

ENCHANTING ANAEROBIC ENDURANCE ACROSS SOCCER PLAYER POSITIONS THROUGH HIGH INTENSITY INTERVAL TRAINING

Sahrur Ramadhan¹, Dikdik Zafar Sidik^{2*}, Fitri Rosdiana³, Ira Purnamasari⁴

^{1, 2*, 3}. Kepelatihan Fisik Olahraga, Fakultas Pendidikan Olahraga dan Kesehatan, Universitas Pendidikan Indonesia

⁴ Pendidikan Kepelatihan Olahraga, Fakultas Pendidikan Olahraga dan Kesehatan, Universitas Pendidikan Indonesia Jl. Dr Setiabudi No.229, Isola, Kecamatan Sukasari, Kota Bandung, Jawa Barat 40154, Indonesia.

sahrurramadhan22@upi.edu, dikdikzafarsidik@upi.edu, fitrirosdiana@upi.edu, irapurnamasari@upi.edu

Abstract

This study aims to examine the effect of the High Intensity Interval Training method on improving the anaerobic endurance of soccer players based on their playing positions: Goalkeeper, Defender, Midfielder, and Striker. The research employed a quasi-experimental method with a one-group pretest-posttest design. The sample consisted of four soccer athletes, each representing a different playing position. The High Intensity Interval Training program was carried out over a period of four weeks with a training frequency of twice per week. Anaerobic endurance was measured using the Running-based Anaerobic Sprint Test (RAST) both before and after the intervention. The data from the pre-test and post-test were analyzed using a paired t-test. Analysis using SPSS version 23 revealed a statistically significant improvement in the anaerobic endurance of the soccer players after participating in the High Intensity Interval Training program, with a significance value of 0.023 ($p < 0.05$). These findings support the effectiveness of the High Intensity Interval Training method as an efficient physical training approach to enhance the anaerobic component of soccer athletes across various playing positions.

Keywords: Anaerobic Endurance, High Intensity Interval Training, Playing Positions, RAST Test, Soccer.

PENINGKATAN DAYA TAHAN ANAEROBIK POSISI PEMAIN SEPAK BOLA DENGAN MENGGUNAKAN METODE HIGH INTENSITY INTERVAL TRAINING

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh metode High Intensity Interval Training terhadap peningkatan daya tahan anaerobik pemain sepak bola berdasarkan posisi bermain, yaitu Goalkeeper, Defender, Midfielder, Striker. Metode yang digunakan dalam penelitian ini adalah metode eksperimen semu (quasi experiment) dengan desain one group pretest-posttest. Sampel penelitian terdiri dari empat orang atlet sepak bola yang mewakili satu posisi permainan yang berbeda. Program metode High Intensity Interval Training dilaksanakan selama empat minggu dengan frekuensi dua kali latihan per minggu. Pengukuran daya tahan anaerobik dilakukan melalui tes Running-based Anaerobic Sprint Test (RAST) sebelum dan sesudah intervensi. Data hasil pre-test dan post-test kemudian dianalisis menggunakan uji paired T-test. Hasil analisis bantuan aplikasi SPSS 23 menunjukkan adanya peningkatan yang signifikan secara statistik terhadap daya tahan anaerobik pemain sepak bola setelah mengikuti program High Intensity Interval Training, dengan nilai signifikansi sebesar 0,023 ($p < 0,05$). Temuan ini memperkuat efektivitas metode High Intensity Interval Training sebagai pendekatan latihan fisik yang efisien dalam meningkatkan komponen anaerobik bagi atlet sepak bola dari berbagai posisi

Kata kunci : Daya Tahan Anaerobik, High Intensity Interval Training, Posisi Pemain, RAST Test, Sepak Bola

INTRODUCTION

Football players are required to have the ability to make quick and accurate decisions in good physical condition. Players must also possess optimal cognitive intelligence and physical endurance to be able to withstand high intensity and adapt quickly to changes in tactics or strategies that occur during the game (Akenhead & Nassis, 2016). In addition to these skills, football players must improve their movement without the ball in all positions on the field. Football players have their roles in their positions and apply strategies and tactics during the game. In technical or strategic training, physical training is essential. It requires players to have the physical ability to give their all and perform at their best (Samsul Huda et al., 2023).

Football in the past differs from football today. Modern football requires players to maintain repeated high-intensity efforts at a constant pace Ribeiro et al. (2021), and the average heart rate has been found to be around 85% of the maximum value, with the peak heart rate approaching the maximum (Evangelos et al., 2016). The results of the analysis conducted by Faizal et al. (2025) on football players during matches covered various metrics, namely total distance covered, running distance at high intensity (15-20 km/h), very high intensity (20-25 km/h), sprint distance (greater than 25 km/h), and acceleration, deceleration, maximum speed movements and change direction. Based on general physical characteristics, football requires high aerobic and anaerobic endurance, muscle strength, speed, power, skill, coordination, and flexibility to improve performance on the field and reduce the risk of injury.

In football positions such as goalkeeper, defender, midfielder, and striker, each role has different physical requirements. Quantitative analysis of motor activity for teams and player position specifications is one of the most important components of modern training processes, which involve player performance in terms of technique, strategy, and physical requirements based on player position (Andrzejewski et al., 2014). Furthermore, research conducted by Bush et al. (2015) has shown that running requirements differ between playing positions, with central midfielders, wing-backs, and wing midfielders covering the most total distance and high intensity, followed by strikers and centre-backs. Each position requires a combination of speed, strength, and endurance, so a targeted training programme is important to optimise performance on the field Dragijsky et al. (2017) and can also help coaches make decisions about selecting players for playing positions (Rismayadi et al., 2023). Physical training is a very important part of the many physical requirements for football players to perform well, requiring coaches to have a thorough understanding of physical training components (Rosdiana et al., 2019).

Football is a sport that requires physical activity using aerobic and anaerobic energy systems (Guldal & Bilge, 2019). Aerobic endurance and anaerobic endurance capacity are important factors for player performance. Specifically, anaerobic endurance is very important for high-intensity actions such as sprinting, jumping, and quick changes of direction, which often occur during a match (Zapata-Lamana et al., 2019). Anaerobic endurance is also a vital component of athletic performance, particularly for football players in the positions of goalkeeper, defender, midfielder, and striker.

With the development of more specific player positions, the physical condition of athletes is an important aspect that coaches must pay attention to in order to optimise performance Elite foot Rismayadi et al. (2023) ball players have the ability to repeat high-intensity actions, whether in possession of the ball or not, quickly during a match (Andrzejewski et al., 2014). The need for position-specific training programmes arises from the different physical demands associated with each player position on the field (Bradley, 2024).

The role of the defender requires explosive power and quick recovery to make effective blocking movements and defend the goal in the team's defensive area. The striker position relies on explosive speed and agility to create scoring opportunities, while the midfielder position must

maintain high intensity efforts throughout the game, balancing attacking and defensive tasks. Accurate assessment of the effects of training is an important part of football training, which involves aerobic endurance and anaerobic endurance training. An athlete's physical characteristics also greatly determine how well they can achieve a high level of success in their chosen sport (Kucsá & Mačura, 2015). High-Intensity Interval Training (HIIT) is one of many methods used to enhance physical capabilities.

Understanding how High Intensity Interval Training affects anaerobic endurance in these various positions can inform specialised training programmes that enhance performance and reduce fatigue and injury risk during matches. High-Intensity Interval Training has emerged as a popular method for improving anaerobic endurance due to its efficiency and effectiveness in enhancing football players' performance. However, the specific impact of High-Intensity Interval Training on football players' anaerobic endurance, particularly as it relates to football player positions such as goalkeeper, defender, midfielder, and striker, has not been specifically explored. In researching the effects of High Intensity Interval Training on anaerobic endurance in football athletes, particularly those focusing on the positions of goalkeeper, defender, midfielder, and striker, a significant gap in the literature becomes evident (Bradley, 2024).

The results of Bradley. (2024) research presented the results of a broad analysis of physical needs and demands, which encouraged researchers to make updates by exploring physical needs in football playing positions and exploring training programmes using the High Intensity Interval Training method to improve anaerobic endurance among football players specific to their playing positions. with the main objective of comparing which football player positions are more effectively served by the High Intensity Interval Training method, by dividing the position groups according to the specific needs and demands of the goalkeeper, defender, midfielder, and striker positions.

High Intensity Interval Training is a training method characterised by short periods of intense exercise followed by short rest periods or high-intensity exercise (Manuel Clemente et al., 2021). This High Intensity Interval Training method is designed to maximise cardiovascular and muscular efficiency in a time-efficient manner (Buchheit & Laursen, 2013). the body performs movements without oxygen and for a short period of time without oxygen (Sidik et al., 2019). The High Intensity Interval Training method can be modified to suit various fitness levels and can be performed with minimal equipment.

METHOD

In this study, the method used was an experimental method with a quasi-experimental approach. An experiment is a type of scientific research in which one or more independent variables are manipulated, and the dependent variables are then observed to determine the variations resulting from these changes. The use of research methods depends on the issues to be discussed. A research method can be said to be effective if, during the research process, positive progress can be seen and leads to the achievement of results. A research method is said to be efficient if it minimises time, costs, and facilities, but produces maximum results.

Population and Sample

In this study, the population consists of 25 football players aged 15-16 years old, namely players who have passed several stages of physical conditioning training and have good VO2Max, as well as football players who have sufficient training age and adequate physical condition, especially in the stages of physical conditioning training. The selected sample will represent the population in accordance with the research objectives.

The sampling technique used was non-probability sampling using purposive sampling. The researcher took a sample of 4 players, consisting of each position representing the goalkeeper, defender, midfielder, and striker. This technique was used because the independent

variable, High Intensity Interval Training, has a requirement of having good VO2Max when using the High Intensity Interval Training method.

Research Design

This study employed an experimental design, specifically a one-group pretest-posttest design, where the experimental group underwent an intervention in the form of training using the High Intensity Interval Training method. This method is used based on the characteristics of experimental research, which is to try something to determine the effect or consequence of a treatment to obtain a result (Lonati et al., 2018).

This design did not compare results with another group but only measured changes before and after the intervention or treatment on the same sample.

Table 1. Design

O1	X	O2
Pretest	Treatment	Posttest

Explanation:

O1: *pre-test* using the *RAST Test*

X: training using the *High Intensity Interval Training* method

O2: *post-test* using the *RAST Test*

Research Instrument

The research instrument used was the RAST Test (running-based anaerobic sprint test), a physical test developed in the United Kingdom in 1997 by Draper and Whyte at the University of Wolverhampton, which is a form of test to measure anaerobic endurance. The RAST test also consists of two main components, namely average power and fatigue index. The researchers used this test instrument technique by adopting the RAST Test, which has been tested for validity and reliability of 0.72 (Burgess et al., 2016).

Procedure

1. *The initial position of the player is standing behind the starting line.*
2. The tester gives the ready signal (whistle blow) to run as fast as possible for a distance of 35 metres for 6 repetitions, with a 10-second rest between each repetition.

Table 2. Rast Test Norm Table

Norm	Category
0 – 4	Excellent
4,1 - 10	Good
10,1 - 15	Fair
15,1 – 20	Poor
>20	Very insufficient

According to (Marckenzie, 2018). Norms for *Running Based Anaerobic Sprint Test*

RESULT AND DISCUSSION

This study aims to determine the improvement in anaerobic endurance in football players based on their positions after undergoing a four-week *High Intensity Interval Training* programme. The sample in this study consisted of four players with high VO2Max from the Bintang Junior football school in four positions, namely *Goalkeeper, Defender, Midfielder, and*

Striker. All players followed a training programme in accordance with the intensity and volume norms designed by the researcher.

Before *the treatment*, the players underwent an anaerobic endurance test using *the Running-based Anaerobic Sprint Test (RAST TEST)* to obtain results as a picture of the players' initial condition. The initial test results showed variations in anaerobic endurance levels based on the players' positions, with *Defenders* and *Strikers* showing relatively better anaerobic performance than *Midfielders* and *Goalkeepers*. This is in line with the characteristics of positions that require more explosive and intense movements for longer durations during a match

Table 3. Result of pre-test RAST TEST

PreTest Result	Football Player Position				Rata-rata
	Goalkeeper	Defender	Miedfilder	Striker	
Opportunity 1	5.66	5.84	5.95	5.73	5.80
Opportunity 2	6.30	6.09	6.14	6.22	6.19
Opportunity 3	6.49	6.13	6.30	6.22	6.29
Opportunity 4	6.94	6.40	6.75	6.78	6.72
Opportunity 5	7.33	6.54	6.92	6.48	6.82
Opportunity 6	7.73	6.86	6.92	7.20	7.18
Average	6.74	6.31	6.50	6.44	

During the *High-Intensity Interval* Training programme, players underwent training twice a week, with each session lasting 30 to 40 minutes, combining strength training, *interval* running, *sprints*, and active *recovery*. This training was tailored to the principles of football player movement. After four weeks, the *RAST* test was conducted again to measure improvements in anaerobic endurance among the players. The *post-test* results showed improvements in nearly all research samples. These improvements were evident in terms of total sprint time, *peak power*, and *fatigue index*, although the degree of improvement varied depending on the player's position.

Table 4. Data Hasil Post test RAST TEST

PostTest Result	Football Player Position				Rata-rata
	Goalkeeper	Defender	Miedfilder	Striker	
Opportunity 1	5.90	5.44	5.72	5.85	5.73
Opportunity 2	6.33	5.61	5.88	5.34	5.79
Opportunity 3	6.43	5.68	6.10	6.20	6.10
Opportunity 4	6.69	5.91	6.06	6.18	6.21
Opportunity 5	6.36	6.00	6.41	6.73	6.38
Opportunity 6	7.73	6.73	6.67	5.85	6.75
Average	6.57	5.90	6.14	6.03	

Defender and *Striker* positions tend to experience the most significant improvement. Visually, the time taken for six sprints on *the RAST* became shorter, with recovery intervals

appearing more efficient. This can be observed directly from the participants' time records and physical expressions after the test, which show their ability to perform at their best even under severe anaerobic conditions. Some players admitted to feeling fitter and lighter when *sprinting* or *performing explosive movements*, even though the training was relatively intense. Meanwhile, the *Midfielder* position also showed considerable improvement, particularly in terms of endurance during repeated sprints.

Although the improvement in this group was not as significant as that of the *Defender* and *Striker* positions, it was still evident that the *High Intensity Interval Training* method had an impact on their ability to cope with match situations that required quick transitions and *running to space*. The *Goalkeeper* position showed the most limited improvement in the *RAST Test* data. This is understandable because their role in the game does not involve many repeated long-distance sprints, even though the *High Intensity Interval Training* provided has been tailored to the movement requirements of *Goalkeepers*. However, some *Goalkeepers* reported improvements in speed *response* and reflexes during training sessions, which, although not directly measured in the *RAST Test*, provide additional insight that the method still offers benefits.

All data from the initial and final tests have been documented for each player. The description of the average values and differences between tests will be explained further in the data analysis section. However, from field observations and brief interviews with players after the programme was completed, most felt that the *High Intensity Interval Training* method helped them not only physically but also in improving their spirit, fighting spirit on the field, and consistency in training.

This significant effect occurred in all football player positions, from *Goalkeeper*, *Defender*, *Midfielder*, and *Striker*. This shows that the *High Intensity Interval Training* method is flexible and can be applied to various roles in the team. Each position showed a positive response

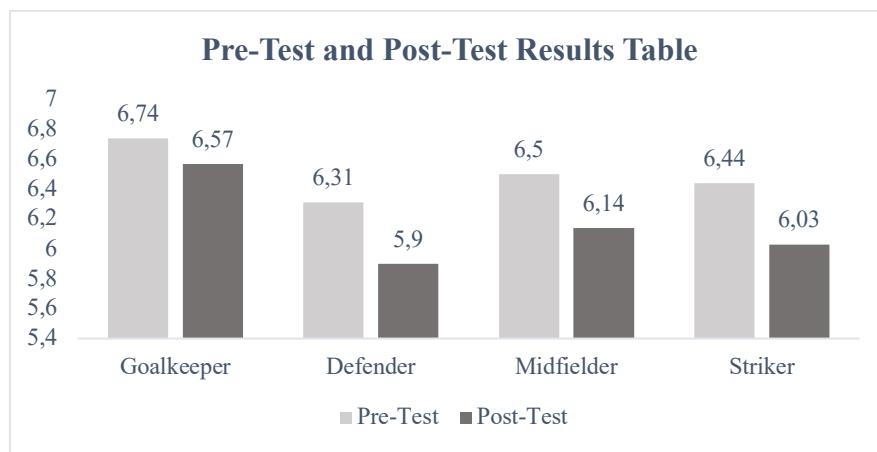


Figure 1. Pre-Test and Post-Test Diagram

to the training programme, although the extent of improvement was not always the same. The *Defender* position showed the most significant improvement in anaerobic endurance, given the characteristics that require anaerobic ability when making quick interceptions and closing down opponents in a short time.

The application of *High Intensity Interval Training* in the context of football training can help improve players' anaerobic energy system capacity. In addition, this training also plays a role in increasing muscle efficiency, resistance to fatigue, and performance in crucial phases or what can be referred to as the final minutes (*additional time*) of a match that require a sudden burst of energy. Thus, the *High Intensity Interval Training* method can be an effective and efficient training alternative in the physical training programme for football athletes. Overall, this study proves that *High Intensity Interval Training* can be used as a strategic approach to improve physical fitness,

particularly anaerobic endurance, which is an important component in supporting the performance of football players. This reinforces the importance of integrating (*holistically*) high-intensity interval-based training programmes into schemes or formations to develop *game plans* in training to prepare for modern and real football matches. This aligns with research on futsal players, where components such as endurance, speed, strength, agility, and explosive power are identified as essential for high-intensity sport performance (Asmara et al., 2023).

Furthermore, studies examining the physical condition and motor abilities of football players emphasise the variability in physical readiness among athletes. For example, football athletes at the FC UNY Academy demonstrated a wide range of motor abilities from excellent to poor highlighting the importance of structured conditioning programmes to elevate baseline performance (Alfian, 2020). Evidence from another study during the new-normal training period showed that a considerable proportion of players remained at moderate or low physical condition levels, reinforcing the need for systematic physical training to maintain high performance (Limayyasya et al., 2022). In this context, HIIT can serve as an effective and time-efficient method to develop anaerobic and aerobic components simultaneously.

This study provides a tangible contribution to the development of practical and position-specific training programmes for football players. This makes the research results more valuable because coaches can adjust training programmes based on the needs of player positions and game formation requirements. Although the sample size is relatively small, this approach is in line with the characteristics of preliminary or pilot studies, which focus on testing the feasibility and initial effects of an intervention, as emphasised in the study by (Anderson et al., 2024). Each player position provides a representative picture of the physiological demands and needs of football players. These findings provide a scientific basis that short-duration High Intensity Interval Training programmes still have high potential effectiveness, particularly in the context of physical interventions aimed at improving anaerobic capacity.

Thus, based on the results obtained, it can be said that the *High Intensity Interval Training* method has the potential to improve the anaerobic capacity of football players, especially if it is tailored to the characteristics of the players' positions. Furthermore, this data will be analysed statistically to see the significance of these improvements quantitatively. However, this study has limitations, namely that the training programme has not been tailored to the movement characteristics of players based on their positions, and this could be developed in future research.

CONCLUSION

Based on the results of the study, it can be concluded that the *High Intensity Interval Training* method has a significant effect on improving the anaerobic endurance of football players. This improvement is clearly seen from the *pre-test* and *post-test* results, which show statistically significant differences. More specifically, the conclusions from the research results on player positions can be summarised as follows:

1. *Goalkeeper*: Although the distance of movement on the field is lower, the anaerobic endurance of goalkeepers also increased significantly, which is important to support performance when performing explosive jumps and quick reactions in *scramble* situations.
2. *Defender* (Back Player) *High Intensity Interval Training* has been proven to improve anaerobic endurance, especially in supporting the need for short sprints when facing pressure from opponents, *changes in direction*, and quick transitions from defence to attack.
3. *Midfielder* (Central Player) This position also shows significant improvement, marked by increased sprint capacity and rapid recovery, supporting the midfielder's role as the most aerobically and anaerobically active player during the match.
4. *Striker* (Forward) There was a significant increase in the anaerobic endurance of strikers after undergoing the *High Intensity Interval Training* programme. This position showed

improvement, in line with the need for explosiveness in getting past opponents and repeated sprints in situations to score goals.

5. Based on the results of the data analysis, the hypothesis stating that there is a significant difference in the effect of the *High Intensity Interval Training* method on the improvement of anaerobic endurance in the *Defender* position shows the highest increase compared to other positions.

Thus, it can be concluded that a four-week *High Intensity Interval Training* programme with a frequency of twice a week is effective in increasing the anaerobic endurance of football players in all positions. These findings support the use of the *High Intensity Interval Training* method as an efficient and applicable physical training method for coaches, especially *fitness coaches*, in preparing athletes to face match situations that demand physical conditions to always be competitive on the field.

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