

[ORIGINAL ARTICLE]**Effect of Different Phases of Menstrual Cycle on Cardiorespiratory Fitness (Vo₂max) and Physical Fitness Index in Physiotherapy Students Age Group between 18 to 25 Years****Choube Rashmi¹, Sapkale Suvarna², Nagulkar Jaywant³**¹BPTh. Intern, ²Assistant Professor, Dept. of Cardiorespiratory Physiotherapy, ³Principal, Dr. Ulhas Patil College of Physiotherapy, Jalgaon.**ABSTRACT**

Background: Cardiovascular fitness is recognized as an important component of health and is necessary for performing functional activities. VO_2 max and physical fitness index are considered reliable indicators for cardiorespiratory efficiency.

Methodology: A cross sectional study was conducted on 41 female physiotherapy students aged between 18 and 25 years. Subjects were selected according to inclusion & exclusion criteria. The Bruce treadmill test method directly assessed VO_2 max (maximum oxygen uptake). The Harvard step test assessed PFI (Physical fitness index) during all three menstrual cycle phases.

Result : VO_2 max in the menstrual phase (20.653 ± 2.052) and in the follicular phase VO_2 max is (22.283 ± 2.184) and in the luteal phase (22.437 ± 2.250). PFI (physical fitness index) in the menstrual phase is (89.406 ± 5.281) in the follicular phase is (92.018 ± 3.762) and in the luteal phase (94.471 ± 4.761) after applying repeated measures of ANOVA, the P value is 0.0001 which is less than 0.5 this indicate that there is a highly significant difference between three phases of the menstrual cycle.

Conclusion : The study concludes that there is an extremely significant difference in cardiorespiratory fitness level VO_2 max and PFI (Harvard step test) during three phases of the menstrual cycle.

Keywords : *Vo₂max, PFI, Bruce treadmill test, Menstrual phase, Follicular phase, Luteal phase, Harvard step test.*

Introduction**Menstrual cycle**

The menstrual cycle is the reproductive cycle in females. The first menstruation begins at puberty and is called as menarche. In human females, menstruation occurs at an average interval of about 28/29 days. The cycle of events, from one menstruation to the next, is called the menstrual cycle.^[1,2]

Phases of menstrual cycle- There are three phases of menstrual cycle. Menstrual, follicular phase (proliferative phase), and luteal phase (secretory phase).^[1,2]

1) The menstrual phase cycle starts with the menstrual phase when menstrual flow occurs, lasting for 3-5 days. The menstrual flow results from the breakdown of the endometrial lining of the uterus, under the Effect of prostaglandin released due to decreased levels of progesterone and estrogen.^[1,2]

2) The follicular phase primary follicle in the ovary grows to become a fully mature Graafian follicle. Simultaneously, the endometrium of the uterus regenerates through proliferation, and the secretion of gonadotropins (LH and FSH) gradually increases during the follicular phase. This phase lasts from the end of the menstruation to the release of the ovum,

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occurring from the 5th to the 13th day of the menstrual cycle.^[1,2]

3) Luteal phase- The duration of this phase is between the ovulation and the beginning of the next menstruation. This is the longest phase, lasting for 14 days, from the 15th to the 28th day of the cycle. The remaining parts of the Graafian follicle transform into the corpus luteum. The corpus luteum secretes a lot of progesterone, essential for maintaining the endometrium.^[1,2]

Hormones regulate various phases of the menstrual cycle. The postmenstrual phase is estrogen-dependent, and the premenstrual phase is progesterone-dependent. Hormonal changes during the menstrual cycle tend to affect various physical fitness parameters. They affect energy substrate metabolism, body water, and electrolyte homeostasis. Thermoregulation and minute ventilation are also affected. Some researchers have also recorded changes in vital parameters such as pulse rate and respiratory rate during different phases of the menstrual cycle. All these parameters do affect the physical fitness status of the female.^[3] In this study, we used (vo2 max) and physical fitness index as outcome measures.

VO2 max- Maximum oxygen uptake (VO2 max), which measures aerobic power, refers to the maximum amount of oxygen that can be utilized in 1 minute during intense or submaximal exercise. It is considered to be the most reliable indicator of cardiorespiratory efficiency.^[3] Cardiorespiratory fitness is recognized as an important component of health and may be necessary for performing functional activities. VO2 max (The 2 is a derivation, V- volume per time, O – oxygen, max – maximum), which vo2 max can be calculated using a treadmill, is one of the most common parameters in measuring a person's cardiorespiratory fitness. VO2 max is the maximum capacity to transport and utilize oxygen during incremental exercise.^[4]

The Harvard Step test is used to measure the physical fitness index. It measures the physical fitness for muscular work and the ability to recover from the work, and it is an important criterion for assessing cardiopulmonary efficiency.^[5] Harvard step test was developed by Lucien Brouha in 1943. This test helped to predict the maximum oxygen uptake (vo2max) and help to measure aerobic fitness. This test has the advantage that it is simple to conduct and requires minimal equipment.^[6]

In today's world, where women have stepped foot in every Field, it becomes essential to understand the physiological changes that occur in her, differing her from her male counterparts, the most important being the monthly menstrual cycle. It is essential to know if these cyclical changes occurring due to hormonal influences have any effect on a woman's day-to-day activities like physical work capacity so as to take necessary steps to minimize the effects. This study is necessary to determine the changes in the cardiorespiratory system in women during different phases to check the efficiency of oxygen consumption at varying phases of menstruation as it affects physical fitness by various means. The VO2 max is necessary to calculate because it represents how much oxygen the body uses during exercise at a maximum effort, and the physical fitness index will measure cardiovascular efficiency. This study will help to find the Effect of VO2 max and PFI in different phases of the menstrual cycle in young females between the ages of 18 and 25. Hence, the need was felt for the Effect of different phases of the menstrual cycle on cardiorespiratory fitness (vo2max) and physical fitness index in physiotherapy students between 18 and 25 years.

Methodology

A Cross-sectional study was conducted on 41 female physiotherapy students at Dr Ulhas Patil college of Physiotherapy. The study duration was 6 months. The sampling technique used in this study is convenient sampling. The total sample size was 41. the sample size was calculated by formula,

$$\text{Minimum sample size (n), } n = Z^2 S^2 / d^2$$

$$n = \frac{(1.96)^2 (4.86)^2}{(1.5)^2}$$

$$n = 41$$

Minimum sample size=41

M=24.06

S=Standard deviation=4.86

d=Absolute precision=±1.5

Z1=1.9 at alpha=5% level of significance

Participants

The subjects included in this study were female physiotherapy students aged 18 to 25 years of age. The sample size was calculated using the minimum sample size formula to estimate the population mean formula. The minimum sample size was 41, and convenient sampling was done. Subjects included in the study were) Healthy females in the age group 18-

25yrs, 2) Regular menstrual cycle with a cycle duration of 28-30 days, 3) No history of medical illness, 4) No history of any drug intake to regularise menstrual cycle. 5) Normal BMI. Subjects excluded were) Female students with irregular menstrual cycles; 2) Students with any medical illness; 3) Students on any medication; 4) Any Gynecological diseases 5) Suffering from PCOS, PCOD 6) History of Respiratory disorder 7) Student with Musculoskeletal disability 8) History of cardiovascular disorder 9) History of Diabetes mellitus, Hypertension 10) History of Major Surgery in recent past 11) Heart rates above 200 beats per minute.

Procedure

Ethical clearance was obtained from the institutional Ethical Committee and the Principal of Dr Ulhas Patil college of Physiotherapy. A written informed consent form was obtained from those who were willing to participate. The subject was screened according to inclusion and exclusion criteria. The aim of the study and its Objective was explained to willing participants. Selected participants demographic details and outcome measures were recorded as follows:

To Calculate Vo2max

Subjects fulfilling the inclusion criteria were given a 5-minute rest followed by a warm-up on the treadmill for 5 minutes at their desired running pace. The Bruce treadmill test was performed to measure the VO₂ max. The treadmill was then set to a speed of 2.74km/hr with an incline of 10%. After 3 minutes, the speed and incline were increased to 4.02 km/hr with an incline of 12%. According to the Bruce protocol, the incline and speed will be increased every 3 minutes.

Standard Bruce Protocol

Stage	Speed (MPH)	Speed (km/h)	Grade (%)	Time (min)
I	1.7	2.7	10	3
II	2.5	4.2	12	3
III	3.4	5.4	14	3
IV	4.2	6.7	16	3
V	5.0	8.05	18	3
VI	5.5	8.8	20	3
VII	6.5	9.6	22	3

This procedure was repeated until the subject could no longer run, and the test was complete. At the end of the procedure, the time taken to complete the test was recorded VO₂ max will be calculated using the below formula:

$$\text{VO}_2 \text{ max (ml/kg/min)} = 14.76 - (1.379 \times T) + (0.451 \times T^2) - (0.012 \times T^3)$$

The experimental protocol was repeated during the three phases of the same menstrual cycle of every subject. The days of the experimental trial during different phases of the menstrual cycle

1) 3rd day of the menstrual cycle for menstrual phase evaluation
2) 10th day of the menstrual cycle for follicular phase evaluation
3) Between 20-24th day of the menstrual cycle for luteal phase evaluation

To Calculate Physical Fitness Index Recording of Physical Fitness Index by using Modified Harvard Step Test. The subjects were asked to relax during the procedure. The subjects were asked to be lightly clothed and asked to sit quietly for 5 min. The resting pulse rate was manually recorded by palpating the radial artery. They were asked to perform the stepping exercise. The person taking the test steps up and down on a platform in a cycle of 2 seconds. The step is a wooden box at a height of 33 cm. The rate of 30 steps per minute must be sustained for five minutes or until the point of exhaustion, which means the point at which the subject cannot maintain the stepping rate for 15 seconds. Stepping up and down a 33 cm high step box at a rate of 30 times/min for 5 min. The total duration of the stepping exercise and post-exercise pulse rate at 1-1.5 minutes will be recorded. Those with heart rates above 200 beats per minute, heavy breathing, or unable to sustain were stopped immediately. Once the participants have accomplished the step test or were ceased due to the reasons mentioned above, they will quickly made to sit down on the box and rest. The fitness test was conducted under close supervision. The detailed procedure of the exercise test was explained to the subjects, and an actual demonstration was given before starting the test. The Physical Fitness Index is calculated using the following formula:

Physical Fitness Index=

$$\frac{(100 \times \text{Test Duration In Seconds})}{(5.5 \times \text{pulse count between 1 and 1.5 minutes})}$$

The Modified Harvard Step test uses the following scores to classify the physical fitness of study subjects.

PFI Rating	PFI score in females
Excellent	>91
Good	84-89
Fair	77-83
poor	<77

Results:

This study included 41 female participants. The data obtained from the participants was statistically analyzed after applying repeated measures of ANOVA. Means and standard deviations were calculated for all the needed variables.

Table 1- The age-wise distribution of subjects

Age in year	No of participants
18-21	18
22-25	23

In this study, 18 participants were between 18-19 years of age, and 23 were between 22-25 years of age.

Table 2- showing changes in vo2 max in ml/kg/min during three phases of menstrual cycle of all subject

	Mean ± standard deviation	P value
Menstrual phase	20.653 ± 2.052	<0.0001
Follicular phase	22.283±2.184	
Luteal phase	22.437±2.250	

Graph 1 : The changes in vo2 max during three phases of menstrual cycle of all subject

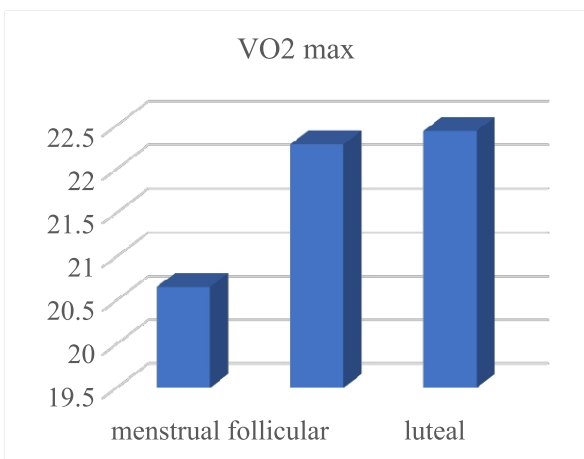
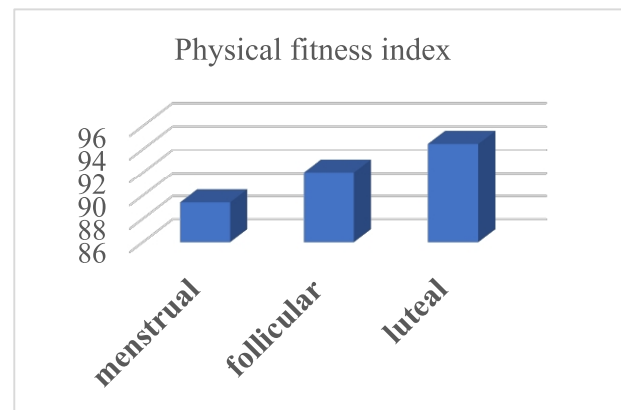


Table 3: Showing changes in the physical fitness index during three phases of menstrual cycle of all subjects

	Mean ± standard deviation	P value
Menstrual phase	89.406±5.281	<0.0001
Follicular phase	92.081±3.762	
Luteal phase	94.471±4.761	

Graph 2: The changes in physical fitness index during three phases of menstrual cycle



Discussion

The normal menstrual cycle in a female is 28 days, with the first day of menstrual bleeding taken as the first day of the cycle. The menstrual phase lasts for 4 to 5 days; from day 6 to day 14, is the proliferative phase, and the last phase is the secretory phase from day 15 to day 28. During this phase, there are various changes in the hormonal levels of the female body, the major ones being estrogen and progesterone². In this study, we have tried to analyze whether these hormonal changes in different phases will affect cardiorespiratory fitness (measured in VO2 max).

The present study was done on 41 females. This study aimed to determine how cardiorespiratory fitness (VO2 max) and physical fitness index were recorded in three menstrual cycle phases.

During the proliferative phase, as estrogen is more, it is called the estrogen phase, and likewise, the secretory phase is called the progesterone phase. These hormones cause cardiorespiratory changes in females. Their primary function in the cardiovascular system includes increased capillary wall strength and vasodilatory Effect on smooth vascular muscle in coronary arteries and peripheral

vascular beds. In addition, it also lowers the response to cardiovascular stress.^[4] According to the present study, the hormonal Effect on cardiorespiratory fitness was measured by estimating vo2 max, and the physical fitness index, measured by the Harvard step test, showed statistically significant changes during three menstrual cycle phases.

According to Sadan Yazar. et al. conducted a study on the Effect of the menstrual cycle phase on exercise capacity measured by treadmill exercise test in sedentary premenopausal women. They concluded that the menstrual phase in sedentary women can influence exercise capacity. These changes may be attributed to the relative changes in the female steroid hormone between the luteal and menstrual phases. Because estrogen and progesterone concentration increase, the increase in estrogen, which is relative to progesterone during exercise, is greater in the luteal phase than in the follicular phase. Studies found better exercise performance during the luteal phase resulted in a higher estrogen-to-progesterone concentration ratio. For that reason, increased exercise performance in the luteal phase may be related to the magnitude of the increase in estrogen during the luteal phase compared with the follicular phase.^[9]

Gayatri Godbole .et. al - They conducted a study on the Effect of female sex hormones on cardiorespiratory parameters. This study was planned to assess the Effect of different menstrual cycle phases on cardiorespiratory parameters like pulse rate, respiratory rate and VO2 max. 100 female medical students aged 17-22 years were studied for three consecutive menstrual cycles. Weight, resting pulse rate, respiratory rate and VO2 max were measured during the premenstrual phase (20th-25th day) and postmenstrual phase (5th to 10th day). They conclude that this study indicates decreased cardiorespiratory efficiency during premenstrual because an Increase in circulating blood volume due to fluid retention and thermogenic action of progesterone after ovulation could be the reason for an Increase in pulse rate and during the premenstrual phase.^[3]

Devries MC, Mazen JH, Phillips SM et al. found that during exercise, both estrogen and progesterone concentration increase; however, the increase in estrogen, which is relative to progesterone during exercise, is more significant in the luteal phase and in the follicular phase. Also, there is a lower rate of glycogen use and a higher whole-body lipid use in

the luteal phase. Therefore, increased exercise performance in the luteal phase may be related to increased estrogen during the luteal phase.^[10]

Reilly found that one of the most important actions of estrogen during the luteal phase is its effects on the cardiovascular system as it may benefit long-term, submaximal exercise by increasing the synthesis of glycogen and intramuscular and hepatic lipids. These effects occur due to increased lipolysis and increased use of free fatty acid, sparing muscle glycogen both at rest and during exercise.^[11]

Conclusion

The study concludes that there is a highly significant difference in cardiorespiratory fitness level (VO₂ max) and physical fitness index (Harvard step test) during three different phases of menstrual cycle VO₂ max and physical fitness index are lower in menstrual than in follicular and luteal phases.

VO₂ max and physical fitness index are improved in the follicular and luteal phases.

The study shows improvement in VO₂ max and PFI in different menstrual cycle phases.

Limitations

VO₂ max and PFI measurements were limited to the individual subject's perception of exhaustion. Other factors that may affect exercise performance between VO₂ max and PFI test sessions, including the amount of sleep and nutrition, were to be controlled. A study on a much larger population must be done to reconfirm the findings.

Future Scope

Studies can be done to check strength and flexibility at different menstrual cycle phases. This study can be performed on an age group beyond 25 years, as well as on obese and pre-obese females.

Clinical Implication

The research study highlights reduced VO₂ max and the Physical Fitness Index (PFI) across different menstrual cycle phases. This may be due to a sedentary lifestyle and limited involvement in sports or physical activities. To address this, it is essential to incorporate cardiorespiratory endurance training in young women, as it can help to improve their physical fitness level, especially in minimizing the cyclical difference induced by hormonal fluctuations.

Conflict of Interest

All authors declare that they have no conflicts of interest.

Source of Funding

Not required.

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