World Applied Sciences Journal 12 (9): 1605-1609, 2011
ISSN 1818-4952

Comparison of Mode of Exercise and Physiological Responses in Menstrual Cycle of Active Females

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Abstract: In order to assess the influence of body weight on training load and in turn its relationship to physiological responses, twenty healthy active females were subjected to two types of ergometry (Treadmill:T and Cycle Ergometer:CE). Anthropometry and body composition variables were measured at rest and physiological variables were measured during and in recovery from graded exercise tests (GXT). The participants performed an incremental exercise on T and CE during their early follicular and luteal phases until they were exhausted. Early follicular was in the fourth day of menstrual cycle and the luteal phase was determined by the level of Progesterone, Prolactin, FSH and LH hormones in blood samples. In the four groups of participants, the pulmonary gas analyzer (K4B2) was applied to measure the Energy Expenditure (EE) in two phases. Results indicated no significant difference of EE in the luteal and early follicular phases of menstrual cycle of active females in none of the two modes of exercise. Additionally, there was higher work rate with increased oxygen consumption and heart rate, from treadmill exercise compared to cycle ergometry. Moreover, the differences between average of EE in two modes of exercise were significant in both groups of participants and it was more in T than CE. ($P<0.05$)

Key words: Menstrual cycle · Energy expenditure · Mode of exercise · Active female

INTRODUCTION

A multi-stage exercise test on treadmill or cycle ergometer will provide a measurement of the rate of work an individual is able to tolerate without symptoms of fatigue and ECG abnormalities [1]. Cycling and running are described as aerobic activities because they both utilize the large muscle groups of the lower body in repeated and rhythmic contractions. The work rate is dependent on the subject's position of body weight in treadmill exercise (TE) and independent on cycle ergometry (CE). The energy output per kilogram and km/hr is more variable in TE as it changes with the speed of walking and running, than it is at a given work load during CE. The energy output on the cycle ergometer is independent of position of body weight. Therefore, usage of both treadmill and cycle ergometer is essential to study the influence of position of body weight on energy output and work performance [2]. Every type of exercises has a unique situation. However, all forms of muscular activity increases metabolic rate, therefore, it is of interest to be able to analyze oxygen consumption, transporting systems and other related physiological changes [3-4]. It found that peak tension developed during each pedal thrust was higher in maximal cycling than in running. This tension difference implies a greater fast-twitch fiber recruitment and, hence, a greater anaerobic contribution [5]. Also, it suggested that biomechanical factors may contribute to greater impairment in skeletal muscle blood flow in cycling than in running. They explained that the contraction portion of the contraction-relaxation cycle is prolonged in cycling. Running, in contrast, is more of a ballistic movement with a very short contraction phase and less impairment to muscle blood flow. At maximal work rate, significant differences were observed in HRmax between tests with higher values on the treadmill. This conclusion ensured athletes and coaches that the use of HR at relative percentage of VO_2max to monitor training sessions is valid. This confirmed the results of a previous study that the HR generated on cycle ergometer or treadmill could be used interchangeably to monitor intensities with either mode of exercise. Additionally, many athletes reported a decrease in performance during the premenstrual and menstrual phase, whereas others

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reported performance enhancement during their menstrual phase. The purpose of this study was to assess the energy expenditure of active females by testing them on treadmill and cycle ergometer separately in early follicular and luteal phases of menstrual cycle. Such studies would help to understand how far position of body causes additional demand on energy expenditure and other physiological mechanisms in menstrual cycle. It also indicates the variations in quantum of load received by the athletes with different position of body. This would help coaches to modify training intensity and duration to give optimal load to every athlete. The results of the study could enhance our understanding of the hormonal influences on breathing during exercise that occurs during the menstrual cycle. The results could have an impact on exercise rehabilitation programs for patient populations, exercise prescription for disease prevention in healthy individuals and training strategies for competitive athletes. The purpose of the study was to compare the breathing responses at during incremental exercise in both the follicular and luteal phases of the menstrual cycle in healthy active females that reported a normal menstrual cycle and were not using birth control medications in two mode of exercise.

Methods: This study was conducted on all the available (n=20) healthy active female who were aged between 19 and 25 years with no known history of cardiopulmonary, metabolic or musculoskeletal disease. All subjects demonstrated a normal menstrual cycle during the previous 4 months as determined by the medical history form and were not currently using birth control medications. The participants were randomly classified in two equal groups and performed an incremental exercise on Treadmill (Technogym) and Cycle Eegometer (Technogym) during their early follicular and luteal phases until they were exhausted. Early follicular was in the fourth day of menstrual cycle and The luteal phase was determined by the level of Progesterone, Prolactin, FSH and LH hormones in serum blood samples(RIA-method). Heart rate and rhythm was monitored continuously throughout the incremental graded exercise test. Lean body mass (LBM) was estimated from skin fold measures and body weight [6]. Body mass index (BMI) was measured by Bio-Electric Impedance Analysis using a Tanita body fat monitor/scale (Model TBF-350, 4-contact electrodes with two on each foot, Tanita Corp, Tokyo, Japan). Energy expenditure was estimated from breath-by-breath metabolic measurements using portable metabolic assessment equipment (Cosmed K4b2, Italy). HR was monitored continuously using a wireless HR monitor (Polar, Kempele, Finland). After a 5-min warm up at 50 W, the subjects rode a progressive exercise test (25 W/min), until they were unable to continue, in the treadmill group, subjects were allowed to walk for 5 min at 2.5 miles/h (mph) and 0% grade and data were collected in the last minute of this workload. Subjects then warmed up for 5 min at a treadmill speed of 4.5-5.0 mph and 0% grade and data were collected in the last minute of this workload. Next, the treadmill speed was increased to a comfortable running speed (determined during a prior visit), which ranged from 5.0 to 7.0 mph. After 1 min at this speed and 0% grade, the treadmill grade was increased 2% every minute until volitional fatigue [7]. After termination of the test protocol, the recovery phase was continued for 20 minutes.

For comparison of energy expenditure in two types of ergometry tests (treadmill vs. cycle ergometer), paired samples T-tests were performed to detect baseline differences across two menstrual phases in two modes of exercise. The values were expressed in terms of mean ± SD. The results indicated no significant difference of energy expenditure in the luteal and early follicular phases of menstrual cycle in none of the two modes of exercise. The differences between averages of energy expenditure in two modes of exercise were significant. Significance was set as 0.05.

RESULTS

Absolute EE (total kJ) and rate of energy expenditure per minute (kJ per min) were not significantly different between early follicular and luteal phases of menstrual cycle in two mode of exercise and, it was more in T than CE. The mean body composition profiles such as age, height, weight, FFM, body fat percent and hemoglobin values are given in Table 1. VO_2max did not differ between cycle and treadmill testing (57.0 ± 12.9 ml.kg.min^{-1} cycle; 59.3 ± 13.7 ml.kg.min^{-1} run; p = 0.44). Absolute energy expenditure values are shown in Table 2. Exercise energy expenditure in follicular and luteal phases with cycle ergometer (follicular: 64.34 ± 12.21 kJ; luteal: 63.97 ± 10.14 kJ) and exercise energy expenditure in follicular and luteal phases with treadmill (follicular: 73.12 ± 6.45 kJ; luteal: 71.24 ± 5.63 kJ) were similar for cycling and running in two phase of menstrual cycle(Table2). Exercise energy expenditure was significantly lower for cycling as compared to running (31.7 kJ vs. 41.4 kJ, respectively). All measurements are reported as mean ± SD(Figure1).

Table 1: Anthropometry and Body Composition Profile (n=20)

Subjects	Age [yr]	Weight [kg]	Height [cm]	% Fat	Fat Mass [kg]	Fat Free Mass [kg]]	BMI
Treadmill n=10	22± 3	52.31± 2.44	165± 4.50	18.3± 2.3	12.2± 2.1	44.8± 2.7	19.8± 1.72
Cycle Ergometer n=10	22± 3	53.43± 4.19	165± 3.77	19.6± 2.7	11.0± 2.2	48.2± 3.3	20.3± 0.65

Table 2: Energy Expenditure During Maximal Work Performance

Mode of exercise	Follicular	Luteal
Treadmill	73.12±6.45	71.24±5.63
Cycle Ergometer	64.34±12.21	63.97±10.14

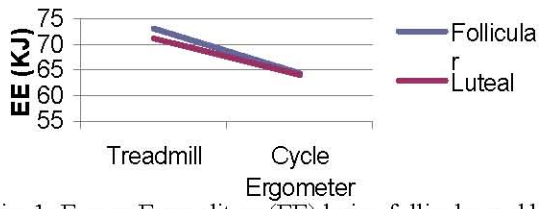

Fig. 1: Energy Expenditure (EE)during follicular and luteal phases of the menstrual cycle with two mode of exercise. Values are means + SD.

Therefore, it is suggested that selection of a particular type of ergometry depending on the type of training activity (treadmill for ambulatory activities and/or cycle ergometer for non-ambulatory activities) is essential in deriving either oxygen consumption or intensity of work rate for precise estimates.

CONCLUSIONS

Females constantly experience a wide fluctuation in estrogen and progesterone levels during their menstrual cycles. Earlier studies have suggested that respiratory function is influenced by female sexual hormones, especially progesterone, which could increase ventilatory response during the luteal phase [8-9] and at exercise [10]. The results of this study indicated that menstrual cycle hormones did not affect respiratory responses across the menstrual cycle during incremental exercise. These results provide additional data suggesting that the timing of the menstrual cycle phase may not be as critical as once thought when designing future exercise ventilation studies. The varying results between these studies and the current study could be related to individual responses and differences in progesterone receptor sensitivity [11]. In addition, it is widely accepted that ventilatory measures demonstrate large within-subject daily variability.

It is generally accepted that variations in oxygen consumption and physiological variables during different forms of exercise reflect differences in the body mass and muscle mass activated [12-13-14]. The experiments carried out by Bobbort [15] and Kirsch *et al*[16] made physiological comparisons on the same subjects during different forms of exercise and found that greater oxygen consumption was obtained with treadmill experiments and bench stepping than those obtained on the cycle ergometer. McArdle *et al.* [17] compared the VO_2max of the subjects by giving continuous and discontinuous protocols on cycle ergometer and treadmill and observed that VO_2max during cycling is 6.4 to 11.2% lower than the treadmill values. Treadmill running also contains a horizontal along with a vertical power output component that may increase the total work output as compared to cycling; we did not account for this horizontal work component. While potential differences in the horizontal and vertical components of power output along with metabolic and work efficiency are certainly possible between an intense bout of cycling and uphill running, it did not promote significant discrepancy in perceived exercise energy expenditure between the work bouts so that subjects also appeared to have worked at the same relative exercise intensity. Martinez, *et al* [18] speculated that, during maximal cycling, high intramural pressures may occur which restrict the muscle blood flow to that area. They found that peak tension developed during each pedal thrust was higher in maximal cycling than in running. This tension difference implies a greater fast-twitch fiber recruitment and, hence, a greater anaerobic contribution. Faulkner, *et al* [19] also suggested that biomechanical factors may contribute to greater impairment in skeletal muscle blood flow in cycling than in running. They explained that the contraction portion of the contraction-relaxation cycle is prolonged in cycling. Running, in contrast, is more of a ballistic movement with a very short contraction phase and less impairment to muscle blood flow. We therefore argue that work output along with the metabolic and work efficiencies were not significantly different between cycling and uphill treadmill running in the menstrual phases. Thus, the usage of graded incremental exercise test would definitely help the coaches, researchers and sports nutritionists to identify scientifically, the influence of position of body weight on the quantum of workload and in turn associated physiological responses and energy needs. Otherwise the load received by the athletes with lower body weight included position of body would have lower VO_2max,

cardiovascular and cardio-respiratory responses that probably leads to no considerable improvement in performance even though they receive training regularly. Apart from this, dual exercise test would also provide the information regarding energy output of the training load and form an important baseline for the formulation of sound program of diet especially the energy allowances, since diet plays a major role in achieving desirable body weight, composition and optimal performance. This study suggests that position of body influences maximal work performance, as is evident from the close correlation between body weight and maximal work performance (muscle mass engaged in running is probably larger than that used in cycling) when subjected to a given exercise intensity. As a result, oxygen consumption levels, energy expenditure were significantly increased on treadmill. Therefore, based on the results of this study, it can be concluded that the identification of variations in amount of work load received based on position of body weight helps coaches and researcher s to formulate individualized training program and to suggest suitable energy needs to achieve desirable body weight in the sitting position, composition and higher levels of work performance during composition. The major finding of this study suggests that menstrual hormones did not affect breathing responses at maximal exercise. Additionally, there were no significant differences in energy expenditure during a maximal graded exercise test between the follicular and luteal phases of the menstrual cycle. It seems that because of the physical depression during menstrual cycle, the replacement of running with cycling, with the aim of making physical activity simpler and encouraging female to continue their activity during this time, is not recommendable.

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