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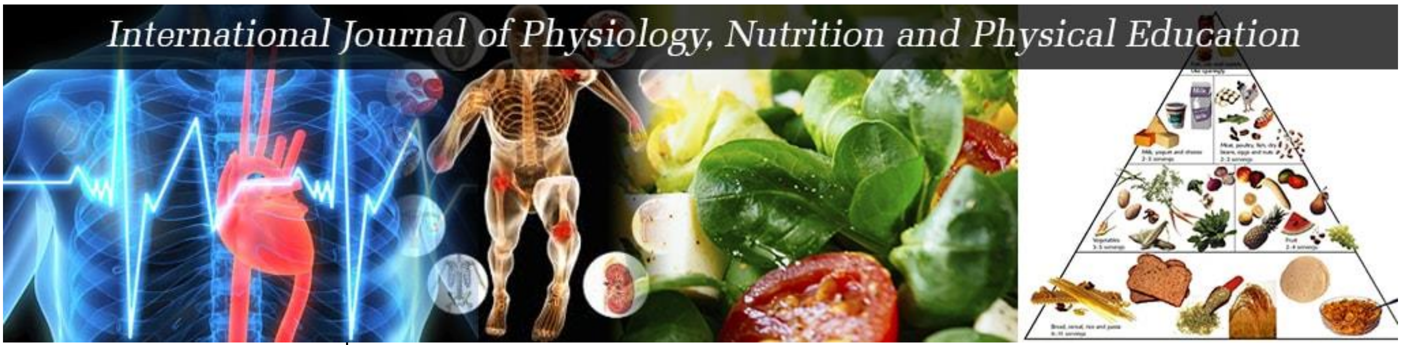


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# Study on recovery heart rate response to aerobic exercise of football players

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**Abstract**
The aim of the present study was to examine the recovery heart rate response immediately after aerobic exercise. To achieve the purpose of the study, 15 female endurance-trained football players who had attended university coaching camp at Annamalai University, Chidambaram were selected. The age of the subjects ranged between 18 to 25 years as per university record. To assess the variability in recovery heart rate the heart rate was assessed at five different time period of 30 second at 1:00 to 1:30, 2:00 to 2:30, 3:00 to 3:30, 4:00 to 4:30and 5:00 to 5:30 minutes after immediate cessation of Cooper twelve minutes run\walk test. The collected data was analyzed using One-Way Repeated Measure ANOVA for comparisons of mean values among five different times of recovery heart rate. When F is significant Scheffe's test was applied as post hoc test to determine the paired mean difference if any, among different times of the recovery heart rate. The value of 0.05 was set for statistical significance. The results of study showed that there was significant difference in recovery pulse rate among first recovery period, second recovery period, third recovery period, fourth recovery period, fifth recovery period as an acute response to aerobic exercise.

**Keywords:** Aerobic exercise, Heart rate recovery, heart rate variability, female football players

## Introduction

Female participation in soccer has grown in popularity in recent years with over 29 million players world wide (Martinez - Laguna's *et al.*, 2014) [16]. As with male soccer, female soccer has become more competitive, with players continuously striving to improve their performance at international tournaments (Martinez - Laguna's *et al.*, 2014) [16]. Yet, despite his increase in professionalism, data on anthropometric and motor characteristics of female players in terms of their playing positions are lacking (Ingebrigtsen *et al*. 2011) [9]. Assessments of this nature are important for evaluating the physical preparedness of a team to contend at international competitions and for the development to formative data (Datson *et al*, 2014) [3].

Soccer is a challenging sport that requires a high level of physical fitness at the elite level (Manson *et al*., 2014) [15]. For instance, elite female soccer players cover an average distance of 10.3 km during the 90 min period of a match (Krustrup *et al*., 2005) [14] which is respectively 23 and 46% more distance compared to elite female athletes competing in netball and field hockey (Davidson and Trewartha, 2008) [4]. The inter mitten nature of the game utilizes all major energy systems (Stolen *et al*., 2005) [25], which can result in acute fatigue, and consequently a reduced capability in technical performance (Hoff, 2005).

Aerobic fitness tests such as the Yo-Yo inter mitten running test Level 1 (Yo-Yo IR1) allow for the assessment of athlete's ability to recover from strenuous activity (Krustrup *et al*., 2005) [14]. At elite levels, female soccer players are reported to achieve an average of 1302 min the Yo-Yo IR1 (Mujika *et al*., 2009) [18]. Aerobic training develops the oxygen transport system This specific training improves the ability to continue exercising for a prolonged period and the ability to quickly recover from high-intensity exercises (Rampini *et al*., 2007) [23]. The oxygen system is best trained by endurance workouts, that is, exercises of relatively long duration at sub-maximal level (Janssen, 2001) [11]. Usually, the intensity and volume of aerobic exercise are inversely related. Increasing the volume (time) of aerobic training will reduce the intensity to a tolerable level.

Aerobic exercise includes lower intensity activities performed for longer periods of time. Activities such as walking, running, swimming and cycling are aerobic and require a great deal of oxygen to generate the energy needed for prolonged exercise.

During exercise, heart rate (HR) and myocardial contractility will be increased to satisfy energy demands of working muscles. Its nervous modulation is considered to be due to the vital withdrawal at low-intensity exercise and the combination of vital withdrawal and sympathetic activation at moderate or high-intensity exercise (Kluess *et al*., 2000) [13]. With the cessation of exercise, the decrease in HR immediately after exercise is mainly thought to be a function of a reactivation of the parasympathetic nervous system (Arai *et al*., 1989) [1]. Later, the further decrease in HR to the pre-exercise value also depends on the gradual withdrawal of the sympathetic system (Perini *et al*., 1989) [20]. The main adaption for endurance training is increase in heart volume with normal thickness of ventricular cavity. Whereas for anaerobic training the adaptation in due to thickening of ventricular value. The endurance training increases the aerobic power and as a result the recovery immediately after exercise is faster.

## Methods

### Subject

To achieve the purpose of the study 15 endurance trained female football players endurance-trained whohad Attendend University coaching camp at Annamalai University, Chidambaram were selected as subjects. The age group of the subjects was between 18 to 25 years as per university record. The study was intended to assess the response of aerobic exercise on recovery pulse rate. Heart rate variability (HRV) parameters in time and frequency domains were assessed at the end of 30 second periods. The subject's data were recorded at the end of 1:00 to 1:30, 2:00 to 2:30, 3:00 to 3:30, 4:00 to 4:30and 5:00 to 5:30 minutes.

**Statistical technique:** The collected data was analyzed using One-Way Repeated Measure ANOVA for comparison of mean values between five different times of recovery heart rate. When F is significant Schaeffer's test was applied as post hoc test to determine the paired mean difference if any. The value of 0.05 was set for statistical significance.

## Result of the study

**Table 1:** The mean standard deviation values on exercise pulse rate, different time of the minutes recovery pulse rate of aerobic exercise

| Groups | | Exercise pulse rate | 1.00-1.30 minutes | 2.00-2.30 minutes | 3.00-3.30 minutes | 4.00-4.30 minutes | 5-5.30 minutes |
|---|---|---|---|---|---|---|---|
| Aerobic exercise | Mean | 123.8 | 120.67 | 116.9 | 113.73 | 110.9 | 108.5 |
| | S.D | 4.53 | 5.32 | 5.44 | 4.83 | 4.46 | 4.68 |

The table 1 show's that the mean values on recovery pulse rate immediately after aerobic exercise of 1.00 -1.30 minutes recovery pulse rate, 2.00-2.30 minutes recovery pulse rate, 3.00 -3.30 minutes recovery pulse rate, 4.00-4.30 minutes recovery pulse rate and 5.00-5.30 minutes recovery pulse rate are 123.8, 120.67, 116.9, 113.73, 110.9 and 108.5 respectively. The one way ANOVA of repeated measures was applied on recovery pulse rate for different time's recovery pulse rate and the results are presented in table-2.

**Table 2:** Summary of one way ANOVA of repeated measures on recovery pulse rate after aerobic exercise

| Source of Variation | SS | df | MS | F |
|---|---|---|---|---|
| A (Factor) | 201067.407 | 1 | 201067.407 | 881.7 |
| Error | 319.259 | 14 | 22.804 | |
| B (Tests) | 2561.956 | 5 | 512.391 | 365.82 |
| Error | 98.044 | 70 | 1.401 | |

*Table value required for significance at 0.05 level with df 1, 14 & 5, 70 were 4.60 and 2.35 respectively.

There is a significant change in recovery pulse rate after performing aerobic exercise at different phases of test. The obtained F ratio of 365.82 is greater than the required table value of 2.35 for the df 5 and 70. Since F ratio is significant Schaeffer's post hoc test was applied.

**Table 3:** Schaeffer's test for the differences among paired means of aerobic training with different time on recovery pulse rate

| Exercise pulse rate | 1.00-1.30 minutes | 2.00-2.30 minutes | 3.00-3.30 minutes | 4.00-4.30 minutes | 5.00-5.30 minutes | Mean difference | Confidence interval |
|---|---|---|---|---|---|---|---|
| 123.8 | 120.67 | | | | | 3.13 | 1.45 |
| 123.8 | | 116.9 | | | | 6.9 | 1.45 |
| 123.8 | | | 113.73 | | | 10.07 | 1.45 |
| 123.8 | | | | 110.9 | | 12.9 | 1.45 |
| 123.8 | | | | | 108.5 | 15.3 | 1.45 |
| | 120.67 | 116.9 | | | | 3.77 | 1.45 |
| | 120.67 | | 113.73 | | | 6.94 | 1.45 |
| | 120.67 | | | 110.9 | | 9.77 | 1.45 |
| | 120.67 | | | | 108.5 | 12.17 | 1.45 |
| | | 116.9 | 113.73 | | | 3.17 | 1.45 |
| | | 116.9 | | 110.9 | | 6 | 1.45 |
| | | 116.9 | | | 108.5 | 8.4 | 1.45 |
| | | | 113.73 | 110.9 | | 2.83 | 1.45 |
| | | | 113.73 | | 108.5 | 5.23 | 1.45 |
| | | | | 110.9 | 108.5 | 2.4 | 1.45 |

Table-3 indicates that there was significant differences on recovery pulse rate between and also among immediately after exercise, first, second, third, fourth and fifth cessation recovery period. The recovery heart rate was significantly reduced from one stage to other stage till the end of the recovery period.

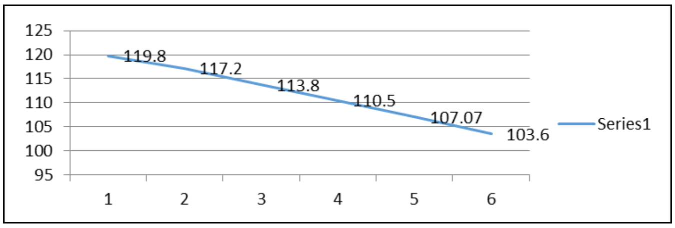


**Fig 1:** Recovery heart rate of endurance athletes at different times of the recovery period

## Discussion

The results of study showed that there was significant decrease in exercise pulse rate among and between first recovery period, second recovery period, third recovery period, fourth recovery period and fifth recovery period after high aerobic capacity is associated with fast HR recovery after exercise. For males, HR recovery was shown to be faster in athletes, who had a higher aerobic capacity than non-athletes (Darr *et al*., 1988) [2]. In the present study shown females endurance trained runner had faster HR recovery after exercise and an indicating higher aerobic capacity as compared to untrained controls. This could imply that faster heart rate recoveries are evident not only for males but also for females and it is inferred that recovery depends upon aerobic capacity rather than gender. A number of studies have shown that physically active men or women demonstrated higher levels of HRV compared with sedentary controls (Jensen-Urstad *et al*., 1997) [12]. Early studies showed that the female runners had significantly higher SDRR, HF power at rest and slightly higher HF power at recovery after exercise than untrained controls. High levels of HRV are associated with rapid HR recovery after exercise. Ohuchi *et al*. (2000) [19] demonstrated that the greater cardiac parasympathetic activity at rest should be in part responsible for the faster HR recovery after exercise. Dixon *et al*. (1992) [5] found that athletes, who had higher vital activity and lower sympathetic activity, also had faster HR recovery after exercise than non-athletes. It is unlikely that hormonal changes contribute to the faster HR recovery in the aerobic runners because according to some studies, endurance training could enhance plasma catecholamine concentration in response to moderate or strenuous exercise (Jacob *et al*., 2004) [10].

Hedelin *et al*. (2000) [7], investigated nine canoeists (six men and three women; 18–23 years) before and after a training regimen corresponding to a 50% increase in normal training load applied during 6 days. Heart rates reduced (–5 to –8 beats/min) both at sub- maximal and maximal levels, which could be due to hyper volume a leading to increased stroke volume and maintenance of cardiac output with lower heart rates. Portiere *et al*. (2001) [22] tested eight runners twice (after a of relative rest period for endurance) and each time the determined HRV parameters. Although the athletes were not trained until over training they concluded that spectral analysis could be a means of demonstrating impairment of autonomic balance for the purpose of detecting a state of fatigue that could result in overtraining. Pichot *et al*. (2000) [21], came to similar conclusions. They assessed ANS activity in seven middle distance runners (24.6-4.8years) during the training cycle (3 weeks heavy training, followed by a relative resting week). HRV was analyzed using FFT and WT. Their results confirmed that heavy training shifted the cardiac autonomic balance of the sympathetic over the Parasympathetic drive. Night-time results of HRV Para meters proved a good tool to estimate cumulated physical fatigue. Therefore, they concluded that HRV could be valuable for optimizing individual training profiles. The 20-hour recovery time between training sessions on consecutive days may not be adequate for restoration of cardiac-parasympathetic activity to baseline among linemen Thus; a capacity for greater chronic workloads may be protective against perturbations in cardiac-autonomic homeostasis among American college football players. McLean *et al*. (2016) [17]. Although a four-fold increase in recovery period allowed a significant increase in the recovery of HHb and HR, this did not increase the physiological, and perceptual responses, or time motion descriptors during the bouts. These results could have been due to the regulation of effort (pacing), in these experienced players performing an exercise task to which they were well adapted. Ganzevles *et al*. (2017) [6], HRR after a standardized warm-up does not predict heart rate during a directly subsequent and standardized training session. Instead, heart rate during the warm-up protocol seems a promising alternative for coaches to make daily individual-specific adjustments to training programs. Suzic Lazic *et al*. (2017) [24], The HRR during 3 min post exercise should be reported for the purpose of better assessing functional adaptation to exercise among elite athletes as well as the age-associated differences in recovery. Higher values of HRR1 should be expected in older athletes, and HRR3 could be used as an index of aerobic capacity, irrespective of age.

## Conclusions

In summary, aerobic runners indicated faster HR recovery after exercise and altered cardiac ANS modulation at rest than untrained controls. The higher levels of HRV, higher aerobic capacity and exaggerated blood pressure response to exercise in the aerobic runners are suggested to be responsible for their faster HR recovery after exercise. There was a significant reduction recovery pulse at each phases of recovery after aerobic exercise.

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