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Does HIIT Training for Professional Soccer Players Affect Body Composition and Endurance?

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Abstract

The aim of this study was to investigate the impact of High-Intensity Interval Training (HIIT) on both body composition and endurance levels among professional soccer players. Twenty-one male professional soccer players from 1461 Trabzonspor Club participated in the study, with an average age of 23.00±0.60 years, a height of 183.16±10.1 cm, and a body weight of 78.40±1.69 kg. Various data were collected, including gender, age, body weight (kg), body fat percentage (%BF), body mass index (BMI), neck circumference, hip circumference, waist circumference (cm), and VO2max (measured using the yo-yo test).The statistical analysis was conducted using SPSS 25. Normality of the data was assessed using the Shapiro-Wilk test, and the paired sample t-test was employed for statistical analysis due to the normal distribution of the data. The results revealed a statistically significant difference in body weight (kg), body fat percentage (%BF), body mass index (BMI), neck circumference, hip circumference, and waist circumference (cm) values ($p<0.05$), indicating that HIIT training was effective in reducing these variables. Additionally, when analyzing the Maximum VO2 values obtained through the yo-yo test, HIIT training demonstrated a statistically significant impact ($p<0.05$), suggesting that it effectively increased this variable. In conclusion, the HIIT training program implemented among professional soccer players led to notable improvements in reducing certain anthropometric values while simultaneously enhancing Maximum VO_2 values.

Keywords: HIIT, Max VO^2, Yo-yo, Interval

Introduction

In a Soccer match, various physical activities such as walking, short-duration light and high-intensity runs, intermittent and continuous physical activities are involved. It is noted in performance analyses and research in Soccer that there are short rest periods between these short-term maximal and submaximal repeated physical activities. Due to the prolonged duration of Soccer matches and the repetition of short-term high-intensity loads within matches, it is crucial to implement training that develops both aerobic and anaerobic capacity (Mohr, Krustrup ve Bangsbo, 2003; Hoff ve Helgerud, 2004; Mohr ve Iaia, 2014; Stolen et al., 2005; Spencer et al., 2005; Bangsbo, Mohr, Krustrup, 2006; Rampinini et al., 2007; Aslan et al., 2012; Mohr ve Krustrup, 2014).

Although aerobic energy production is more effective in providing energy in Soccer, elite-level players engage in short bursts of high-intensity actions during a match. This results in high anaerobic demands during intense periods of play. Maintaining high levels of activity during intense periods and simultaneously enhancing fatigue-limiting capabilities are essential for high match performance, implying the necessity for well-developed aerobic endurance in players (Koklu et al., 2015).

In the literature, "High-Intensity Interval Training (HIIT)" is generally defined as training sessions performed at or near maximal effort, with intervals of rest or lower intensity, and typically exceeding 90% of maximum oxygen consumption (Gibala and McGee, 2008). Interval training involves the systematic alteration of high and low-load cycles or work and rest periods (Revan et al., 2008). The rest in this context is not complete rest, and the aim of this training seems to be to increase fatigue resistance to enhance endurance performance capacity (Demiriz, 2013). Numerous studies have demonstrated similar physiological adaptations in athletes after various HIIT protocols with different rest durations and repetition numbers (Kubukeli et al., 2002). Generally, despite variations in the application of HIIT, studies have shown nearly identical physiological adaptations in athletes following these types of training, including increased mitochondrial density, improvement in MaxVO2, enhanced fat oxidation, muscular endurance, and citrate synthase activation (Weston et al., 1996; Laursen and Jenkins, 2002; Laursen, Blanchard et al., 2002; Talanian et al., 2007; Burgomaster et al., 2008; Little et al., 2010).

Endurance exercises are not only pivotal for enhancing sports performance but also crucial for improving overall health and mitigating the risk of chronic diseases (Rana et al., 2007; Reddigan et al., 2011). The quantity of body fat serves as a significant determinant of human health, directly correlating with the prevalence of obesity. The combination of physical inactivity and obesity significantly increases the risk of developing chronic diseases such as cardiovascular disorders, type 2 diabetes, and metabolic syndrome.

In addition to its efficacy in bolstering endurance, High-Intensity Interval Training (HIIT) stands out as a favored training modality due to its profound impact on body fat reduction. Research exploring the effects of endurance training on body composition consistently underscores notable reductions in body fat percentage, body mass index, total body weight, and skinfold thickness, accompanied by significant increases in lean body mass and body density (Gökdemir, Koç, & Yüksel, 2007; Patlar et al., 2003; Trap et al., 2008).

The primary objective of this study is to investigate the ramifications of implementing HIIT training among professional soccer players on specific body composition metrics and endurance parameters.

Material and Method

Ethics committee permission

The study group was informed about the research, and participants signed an informed consent form detailing the purpose and methods of the study. Ethics approval for this study was obtained from the Gazi University Health Sciences Ethics Committee with decision number 2023-1081.

Study Participants

A total of 21 voluntary male professional Soccer players from 1461 Trabzonspor Club participated in the study. The research group was determined using a stratified sampling method.

When looking at Table1, descriptive statistics for the Soccer players participating in the study are presented as mean, standard deviation, minimum, and maximum values.

Table 1. Descriptive Statistics for Soccer Players (n=21)

Variables	x̄	Ss	Min	Max
Age (Year)	23.00	0.60	18	31
Body Weight (kg)	78.40	1.69	64	92
Height (cm)	183.16	10.1	172.14	198.13

The average age of the players was 23.00 ± 0.60 years, with an average height of 183.16 ± 10.1 cm and a body weight of 78.40±1.69 kg.

Data Collection Tools

Measurements of the research group included height measured with a stadiometer (Holtain brand), body weight and body fat percentage measured with a digital scale (Tanita BC 480). Body Mass Index (BMI) was calculated using the formula BMI = weight (kg) / [(height (m)]^2. Neck, hip, and waist circumferences (cm) were measured with a tape measure. Additionally, aerobic capacity was determined using the Yo-Yo IRT 1 test, and MaxVO_2 was calculated using the formula "MaxVO_2 (ml/min/kg)= IR1 distance (m)×0.0084+36.4" (Bangsbo, Laila and Krustrup ,2008).

Training Protocol

The applied training sessions were conducted over a 6-week preparatory period. In the first week of the training period, the volume and intensity of the training were kept low to allow players to adapt. During the training period, athletes were provided with essential guidance regarding nutrition and rest to ensure optimal performance. Additionally, potential factors such as external activities or lifestyle habits that could influence the results were discussed and considered to the best extent possible.

During the 6-week period, participants engaged in training sessions three days a week (non-consecutive days), performing 4 sets lasting 4 minutes each at 80-90% of maximum heart rate. Passive rest was provided between sets, and participants started the next set when their heart rate reached 50-60% of the maximum heart rate. Heart rate measurements during the HIIT sessions were recorded using a heart rate monitor (Polar Team Pro 2, Polar Electro, Finland), which measures heart rate at 1-second intervals, ensuring accurate tracking of participants' heart rates throughout the sessions. This training protocol was adapted from the

one used by Helgerud et al. and has been observed to enhance aerobic performance in soccer players.

Table 2 provides the weekly High-Intensity Interval Training (HIIT) Protocol.

Table 2. High-Intensity Interval Training Protocol

Weeks	1st Training	2nd Training	3rd Training
1st week	2 min x 2 set %70-75 MaxHR	2 min x 2 set %70-75 MaxHR	2 min x 2 set %70-75 MaxHR
2nd week	3 min x 3 set %80-90 MaxHR	3 min x 3 set %80-90 MaxHR	3 min x 3 set %80-90 MaxHR
3rd week	4 min x 3 set %80-90 MaxHR	4 min x 3 set %80-90 MaxHR	4 min x 3 set %80-90 MaxHR
4th week	4 min x 4 set %80-90 MaxHR	4 min x 4 set %80-90 MaxHR	4 min x 4 set %80-90 MaxHR
5th week	4 min x 4 set %80-90 MaxHR	4 min x 4 set %80-90 MaxHR	4 min x 4 set %80-90 MaxHR
6th week	4 min x 4 set %80-90 MaxHR	4 min x 4 set %80-90 MaxHR	4 min x 4 set %80-90 MaxHR

Data Collection

Height measurement: Height measurements of the enrolled students were conducted utilizing a Holtain brand stadiometer, renowned for its precision with a sensitivity of 0.1 cm. Standard protocol was adhered to for height determination, whereby participants were instructed to take a deep breath, maintaining an upright head position with eyes gazing straight ahead, while the stadiometer was positioned at the apex of the head.

Body Weight and Body Fat Percentage Measurement

The body weights and body fat percentages of the Soccer players were measured using Tanita BC 480 while wearing shorts and without shoes.

Body Mass Index (BMI) Measurement

The BMI of the Soccer players was calculated using the formula BMI = weight (kg) / (height (m^2).

Waist-Neck-Hip Circumference Measurements

The waist, neck, and hip circumferences of the Soccer players were measured with a non-stretchable standard tape measure.

Yo-Yo IRT-1 Test and MaxVO2 Calculation

The test was performed to measure the aerobic endurance performance of soccer players. Before starting the test, participants performed a 10-minute free warm-up protocol with dynamic warm-up movements. The Yo-Yo IR1 is an endurance test consisting of repeated runs between the start, turn and finish lines in a 2 x 20 m field; participants start at a running speed of 10 km/h and gradually increase their running speed according to audible signals emitted from a signaling device. The test takes place on grass and cones are used to mark 2 x 20 m running lanes. After each 40 m sprint, there is a 10-second active recovery area consisting of 2 x 5m. The test is terminated if the participant misses three consecutive signals or reaches the exhaustion point (Krustrup et al., 2003; Svensson and Drust, 2005). After determining the total running distances of the participants with the Yo-Yo IRT 1 test, the

aerobic capacity of the participants was determined using the formula "$MaxVO_2$ (mL/min/kg) = IR1 distance (m) × 0.0084 + 36.4" (Bangsbo, laila & Krustrup, 2008).

Statistical Analysis

SPSS 25 software was used for statistical analysis of the collected data. Descriptive statistics, including mean, standard deviation, minimum and maximum values, were used to present the data. The normal distribution of body composition and $MaxVO_2$ values was examined with the Kolmogorov-Smirnov test, indicating that the data were suitable for

parametric testing. As the data showed a normal distribution, a paired samples t-test was applied for statistical analysis.

Findings

In this section, the statistical procedures of the obtained data, along with tables and interpretations, are provided. Table 3 presents the t-test results comparing the body composition and $MaxVO_2$ pre-test values with post-test values for soccer players.

Table 3. Comparison of Body Composition and $MaxVO_2$ Pre-Test vs. Post-Test Values for Soccer Players

Variables	Tests	X	Sd	t	p
Body Weight (kg)	Pre test	78.40	1.69	19.20	**0.000**
	Post test	73.19	1.56		
Body Mass İndex (BMİ)	Pre test	23.28	0.43	18.09	**0.000**
	Post test	21.73	0.38		
Body Fat Percentage (%BF)	Pre test	11.25	0.41	10.41	**0.000**
	Post test	8.82	0.31		
Waist Circumference (cm)	Pre test	84.23	1.04	5.08	**0.000**
	Post test	81.04	0.90		
Neck Circumference (cm)	Pre test	39.76	0.35	6.00	**0.000**
	Post test	38.04	0.29		
Hip Circumference (cm)	Pre test	99.42	0.83	6.78	**0.000**
	Post test	95.00	0.74		
Max VO2 (ml/kg/dk)	Pre test	52.06	0.62	-11.93	**0.000**
	Post test	55.62	0.49		

X:Mean; SD: Standart Deviation

Table 3 demonstrates the statistical significance of pre-test versus post-test values for body composition and $MaxVO_2$ among soccer players, with $p<0.05$ indicating significant differences. The results highlight significant disparities in these parameters before and after the implementation of High-Intensity Interval Training (HIIT). Specifically, the HIIT program proves effective in reducing body weight, BMI, body fat percentage, waist circumference, neck circumference, and hip circumference values, while concurrently enhancing $MaxVO_2$ values. These findings underscore the efficacy of HIIT in both improving body composition and boosting cardiovascular endurance among soccer players.

Discussion and Conclusion

This study delves into the effects of a 6-week High-Intensity Interval Training (HIIT) program on body composition and $MaxVO_2$ values among professional soccer players. The findings underscore significant disparities between pre-test and post-test measurements for body weight, body mass index (BMI), body fat percentage, waist circumference, neck

circumference, and hip circumference ($p<0.05$). The findings underscore significant disparities between pre-test and post-test measurements for body weight, body mass index (BMI), body fat percentage, waist circumference, neck circumference, and hip circumference ($p<0.05$).

When looking at the $MaxVO_2$ values, similarly, a significant difference is observed in pre-test vs. post-test values after the 6-week HIIT program ($p<0.05$). The findings highlight the potential of the 6-week HIIT program to improve both body composition and aerobic capacity in professional Soccer players.

HIIT has been shown to produce significant results in the short-term development of endurance due to its physiological impact (Buchheit and Laursen,2013). Despite the variations in methods used in different HIIT protocols (cycling, running, field-based), the results consistently demonstrate a substantial improvement in individuals' aerobic endurance characteristics (Ojeda et al., 2017; Sperlich et al., 2011; Whyte et al., 2010).

In a study by Impellizzeri et al., Soccer players undergoing traditional HIIT protocols showed a significant increase in $MaxVO_2$ values (Pre-test:55.6±3.4 ml/kg/min, Post-test: 60.2±3.9 ml/kg/min). In line with Impellizzeri et al.'s findings, our study also demonstrated a significant increase in $MaxVO_2$ values after HIIT training, confirming the effectiveness of this method in improving aerobic capacity in Soccer players.

Studies by Sperlich et al. and Helgerud et al. reported an increase of 7% to 11% in VO2max in Soccer players after 5-8 weeks of HIIT training (Sperlich et al., 2011; Helgerud et al.,2001). Another study indicated a 25% increase in running distance after high-intensity interval training (Akılveren,2018), consistent with the parallel results in our study.

Looking at other research, it can be said that interval aerobic exercises significantly increase $MaxVO_2$ values (Ribeiro et al., 2004; Daussin et al., 2007; Gorostiaga et al., 1991). Despite the short duration of HIIT sessions, they are not only effective in impacting $MaxVO_2$ but also offer satisfying metabolic benefits.

HIIT programs, despite their short duration, have proven to be effective in various metabolic benefits, including a significant reduction in body fat percentage and body fat mass (Khammassi et al., 2018; Racil et al., 2016; Zhang et al., 2015). When examining the rate of fat burning and the reduction in body fat mass, HIIT programs stand out as a significant training strategy (Laursen and Jenkins, 2002, Buchheit and Laursen, 2013). In a study by Bagley et al., athletes observed increased fat acid oxidation by 10% through an HIIT training program.

HIIT, especially in overweight/obese young individuals, can be an effective method in improving body composition, fitness, and lipid profiles, reducing the risk of metabolic and cardiovascular complications (Len Kravitz, 2011; Martins et al., 2016).

The impact of HIIT training on body composition is evident in our study with noticeable differences in pre-test and post-test values. Significant reductions were observed in parameters such as body weight, body mass index (BMI), body fat percentage, waist circumference, neck circumference, and hip circumference. These results indicate that HIIT training can positively influence body composition and optimize the physical appearance of Soccer players (Maillard et al., 2020).

Moreover, the impact of HIIT training on $MaxVO_2$ is also clearly evident ($p<0.05$). In line with a similar study conducted by Impellizzeri et al., HIIT training in Soccer players has been shown to increase aerobic capacity (Impellizzeri et al., 2005). The increase in $MaxVO_2$ values can elevate athletes' endurance levels and provide more energy during matches.

High-intensity interval training (HIIT) has been supported as an effective training strategy for football players in previous studies. Research by Sperlich et al. and Helgerud et al. has

demonstrated that HIIT can significantly increase the VO^2max of football players (Sperlich et al., 2013; Helgerud et al., 2007). Furthermore, HIIT has been reported to have the potential to increase running distance (Buchheit et al., 2010).

Other studies in the literature also indicate that HIIT has similar effects on maximum oxygen uptake (Weston et al., 2014; Tjønna et al., 2013). These studies emphasize the potential of HIIT training to accelerate endurance development in football players.

In conclusion, this study demonstrates that a 6-week HIIT training program has positive effects on body composition and maximum oxygen consumption in professional Soccer players. HIIT training has the potential to accelerate endurance development, regulate body composition, and enhance performance in Soccer players. Therefore, we believe that HIIT training is an effective option for coaches and athletes aiming to improve physical performance in Soccer players.

From a practical perspective, coaches working with professional soccer players may consider incorporating HIIT protocols, similar to the one used in this study, during pre-season or in-season periods to efficiently improve both aerobic capacity and key anthropometric parameters. Given the time-efficient nature of HIIT, it can be strategically used when training time is limited or when there is a need to simultaneously target multiple fitness components. Furthermore, carefully monitoring players' heart rates, as implemented in this study, may help coaches to ensure training intensity remains within optimal zones for maximal benefit.

Limitations

One of the primary limitations of this study is the absence of a control group. In professional teams, with the goal of preparing players as thoroughly as possible for the season, it is not feasible to create a control group within the same team due to the fixed number of players in the squad. Additionally, the creation of a control group from a different professional team at the same level was not possible, as there is no other team at the same level in the same city. Therefore, this study was planned without a control group.

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