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Profile Analysis of Heart Rate Recovery after Maximum Exercise in Student Athletes in Dynamic Sports

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ABSTRACT

Destination: The main objective of this study was to determine the Heart Rate Recovery (HRR) profile after performing Maximal Exercise (EM).

Method: 86 student athletes (age: 18.6 ± 2.69 years) who came from dynamic sports, running and jumping athletics (n = 9), from basketball (n = 5), from volleyball (n = 17), from hockey (n = 22), from roller skating (n = 15), from beach volleyball (n = 15), and from tennis (n = 3). Performs a 30m sprint speed test. Furthermore, HRR is measured using the Polar type H10 tool using the Polar Team monitor system. Furthermore, HRR was recorded at 1, 2, 3, 4, and 5 minutes just after doing maximal exercise. Furthermore, using the paired t-test and Friedman's test to see the significance of the difference in value every minute. Furthermore, to obtain a sticky heart rate recovery profile, the HRR is calculated with the maximum heart rate (HR).

Result: It was found that the results were significant differences in the HRR values 1, 2, and 3 χ2F (2) = 170.02, p <0.001 using the Friedman's test. Significant differences were also found in the HRR values of 4 and 5 using the paired sample t-test HRR 4 (Mean = 104.07, SD = 8.838) and HRR 5 (Mean = 95.35, SD = 7.232) under conditions; t (85) = 15,618, p = 0.000. Furthermore, so that the difference in HRR is significant, a further test is carried out by looking for Δ HRR1,2,3,4, and 5 with HRmaximal and the value of nilaiHRR 1 is 19.18 ± 6.6, then sequentially Δ HRR 2:29.45 ± 7.10,Δ HRR 3: 38.06 ± 6.88, Δ HRR 4:43.72 ± 5.54, andΔ HRR 5:48.44 ± 4.67.

Conclusion: In this study it can be proven that the HRR profile of student athletes can be used as an indicator of athletes' readiness to accept and participate in training programs..

1. Introduction

Heart Rate Recovery (HRR) is the decrease in Heart Rate (HR) in the first minute after a person performs physical activity (Del Rosso et al., 2017). The rate of reduction in HRR can vary from a few seconds after exercise (20-30 seconds) to a few minutes after exercise (1 - 5 minutes).(Del Rosso et al., 2017). In other studies HRR was recorded as a decrease in HR at 1, 2, and 3 minutes after a person performed maximum physical activity(Adabag & Pierpont, 2013).

HRR is also mentioned as an indicator of the fitness condition of an athlete. HRR is mentioned as an indicator of the adaptability of the athlete's cardiorepiratory system in facing training loads(Rave et al., 2018). HRR is also mentioned as a predictor to see the biological age of a person(Cunha et al., 2015).

HRR is a description of the performance of the parasymphatetic nervous system, which is known in the heart as the muscarinic receptors (Rachel Nall, MSN, 2020). The function of the muscarinic receptors is to maintain HR at a safe level to stay fit during activities. This parasympathetic nervous system works automatically in response to a given training load(Bisschoff et al., 2018). In other studies, it is stated that social emotional stress factors can also affect a person's HRR value(Mohammadi et al., 2019). A person in stressful conditions will experience an increase in HR. HRR is also influenced by several factors such as training programs, environmental conditions, and the body's automatic response to competition(Buchheit, 2014).

The HRR profile can show the performance of the heart when the athlete competes or races(Cornforth et al., 2015). In addition, the HRR profile of a person can predict the likelihood of sudden death as a result of loss of work function of the heart(Kwon et al., 2016).

Dynamic sports are sports that require optimal physical abilities.(Levine et al., 2015)The physical abilities in question include cardiovascular endurance, muscle endurance, and explosive power. The intensity of the competition load causes dynamic sports to require optimal physical performance from an athlete.

The importance of looking at the profile of HRR has become the focus of research by sports sciences experts in the world, however, the HRR profile after maximal exercise in student athletes in dynamic sports has not been studied in depth. So that this study will describe the HRR profile of student athletes after doing maximal exercise. The hypothesis in this study is that there is a significant difference (delta) in decreasing HR 1, 2 (80% of HRmax), 3, 4, and 5 (50% of HRmax) as a result of the exercise program that has been undertaken.

2. Method

The data in this study were 86 student athletes (age: 18.6 ± 2.69 years) from sports that were classified as dynamic sports. The 86 athletes consisted of running and jumping athletics (n = 9), from basketball (n = 5), from volleyball

(n = 17), from hockey (n = 22), from sports. roller skates (n = 15), from beach volleyball (n = 15), and from tennis (n = 3).

Research data collection was carried out at the Achilles Sport Science and Fitness Center Laboratory of Unesa Surabaya. The first participant performs a maximum speed test by sprinting 30m. Furthermore, Heart Rate Recovery is measured using the Polar type H10 tool using the Polar Team monitor system.

*Heart Rate Recovery (HRR)*at 1, 2, 3, 4, and 5 minutes are recorded. Furthermore, the Kolmogorov-Smirnov normality test was performed(Mohd Razali & Bee Wah, 2011)Furthermore, to see the significance of the changes that occurred in this study using the paired sample t-test on the data group that was normally distributed or the Friedman's test for the data group that was not normally distributed. Analysis using software*Statistical Package for the Social Science* (SPSS) version 22

The acceleration of the HRR change or decrease in HR (delta) in every minute, from the first minute to the fifth minute is documented in Microsoft Excel 2007 tables and graphs. By using the formula in previous research by(Cunha et al., 2015)HRR is used to determine the percentage reduction:

% HRR = (ΔHRR / HRRmax) x 100, ΔHRR is obtained from the absolute difference between HRRmax and HRR1,2,3,4, & 5.

3. Research result

The characteristic data of student athletes is shown in table 1.

Table 1: Basic Characteristics of the Research Subject

Characteristics	Mean(N = 86)
Age (years)	18.62 ± 2.69
Height (m)	1.62 ± 0.14
Weight (kg)	53.13 ± 12.71
BMI (kg.m-2)	20.04 ± 2.69

In table 1, it can be seen that the characteristics of the height of the research subjects have a data distribution that is close to 0 ($\sigma = 0.14$), meaning that the data distribution is getting closer to the mean value. While the distribution of variations from the largest data is found in the weight variable with a standard deviation value of ± 12.71, and for age characteristics and Body Mass Index (BMI) are at the same variation, namely ± 2.69.

Table 2 shows the Kolmogorov-Smirnov normality test of HRR measurement data at 1, 2, 3, 4, and 5 minutes after the subject did maximal exercise.

Table 2:Kolmogorov-Smirnov normality test

	HRR 1	HRR 2	HRR 3	HRR 4	HRR 5
N	86	86	86	86	86
Statistical Test	0.13	0.11	0.17	0.09	0.08
Asymp. Sig. (2-tailed)	0.00	0.01	0.00	0.07	0.20

In table 2 above, it can be seen that HRR 1 does not follow the normal distribution, D (86) = 0.13, p = 0.00. Likewise at HRR 2 and 3, D (86) = 0.11, p = 0.01 and D (86) = 0.17, p = 0.00. whereas at HRR 4 and HRR 5 the data followed a normal distribution with D (86) = 0.09, p = 0.07 and D (86) = 0.08, p = 0.20.

Furthermore, to perform a different test based on the results of the Kolmogorov-Smirnov normality test, the variables HRR1, HRR 2, and HRR 3 used the Friedman's test and for HRR 4 and HRR 5 used the paired sample t-test. This difference test was conducted to prove statistically that there was a difference in the average between HRR 1, HRR 2, HRR 3, HRR 4, HRR 5.

Table 3Friedman's Test non-parametric difference test

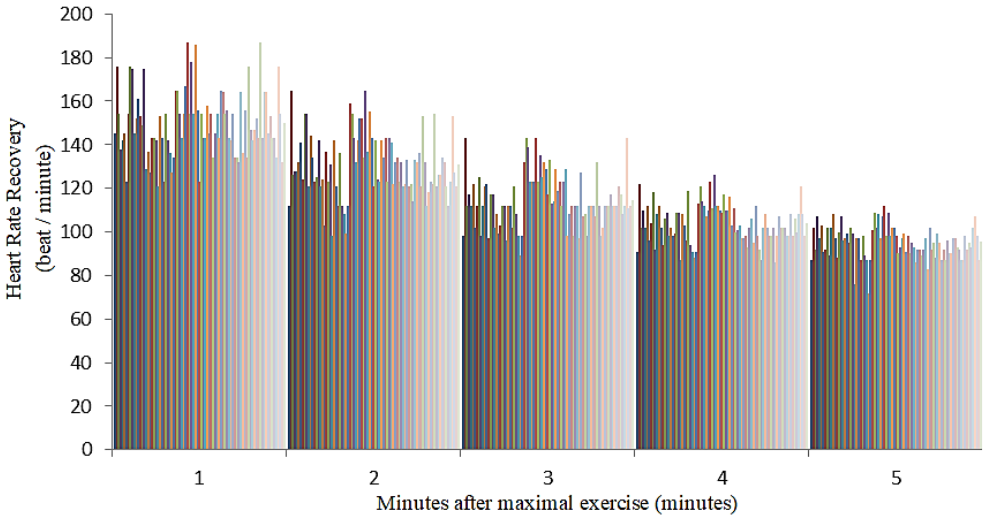
Description	Score
N	86
Chi-square	170.02
df	2
Asym. Sig	0.000

From table 3 it can be concluded that the different test using the Friedman's test states that there is a significant difference between the value of changes in HRR 1, HRR 2, and HRR 3, $\chi 2F$ (2) = 170.02, p <0.001.

Table 4Paired sample t-test different test

Description	Score
HRR 4:	
Mean	104.07
SD	8,838
HRR 5:	
Mean	95.35
SD	7,232
Pair HRR 4 - HRR 5	
Mean	8,721
Std. Deviation	5,178
Std. Mean Error	0.558
t	15,618
df	85
Sig. (2-tailed)	0.000

Table 4 is a paired sample t-test to show the difference between HRR 4 and HRR 5, the results show a significant difference in HRR 4 values.
(Mean = 104.07, SD = 8.838) and HRR 5 (Mean = 95.35, SD = 7.232) in the conditions; t (85) = 15,618, p = 0.000.



Picture 1Heart Rate Recovery Profile for student athletes after maximal exercise

Furthermore, in this study shows the percentage reduction in HR at 1, 2, 3, 4 and 5 minutes the results are displayed in graphical form in Figure 1 and in tabular form in Table 4.

In table 4 it can be seen that the average HR maximal for the study subjects was 185.63 with a standard deviation of ± 13.14, while the HRR profile had decreased in value, meaning that the average decrease in the first minute (HRR 1 = 149.87 ± 15.17) then continued to decrease each time. minutes and at the 5th minute (HRR 5 = 95.35 ± 7.23).

Table 4HRR profile and% ΔHRR

N = 86	Score
HRmaximl	185.63 ± 13.14
HRrecovery 1 (beats / minute)	149.87 ± 15.17
HRrecovery 2 (beats / minute)	130.74 ± 14.34
HRrecovery 3 (beats / minute)	114.63 ± 12.14
HRrecovery 4 (beats / minute)	104.07 ± 8.84
HRrecovery 5 (beats / minute)	95.35 ± 7.23
Δ HRrecovery 1 (%)	19.18 ± 6.66
Δ HRrecovery 2 (%)	29.45 ± 7.10
Δ HRrecovery 3 (%)	38.06 ± 6.88
Δ HRrecovery 4 (%)	43.72 ± 5.54
Δ HRrecovery 5 (%)	48.44 ± 4.67

4. Discussion

This study develops previous research, to see whether there is a significant difference between HRR 1, 2, 3, 4, and 5 minutes in student athlete subjects with an age range of 18.62 ± 2.69 years after doing maximal exercise.

The main findings in this study are that: 1) there is a significant difference between the values of HRR 1, HRR 2, HRR 3, HRR 4, and HRR 5 in student athletes in dynamic sports. 2) there is a decrease in the average HRR in the 5th minute so that it reaches the HR resting target of 50% - 80% of the maximum HR,

(Syd et al., 2010) concluded that it is important to know and maintain HRR at the level of 50% -80%(Jensen et al., 2013). Because HRR can be a benchmark for knowing the performance of the heart.(Raisi-Estabragh et al., 2020)in his research also states that HRR or resting heart rate is a single indicator to determine the fitness of the cardiovascular system applicable to all age groups, physical conditions of people with osbes, and all genders. In line with previous studies, this study also confirmed that in the student athlete group (18.62 ± 2.69) HRR was at the level of 50% -80% of the maximum HR.

According to(Valle, 2020)HR and HRR are data that have been around for a long time, and are always part of every measurement of the physical condition of athletes. The benefits of HRR itself are still less explained in more depth when it comes to athletic achievement, it is still defeated by the role of muscle explosiveness or running speed. HRR can be used as an indicator of the performance of the heart which is the driving force of every body activity.

(Buchheit et al., 2014) In his research, he conveyed several factors that could be used by knowing the value of HRR, for sports HRR can be used as an indicator of the readiness of the athlete's body condition in facing a given training program.

5. Conclusions and Suggestions

In line with previous research on the application of HRR in sports, this study succeeded in drawing the conclusion that the HRR profile of student athletes shortly after doing maximum exercise illustrates the athlete's readiness in carrying out the next exercise program. The conclusions in this study have limitations and require testing for a larger number of samples.

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