

The Effect of Exhaustive Exercise in the Morning and Evening on ECG Parameters in Male Athletes

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Abstract

The purpose of this study was to investigate the effects of exhaustive exercise in the morning and evening on the electrical activity of the heart of middle-aged male athletes. This study was based on the quasi-experimental method. The study population included all male athletes in Shiraz. 17 athletes were voluntarily selected as the sample size. In this study, the independent variable was the time and exhaustive exercise which was conducted in the morning and evening. The dependent variables included QRS-T-wave changes, PR segment, PR interval, and QT interval. They were measured in the stages of exhaustion and recovery as a pretest. All the participants were prepared to exercise to the point of maximum exhaustion. They were tested using the Bruce protocol as a routinely used and well-validated exercise treadmill test. There were seven stages in total, and each stage lasted 3 min. There was a progressive increase in workload in terms of speed and incline with each successive stage. The electrical activity of the heart was recorded by electrocardiogram at each stage. The hypotheses were tested using repeated measures ANOVA through SPSS.16 software at the significance level of $P \leq 0.05$. The results showed that there is no significant difference between the variables, including QRS-T-wave changes, PR segment, PR interval, and QT interval in the morning and evening.

Keywords: exhaustive exercise, electrocardiogram, men, athlete

Introduction

An increase in the cardiovascular disease is common in many countries. The disease is the top killer diseases in the world. It is estimated that by 2030 about 23 million people will lose their lives due to cardiovascular disease. In Iran, the highest mortality rate of adult age group is related to cardiovascular disease. Studies show that physical activity as an appropriate method resolves problems with cardiovascular disease. Research has shown that different factors associated with cardiovascular system, such as heart rate and blood pressure, follow a circadian rhythm. There is a relationship between the electrical activity of the heart and the circadian rhythm. The circadian rhythm affects the electrical

activity of the heart in humans and many other mammals (Pysyvn et al., 2000).

Wahlberg and Strand (2003) investigated twenty men with maximum exercise at 3 and 15. They concluded that the heart rate during exercise is lower than the same period in the evening. Researchers calculated the heart rate at rest and recovery after performing the exercise for about seven times a day. The results showed that the lowest rate is between 4 and 8; the temporary pattern is true during and after exercise (Salehpour, 2004). Pysyvn et al. (2005) investigated the effect of circadian rhythm on the electrical activity of the heart in humans and a wide range of mammals. Electrocardiogram (ECG) is a safest and simplest diagnostic tool that measures and records the electrical activity of the heart for physicians. ECG is useful for the heart pain and myocardial infarctions and is considered as a routine measure in all those suspected of having acute heart problems. Circadian rhythms in the electrical activity of the heart are caused by ionic changes, leading to changes in morphology and dynamics of cardiac action potential. Some events may occur, including the prolongation or shortening of action potential or QT interval and cardiac conduction slower pace. Changes in such factors may be prone to developing cardiac arrhythmias (Cheng et al., 2011). This is perhaps the reason why the ventricular arrhythmia occurs in the morning (Gave and Stein, 2003, Pvrtaľpy and Hermida, 2007). Bohr (2013) argued that the physical activity can lead to changes in heart electrical waves because of affecting the sympathetic and parasympathetic nerves.

Considering that the electrocardiogram provides the information about cardiovascular irregularities, changes at different times can be useful in boosting the athletic performance and preventing cardiopulmonary damage. Hence, this study aims to investigate the effects of exhaustive exercise in the morning and evening on the electrical activity of the heart of middle-aged male athletes. The results of this study can be useful for professional athletes subjected to heavy pressure on the heart and cardiopulmonary damage during exercise, amateur athletes and patients with heart disease who want to have a regular exercise, and sports physiologists and cardiologists monitoring the physical activities of the patients. The results

can develop human knowledge in the field of sports medicine and safe operations.

Literature Review

Reghbati (1997) conducted a study entitled “the effect of circadian rhythm on cardiorespiratory endurance in male students”. There were 14 participants with a mean weight of 63.35 ± 10.10 , a mean age of 21.5 ± 2.03 , a mean height of 174.9 ± 6.04 . The study investigated the maximum oxygen uptake, heart rate, blood pressure (systolic and diastolic) during rest, exercise and recovery, body temperature before and after exercise in the morning (8-6), noon (4-12), evening (2-18) and evening (2-24). The results indicated that regular rhythm in body temperature and regular changes in heart rate are two factors affecting the maximal oxygen uptake. There were significant differences in maximal oxygen uptake at different times of the day.

Hessam Far (1997) investigated aerobic and anaerobic capacity of the girls in the morning and evening. The population included 10 female athletes aged 21-25 in the School of Sport Science and Physical Education of Tehran University. Tests of height and weight, Margarya stairs, Kalamn (anaerobic measurement) and strand bicycle (measurement of aerobic capacity) were performed in this study. The results showed that there was a significant difference in the anaerobic capacity of female athletes in the morning and evening. In addition, there was a significant difference in the aerobic capacity of female athletes in the morning and evening.

Moradi et al. (2009) investigated the impact of circadian cycle on the response of ST segment of the electrocardiogram. In this study, the population included 13 male athletes on whom ECG was performed in the morning and evening. The results showed that the submaximal performance testing significantly decreases the response of ST segment of the electrocardiogram for athletes' heart in the morning and evening compared to the state of rest. However, there was no significant difference between the mean values of morning and evening. The researchers concluded that although the submaximal performance testing decreases the response of ST segment of the electrocardiogram, this reduction is not significant pathologically (less than 1 mV), and the time of day (morning or evening) does not affect the ST-segment response.

Williams et al. (2007) investigated the relationship between anaerobic capacity of the upper body and the speed of 50 m freestyle swimming. The Wingate test was used to measure the anaerobic capacity of the upper body. The results showed that there is a significant correlation between peak power, mean power, fatigue index and speed of 50-meter freestyle

swimming. Plysya et al. (2008) performed the ECG screening for 12,550 Italian young athletes. The results showed that 81 athletes have abnormal ECG and 6 percent of them have cardiomyopathy. One person died suddenly and one person suffered a cardiac arrest. However, athletes with normal ECG had no sign of heart problems.

Moines et al. (2011) evaluated ECG for 87 marathon runners before and after the race. Changes in ECG were shown for 44 runners. The most significant changes included atrial enlargement (37 cases), conduction abnormality, new Q waves, and ST-T wave changes.

Farahani et al. (2012) conducted a study on 239 international athletes and concluded that 60% of the athletes have sinus bradycardia. 84% of the athletes had at least one abnormal ECG finding. The mean values for PR, QRS and QT intervals, P wave and QRS axis were in the normal range. The abnormal ECG findings included right axis deviation (4.2%), left ventricular hypertrophy (6.2%), sinus arrhythmia (6.2%), RBBB (24.2%), ST elevation (72.5%), long QT interval (1.7%) and T wave inversion (3.1%). The response of athletes to ECG during the exercise on a treadmill was natural and without ischemia and arrhythmia.

Kumar et al. (2013) investigated the impact of gender on the high school athletes' ECG. The population included 181 student athletes in 17 sports fields. The values of QRS and Q wave intervals and T-wave amplitude in boys was significantly higher than girls. In contrast, the value of QT wave intervals in girls was higher than boys.

Bruce Nan et al. (2014) compared anomalies identified by ECG for endurance and non-endurance athletes. According to the findings, ECG abnormalities are more common in elite athletes. In addition, endurance athletes had more ECG abnormalities than non-endurance athletes. Right ventricular hypertrophy and T wave inversion were usually common in endurance athletes because of an increase in the structural remodeling and right ventricular electrical status in this group of athletes.

A few studies have been carried out to investigate the relationship between physical activity and changes in ECG parameters. The existing studies also contain many contradictions. No study has been carried out to investigate the impact of different time periods for exercise on changes in the electrocardiogram. Hence, this study aims to investigate the effect of the exercise duration (morning and evening) on electrocardiogram changes of female athletes after exhaustive exercise.

Definition of key terms

ECG: the electrical display of myocardial contraction and relaxation (heart muscle).

Circadian rhythm: the cyclical changes in physiological processes that occur regularly at certain times of the day.

QRS wave: waves of the QRS complex represent ventricular depolarization. In general, the duration of the QRS complex should be less than 0.12 seconds (3 mm) (If too long, indicating blocking the transfer of momentum).

T wave: it represents ventricular repolarization. It is an upward wave that follows the QRS complex. The length and the size are different, but T-wave is usually round and has little height. It is usually in line with the R wave. T wave deviations are signs of myocardial ischemia, ventricular hypertrophy, and electrolytic disorders.

PR segment: it is the flat, usually isoelectric segment between the end of the P wave and the start of the QRS complex. The PR segment represents the time of AV nodal delay and transmission to the ventricles.

PR interval: it is the period, measured in milliseconds, that extends from the beginning of the P wave (the onset of atrial depolarization) until the beginning of the QRS complex (the onset of ventricular depolarization); it is normally between 120 and 200ms in duration. A shorter time period indicates pre-stimulation syndrome and a longer time period indicates the AV block.

Athlete: someone who does the physical activity during three regular sessions lasting 2 hours. In this study, athletes refer to the mountaineering athletes who have at least three years of experience about three regular sessions a week.

Exhaustive exercise: Moderate and vigorous physical activities that lead to the exhaustion and prevent the person from continuing activities. In this study, exhaustive exercise refers to the Bruce protocol which consists of seven stages in total, each lasting 3 min. There is a progressive increase in workload in terms of speed and incline with each successive stage.

Research hypotheses

1. Exhaustive exercise in the morning and evening has a different effect on electrocardiogram QRS wave voltage in male athletes.
2. Exhaustive exercise in the morning and evening has a different effect on electrocardiogram T wave interval in male athletes.

3. Exhaustive exercise in the morning and evening has a different effect on electrocardiogram PR-segment depression in male athletes.

4. Exhaustive exercise in the morning and evening has a different effect on electrocardiogram PR interval changes in male athletes.

5. Exhaustive exercise in the morning and evening has a different effect on electrocardiogram QT interval changes in male athletes.

Research Methodology

This study was based on the quasi-experimental method. The study population included all male athletes in Shiraz. 17 athletes were voluntarily selected as the sample size. Inclusion criteria for the study included public health and the lack of cardiovascular and musculoskeletal problems, regular exercise, and ability to perform exhaustive exercise test.

In this study, the independent variable was the time and exhaustive exercise which was conducted in the morning and evening. The dependent variables included QRS-T-wave changes, PR segment, PR interval, and QT interval. They were measured in the stages of exhaustion and recovery as a pretest. All the participants were prepared to exercise to the point of maximum exhaustion. They were tested using the Bruce protocol as a routinely used and well-validated exercise treadmill test. There were seven stages in total, and each stage lasted 3 min. There was a progressive increase in workload in terms of speed and incline with each successive stage. The electrical activity of the heart was recorded by electrocardiogram at each stage.

The Bruce protocol is a diagnostic test used in the evaluation of cardiac function, developed by Robert A. Bruce. Usually at the beginning, a person walks on a treadmill. By increasing the speed and incline, the person walks fast from the third and fourth stage and then begins running. Each stage lasts 3 minute, and the incline and speed increase at each stage. Table 1 shows incline and speed of Bruce maximal test. In Bruce maximal test, the person can rarely run continuously up to the sixth and seventh stage. Endurance runners have the potential to run continuously. Whenever the person suffers from exhaustion and is not able to continue the activity, the exercise stops.

Table 1: Incline and Speed of Bruce Maximal Test

Speed (KPH)	Incline (percent)	Stage
2.7	10	First
4	12	Second
5.5	14	Third
6.8	16	Fourth
8	18	Fifth
8.8	20	Sixth
9.6	22	Seventh

The hypotheses were tested using repeated measures ANOVA through SPSS.16 software at the significance level of $P \leq 0.05$.

Research Findings

1- QRS voltage changes of male athletes at different times of the day during an exhaustive exercise session

Table 2: The results of repeated measurements ANOVA on QRS voltage

Time	Number	Mean	SD	F	Df	Sig.
Pretest in the morning	17	8.58	3.33	35.53	5 and 16	0.001
exhaustion in the morning		2	3.27			
Recovery in the morning		3.47	3			
Pretest in the evening		7.29	3.6			
exhaustion in the evening		1.94	2.6			
Recovery in the evening		4.29	2.75			

According to Lambda values and the sig-value in the above table, QRS voltage different times were statistically different. The Bonferroni test was used to determine the difference point. The results are presented in Table 3.

Table 3: Results of Bonferroni post hoc test on the QRS voltage

	Pretest in the morning	exhaustion in the morning	Recovery in the morning	Pretest in the evening	exhaustion in the evening	Recovery in the evening
Pretest in the morning						
exhaustion in the morning	P<0.001					
Recovery in the morning	P<0.001	NS				
Pretest in the evening	NS	P<0.001	P<0.001			
exhaustion in the evening	P<0.001	NS	P<0.001	P<0.001		
Recovery in the evening	P<0.001	NS	NS	P<0.002	P<0.002	

As displayed in the above table, the p-value for the pretest in the morning (8.58) is significantly higher than the p-values of exhaustion in the morning (2), recovery in the morning (3.47), exhaustion in the evening (1.94), and

recovery in the evening (4.29). The p-value for the pretest in the evening is significantly higher than the p-values of exhaustion in the morning, recovery in the morning, exhaustion in the evening, and recovery in the evening.

Hence, the p-values of the QRS voltage are not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

2- T interval changes of male athletes at different times of the day during an exhaustive exercise session

Table 4: The results of repeated measurements ANOVA on the T interval

Time	Number	Mean	SD	F	Df	Sig.
Pretest in the morning	17	0.18	0.03	10.8	5 and 16	0.002
exhaustion in the morning		0.12	0.02			
Recovery in the morning		0.14	0.03			
Pretest in the evening		0.17	0.04			
exhaustion in the evening		0.13	0.02			
Recovery in the evening		0.16	0.02			

According to Lambda values and the sig-value in the above table:

$$\lambda = 0.24 \quad F(5, 16) = 7.33 \quad P = 0.002$$

Physical activity has created a significant difference in the T interval. The Bonferroni test was used to determine the difference point. The results are presented in Table 5.

Table 5: Results of Bonferroni post hoc test on the T interval

	Pretest in the morning	exhaustion in the morning	Recovery in the morning	Pretest in the evening	exhaustion in the evening	Recovery in the evening
Pretest in the morning						
exhaustion in the morning	P<0.001					
Recovery in the morning	P<0.001	NS				
Pretest in the evening	NS	P<0.01	NS			
exhaustion in the evening	P<0.004	NS	NS	NS		
Recovery in the evening	NS	P<0.01	NS	NS	NS	

As displayed in the above table, the p-value of the T-interval for the pretest in the morning is significantly higher than the p-values of exhaustion in the morning and evening, and recovery in the morning. This means that the p-value of the T-interval in the exhaustion is lower than the p-value of the pre-test. The p-value of the T-interval for the exhaustion in the evening (0.13) is significantly lower than the p-values of the pretest in the evening (0.17) and recovery in the evening (0.16).

Hence, the p-values of the T interval are not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

3- PR interval changes of male athletes at different times of the day during an exhaustive exercise session

Table 6: The results of repeated measurements ANOVA on the PR interval

Time	Number	Mean	SD	F	Df	Sig.
Pretest in the morning	17	0.13	0.03	6.83	5 and 16	0.02
exhaustion in the morning		0.09	0.03			
Recovery in the morning		0.12	0.03			
Pretest in the evening		0.13	0.03			
exhaustion in the evening		0.09	0.02			
Recovery in the evening		0.12	0.02			

According to Lambda values and the sig-value in the above table:

$$\lambda = 0.39 \quad F(5, 16) = 3.72 \quad P = 0.02$$

Physical activity has created a significant difference in the PR interval. The Bonferroni test was used to determine the difference point. The results are presented in Table 7.

Table 7: Results of Bonferroni post hoc test on the PR interval

	Pretest in the morning	exhaustion in the morning	Recovery in the morning	Pretest in the evening	exhaustion in the evening	Recovery in the evening
Pretest in the morning						
exhaustion in the morning	P<0.02					
Recovery in the morning	NS	P<0.05				
Pretest in the evening	NS	P<0.01	NS			
exhaustion in the evening	P<0.01	NS	NS	P<0.005		
Recovery in the evening	NS	NS	NS	NS	P<0.04	

As displayed in the above table, the p-value of the PR -interval for the pretest in the morning is significantly higher than the p-values of exhaustion in the morning and evening. The p-value of exhaustion in the morning is significantly lower than the p-values of recovery in the morning and pretest in the evening. The p-value of exhaustion in the evening is significantly lower than the p-values of recovery in the evening and pretest in the evening.

Hence, the p-values of the PR interval are not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

4- QT interval changes of male athletes at different times of the day during an exhaustive exercise session

Table 8: The results of repeated measurements ANOVA on the QT interval

Time	Number	Mean	SD	F	Df	Sig.
Pretest in the morning	17	0.34	0.04	45.59	5 and 16	0.001
exhaustion in the morning		0.24	0.02			
Recovery in the morning		0.28	0.04			
Pretest in the evening		0.34	0.03			
exhaustion in the evening		0.23	0.02			
Recovery in the evening		0.30	0.02			

According to Lambda values and the sig-value in the above table:

$$\lambda = 0.09 \quad F(5, 16) = 23.95 \quad P = 0.001$$

Physical activity has created a significant difference in the QT interval. The Bonferroni test was used to determine the difference point. The results are presented in Table 9

Table 9: Results of Bonferroni post hoc test on the QT interval

	Pretest in the morning	exhaustion in the morning	Recovery in the morning	Pretest in the evening	exhaustion in the evening	Recovery in the evening
Pretest in the morning						
exhaustion in the morning	P<0.001					
Recovery in the morning	P<0.001	NS				
Pretest in the evening	NS	P<0.001	P<0.001			
exhaustion in the evening	P<0.001	NS	P<0.01	P<0.001		
Recovery in the evening	P<0.009	P<0.001	NS	P<0.001	P<0.001	

As displayed in the above table, the p-value of the QT -interval for the pretest in the morning (0.34) is significantly higher than the p-values of exhaustion in the morning (0.24) and evening (0.23), recovery in the morning (0.28) and evening (0.30). The p-value of exhaustion in the morning (0.24) is significantly lower than the p-values of pretest in the evening (0.34) and recovery in the evening (0.30).

Hence, the p-values of the QT interval are not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

5- PR segment depression of male athletes at different times of the day during an exhaustive exercise session

Table 10: The results of repeated measurements ANOVA on the PR segment depression

Time	Number	Mean	SD	F	Df	Sig.
Pretest in the morning	17	0.051	0.018	41.55	5 and 16	0.001
exhaustion in the morning		0.028	0.01			
Recovery in the morning		0.049	0.017			
Pretest in the evening		0.049	0.017			
exhaustion in the evening		0.027	0.009			
Recovery in the evening		0.049	0.017			

According to Lambda values and the sig-value in the above table:

$$\lambda = 0.208 \quad F(5, 16) = 28.53 \quad P = 0.001$$

Physical activity has created a significant difference in the PR segment depression. The Bonferroni test was used to determine the difference point. The results are presented in Table 11.

Table 11: Results of Bonferroni post hoc test on the PR segment depression

	Pretest in the morning	exhaustion in the morning	Recovery in the morning	Pretest in the evening	exhaustion in the evening	Recovery in the evening
Pretest in the morning						
exhaustion in the morning	P<0.001					
Recovery in the morning	NS	P<0.001				
Pretest in the evening	NS	P<0.001	NS			
exhaustion in the evening	P<0.001	NS	P<0.001	P<0.001		
Recovery in the evening	NS	P<0.001	NS	NS	P<0.002	

As displayed in the above table, the p-value of the PR segment for exhaustion in the morning (0.02) is significantly lower than the p-values of the pretest in the morning (0.05), recovery in the morning (0.04), pretest in the evening (0.04), and recovery in the evening (0.04). The p-value of the PR segment for pretest in the morning (0.05) is significantly higher than the p-values of exhaustion in the morning (0.02) and evening (0.02).

Hence, the p-values of the PR segment depression are not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

Conclusion

A summary of the inferential findings is presented below:

The findings of this study showed that QRS voltage is significantly reduced after beginning the physical activity in the morning and evening and this value slightly increases in the recovery status, but it is significantly lower than the pre-test values. Hence, the p-values of the QRS voltage were not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

The rapid conduction of the action potential in the ventricles is associated with the rapid depolarization in the ventricular myocardium. It is shown as QRS complex in the ECG. In a normal heart, atrial repolarization is not seen in the ECG. Wave amplitude of atrial repolarization is very small and QRS wave is seen as the dominant wave. In total, the three waves show QRS complex and ventricular depolarization.

Normal heart rhythm is called sinus rhythm. The rhythm of the heart is normally determined by a pacemaker site called the sinoatrial (SA) node. This means that the electrical message starts from the SA node and is naturally conducted across the heart. Normal sinus rhythm is displayed by a regular rhythm that the QRS complex and P wave are normal. When the heart rate is between 60 to 100 beats per minute, QRS complexes and P waves are similar pulses. Since the sympathetic stimulation during exercise increases the heart rate, a message starts from the SA node and is naturally conducted. Thus, sinus rhythm with a heart rate over 100 beats per minute is called sinus tachycardia. During the exercise, changes in duration of action potential and rate of conduction and contraction are associated with an increase in the heart rate, an increase in Q wave amplitude, a minor decrease in R wave amplitude, and shortening of the QRS complex.

The findings of this study showed that the T interval is significantly reduced after beginning the physical activity in the morning and evening. Hence, the p-

values of the T interval were not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

The T-wave shows the ventricular repolarization. It is the distance between the first deviation of ST segment and return to the isoelectric line. The T waveform is usually asymmetric. The incline of the first segment is lower than the second segment. T wave direction usually represents the direction of the QRS complex. Although there is no specific measure for the T wave amplitude, it is usually associated with the R wave height (the larger the R-wave, the larger the T-wave will be). It is considered normal when it has more than one-eighth and less than two-thirds of the previous R-wave amplitude.

The heart rate increases with the onset of the physical activity, leading to the upward incline of the ST segment, shortening the QT interval associated with speed, and an increase in the T wave amplitude. P wave overlays T wave in successive pulses, reflecting a short diastole that increases the heart rate as a dominant mechanism during exercise.

The findings of this study showed that the PR interval is significantly reduced after beginning the physical activity in the morning and evening. Hence, the p-values of the PR interval were not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

The PR interval is the period that extends from the beginning of the P wave (the onset of atrial depolarization) until the beginning of the QRS complex (the onset of ventricular depolarization). The PR interval indicates the time when an action potential is released from AV node in the AV atrium and Junction. In fact, it is a distance between the starting points of the P wave deviation from the isoelectric line to the QRS wave deviation from the isoelectric line. The normal PR interval is between 120 – 200 ms duration (three to five small squares).

The PR interval before the dropped beat is the longest, while the PR interval after the dropped beat is the shortest. The shortest one should be considered. The PR interval is in the normal range at all times. The PR interval is shorter than usual at the time of exhaustion in the morning and evening.

The findings of this study showed that the QT interval is significantly reduced after beginning the physical activity in the morning and evening. Hence, the p-values of the QT interval were not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

The QT interval is the time between the onset of ventricular depolarization and the end of ventricular

repolarization (from the beginning to the end of the T wave). The QT interval is the distance between the starting points of the QRS wave deviation to return to the isoelectric line. The QT interval is associated with heart rate. Heart rate reduction leads to an increase in the QT interval and vice versa. The QT interval is reduced in the morning and evening when sporting activities start and the heart rate reaches its maximum rate at the time of exhaustion. The QT interval should be equal to 0.35 to 0.45 seconds, and should not be greater than half the PR interval. These values are the same in the rest status. Sporting activities shorten the QT interval. In the present study, the QT interval is reduced at the time of exhaustion in the morning and evening.

The findings of this study showed that the PR segment is significantly reduced after beginning the physical activity in the morning and evening. Hence, the p-values of the PR segment were not significantly different in the pretest in the morning and evening, exhaustion in the morning and evening, and recovery in the morning and evening.

The PR segment is the isoelectric segment between the end of the P wave and the start of the QRS complex. The PR segment represents the time of AV nodal delay and transmission to the ventricles.

The results showed that there is no significant difference between the variables, including QRS complex, T-wave, PR segment, PR interval, and QT interval in the morning and evening. It can be concluded that the activities in the morning and evening does not have a different effect on ECG variables and athletes can exercise in both periods of time. According to the findings, it is suggested that athletes can exercise in the morning and evening without worrying about the effects of the circadian rhythm on the cardiovascular system.

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