

## High-Intensity Interval Training (HIIT) Progressive Sprint-Release Model: Its Effect in Increasing Speed, Aerobic Capacity, and Anaerobic Capacity of Athletes

### Modelo de liberación de sprint progresivo del entrenamiento en intervalos de alta intensidad (HIIT): su efecto en el aumento de la velocidad, la capacidad aeróbica y la capacidad anaeróbica de los atletas

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**Abstract.** Physical abilities is one of the most important aspects influencing an athlete's competitive success. This research aims to determine the effect of the High-Intensity Interval Training (HIIT) Progressive Sprint-Release model in increasing athletes' speed, aerobic capacity, and anaerobic capacity. The research method used is quasi-experimental quantitative research with a research design, namely a randomized pretest-posttest group design. Purposive sampling technique was used to determine research subjects with the criteria of female rugby athletes aged 18–22 years, exercising regularly six times per week, healthy, and without injuries. There were 20 athletes who were willing to be research subjects and were divided into two groups randomly, namely 10 athletes in the group that underwent the High Intensity Interval Training (HIIT) treatment with the Progressive Sprint-Release (PSRG) model and 10 other athletes in the control group (CG). Progressive Sprint-Release model HIIT treatment for 8 weeks with training frequency 3 times a week. The research instruments used were a 20-meter sprint to measure speed, an MFT to measure aerobic capacity, and a 300-meter sprint to measure anaerobic capacity. Data analysis technique used was the paired sample t-test and the independent sample t-test, and SPSS software version 25 was used. The results of the paired sample t-test, which compared the pre-test with the post-test in the PSRG group (pre-test vs. post-test), showed a significant increase in speed ( $3.99 \pm 0.231$  vs.  $3.87 \pm 0.253$  seconds,  $p < 0.05$ ), aerobic capacity ( $29.23 \pm 4.026$  vs.  $31.81 \pm 4.346$  ml/kg/min,  $p < 0.05$ ), and anaerobic capacity ( $75 \pm 9.821$  vs.  $63.6 \pm 6.736$  seconds,  $p < 0.05$ ). The results of the independent sample t-test showed that there were significant differences between PSRG and CG in speed ( $p < 0.05$ ), aerobic capacity ( $p < 0.05$ ), and anaerobic capacity ( $p < 0.05$ ). In conclusion, the HIIT Progressive Sprint-Release model can increase speed, aerobic capacity, and anaerobic capacity.

**Keywords:** Progressive sprint-release exercise; high-intensity interval training; anaerobic capacity; aerobic capacity; speed

**Resumen.** Las habilidades físicas son uno de los aspectos más importantes que influyen en el éxito competitivo de un atleta. Esta investigación tiene como objetivo determinar el efecto del modelo de sprint-liberación progresiva del entrenamiento en intervalos de alta intensidad (HIIT) para aumentar la velocidad, la capacidad aeróbica y la capacidad anaeróbica de los atletas. El método de investigación utilizado es una investigación cuantitativa cuasiexperimental con un diseño de investigación, es decir, un diseño de grupo aleatorizado pretest-posttest. Se utilizó una técnica de muestreo intencional para determinar los sujetos de la investigación con los criterios de atletas de rugby de entre 18 y 22 años, que hacían ejercicio regularmente seis veces por semana, estaban sanas y sin lesiones. Hubo 20 atletas que estuvieron dispuestos a ser sujetos de investigación y se dividieron en dos grupos al azar, es decir, 10 atletas en el grupo que se sometió al tratamiento de Entrenamiento en Intervalos de Alta Intensidad (HIIT) con el modelo de Liberación Progresiva de Sprint (PSRG) y otros 10 atletas. en el grupo control (GC). Tratamiento HIIT modelo Sprint-Release progresivo durante 8 semanas con frecuencia de entrenamiento 3 veces por semana. Los instrumentos de investigación utilizados fueron un sprint de 20 metros para medir la velocidad, un MFT para medir la capacidad aeróbica y un sprint de 300 metros para medir la capacidad anaeróbica. La técnica de análisis de datos utilizada fue la prueba t para muestras pareadas y la prueba t para muestras independientes, y se utilizó el software SPSS versión 25. Los resultados de la prueba t para muestras pareadas, que comparó el pretest con el posttest en el grupo PSRG (pretest vs posttest), mostraron un aumento significativo en la velocidad ( $3,99 \pm 0,231$  vs.  $3,87 \pm 0,253$  segundos,  $p < 0,05$ ), capacidad aeróbica ( $29,23 \pm 4,026$  vs.  $31,81 \pm 4,346$  ml/kg/min,  $p < 0,05$ ) y capacidad anaeróbica ( $75 \pm 9,821$  vs.  $63,6 \pm 6,736$  segundos,  $p < 0,05$ ). Los resultados de la prueba t para muestras independientes mostraron que hubo diferencias significativas entre PSRG y CG en velocidad, capacidad aeróbica, y capacidad anaeróbica ( $p < 0,05$ ). En conclusión, el modelo HIIT Progressive Sprint-Release puede aumentar la velocidad, la capacidad aeróbica y la capacidad anaeróbica.

**Palabras clave:** Ejercicio de liberación progresiva del sprint; entrenamiento por intervalos de alta intensidad; capacidad anaeróbica; capacidad aeróbica; velocidad.

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## Introduction

One of the factors that plays an essential role in determining an athlete's sporting performance is physical ability (Baxter-Jones, 2019; Söğüt et al., 2019). Physical ability is vital because it contributes to improving competition performance and the level of tactics and techniques of an athlete (Liu et al., 2022). Apart from that, physical abilities can also be used to predict performance and assess the potential of an athlete (Corluka et al., 2019). However, if the aim is to improve the athlete's physical abilities, the training

carried out must be adapted to the biomotor components that are dominant in the sport (Pino-Ortega et al., 2019), the characteristics of the sport (Darmayasa et al., 2022), and the functional anatomy (Carr & Feit, 2022; Milner, 2008).

One of the training methods that are still popular and has become a fitness trend for the world's population is High-Intensity Interval Training (HIIT) (Thompson, 2018). HIIT can become popular because it has better time efficiency in improving physical fitness (Naimo et al., 2015) in different populations (Evangelista et al., 2021), especially

in athletes from various types of sports (Briand et al., 2022). HIIT is known as high-intensity exercise performed repeatedly, short to long, alternated with recovery periods, either rest or low intensity (Buchheit & Laursen, 2013). Generally, HIIT is performed with an intensity approaching 80% to 95% of the maximum heart rate and work intervals ranging from 15 seconds to 4 minutes (Roy, 2013).

There has been much research that proves the benefits of HIIT on athlete performance. For example, research on basketball players proved that HIIT carried out for 5 weeks could effectively increase basketball players' aerobic capacity and sport-specific skills (Kumari et al., 2023). Other research also shows that aerobic HIIT training can increase VO<sub>2</sub>max significantly better than moderate training (Helgerud et al., 2007). HIIT is also known to significantly improve an athlete's physical components, such as anaerobic capacity, speed, explosive power, and agility (Arazi et al., 2017; Fajrin et al., 2018; Stöggel & Björklund, 2017).

Currently, many sports still require anaerobic endurance, where activities use speed, aerobic capacity, and anaerobic capacity components. However, many trainers still use long-duration continuous low-intensity training methods to increase endurance abilities. Thus, the physical training carried out by athletes is still not by the characteristics, functional anatomy, and physical biomotor required and results in not achieving the targeted or expected sports performance. Thus, the Progressive Sprint-Release Model HIIT training protocol was developed in this research because it is a new and appropriate physical exercise to increase speed, aerobic capacity, and anaerobic capacity by the match's intensity according to the game sport's characteristics. This research aims to reveal the effects of the High-Intensity Interval Training (HIIT) Progressive Sprint-Release Model on speed, aerobic capacity, and anaerobic capacity.

## Methods

### Study Design

This research is quasi-experimental, and the research design used is a randomized pretest-posttest group design. The subjects in this study were determined using a purposive sampling technique and divided into two groups randomly, namely the group given the HIIT treatment with the Progressive Sprint-Release (PSRG) model and the control group (CG).

### Subjects

In this study, the research population was female rugby athletes from Grobogan Regency, Central Java, Indonesia. The research sample was taken using a purposive sampling technique with criteria, namely: 18–22 years old, exercising regularly six times per week, healthy body, and no injuries. The research subjects obtained in this study were 20 athletes who were divided randomly into two different groups, namely 10 athletes in the group who underwent High Intensity Interval Training (HIIT) treatment with the

Progressive Sprint-Release (PSRG) model and 10 other athletes in the other group. control (CG). Written consent was obtained from the research subjects after they were informed about the procedure being used.

### Treatment Procedure

The Progressive Sprint-Release model HIIT training activity is carried out with a loading of 4 sets, 6 repetitions, and the ratio t work: t rest is 1: 3. This exercise is carried out for 8 weeks with a training frequency of 3 times a week. The training duration used in each training session is 60 minutes with details: 10 minutes warm-up, 60 minutes core phase, and 10 minutes cool-down. The training intensity is high (85% - 95% HR max). A polar heart rate monitor (H10) (20–22) monitored heart rate and exercise intensity. To get an overview of the HIIT training procedure for the Progressive Sprint-Release model in two repetition, see Figure 1.

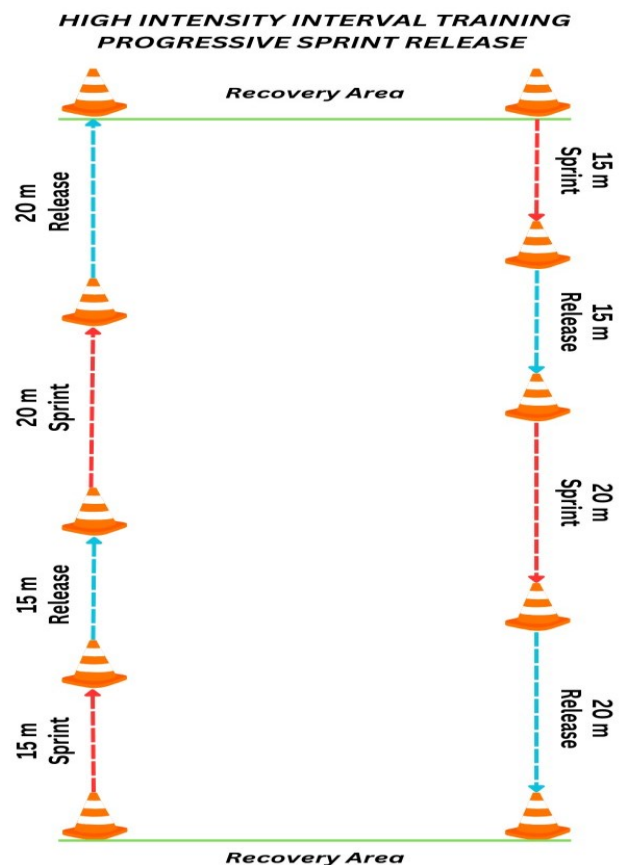


Figure 1. High Intensity-Interval Training (HIIT) Progressive Sprint-Release Model

### Instrument and Data collection

The instruments used were the 20-meter sprint test used to measure speed (Chiwaridzo et al., 2017; Darrall-Jones et al., 2016), the Multistage Fitness Test (MFT) used to measure aerobic capacity (Castro-Piñero et al., 2021; Till & Jones, 2015), and the 300-meter sprint test used to measure anaerobic capacity (Angeltveit et al., 2016; Arı & Deliceoglu, 2021; Lima et al., 2011). The three test instruments were used twice, namely during the pretest (before

treatment), which was carried out before the training intervention was given, and during the posttest (after carrying out the exercise), which was carried out the day after the 24th or last training meeting.

### Statistical analysis

Statistical analysis in this research uses descriptive analysis techniques such as normality tests, homogeneity tests, paired sample t-tests to see the differences between the pre-test and posttest, and independent sample t-tests to analyze the differences between the two groups. This analysis process uses Microsoft Excel 2021 and SPSS version 25 software. The results of the normality (shapiro-wilk) and homogeneity (levene's test) tests that have been carried out show that the data in this study is normally distributed ( $p > 0.05$ ) and has a homogeneous data variance ( $p > 0.05$ ).

## Results

The results of descriptive statistical data analysis related to the characteristics of the 20 research subjects and descriptive statistics from the pretest and posttest of the variables speed, aerobic capacity, and anaerobic capacity are presented using mean values and standard deviations, as shown in table 1.

Table 1.  
Descriptive statistical test results

Variable	Mean $\pm$ SD	
	PSRG (n=10)	CG (n=10)
Age (Year)	21 $\pm$ 1.49	20.3 $\pm$ 2,63
Height (m)	1.57 $\pm$ 0.04	1.56 $\pm$ 0,04
Weight (kg)	55.09 $\pm$ 9.39	56.8 $\pm$ 5,69
BMI (kg/m <sup>2</sup> )	22.18 $\pm$ 3.19	23.38 $\pm$ 2,64
Pre test 20-meters sprint test (s)	3.99 $\pm$ 0.23	4.01 $\pm$ 0.17
Post test 20-meters sprint test (s)	3.87 $\pm$ 0.25	3.97 $\pm$ 0.16
$\Delta$ 20-meters sprint test (s)	0.12 $\pm$ 0.06	0.04 $\pm$ 0.03
Pre test Multistage Fitness Test (ml/kg/min)	29.23 $\pm$ 4.03	29.02 $\pm$ 3.83
Post test Multistage Fitness Test (ml/kg/min)	31.81 $\pm$ 4.35	29.92 $\pm$ 3.84
$\Delta$ Multistage Fitness Test (ml/kg/min)	2.58 $\pm$ 1.4	0.9 $\pm$ 0.42
Pre test 300-meter sprint test (s)	75.00 $\pm$ 9.82	77.50 $\pm$ 7.12
Post test 300-meter sprint test (s)	63.30 $\pm$ 6.63	73.30 $\pm$ 8.11
$\Delta$ 300-meter sprint test (s)	11.70 $\pm$ 5.08	4.20 $\pm$ 2.66

Data collection on speed, aerobic capacity, and anaerobic capacity was carried out twice. Data were collected before being given treatment (pretest) and after being given training treatment (posttest). Below is presented table 2, which contains the results of inferential statistical tests, which include the paired sample t-test and the independent sample t-test.

Table 2.  
Test results of paired sample t-test and independent sample t-test

Variable	Group	p-value	
		Paired sample t-test	Independent sample t-test
Speed	PSRG	0.000*	0.001 <sup>o</sup>
	CG	0.007*	
Aerobic Capacity	PSRG	0.000*	0.002 <sup>o</sup>
	CG	0.000*	
Anaerobic Capacity	PSRG	0.000*	0.001 <sup>o</sup>
	CG	0.001*	

\*: there is a significant difference between pretest and posttest ( $p < 0.05$ ); <sup>o</sup>: there are significant differences between PSRG and CG ( $p < 0.05$ )

The results of the paired sample t-test showed that the two groups in this study (PSRG and CG) had significant changes ( $p < 0.05$ ) in the variables of speed, aerobic capacity, and anaerobic capacity. Apart from that, the results of the independent sample t-test also showed that there was a significant difference between the PSRG and CG groups ( $p < 0.05$ ), so it can be seen that the PSRG group was better than the CG group.

Data on differences between pre-test and post-test in the two groups (PSRG and CG) variables of speed, aerobic capacity, and anaerobic capacity, and data on differences in changes that occurred in the two groups can be seen in Figure 2.

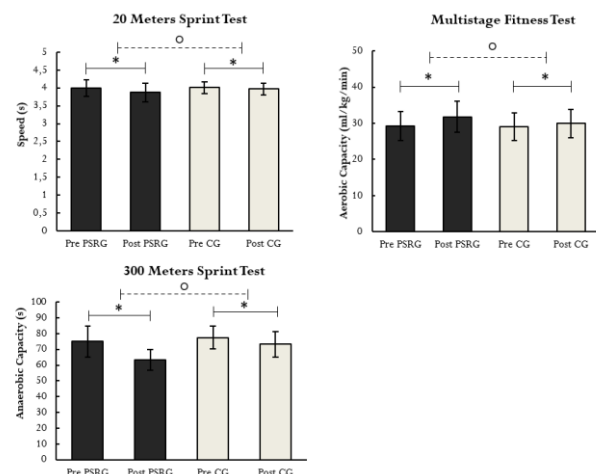


Figure 2. Changes from pretest to posttest variables of speed, aerobic capacity, and anaerobic capacity in the PSRG and CG groups. The data presented uses mean  $\pm$  SD values, paired sample t-test results, and independent sample t-test results. (\*): there is a significant difference between pretest and posttest ( $p < 0.05$ ); and (o): there is a significant difference between PSRG and CG ( $p < 0.05$ ). s: seconds; ml/kg/min: milliliters per kilogram per minute.

## Discussion

Research that aims to see the effect of implementing the High-Intensity Interval Training (HIIT) Progressive Sprint-Release Model on speed, aerobic capacity, and anaerobic capacity has obtained results in the form of a significant increase in the variables of speed, aerobic capacity, and anaerobic capacity ( $p < 0.05$ ) after being given training for 8 weeks with a training frequency of 3 times a week. The results of independent sample t-test also showed that PSRG group had a significant difference compared to CG group ( $p < 0.05$ ) in speed, aerobic capacity, and anaerobic capacity.

The results of this research are supported by previous research conducted by Jatmiko et al. (2023), where the Tuja Shuttle-Run HIIT model developed significantly improved athletes' physical components. The HIIT Tuja-Shuttle Run model has been proven to increase speed, agility, and anaerobic capacity, and can be implemented in various sports (Jatmiko et al., 2023). The Tuja Shuttle-Run HIIT training model can also be used to increase Vo<sub>2</sub>max for athletes aged 14 to 17 years (Jatmiko et al., 2024). Other

research related to HIIT with research subjects of rugby-seven athletes is known to have positive effects. HIIT with the Sprint Interval Training (SIT) model has been proven to be able to increase VO<sub>2</sub>peak and repeated-sprint ability (RSA) effectively and significantly in rugby-seven athletes (Robineau et al., 2017).

Several research reviews show that HIIT has comprehensive benefits. HIIT is known to increase exercise capacity, such as aerobic endurance, anaerobic capacity, maximal oxygen uptake, and metabolic health in various populations (Atakan et al., 2021). Other findings also state that HIIT significantly impacts young athletes because it can improve certain essential variables related to anaerobic and aerobic performance (Engel et al., 2018). Research examining the effects of HIIT on female athletes has found evidence that HIIT has a significant impact on increasing speed, change of direction speed, repeated-sprint ability (RSA), VO<sub>2</sub>max, and explosive power (Stankovic et al., 2023).

Thus, the results of this research will positively contribute to and impact the development of the physical abilities of athletes in various sports, especially in increasing aspects of speed, aerobic capacity, and anaerobic capacity. Remember that physical ability can be used as a predictor in assessing an athlete's potential and performance during the scouting stage (Jeon & Eom, 2021; Xavier et al., 2019). Apart from that, it is also important to remember that the physical abilities possessed by an athlete have a significant influence on mastery of technique, tactics, and competition performance (Brown et al., 2017; Carvalho et al., 2018). So, meeting the needs for physical abilities in accordance with the needs and characteristics of sports will increase the possibility of an athlete achieving the highest performance and achievements.

## Conclusion

High Intensity-Interval Training Model Progressive Sprint-Release carried out for 8 weeks can increase speed and aerobic and anaerobic capacity in female rugby athletes. Thus, the results of this research can be used and implemented by coaches and athletes in the training process to improve the athletes' physical performance, especially in speed, aerobic capacity, and anaerobic capacity.

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