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Effectiveness of Aerobic Exercise in Developing Maximum Aerobic Capacity (VO2max) during Menstrual Cycle Phases

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Abstract

The purpose of this study is to analyze the physiological determinants and effectiveness of aerobic exercise for maximal aerobic capacity (VO2max) on the premenstrual, menstrual, and postmenstrual cycle phases of female students at the Faculty of Sports, Padang State University. Maximum oxygen absorption (VO2max) was chosen because it is considered the best indicator of an organism's aerobic capacity. Previous studies used several forms of exercises to determine these physiological determinants; however, this research utilized the maximal aerobic capacity. This study provides a solution for developing VO2max during the pre-menstruation, menstruation, and post-menstruation cycle of female students. Data were obtained from the cardio-respiration analysis of 20 Faculty of Sport Universitas Negeri Padang. The results showed that aerobic exercise has a positive effect on VO2max, through the production of adequate energy and metabolism during various phases of the menstrual cycle. It can apply this finding to women to use aerobics for bodily health.

Keywords: *Aerobic Exercise, Maximum Aerobic Capacity, Menstrual Cycle.*

1. Introduction

The maximum metabolic rate is defined as the utmost level of oxygen consumption (VO2max) obtainable by a person at a certain temperature with physiological responses to physical activity(Biro et al., 2018; Norin & Clark, 2016; Zhao et al., 2013). In accordance with specific training principles, endurance training is associated with an increase in maximal aerobic capacity to obtain adequate resistance to fatigue. Meanwhile, strength training is associated with muscle hypertrophy and increased strength generating capacity(MacInnis & Gibala, 2017).

Gender differences affect a person's endurance level during training due to the differences surrounding estrogen(Devries, Hamadeh, Phillips, & Tarnopolsky, 2006). Menstrual phase variations are largely a consequence of changes in exercise metabolism that are stimulated by fluctuations in ovarian hormone concentrations (Oosthuyse & Bosch, 2010). Many studies have reported changes in the metabolic and cardiorespiratory responses associated with the menstrual cycle. (Saxena, 2018) stated that in these studies, the menstrual cycle does not affect pulmonary ventilation thresholds. The use of aerobic exercises is beneficial to individual health (Gupta, Mohanty, & Pattnaik, 2019). Other findings also found that aerobic exercise has the ability to improve individual cardiorespiratory fitness (Morales-Palomo, Ramirez-Jimenez, Ortega, & Mora-Rodriguez, 2019; O'Brien, Tynan, Nixon, & Glazier, 2016). The above findings showed that aerobic exercise is beneficial for launching a woman's menstrual cycle (Akbaş & Erdem, 2019).Menstrual periods do not affect aerobic performance and endurance in women(Wiecek, Szymura, Maciejczyk, Cempla, & Szygula,

2016). This exercise has also benefited the physiotherapist process in the medical world (Foster et al., 2019).

In addition, the increase in female steroid hormones during the menstrual ovulation cycle has a slight adverse effect on aerobic capacity (Oosthuyse & Bosch, 2010). Therefore, an increase in exercise participation leads to a rise in women's physiological and metabolic responses to physical activities (Tsampoukos, Peckham, James, & Nevill, 2010). The repeated training activities carried out over a specified period, led to many physiological changes that improved performance in physical exercises (Jones & Carter, 2000).

Generally, aerobic exercises improve recovery from lactate removal and increase PCr regeneration (Tomlin & Wenger, 2001). It is safe when combined with strength training and may be effective in increasing maximal aerobic capacity or VO2max(Burdette & Whitaker, 2005). This study ascertains that aerobic exercise is used to develop the maximum aerobic capacity of VO2max in the menstrual cycle phase.

2. Methodology

This research was designed using one group pretest and posttest experiment (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003). Data were obtained from 20 students of the Faculty of Sport Universitas Negeri Padang students enrolled in the July-December 2019/2020 semester, using the maximum aerobic capacity test (VO2max). The procedures are as follows: 1) intervention procedure, the female students were categorized into a group of 20 people. The research procedure was conducted in the sports science laboratory of UniversitasNegeri Padang, 4 times a week for 3 months; 2) observer reliability, two health team assessors evaluated all female students; however, they were not involved in carrying out experimental tests. Each observer evaluated the student's maximum aerobic capacity (VO2max) and recorded it on a standard score sheet. The assessors used a stopwatch, to ascertain the students' reliability, using one score sheet per trial. Intra assessors' reliability was examined after observation, and the female students were evaluated the following day.

The students' statistical analysis of data was determined using the SPSS program version 24, at a 0.05 significance level. Before the data were analyzed, they were tested for variance, using the Kolmogorov-Smirnov test (KS test), covariance matrix equality test, and homogeneity test. The result showed that there is no significant value at $p < 0.05$. Therefore, the data do not significantly differ from the multivariate normality of variables, thereby leading to the application of the parametric tests.

3. Results and Discussion

The study is influenced by the maximal aerobic capacity (VO2max) of the menstrual cycle of Faculty of Sport Universitas Negeri Padang students before and after aerobic exercises. Table 1 illustrates the training provided by the previous results.

The normality table 1 shows that the statistical prices before aerobic exercises using the Kolmogorov-Smirnov test are at 0.130, 0.114, and 0.182 with sig or p-values of 0.200 0.070> 0.05 for VO2max capacity during the menstrual cycle. Therefore, H0 was accepted. Figure 1 provides more details on the normal diagram of the Quantile and Quantil (Q-Q) plots.

In addition to the normal Q-Q Plot, VO2max capacity normality data testing during the menstrual cycle phase is also seen from the Detrended Normal Q-Q Plot. The data is normally distributed, assuming it is in the form of dots and gathers around a horizontal line through the zero points.

Table 1: Tests of Normality

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Premenstruation_Before	.130	20	.200(*)	.950	20	.374
Premenstruation_After	.206	20	.026	.893	20	.030
Menstruation_Before	.114	20	.200(*)	.938	20	.222
Menstruation_After	.239	20	.004	.836	20	.003
Postmenstruation_Before	.185	20	.070	.971	20	.775
Postmenstruation_After	.275	20	.000	.806	20	.001

* This is a lower bound of the true significance.
A Lilliefors Significance Correction

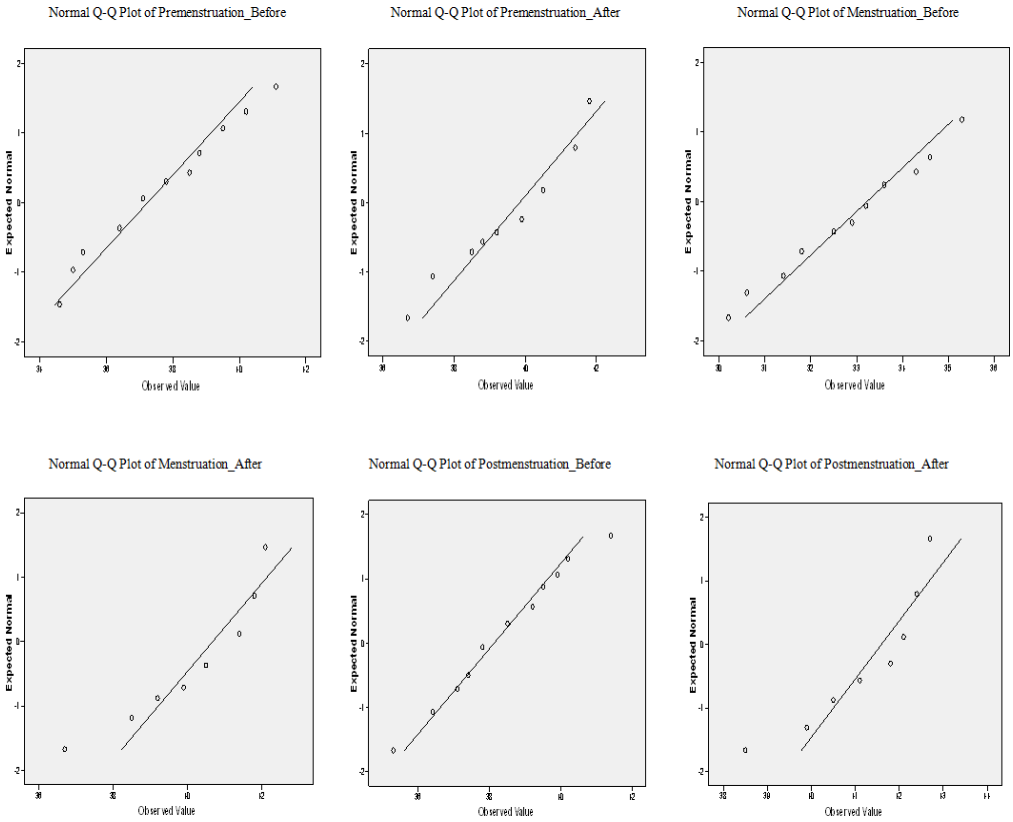

Figure 1: Diagram of Normal Quantile and Quantil (Q-Q) Plots Before And After

Table 2; Test of Homogeneity of Variance

Levene Statistic	df1	df2	Sig.
1.433	5	114	.218

The statistical Lavene test based on all criteria with sig values is above 0.05. Because the sig value is 0.218> 0.05, it can be concluded that the premenstrual, menstrual, and postmenstrual variables come from a homogeneous population. Therefore, the maximum aerobic capacity (VO2max) is obtained from the homogeneous group. Meanwhile, the ANOVA table obtained a price F, and a p-value of 75.959, and 0.000 <0.05, which means the significant difference in VO2max is from the six data groups.

Table 3: Anova

	Between Groups	913.364	5	182.673	75.959	.000
	Within Groups	274.155	114	2.405		
	Total	**1187.519**	**119**			

In the Paired Sample Statistics table 4, the average VO2max capacity of students before the aerobic exercise was 37.24 for pre-menstruation, 33.23 for menstruation, and 38.12 for post-menstruation, with standard deviations of 1,900, 1, 59 and 1,508, respectively. However, after administering the aerobic exercise, the premenstrual, menstrual, and postmenstrual groups were 39.84, 40.68, and 41.59, with standard deviations of 1,632, 1,463, and 1,089, respectively. This descriptively means that there are differences in the average capacity of VO2max in the three phases before and after aerobic exercise.

Table 4: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Premenstruation_Before	37.24	20	1.900	.425
	Premenstruation_After	39.84	20	1.632	.365
Pair 2	Menstruation_Before	33.23	20	1.598	.357
	Menstruation_After	40.68	20	1.463	.327
Pair 3	Postmenstruation_Before	38.12	20	1.508	.337
	Postmenstruation_After	41.59	20	1.089	.244

Table 5 shows the correlation coefficient of the students' menstrual cycle phase before and after aerobic exercises. These were at 0.103, 0.920, and 0.352 for the premenstrual, menstrual, and postmenstrual groups p-values of 0.103, 0.920, and 0.352, at a significant level above 0.05.

Table 5: Paired Sample Correlations

		N	Correlation	Sig.
Pair 1	Premenstruation_Before&Premenstruation_After	20	.375	.103
Pair 2	Menstruation_Before&Menstruation_After	20	-.024	.920
Pair 3	Postmenstruation_Before&Postmenstruation_After	20	.220	.352

In the Paired Samples Test table 6, mean differences of 2,600 7,455 and 3,470 were obtained in the different phases after and before the aerobic exercise. The table also shows the std.error Mean and the standard error rate of the average differences.

The most important results from table 6 are the statistical value of t at 5.853, 15,208, and 9,379 for premenstrual, menstrual, and postmenstrual groups, with dB = 19 and p-value of 0,000 <0.05 with H0 rejected. Therefore, it was concluded that there was a significant influence of VO2max capacity on three phases of the menstrual cycle before and after the aerobic exercise training.

According to Kappenstein&Ferrauti, aerobic exercise is a powerful and timesaving training method used to induce cardiovascular adaptation and the skeletal muscle associated with improving health (Kappenstein & Ferrauti, n.d). Maximum aerobic capacity increases lung ventilation, and endurance capacity in all phases of the menstrual cycle (Chatterjee, Maitra, & Bandyopadhyay, 2011). During the luteal and menstrual phases, women

experience adverse health effects on physical work output (Girija & Veeraiah, 2011).

There are no differences between the sexes in central cardiovascular adaptations for aerobic training; however, women generally have a lower O2 transport capacity (Joyner & Dominelli, 2020). The different phases of the menstrual cycle had no significant effect on other performance tests in the measured cardiorespiratory variable(Julian, Hecksteden, Fullagar, & Meyer, 2017). In addition, the menstrual cycle does not affect performance parameters such as muscle strength, endurance, and aerobic-anaerobic capacity (Köse, 2018; Smekal et al., 2007).

Table 6: Paired Samples Test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Upper	Lower			
	Premenstruation Before - PremenstruationAfter	2.600	1.987	.444	3.530	1.670	5.853	19	.000
	Menstruation Before - Menstruation After	7.455	2.192	.490	8.481	6.429	15.208	19	.000
	Postmenstruation Before-PostmenstruationAfter	3.470	1.655	.370	4.245	2.695	9.375	19	.000

The maximal aerobic capacity (VO2max) during the menstrual cycle phases decreases during normal times and increases through aerobic exercise (Vidiari, 2017). Table 6 shows that aerobic exercise's use positively impacts the development of maximum aerobic capacity in the menstrual cycle (at p-level of 0,000 <0.05.

According to previous studies, women's physiology is not affected by hormonal changes in the menstrual cycle (de Jonge, 2003; Redman & Weatherby, 2004). There is a growing belief that estrogen and progesterone play an important role in regulating substrate metabolism during exercise (Rechichi, Dawson, & Goodman, 2009). Aerobic performance and adaptation of cardiorespiratory for exercise are not affected during the menstrual cycle. This means that high-intensity exercise performance and increased lactate production reduces the luteal phase with a rise in estradiol and progesterone levels (Jurkowski, Jones, Toews, & Sutton, 1981).

Tymko (2017), stated that regular aerobic exercise accelerates cardiovagal reactivation in the menstrual phase (Nakamura, Hayashi, Aizawa, Mesaki, & Kono, 2013). Aerobic exercise has been globally accepted as a determinant of maximum performance and controlled by the cardiovascular transportation of oxygen (Bandyopadhyay & Dalui, 2012). Aerobic exercise can improve pulmonary ventilation in women during their menstrual cycle, which in turn increases their maximum aerobic capacity (VO2max).

Research showed that carrying out aerobic exercise at least three times per week for five weeks can improve cardiorespiratory fitness, strength, body composition, and quality of life (O'Brien, et al., 2016). The individual's body tends to respond to what has been stimulated and trained. Other studies have also found that aerobic training programs for 16 weeks increase low initial cardiorespiratory fitness (Morales-Palomo, et al., 2019). The effectiveness of the use of aerobic exercise helps to improve individual health (Gupta, et al., 2019). It also has beneficial effects on the systemic vascular function and reduces stiffness (Augustine, Nunemacher, & Heffernan, 2018).

The above findings are in accordance with the study carried out by (Joshi, Pendse, & Vaidya, 2018), which stated that planned aerobic exercise improves the function of the reproductive system and regulate the menstrual cycle. Hayashida, Yoshida, & Tanaka (2016) also reported that aerobic exercise helps in the production of salivary secretory immunoglobulin A. The findings of previous studies also explained that intermenstrual bleeding in women that participate in aerobic exercises was significantly reduced, with a

decrease in pain and a positive effect on menstruation symptoms (Akbaş & Erdem, 2019; Joshi, et al., 2018). These findings need to be publicly disseminated to provide knowledge on the menstrual cycle in women. The results can motivate female students to participate in sports, especially aerobics, to smoothen their menstrual cycle.

4. Conclusion

The use of aerobic exercise has been proven to be able to develop maximum aerobic capacity (VO2max) during the menstrual cycle. This study showed that a short, high-intensity exercise with a longer recovery period has a profound effect on maximal aerobic capacity (VO2max) in the menstrual cycle phase.

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