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Cardiovascular system adaptability to physical exercise during follicular phase of endometrial cycle in female trained athletes and non-athletes

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Abstract

Background: The physiological role of oestrogen on the cardiovascular system is well studied during phases of the endometrial cycle. There is very high rise in both progesterone around 37% and oestradiol around 13.5%, in the previous studies it has been observed there FSH and LH plasma levels do not change in trained exercising females. Hence this study was aimed to see the restrictions of the cardiovascular system adaptability to exercise in follicular phase of endometrial cycle in peri-menopausal females.

Material and Methods: The study included healthy females adults aged between 42-45years, the participants who had undergone regular training and had participated in competitive running events 3-4 years in middle distance were selected in the athlete group and other set of participants had no regular exercise schedule or training program were selected for non-athlete group. Dynamic cardiac functions were measured before exercise in both the groups and after standard protocol of treadmill testing, they were evaluated.

Results: The study results showed a statistically significant variations in cardiovascular function parameters due to exercise per se in each of two of the groups of athletes and non-athletes.

Summary and Conclusion: The present study observations and results supports the theory from the previously studies that the most restricting component in the distribution of oxygen to the tissues is the cardiovascular system even under the potent influence of oestrogen hormone during follicular phase of endometrial cycle and which exercise further accentuates it.

Keywords: Follicular Phase, Oestrogen Role in Exercise, Dynamic Cardiac Functions, Adaptability, Maximal Oxygen Consumption (Vo2 Max).

Introduction

In a typical endometrial cycle of 28 days, the first 5 days of cycle are patterned by exfoliating of the endometrial lining, after which next event is followed by neo-proliferation of mucosa in preparation for an egg. The first phase usually lasts 14 days and is called the follicular phase (FP).

After ovulation, normally in day 15, the luteal phase (LP) starts, lasting until the day before menses, normally about day 28. A complex system regulates the steroid hormonal system, predominantly oestrogen and progesterone, which in turn are modulated in a feedback system by luteinizing hormone (LH) and follicular stimulating hormone (FSH) secreted by the pituitary gland. The cycle continues from the beginning of the first menses in young women until menopause. The pituitary gland is regulated by the hypothalamus centers, via gonadotropin-releasing hormone (GnRH), and altered by various other factors, including physical exercise, psychological conditions, stressful events and body metabolic status, etc.(1)

With respect to maximal oxygen consumption (VO2max), contrasting results have been established depending on the intercommunication of endometrial cycle with mobilization, energy intake, energy reserve and body water status, heart rate and cardiac output and general nutritional state. Commonly no big variations are noted, even if, with respect to the lactate metabolism, a chance of improvement in exercise time duration to exhaustion level during the middle of luteal phase (LP) (with an uncertain increase in VO2max) has been described. It is observed that an increased fat metabolism might be present during the Luteal Phase, with glycogen spared and decreased lactate response to exercise, in converse to the increased lactate status seen in the mid follicular phase (FP).(2) These effects seem to bank on mainly on oestrogen.(1) Physiologically, the greater the maximal oxygen uptake (VO2 Max), the higher capability to work for longer period of duration.(3)

The physiological functions of female sex hormones (oestrogen and progesterone) on the normal cardiovascular system in distribution oxygen (O2) to accommodate the needs during various phases of exercise has been a subject of debate. A group research have observed cardiovascular system as the normally the most important restricting factor in the distribution of oxygen to the muscle tissues during maximal muscle aerobic metabolism. Whereas many other researchers do not agree to this theory.(3) Hence with many conflicting opinions from various studies it is very important to study the effect of female sex hormones during the follicular phase of endometrial cycle on cardiac functions after standardized exercise.(4)

The mechanical restraints on exercise induced hyperpnoea has been researched as an important factor reducing efficiency in endurance athletes.(5,6) Others researchers have studied the lack of structural adaptability to physical training as one of the “weaknesses” inherent in the normal cardiovascular system response to exercise.[7,8]

Cardiac functions are vital part of physiological diagnostics,[9] assisting selection and improvisation of physical training and early diagnosis of sports pathology and disorders. Functional assessment of exercise response of dynamic pulmonary functions in the normal healthy cardiovascular system in the physically trained and the untrained has a role in clearing gaps in the above areas especially a unique group like peri-menopausal females.[10]

Material and Methods

This study was researched as a segment of cardiac and pulmonary efficiency research on two sets of participants, age and gender comparable set of non-athletes (n=10) and set of trained athletes (n=10).

The participants underwent detailed systemic clinical examination to exclude any underlying clinical disorders. Participants were educated about the study and informed consent was taken. Healthy females adults aged between 42-45 years, and who had undergone regular training and had participated in competitive running events 3-4 years in middle distance were selected in the athlete group and other set of participants had no regular exercise schedule or training program were selected for non-athlete group were included for the study. Exclusion criteria included substance abuse (tobacco smoking or chewing, alcohol dependence and other substance), clinical evidence of anaemia, obesity, diseases of cardiac and respiratory system. Endometrial history was obtained to confirm follicular phase of endometrial cycle.

The participants were explained about the protocol of exercise treadmill testing and dynamic lung function tests using spirometry.

In both batches of participants dynamic cardiac functions were measured before exercise following standard procedure of treadmill testing. All participants were subjected to maximal exercise capacity and VO2 max was calculated. Standardized motorized treadmill was used for the procedure.

After standard treadmill exercise testing, the dynamic pulmonary functions assessment was repeated. The set of procedure and recordings were recorded on two the set of participant’s of non-athlete and the athlete groups.

Paired students t-test was utilized for statistical analysis for comparing parameters within the set of participants before and after standard exercise testing, and for comparing the between athletes and non-athletes groups, un-paired students t-test was utilized.

A p-value of < 0.01 was deliberated as significant.

Results

Table 1: Anthropometric data and Maximum oxygen uptake (Vo_2) comparison between the groups with statistical analysis

Parameter	Non-Athletes	Athletes	P- value	Remarks
Age (Yr)	43.52 ± 2.62	43.47 ± 2.84	< 0.10	NS
Height (cm)	160.71 ± 7.50	155.91 ± 7.24	< 0.10	NS
Weight (kg)	52.65 ± 5.66	55.44 ± 6.26	<0.05	NS
BMI (kg/m²)	22.01 ± 2.47	21.61 ± 1.75	< 0.10	NS
VO2 max(lit/min)	2.49±0.15	2.96±0.28	< 0.001	HS

NS=Not significant
P< 0.01 Significant
P< 0.001 Highly Significant

Table 2: Comparison of Dynamic cardiopulmonary Functions of Non- Athletes before exercise testing (BE) and after exercise testing (AE) with statistical analysis. Non-Athletes (n=10)

Parameter	BE	AE	P- value	Remarks
Heart Rate bpm	76.09	86.00	< 0.10	NS
FEV1 (L)	3.10 ± 0.51	2.98 ± 0.05	< 0.05	NS
FEV1/FVC	0.951	0.962	< 0.05	NS

NS = Not Significant
P< 0.01 is considered significant

Table 3: Comparison of Dynamic Lung functions of Athletes before exercise testing (BE) and after exercise testing (AE) with statistical analysis. Athletes (n=10)

Parameter	BE	AE	P- value	Remarks
Heart Rate bpm	70.10	78.08	< 0.10	NS
FEV1 (L)	3.11 ± 0.51	2.99 ± 0.04	< 0.05	NS
FEV1/FVC	0.95	0.97	< 0.05	NS

NS = Not Significant

P< 0.01 is considered significant

Discussion

Substantial amount of information can be obtained by studying the exercise response of dynamic cardiopulmonary functions in non-athlete and athlete subjects.

Comparison within the study group is beneficial in studying the exercise response and comparison between the study groups in studying adaptability of the cadio-respiratory system to physical training.

Anthropometrical data comparison of the both study participant batches, clearly states that the age and gender matched participants had no statistically significant difference in anthropometric parameters (height, weight and Body mass index). p-value of <0.01as considered significant.

Last Menstrual Period (LMP) and basal body temperature chart were considered to approximate the phases of menstrual cycle and the hormonal changes for the respective phases. Daily basal body temperature (BBT) recordings were performed by females as a way to assess for ovulation.[11,12]

Biphasic changes in basal body temperature are characteristic of the ovulatory cycle and occurs secondary to alterations in progesterone. A temperature change of 0.5–1.0°F signifies ovulation and the beginning of the luteal phase.[11,12]

The last day of menstrual bleeding was defined as day 1 of the follicular phase of menstrual period. The first day of ovulation (days 15–18 for our subjects) defined the luteal phase of the menstrual cycle.

Maximum oxygen consumption (Vo2 max) showed high values in trained athletes and was statistically significant (P< 0.001). This observational conclusion is in expected lines in view of the training stimulus and adaptability of both the respiratory system and the cardio vascular system. The functional capability of the human body's ability to generate power is objectively measured by Vo2 max.

The Forced expiratory volume in first second (FEV1) was earlier used as an indirect method of assessing its predecessor as the main respiratory function test, the maximal breathing capacity.[13]

Within the two study batches, the comparison of the response of exercise and in between them, there was no statistically significant difference in Forced vital capacity (FVC) and FEV_1 under any circumstances. It is always observed a normal ratio between FEV1/FVC.

Table 2 and Table 3 observation, it is indicative that exercise by itself does not object a statistically significant change in dynamic cardio-respiratory parameters in either of the groups. This finding backs the hypothesis that the cardiovascular system is normally the most restricting factor in the distribution of oxygen.[14]

Thirty minutes of exercise at seventy four percent of maximum oxygen consumption (Vo2 max) was found to cause a significant rise in both progesterone (37%) and oestradiol (13.5%), whereas no change in plasma follicular stimulating hormone (FSH) and luteinising hormone (LH) was recognized in exercising women[15] others studied have established these findings.[16] This finding backs the hypothesis that the cardiovascular system is normally the most restricting factor in the distribution of oxygen even under the predominant influence of oestrogen in follicular phase of endometrial cycle which is further accentuated by physical exercise.[17]

Summary and Conclusion

The present study observations and results supports the theory from the previously studies that the most restricting component in the distribution of oxygen to the tissues is the cardiovascular system even under the potent influence of oestrogen hormone during follicular phase of endometrial cycle and which exercise further accentuates it.

The authors conclude that there is possible difference in the observations observed in the study to that of other studies, as many factors (inter-subject variations, the type of the exercise, and the general nutritional status of the participants, small variations that could be attributed to the endometrial cycle) can influence the performance.

Study Limitations

1. Sample size was 10 participants in each batch is small and restricts the generalization of these study observations.
2. Age group 42-45years is narrow and restricts the generalization.
3. The research findings has to considered in the background of the kind of participants that is women athletes in the peri-menopausal group availability of consenting participants being difficult.

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