparison (*p* value) of mean difference between the groups by Tukey's test

Comparisons	FVC	FEV1	PEFR	FEV1/FVC
Menstrual phase vs. proliferative phase	0.004	0.011	<0.001	0.019
Menstrual phase vs. secretory phase	<0.001	0.001	0.001	0.626
Proliferative phase vs. secretory phase	0.700	0.687	0.757	0.180

The pulmonary function tests parameters levels at three different periods (menstrual phase, proliferative phase, and secretory phase) are summarized in Table 1. The mean levels of all the pulmonary function tests parameters were lower in the menstrual phase when compared with both proliferative and secretory phases. By comparing the mean levels of each pulmonary function tests parameters between the three groups (or periods), ANOVA revealed significantly ($p < 0.05$ or $p < 0.01$, or $p < 0.001$, respectively) different levels of FVC, FEV1, PEFR, and FEV1/FVC among the groups. Furthermore, Tukey's test revealed that the mean FVC, FEV1, and PEFR were significantly different and higher ($p < 0.05$, or $p < 0.01$, or $p < 0.001$, respectively) in both proliferative and secretory phases when compared with menstrual phase (Table 2). In addition, the mean FEV1/FVC ratio was also found significantly ($p < 0.05$) different and higher in the proliferative phase when compared with the menstrual phase.

DISCUSSION

This study was undertaken to evaluate the effect of endogenous female sex hormones on pulmonary function tests parameters during the three phases of menstrual cycle in healthy female adults at rest. Majority of the studies have evaluated the effects on the follicular and luteal phases without any evaluation done on the menstrual phase. In this study, the effect on menstrual phase was also evaluated, and pair-wise comparisons were made. This study demonstrated better lung volumes during the secretory phase of menstrual cycle when compared with those in the proliferative and menstrual phases. Statistical significances were also shown below every bar diagram. These findings were consistent with the reports of Resmi et al.,^[6] Pai et al.,^[7] Dabhoiwala et al.,^[8] and Arora et al.,^[9] who found different values.

The study done by Kannan et al.^[10] and Nandhini (2006) also showed the same result that FEV1 and FVC values increased in the luteal phase and FEV1/FVC ratio was higher as seen in the mid-luteal phase. In this study, PEFR has not shown any significant difference. It is considered that progesterone is a great stimulant, which has a role in hyperventilation in the luteal phase of the menstrual cycle.^[10,11]

Hebbar^[12] showed increased FVC and FEV1, suggestive of stimulation of ventilation by progesterone. He concluded that subjects using combined oral contraceptive pills showed improved lung function than controls when evaluated with computerized spirometer.

This study showed that respiratory parameters of women in the reproductive age group showed significant variations

during the different phases of the menstrual cycle, which could be owing to the hyperventilation caused by increased levels of progesterone in the luteal phase. Progesterone induces hyperventilation through the central, medullary, and peripheral receptors. According to Bayliss and Millhorn,^[13] the respiratory response to progesterone is mediated at hypothalamic sites through an estrogen (E2)-dependent progesterone receptor (PR)-mediated mechanism requiring RNA and protein synthesis (i.e., gene expression). The neural mechanisms underlying the stimulation of respiration by progesterone are similar to those mediating its reproductive effects.

On the other hand, Williams and Parsons,^[14] Chong and Ensom,^[15] and da Silva et al.^[16] observed that there were no significant differences in the different phases of menstrual cycle for any spirometric variables and concluded that menstrual cycle phases did not influence ventilator responses at rest.

This study does not agree with the aforementioned results.

Limitations and Issues for Further Study

Female sex hormones were not measured during the menstrual cycle phases owing to practical constraints. However, all the subjects reported a normal regular menstrual history. A well-designed study with healthy female subjects in different age groups and different phases of reproductive life as volunteers with measurement of ovarian hormones and pulmonary function tests parameters could determine the consistency of the relationship.

CONCLUSION

The results indicated that pulmonary functions were better during the secretory phase of menstrual cycle when compared with those in the proliferative and menstrual phases in regularly menstruating women, which suggested a possible role of the increased levels of progesterone during this phase on the respiratory system.

REFERENCES

1. Rajesh CS, Gupta P, Vaney N. Status of pulmonary function tests in adolescent females of Delhi. *Indian J Physiol Pharmacol.* 2000; 44(4):442-8.
2. Skobeloff EM, Spivey WH, St Clair SS, Schoffstall JM. The influence of age and sex on asthma admissions. *JAMA.* 1992;268(24):3437-40.

3. Wise RA. Changing smoking patterns and mortality from chronic obstructive pulmonary disease. *Prev Med.* 1997;26(4):418–21.
4. Gillum RF. Frequency of attendance at religious services and cigarette smoking in American women and men: the Third National Health and Nutrition Examination Survey. *Prev Med.* 2005;41(2):607–13.
5. Prescott E, Bjerg AM, Andersen PK, Lange P, Vestbo J. Gender difference in smoking effects on lung function and risk of hospitalization for COPD: results from a Danish longitudinal population study. *Eur Respir J.* 1997;10(4):822–7.
6. Resmi SS, Samuel E, Kesavachandran C, Shashidhar S. Effect of oral contraceptives on respiratory function. *Indian J Physiol Pharmacol.* 2002;46(3):361–6.
7. Pai RS, Prajna P, D'Souza UJA. A correlative study on blood pressure and lung function profiles during different phases of menstrual cycle among Indian population. *Thai J Physiol Sci.* 2004;17(2):30–4.
8. Dabhoiwala S, Kathrotia R, Patel D, Dave A, Joshi A, Oommen E. Pulmonary functions in different phases of menstrual cycle and its relation with serum progesterone levels. *Natl J Integrated Res Med.* 2012;3(1):39–42.
9. Arora D, Kaur P, Arora M, Gupta U. Influence of three phases of menstrual cycle on pulmonary functions. *Indian J Appl Pure Biol.* 2012;27(1):27–32.
10. Kannan N, Kumar RA, Ramaprabha P, Naveen P, Shaker IA. Evaluation of hematological and pulmonary function test parameters in different phases of menstrual cycle in rural south Indian population. *Int J Bioassays.* 2013;2(3):506–9.
11. Nandhini R, Subhashini AS. Variation in the pulmonary functions with the phases of the menstrual cycle in adolescent females. *J Clin Diagn Res.* 2012;6(2):173–5.
12. Hebbar RK. Comparative study of pulmonary function tests in women in different phases of menstrual cycle with and without contraceptive pills. *IOSR J Dent Med Sci.* 2013;8(5):21–5.
13. Bayliss DA, Millhorn DE. Central neural mechanisms of progesterone action: application to the respiratory system. *J Appl Physiol.* 1992;73(2):393–404.
14. Williams JS, Parsons SM. Ventilatory and respiratory muscle function at rest and during exercise across the menstrual cycle. *J Exerc Physiol Online.* 2011;14(5):109–17.
15. Chong E, Ensom MH. Peak expiratory flow rate and premenstrual symptoms in healthy nonasthmatic women. *Pharmacotherapy.* 2000;20(12):1409–16.
16. da Silva BS, de Sousa Ramalho Viana E, de Sousa MB. Changes in peak expiratory flow and respiratory strength during the menstrual cycle. *Respir Physiol Neurobiol.* 2006;150(2–3):211–9.

How to cite this article: Mishra A, Kamal RB. Variation in pulmonary function tests parameters in different phases of menstrual cycle in healthy female medical students. *Natl J Physiol Pharm Pharmacol* 2015;5: 357-360.

Source of Support: Nil, **Conflict of Interest:** None declared.