Haykobi Ctatti

Research articles

Assessment of Skeletal Muscle Strength, Fatigue and Respiratory Efficiency in Young Healthy Females during Different Phases of Menstrual Cycle

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Introduction. Physiological functions of women are different from men. Though the muscle strength of women is lesser than in men, their engagement in sports is markedly increased and is equal to man nowadays. Females are more prone for sports related injuries compared to males [1]. Young females have lot of restrictions in developing countries like India for participation in sports [2]. Fluctuating levels of sex steroids affect the sensory – motor association in females [3]. Fluctuating levels of sex steroids during menstrual cycle can affect the performance of woman both physically and psychologically.

Ability to perform physical exercise largely depends on respiratory efficiency as it requires more amount of oxygen for utilization. The changes in skeletal muscle performance have been expected as a consequence of alteration in autonomic reactivity and metabolism during menstrual cycle [4].

With increase in participation of women in competitive sports, many studies have been conducted to learn the effect of female sex hormones on muscle strength and respiratory efficiency along the different phases of menstrual cycle [5, 6]. Menstrual cycle has appeared to have significant effect on pulmonary function test parameters. Cyclical endocrine profile of females do have a correlation with bronchial hyperreactivity, bronchial asthma related hospital admissions [7]. Different studies have showed varied results [8]. Because of the existing of controversies and lack of such studies in non-athletic females of our locality this theme of the study has been chosen.

Aim. This study has been aimed at assessing of the muscle strength, time of fatigue and respiratory efficiency during different phases of menstrual cycle in non-athletic healthy females of our locality.

Objectives. 1. To assess and compare the muscle strength and time of fatigue during premenstrual and proliferative phase of menstrual cycle. 2. To assess and compare respiratory blast test and respiratory endurance during premenstrual and proliferative phase of menstrual cycle.

Materials and methods. After getting the institutional ethical committee clearance, this observational study has been conducted in the department of Physiology, Sri Venkateshwaraa medical college hospital and research centre. Fifty young healthy non-athletic female subjects aged 20-30 years, with history of regular menstruation have been selected. All the participants have had normal BMI (18-25 kg/m²).

Females with history of irregular menstruation, chronic respiratory problems like asthma, anemia, and hormonal abnormalities like diabetes, thyroid disorders, hypertensive and on chronic medications or muscular weakness, athletes have been excluded from the study. After explaining the procedures, a consent has been obtained from all the subjects and the tests have been conducting in the department of physiology in the morning from 10 am to 11 am during premenstrual (24th-25th day) and proliferative phase (6th-7th day) of the menstrual cycle [9]. The phases have been divided basing on the LMP. The subjects have been advised not to take any kind of energy drink like coffee and not to perform exercise one day before and on the day of the test. The participants have been asked to sit comfortably and hand grip strength of the dominant hand has been measured using hand grip dynamometer with elbow extended. The subjects have been asked to contract the forearm flexor muscles maximally and have been motivated during the procedure. This has been repeated thrice with the interval of 2 mins. The highest of the three readings has been taken as maximum voluntary contraction (MVC). Time of fatigue had been noted as long as the subject maintains sustained contraction at 30 % of their MVC. Muscle strength is expressed in kg and time of fatigue in seconds [3].

Respiratory efficiency has been measured using respiratory blast test and respiratory endurance test. In respiratory blast test the participants have been instructed to take a deep inspiration and to expire maximally through the rubber tube of the sphygmomanometer which has been disconnected from the cuff. The subjects have been asked to close the nose during this procedure. Three successive trials have been conducted and the maximum is recorded in mm of Hg. Respiratory endurance has been measured by repeating the same procedure and recording the time(in seconds) as long as the subject maintain the mercury column at 40 mm of Hg [10].

Results. Datas are expressed in terms of Mean $\pm$ SD. Statistical analysis has been done by Graphpad prism using student's paired test. $P < 0.05$ has been considered to be statistically significant. The mean age of the participants are 24.56 ± 4.99 and the mean BMI of the subject is 21.705 ± 1.79 .

Table 1

Muscle strength and fatigue during different phases of menstrual cycle

Parameters tested	Proliferative phase	Premenstrual phase	P value
Maximum voluntary contraction (kg)	23.66 ± 5.025	22.62 ± 5.306	0.1030
Time of fatigue (secs)	149.7 ± 23.41	142.3 ± 23.22	0.0028*

*p < 0.05 – statistically significant.

Table 1 shows that maximum voluntary contraction is slightly increased in the proliferative phase but do not show any significant difference between premenstrual and proliferative phase of the menstrual cycle. Time of fatigue is significantly increased in the proliferative phase compared to the premenstrual phase.

Table 2

Respiratory efficiency during different phases of menstrual cycle

Parameters tested	Proliferative phase	Premenstrual phase	P value
Respiratory blast test (mm of Hg)	42.32 ± 3.987	41.72 ± 2.425	0.213
Respiratory endurance (secs)	39.08 ± 6.219	38.06 ± 6.192	0.0538

Table 2 shows that respiratory blast test and respiratory endurance are in an increasing trend in proliferative phase but there is no significant difference between both the phases of menstrual cycle.

Discussion. In this study the muscle strength shows a trend of increase in the proliferative phase comparing to a premenstrual phase of the menstrual cycle but there is no statistical significance. However the muscle undergoes easy fatigability in the premenstrual phase indicated by significant increase in the time of fatigue in the proliferative phase comparing to a premenstrual phase. This shows that cyclical changes in the female sex hormones have some effect on muscle strength and fatigability. Our results are similar to the study done by Ayesha Juhi et al. [5]. They have reported that muscle strength and estrogen have had a positive correlation. Muscle strength has been significantly higher during the follicular phase before ovulation suggesting a positive isotropic effect of estrogen on skeletal muscle [11]. Sarwar et al. by measuring maximum voluntary isometric force in quadriceps muscle and hand grip reported that estrogen before ovulation has had a muscle strengthening effect [12]. This has been further supported by the study conducted by Philips et al. which suggests that there is a decrease in muscle strength in the postmenopausal women due to decline in estrogen level. They also have found the reversal of muscle strength with hormone replacement in postmenopausal women [13]. Athletic performance has appeared to be better during the proliferative phase when comparing to the premenstrual and menstrual phase that has emphasized the importance of estrogen in proliferative phase [14]. West et al. have reported that the aerobic capacity has been decreased during the luteal phase [15]. Various studies suggests that estrogen may promote endurance performance by altering the carbohydrate, fat and protein metabolism with progesterone often appearing to act antagonistically [16]. Luteal phase being associated with the increase in the serum concentration of progesterone indicates its negative influence on the muscle strength. Estrogen promotes glucose availability and uptake into type I muscle fibers providing the fuel of choice during short duration exercise and increases free fatty acid availability and oxidative capacity in exercise, favoring endurance performance [3]. Redman et al. reported that anaerobic performance has decreased in the luteal phase of women who have not used oral contraceptives [17]. The ovarian hormones are known to have a remarkable influence on protein metabolism at rest and during exercise. Progesterone has been found to be responsible for increased protein catabolism in luteal phase while estrogen might reduce the protein catabolism. Thus Eunsook et al. have reported that follicular phase based on strength training induces greater effect on the muscle strength in contrast with the luteal phase [18]. Autonomic activity during different phases of menstrual cycle reported that parasympathetic activity has been decreased in the premenstrual phase and sympathetic activity has been increased in the premenstrual phase comparing to the proliferative phase of the menstrual cycle [19] Kei Mizuno et al. have reported that decreased parasympathetic activity induces fatigability. This might be the reason for increased fatigability in the premenstrual phase compared to the proliferative phase of the menstrual cycle [20].

In our study the respiratory blast test and respiratory endurance shows a trend of increasing in the proliferative phase in contrast with the premenstrual phase, but they are not statistically significant. Talking about the study of Rajani Bala et al. where there is a significant increase in the respiratory efficiency in the luteal phase has been compared to the follicular phase [21]. They have reported that progesterone in the luteal phase acts as a smooth muscle relaxant and hence better lung function during the luteal phase compared to the follicular phase. Bayliss et al. have reported that respiratory response to progesterone is mediated at hypothalamic sites through an estrogen dependent progesterone receptor that has mediated mechanism requiring RNA and protein synthesis [22] Gibbs et al. have reported that there is premenstrual

exacerbation of asthma where the progesterone level is decreased just before menstruation. This is in favour of our results where the respiratory efficiency has been decreased in the premenstrual phase compared to the proliferative phase [23]. Kathleen et al. also have reported a non-significant decline in the maximal ventilation in the premenstrual phase along with decrease in the progesterone [24]. Gayatri et al. also have reported about decreased cardiorespiratory efficiency during the premenstrual phase [25]. Our results may be caused by progesterone that increases sensitivity of the respiratory neurons to CO₂ thus decreasing the respiratory endurance during the premenstrual phase as it has been said by Das et al. [26].

Conclusion. Though muscle strength and respiratory efficiency have not shown any significant difference during premenstrual and proliferative phase of menstrual cycle, muscles undergo easy fatigability during the premenstrual phase because of progesterone antagonizing the positive role of estrogen on skeletal muscle.

Limitation. Hormonal estimation that could divide the menstrual phases appropriately has not been done. One more group of athletic women should have been included for better comparison of muscle strength and respiratory efficiency along different phases of menstrual cycle.

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Background. Fluctuating levels of sex steroids across the menstrual cycle not only produce physiological changes in the reproductive system but also affect skeletal muscle strength and the respiratory efficiency. Increasing participation of women in competitive sports has drawn attention of the scientists to understanding of the effect of the menstrual cycle on athletic performance. Physical work capacity depends on respiratory efficiency and skeletal muscle strength.

Objectives. To evaluate skeletal muscle performance and respiratory efficiency during different phases of menstrual cycle in non-athletic eumenorrheic women.

Materials & methods. Fifty non-athletic healthy female subjects aged between 20-30 years of age with normal BMI and history of regular menstrual cycle have been selected. Muscle strength and time of fatigue has been determined using hand grip dynamometer. Respiratory efficiency has been assessed using respiratory blast test and respiratory endurance test during premenstrual and proliferative phase of menstrual cycle. Student's paired test has been used for analyzing of the data. $P < 0.05$ has been considered to be statistically significant.

Result. Muscle strength, respiratory blast test and respiratory endurance tests are not statistically significant during different phases of menstrual cycle. Time of fatigue is significantly higher ($p < 0.05$) during the proliferative phase compared to the premenstrual phase.

Conclusion. In females, muscles undergo easy fatigability during premenstrual phase hence it has to be considered during athletic training and selection program.

Key words. follicular phase, luteal phase, respiratory blast test, respiratory endurance, skeletal muscle performance.