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The Effect of High Intensity Interval Exercise on Changes in Basal Rate and Vo2max

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Abstract

Football is an achievement sport that has special characteristics and physical characteristics for players. A good Vo2max endurance capacity can give an advantage to the athlete's performance when competing on the field. Football in Indonesia tends to have an average Vo2max which is still below the standard. One of the reasons is when adolescent athletes are never used to doing intensive physical exercise so that the training age is still small and it will take a long time to improve. In addition to increasing Vo2max, physical exercise also affects changes in suppressing the pulse. Because when someone with a low resting pulse rate, the endurance to carry out an activity, high-intensity exercise and competition will last longer. The purpose of this study is to find out and compare the effectiveness of the HIIT training method with two different forms or variants with a design according to the principle of load training on basal pulse and Vo2max. This study used a quasi-experimental design with Randomized Control Group Pretest-Posttest Design with a sample of 30 divided into 3 groups consisting of 10 athletes in the Shuttle run experimental group, 10 athletes in the around rectangle group and 10 athletes in the control group. Treatment is given within 8 weeks with 3 meetings per week using a Polar H10 device to control exercise intensity. Data analysis using (MANOVA) with the help of the SPSS statistical program. The results showed that the two exercises had a significant effect in improving the pulse p-value 0.001 < 0, 05 in the Shuttle run exercise and Vo2max 0.000 < 0.05, from Around rectangle on pulse p-value 0.000 < 0.05 and Vo2max 0.000 < 0.05. Meanwhile, the effectiveness of the two exercises is the same as the p-value 1,000 > 0.05. Therefore, HIIT is not based on its form but on its duration and intensity which is monitored using a heat rate check for each exercise.

Keywords
exercise; intensitas; pulse; Vo2max

I. Introduction

Exercise is a planned process, structured at a certain time and with a specific purpose. In carrying out the exercises, they must be carried out in an appropriate way, arranged in a systematic way with the right repetitions in a balanced duration, the longer they increase (the principle of overload) with the excess weight with different situations for each individual. Exercise must use the principles of training so that the quality of the exercise can be achieved optimally, according to (Bompa, 2009) the principles of training are the principle of overall development (general), the principle of specialization (special), the principle of individual, the principle of development based on the training model in competition, the principle of increasing training load (progressive and overload), and the composition of the exercise.

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Physical exercise in addition to improving fitness for people in general is very important and cannot be separated from athletes. For athletes, in order to obtain a good and excellent level of endurance fitness, athletes need to do exercises that are different from ordinary people in general because athletes are people who are prepared for competitions. For example, soccer, both in its improvement and in its maintenance, really needs a physical condition factor in achieving achievement goals. Further stated by Stone and Kroll (1991) If training and conditioning programs have a big role in improving sports skills, especially performance sports. Physical activity is an inseparable part of the life of living things, ranging from simple to very complex activities. As a living creature, humans need physical activity as an effort to maintain the existence of their lives. Every individual in his life must be doing physical activities both intentionally and unintentionally, because physical activities are carried out with diverse and diverse purposes. (Sulaiman, et al. 2020)

In everyday life, both athletes and general people who have the excellent physical condition are able to carry out daily activities without experiencing fatigue and still save energy to carry out the next activity. All of this is due to the high Vo2max (Volume Oxygen Maximal). According to Muluk (2011) Vo2max is the maximum amount of oxygen capacity, in milliliters, that can be used in one minute per kilogram of body weight. People who have good fitness have higher Vo2max values and can perform more vigorous activities than those who are not in good condition. Someone who has good fitness will also have an impact on increasing the ability to move efficiently and increasing the ability to recover organs after exercising and increasing the responsiveness or reaction of the body (Ciptadi, 2013).

To increase Vo2max is by aerobic endurance training and anaerobic endurance training. Now what is needed in some sports is anaerobic endurance, where this system is a combination of strength and endurance which allows this system to carry out high-intensity activities. One of the most famous research studies on high-intensity interval training methods by Dr. Izumi Tabata titled "Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and VO2max" in the study of Tabata et al., (1996) revealed that high-intensity intermittent training can improve both anaerobic and aerobic capacity.

The pulse is the wave experienced in the arteries caused by the pumping of blood by the heart towards the blood vessels (Gabriel, 2012). The frequency of the pulse is the same as that of the heart rate. Physical exercise or exercise has a good effect on the function of the heart. The impact of the exercise, on the duration of rest the number of pulses in 1-minute inexperienced people trained was lower than those without exercise experience. A pulse of 40-80 in athletes is something that is often found. This resting pulse becomes a very important part of the training process, especially in terms of readiness and planning preparation. Because basically when someone with a low resting pulse rate, the endurance to do an activity, high-intensity exercise, and competition will last longer.

Sidik et al., (2019) revealed that for athletes and ordinary people with a limited duration to carry out physical activities in a regular way, it is necessary to carry out high-intensity interval training, which is a mixture of high-low-intensity exercise so that it can increase the endurance of the cardiovascular system, lung capacity, physical fitness, and with one goal. keep the resting pulse as low as possible, push the maximum working pulse as high as possible, and shift the aerobic–anaerobic deflection as slowly as possible. It is intended that trained athletes get used to a high pulse rate so that the impact is not too quickly from lactic acid in the body because the athlete's body energy work system is still aerobic.

At this time, one of the sports that prioritizes achievement goals is football. Football is a very popular sport and has many fans in this world (Periard & Racinais, 2013). Although this sport can be said to be easy for everyone to play, at the next level of ability it requires more systematic training and better physical appearance of the players. Bangsbo et al., (2006) reveals a player's heart rate during a running match is generally above 65% of the maximum value, at high intensity it can reach 90% of the maximum value. A soccer athlete must indirectly have optimal physical endurance. A good Vo2max endurance capacity can give an advantage to the athlete's performance when competing on the field.

According to Pate and Kriska (1984) There are at least 3 important aspects in taking into account the physical condition of individual football athletes: aspects of maximum oxygen absorption, movement effectiveness, and lactate threshold. But among the three aspects, maximum oxygen absorption is one that is often used. Football in Indonesia tends to have an average Vo2max which is still below the standard. Susetyo (2020) said the Vo2max test results for Persik players were still far below the standard for the Shopee Liga 1 2020 match, the highest caste football competition in Indonesia. Arnason et al., (2004) argues that the average Vo2max value of a professional football athlete is between 56.2 to 67.6 mL (kg/minute). Meanwhile, adolescents or seniors aged 16 to 18 years ranged from 49.0 to 55.7 mL (kg/minute). There are many possibilities that are a factor in the lack of Vo2max average for football athletes in Indonesia when they reach the professional level. For example, when teenage athletes are never used to doing intensive physical exercise, so that the training age is still small and it will take a long time to improve. To get peak performance, these athletes need a long period of training.

One method that can improve physical abilities, especially endurance, which has been widely recommended, and improve fitness, is by practicing HIIT (High-Intensity Interval Training). HIIT is a cardiovascular exercise method that uses high intensity with a speed or training load above the anaerobic threshold in a short time and is interspersed with interval active recovery periods. The results of research from Kemi et al., (2005) proved that cardiovascular adaptation to exercise depends on the given intensity.

The purpose of this study is to determine whether there is a significant effect of giving high intensity interval training methods using innovation and also to compare how effective the HIIT training method is with two different forms or variants with a design according to the principle of exercise load on basal pulse and Vo2max.

II. Research Method

This study uses a quasi-experimental design *Randomized Control Group Pretest-Posttest Design.*

R	T_1	X_1	T_2
R	T_1	X_2	T_2
R	T_1	~	T_2

Figure 1. *Research Design*

Information:

T_1 = Pretest
T_2 =Posttes
~ = no treat
X_1 = *Treadment Shuttle Run*

X_2 = *Treadment Running around rectangle*
R = Random
(Maksum,2018

The location of the research was carried out in the Soccer Field of the Brawijaya Military Command Surabaya. The time required for treadment in this study was 24 meetings for 8 weeks where the preparation and pretest stages were carried out before the first week, followed by 8 weeks for treadment (3 times / week) and the last week for the posttest. In accordance with the principles of practice expressed by Fox in Kushartanti(1984)In order to adapt to the body, it must be done regularly and the effects of the exercise will disappear if the exercise is stopped. Aerobic endurance will decrease after one week of not exercising.

In this study, the population was 60 with samples taken by systematic random sampling into 3 groups with 10 students in each group, so a total sample size of 30 consisted of 10 teenage athletes as the experimental group for the shuttle run variant, 10 teenage athletes in the running around variant experimental group. rectangle, and 10 adolescent athletes as a control group. Sampling is a method of collecting data by recording a portion of the population that represents all members of the existing population (Maksum, 2018)

A variable is a concept that has variability or diversity that is the focus of research. Variables can also be classified into independent variables and dependent variables (Maksum, 2018) This study has 3 variables, namely 1 independent variable with two variants and 2 dependent variables, each of which consists of:

a) Independent Variable
   HIIT workout (variant one)
   HIIT workout (variant two)
b) Dependent variable
   1) Basal Pulse
   2) *Vo2max*

The instruments used in this research are:

A. Basal Pulse Rate Calculation
   In calculating the basal pulse using pulse checking which can be done using a pulse oximeter.
B. 15 Minute Running Test (Balke Test)
   To find out VO2max using the Balke test. Where this test is relatively easy to implement because it does not require expensive but simple equipment. In this study, the instrument used was a 15-minute running test (Balke Test) for adolescent soccer athletes. The balke test is not only used to measure Vo2max but also to measure a person's Maximum Aerobic Speed (MAS).

In this study, the HIIT (High Intensity Interval Training) exercise program was designed individually because in this study, researchers made an exercise program according to the ability of research subjects who had been tested with a 15-minute balke test. From the results, researchers sought Maximum Aerobic Speed (MAS). The MAS is the maximum speed that an athlete can reach in aerobic endurance activities. A simple way to determine this is to run a 2000-meter run time test on all athletes, i.e., 5 laps on a 400-meter track. Or you can use a 12-minute running test (Cooper Test) and the 15-minute test (Balke). For example: if one athlete finishes running 2000 m in 8 minutes 20 seconds then their MAS = 2000m/500sec = 4 m/sec. If the other athlete finishes in 9 minutes, then MAS = 2000m/540sec = 3.7m/sec.

In the data analysis process, the researcher uses the help of the IBM statistical product and service solution (SPSS) 25 for windows program in the following order:

1. Descriptive statistical tests include the mean and standard deviation. For the presentation of data in descriptive statistics through tables, graphs or diagrams
2. The purpose of the normality test is to ensure that the data obtained are symmetrically or normally distributed.
3. Paired-Sample T test to measure differences in similar samples
4. Homogeneity test which aims to ensure the same or similar groups so that comparisons can be made fairly.
5. To find out the differences in variations that arise due to several interactions of the three groups on the two dependent variables, the MANOVA test was carried out.
6.

III. Result and Discussion

The results of the study will discuss the relationship between the independent variable and the dependent variable. The independent variables consisted of the Shuttle run and Around Rectangle exercises, while the dependent variables were the basal pulse and Vo2max. Data analysis was carried out in two forms, namely descriptive data analysis and inferential data analysis used to answer the research hypothesis.

3.1 Descriptive Data

Aftermeasurements were made, the data obtained from research on basal pulse rate and Vo2max in each group are as follows:

a. Basal Pulse

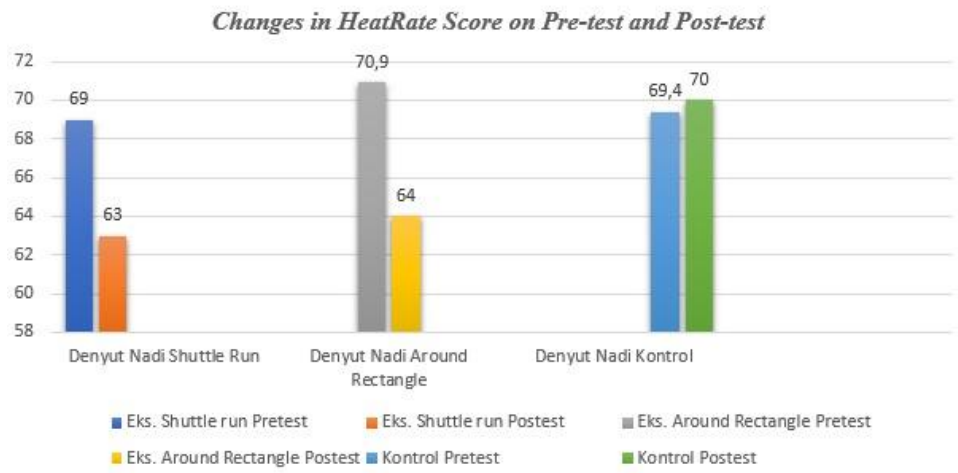


Figure 1.*Pulse rate result graph*

In the graph above, there is a change in the average pulse rate in all groups. The Grub shuttle run has decreased by 8.7%. Grub Around rectangle 9.8%. Meanwhile, the control group experienced an increase of 0.9%.

b. Vo2max

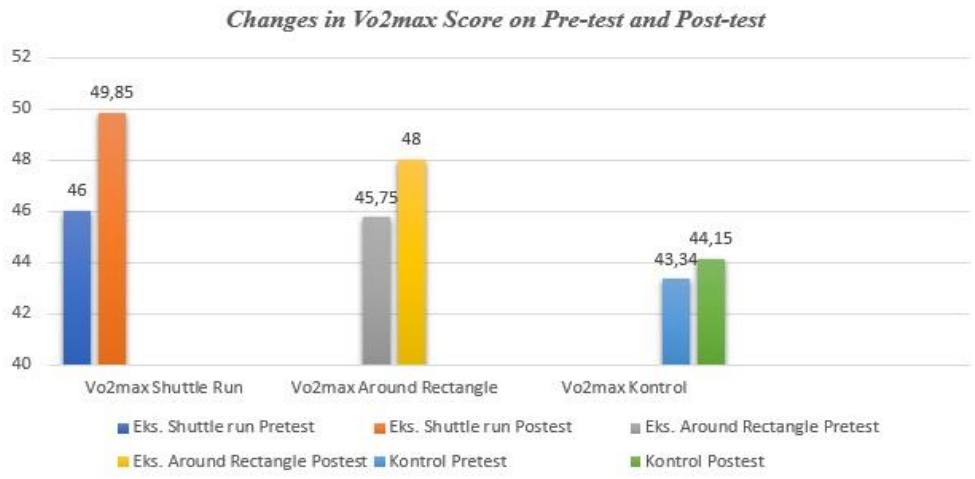


Figure 2.*Vo2max result graph*

In the graph above, there is an increase in Vo2max in all groups. Grub shuttle run has increased by 7.7%. Grub Around rectangle 4.7%. While the control group experienced an increase of 1.8%.

3.2 Hypothesis testing

There are two conditions to test the hypothesis, the condition is that the data must be normally distributed and homogeneous. Then the test for normality and homogeneity must be carried out first.

a. Normality test

Test Normality aims to ensure that the data obtained is symmetrically or normally distributed. The normality test has provisions if the p-value is greater than 0.05 then it is declared normal but otherwise it is declared abnormal. The following are the results of the normality test using Shapiro-Wilk on the data obtained from the study.

Table 1. Shapiro-Wilk Normality Test

	Shuttle run		Around Rectangle		Kontrol	
	Pre test	Postest	Pre test	Postest	Pre test	Postest
Denyut Nadi	0,981	0,999	0,386	0,181	0,200	0,596
Vo2max	0,774	0,357	0,680	0,592	0,225	0,279
Keterangan	Normal	Normal	Normal	Normal	Normal	Normal

From the results of the analysis above, it appears that all variables have a p-value > 0.05, so that the data for all groups is declared normally distributed because the p-value is greater than 0.05 and the analysis can be continued with parametric statistics.

b. Homogeneity Test

The homogeneity test aims to ensure that the variance of each group is the same or similar, so that comparisons can be made fairly. From the data shown in table 4.

Table 2. Homogeneity Test

	Levene Statistik	df1	df2	Sig.	Keterangan
Denyut Nadi	0,656	2	27	0,527	Homogen
Vo2max	1,565	2	27	0,227	Homogen

In the homogeneity test, the provisions as in the normality test apply, namely: if the p-value is greater than 0.05, it is declared homogeneous. From the results of the analysis, it can be stated that the data for all groups are homogeneous, because the p-value of pulse rate is greater than 0.05 or 0.527 > 0.05 and Vo2max is 0.227 > 0.05.

c. Similar sample T-test (Pair Sample T test)

In this analysis will be tested whether there are differences in similar samples. Decision making if the value of Sig. <0.05, then Ho is rejected and Ha is accepted, otherwise if the value of Sig. > 0.05 then Ho is accepted and Ha is rejected.

Table 3. T . Test Results

Uji Paired samples Test			
Shuttle Run		Sig.	Keterangan
Denyut Nadi	Pre test-Postest	0,001	Different
Vo2max	Pre test-Postest	0,000	Different
Around Rectangle			
Denyut Nadi	Pre test-Postest	0,000	Different
Vo2max	Pre test-Postest	0,000	Different
Kontrol			
Denyut Nadi	Pre test-Postest	0,627	Simmiliar
Vo2max	Pre test Postest	0,502	Simmiliar

From the results of the analysis in the table, there is a calculation of the Pair sample T-test, it is known that the shuttle run group has a Sig value. 0.001 < 0.05 on the pulse variable and 0.000 < on the Vo2max variable, then Ho is rejected and Ha is accepted. So it can be concluded that there is an average difference between pulse rate and Vo2max pre-test and post-test, which means that there is an effect of HIIT training in the form of shuttle

run in influencing basal pulse and Vo2max. For the Around Rectangle group, the Sig value is known. 0.000 <0.05 on the pulse variable and 0.000 on Vo2max, then Ho is rejected and Ha is accepted. So it can be concluded that there is also an effect of the Around Rectangle HIIT method training in influencing the basal pulse rate and Vo2max. While in the control group the value of Sig. 0.627 > 0.05 and 0.0502 > 0, 05 on the pulse and Vo2max variables, then Ho is accepted and Ha is accepted. So that there is no effect that occurs in the control group or there is a significant similarity.

3.3 Manova

To find out the differences in variations that arise due to several interactions of the three groups on the 2 dependent variables, the MANOVA test was carried out.

Table 4. Manova Test

Tests of Between-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[c]
HIIT	Denyut Nadi	313,267	2	156,633	5,872	0,008	11,744	0,834
	Vo2max	169,117	2	84,558	5,249	0,012	10,497	0,788

In the table showsthe results of the test of the effect of one independent variable, namely HIIT on each dependent variable. From the above results, the value in the column Sig. said to be significant if the value of Sig. < 0.05. All variables both values show 0.008 and 0.012 where <0.05, so the conclusions and answers are:

- HIIT significantly affects changes in pulse rate with a p-value of 0.008, which means Ho is rejected and Ha is accepted
- HIIT significantly affects the increase in Vo2max with a p-value of 0.012, which means Ho is rejected and Ha is accepted
-

Table 5. Post hoc test

Multiple Comparisons

Bonferroni

Dependent Variable	(I) HIIT	(J) HIIT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Denyut Nadi	Shuttle run	Around rectangle	-1,000	2,3097	1,000	-6,895	4,895
		Kontrol	-7,300*	2,3097	0,012	-13,195	-1,405
	Around rectangle	Shuttle run	1,000	2,3097	1,000	-4,895	6,895
		Kontrol	-6,300*	2,3097	0,033	-12,195	-0,405
	Kontrol	Shuttle run	7,300*	2,3097	0,012	1,405	13,195
		Around rectangle	6,300*	2,3097	0,033	0,405	12,195
Vo2max	Shuttle run	Around rectangle	1,140	1,7376	1,000	-3,295	5,575
		Kontrol	5,700*	1,7376	0,009	1,265	10,135
	Around rectangle	Shuttle run	-1,140	1,7376	1,000	-5,575	3,295
		Kontrol	4,560*	1,7376	0,042	0,125	8,995
	Kontrol	Shuttle run	-5,700*	1,7376	0,009	-10,135	-1,265
		Around rectangle	-4,560*	1,7376	0,042	-8,995	-0,125

The table above shows the results of the post hoc test. After confirming that there is a significant effect and difference, the analysis is continued with Post Hoc Comparison using the Bonferoni test. In the table above it can be concluded as follows:

- For differences in pulse rate changes based on high-intensity interval training, the difference is the Shuttle run group with control and Around rectangle with control. While the Shuttle run with Around rectangle is the same, there is no difference.
- For the difference in the increase in Vo2max based on high-intensity interval training, what has the difference is the Shuttle run group with control and Around rectangle with control. While the Shuttle run with Around rectangle is the same, there is no difference.

3.4 Discussion

The purpose of this study was to determine whether there was a significant effect of giving the high intensity interval training method and the effectiveness of the two forms of exercise, namely Shuttle run and Around Rectangle on basal pulse rate and Vo2max. The provision of high-intensity exercise is monitored with an auxiliary sensor device in the form of a polar H10 to ensure the subject performs at high intensity.In physical exercise, there are many methods and forms of exercise that can be used to increase VO2Max, for example, HIIT training. In addition to being characterized by a high VO2Max, a person's fitness level can be measured by a person's low basal pulse rate. which is where people who have a low basal pulse rate, the person's fitness level is getting better(Naesilla & Mukono, 2015)

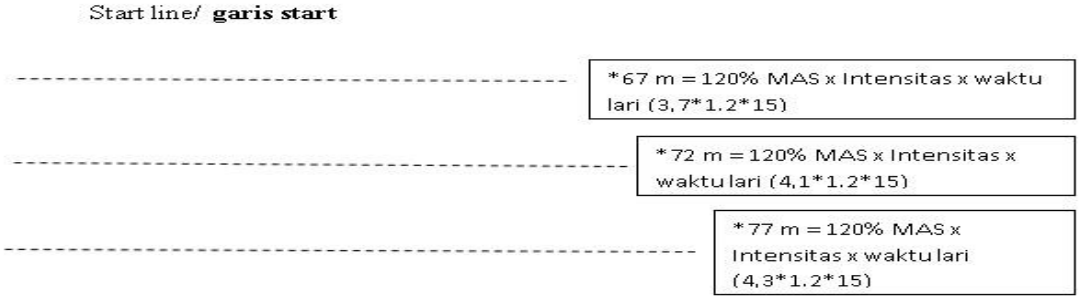
a. Group (Shuttle run)

In that group, the effect of the shuttle run exercise has an effect on the pulse rate and Vo2max variables with a sig value. < 0.05, which means Ho is rejected and Ha is accepted. Then there is a significant difference between pulse rate and vo2max before and after intensity interval trainingthe height of the shuttle run form.

According to Naesilla (2015) This exercise is defined where there are two different cycles in time, namely short or moderate time or duration using high intensity and each exercise cycle is interspersed with rest periods in the form of light intensity exercise.

In the HIIT shuttle run exercise program, the researchers made a high intensity of 120% of Vo2max with a measurement of 120% of the Maximum Aerobic Speed (MAS) of each individual as mentioned above. With a 1:1 ratio where 15 seconds of doing work or sprints with high intensity and followed by 15 seconds of active rest for 10 times taking into account the condition of the athlete himself for a total of 15 minutes.

The high-intensity interval training method Shuttle runs were carried out on 3 different subject groups at 100-120% MAS their speed. All groups ran at 120% of this speed, as in the example line below, run 15 seconds, rest 15 seconds, continuously for 5-10 minutes.



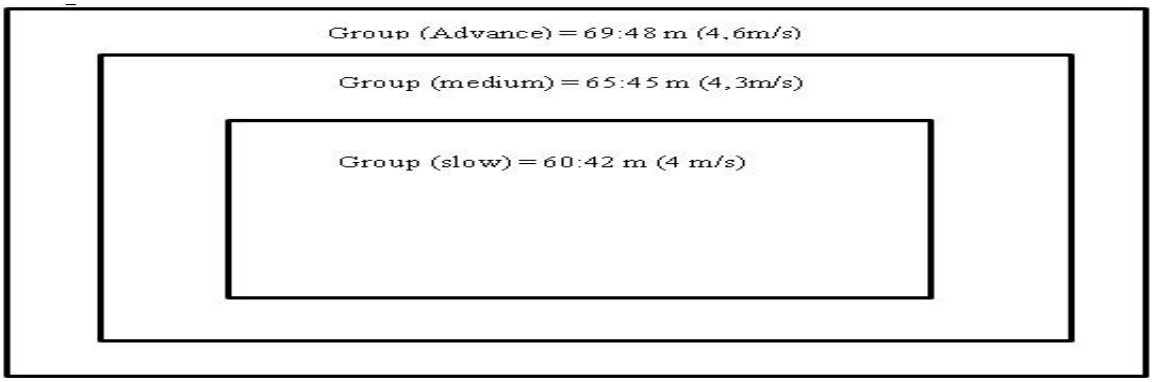
Information:

- Exercise is done for 3 sets with a break of 3 minutes each set or 60-65% Heatrate check.
- During this exercise will monitor the heart rate of the subjects and also to observe how they cope with the intensity of the exercise using the Polar H10 tool to gain an understanding of whether the intensity can be increased by adding more sets, reducing the time interval or increasing the distance.

During the 6-week walking training process, there were several subjects who adapted quickly and were able to handle this exercise well, therefore according to individual and progressive principles in the subject's training, it was improved by reducing running and resting time. According to Sukadiyanto (2011) in loading must be done progressively and changed according to the level of the athlete. The load received is individual, but in principle it is given a load until it is close to the maximum. The load carried out by the athlete must be heavier than the previous exercise at the threshold of sensitivity. (Bompa, 2009). Based on the results of the study which showed significant value and meaningful discussion, it was found that high-intensity interval training (HIIT) in the form of a shuttle run affected the basal pulse rate and vo2max in adolescent athletes aged 16-18 years.

b. Group (Running around Rectangle)

A rectangular grid with long side at 100% MAS and short side at 70% MAS for each running group. Each side takes 15 seconds to complete, with a full rectangle taking 1 minute. The distances are Group 1 (Continued) = 69m: 48m, group 2 (Medium) = 65m: 45m, group 3 (Slow) = 60m: 42m. Each group runs on their own square and all athletes reach the same corner at the same time, every 15 seconds. 5 repetitions per interval for 5 sets with 1-3 minutes rest between sets. The total training time is 30 minutes. For example, the form is:



In the Around rectangle group, the effect of this exercise has an effect on the pulse rate and Vo2max variables with a sig value. < 0.05, which means Ho is rejected and Ha is accepted. So there is a significant difference between pulse rate and vo2max before and after high-intensity interval training in the form of Around rectangle.

c. The difference between the Shuttle run and around rectangle practice effects

Based on the results of the analysis that has been carried out on the pulse rate and Vo2max variables, the Sig. > 0.05, which means that Ha is rejected and Ho is accepted. So it can be concluded that there is no significant difference between high-intensity interval training in the form of Shuttle run and Around rectangle.In these two exercises, the

research subjects carried out activities in the high-intensity exercise zone, this was proven in the implementation of being monitored using the heart rate using the Polar H10 tool. According to Tanzila & Bustan (2017) If someone has a heart that works more efficiently and optimally, it will make that person more energetic. The training duration of 16 meetings was chosen because it is known that physiological adaptation can occur within a certain time span (Miller, Herniman, Cheatham, & Michael, 2006). Similar to research conducted, exercise for 24 meetings can improve cardiovascular performance.

So the research that has been done has found that high-intensity interval training Shuttle run with Around rectangle is able to increase Vo2max and changes in basal pulse rateand have the same effectiveness.

IV. Conclusion

Based on the results and discussions that have been described, it can be concluded as follows:

1. There is a significant effect of Shuttle run High Intensity Interval training on changes in basal pulse rate and Vo2max in adolescent athletes aged 16-18
2. There is a significant effect of High Intensity Interval around Rectangle on changes in basal pulse rate and Vo2max in adolescent athletes aged 16-18.
3. Both exercises have the same effectiveness in improving the basal pulse rate and Vo2max.
4. High Intensity Interval Training is not based on the form but on the duration and intensity that can be monitored using a heat rate check every time you do exercise

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