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Original Research

Anaerobic Power and Sprint Performance in U19 Elite Football Players

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ABSTRACT

Objective: This study aimed to investigate the relationship between anaerobic power and sprint performance in U19 players of the Türkiye Football Federation Elite Academy League.

Methods: A total of 23 male football players voluntarily participated in the study, with a mean age of 17.73±0.54 years, mean height of 174.18±6.58 cm, mean body weight of 67.99±6.30 kg, and mean body fat percentage of 22.38±1.01%. The Wingate Anaerobic Power and Capacity Test (WAnT) was used to assess anaerobic power and performance capacities, while 10m and 30m sprint tests were conducted to evaluate sprint speed performance. In the statistical analysis, variance homogeneity was tested using Levene's Test, and normality distribution was assessed with the Shapiro-Wilk Test Pearson correlation analysis was applied for all parameters.

Results: The results indicated a moderate negative correlation between anaerobic power (W) and the 10m sprint performance parameter ($r = -0.45$, $p = 0.03$), and a strong negative correlation with the 30m sprint parameter ($r = -0.59$, $p = 0.01$), both statistically significant.

Conclusion: The findings revealed a significant relationship between anaerobic power and sprint performance in Elite Academy League players. The direct influence of anaerobic power on the connection between these two parameters was also evident. Given that this age group represents the final stage of development in the league, systematically incorporating sprint speed training into the training regimen with appropriate periodization is recommended to enhance the players' athletic performance and improve anaerobic power capacities.

Keywords: Elite Academy League, athletic performance, youth soccer, power

INTRODUCTION

Today's football requires players to have more advanced physical and physiological characteristics. This is in parallel with the development of football in recent years. This parallelism has increased the importance of anaerobic power and endurance [1]. The competitive environment in football demands a high level of technical skills from players. Accordingly, aerobic and anaerobic power must be high to sustain technical performance throughout the match. The physical-physiological performance parameters of football players must also be at a high level to be successful [3]. Training programs developed for success include speed and explosive power. The footballer needs these skills throughout the match. A high sprinting speed and explosive strength is an important advantage during a match. In addition, the relationship between the anaerobic system, vertical jump and sprint speed is an indispensable element of modern football [4].

Football is a high-intensity sport that involves variables such as muscular endurance and cardiovascular endurance. Technological developments have influenced football [5, 35]. This influence is also reflected in training techniques. Anaerobic-based modified speed drills are among the drills that are shaped according to game strategies [6].

In football, strength and speed characteristics and sprint performance are critical for high-level performance [7]. Player development is favourable if these performance characteristics are used in combination. Studies have also emphasized that such applications depend on properly adjusting training workload intensity, timing and dosage [8].

Studies indicate that incorporating different sprint speed drills tailored to anaerobic performance profiles can enhance athletes' power output, acceleration, and overall sprinting performance. Moreover, adapting these drills to individual anaerobic capacities can lead to more efficient training outcomes and reduce the risk of injury. Similarly, adjusting the intensity and duration of sprint training according to the specific demands of the athlete's energy systems may further support effective performance development. [9, 36].

The continuous movement of players throughout a match, their need for high-intensity efforts, and the repeated execution of high-speed sprints over the distance covered all play a significant role in determining match outcomes. In recent years, modern football has increasingly focused on incorporating various strength-based training methods, which are often adapted and combined to improve performance. Research has shown that incorporating sprint speed drills tailored to the anaerobic performance profiles and movement patterns of players has led to notable improvements in overall team performance levels. These training approaches have been particularly effective in enhancing players' speed, endurance, and overall match performance, ultimately contributing to better team success on the field [10, 37].

Main Points

- Anaerobic power and sprint performance were studied in U19 elite football players.
- Wingate test and 10m–30m sprint tests were used for performance assessment.
- Significant negative correlations were found between anaerobic power and sprint times.
- Sprint-focused training may enhance anaerobic performance in youth athletes

Over time, numerous field tests have been employed to assess players' performance capacities in football. Given the sport's demanding nature, which includes one-on-one duels, sudden directional changes, short and intense runs, and repeated sprints, players must develop their endurance capacity to sustain physiological resilience throughout the match [11].

The Wingate anaerobic power test is among today's field tests to assess anaerobic endurance development. This test evaluates players' ability to generate high power levels during training and matches by measuring their average anaerobic power and fatigue index values [12]. Lower extremity muscle strength is a crucial parameter in football players, and studies have highlighted the Wingate anaerobic power test as a significant field assessment for evaluating and improving muscle strength. Generating power through the lower extremities is also essential for football players to frequently perform high-intensity sprints [13].

On the other hand, research indicates that training protocols designed to improve anaerobic endurance capacity in football are also associated with enhanced sprint speed performance. In this context, endurance training programs that are well-structured to optimize the intensity of the anaerobic energy system have positively impacted sprint speed performance [14]. Historically, anaerobic power and sprint speed capabilities were considered independent traits, particularly in developmental leagues. Contrary to this general belief, the present study suggests that training applications and protocols to enhance athletic performance in developmental league players may contribute significantly to player development.

This study specifically aimed to investigate the relationship between anaerobic power and sprint speed performance in elite academy (U19) league players, focusing on identifying the correlation between these performance parameters in the context of developmental leagues. The performance of elite academy players in sprinting and other high-intensity efforts is critical for their success in competitive football. Given the importance of anaerobic power in short-duration, high-intensity physical activities, understanding its role in sprint speed performance is essential for optimizing training regimens. This study specifically aimed to investigate the relationship between anaerobic power and sprint speed performance in elite academy (U19) league players, with a particular focus on identifying the correlation between these performance parameters in the context of developmental leagues.

Hypotheses; In line with the study's objectives, the following hypotheses were formulated;

Hypothesis 1: There is a positive correlation between anaerobic power and sprint speed performance in elite academy (U19) league players. This hypothesis suggests that players with higher anaerobic power are expected to demonstrate superior sprint speed performance.

Hypothesis 2: Elite academy (U19) league players with higher anaerobic power will demonstrate better performance in sprint-based tests compared to those with lower anaerobic power. This hypothesis posits that anaerobic power is a key determinant in sprint performance.

Hypothesis 3: The relationship between anaerobic power and sprint speed performance in elite academy (U19) league players is stronger during high-intensity sprint efforts. This hypothesis highlights that the impact of anaerobic power is more pronounced during high-intensity sprints, where anaerobic energy systems are primarily engaged.

Hypothesis 4: The correlation between anaerobic power and sprint speed performance will be stronger in developmental leagues compared to established senior leagues. This hypothesis suggests that in developmental leagues (such as U19), the relationship between anaerobic power and sprint performance might be more significant, as players are still in their physical development stages.

These hypotheses aim to provide a comprehensive understanding of the role of anaerobic power in sprint performance, specifically in the context of elite youth football. The findings of this study will contribute to the development of more effective training strategies tailored to enhance both anaerobic power and sprint speed in these players.

MATERIAL AND METHODS

Subjects

This study involved 23 male football players from a professional football team in the Türkiye Football Federation Elite Academy League, with an average age of 17.73 ± 0.54 years, average height of 174.18 ± 6.58 cm, average body weight of 67.99 ± 6.30 kg, and an average body fat percentage of 22.38 ± 1.01%. Prior to the study, the purpose, methods, procedures, and potential risks were verbally communicated to the players. Additionally, information regarding the players' contributions and the possibility of injuries during measurements was provided. Furthermore, the players were given an informed consent form based on the provided information, which was signed before participation. Ethical approval for this study was obtained from the Health Sciences Ethics Review Committee of Çankırı Karatekin University (Approval code: 2023/8, Date: 20.06.2023), and the study was designed and conducted in accordance with the World Medical Association's Helsinki Declaration protocol.

Inclusion and Exclusion Criteria; Participants in this study were selected based on the following inclusion criteria: Male football players aged between 17 and 19 years. Players actively participating in the Türkiye Football Federation Elite Academy League. Players who had no history of significant musculoskeletal injuries in the past six months. Players who were free from any cardiovascular, respiratory, or metabolic disorders that could interfere with physical performance or participation in sprint tests. Players who provided informed consent and agreed to participate in the study after being fully informed about the purpose, methods, and potential risks of the study.

Exclusion criteria included: Players who were unable to participate in the required physical tests due to injury or illness during the study period. Players who did not sign the informed consent form or withdrew from the study prior to its completion. Players with any medical condition that could interfere with safe participation in high-intensity physical activity or sprint tests. Players who were not actively involved in the Elite Academy League or were not available for the duration of the study.

By adhering to these criteria, the study ensured a homogenous group of participants who were capable of safely and effectively engaging in the required tests.

Study Design

The study was limited to football players participating in the

Elite Academy (U19) league, specifically focusing on players from the Turkcell Super League Development League. The study design was based on the 3rd month of the first competition period of the 2022-2023 U19 Elite Academy League season. The main aim of this design was to assess the physical preparation of players who had completed their pre-season training and match adaptation. The tests involved in the study (three testing procedures) were designed and conducted in two phases. In the first phase, on the initial day, body composition and sprint performance tests were performed in the club's international standard indoor sports hall (at 10:00 AM). In the afternoon, the planned sprint speed test was conducted on the professional team's regularly used natural grass field (at 4:00 PM). On the following day, the Wingate anaerobic power measurements were taken using a lower extremity cycle ergometer (Monark 894E, Monark, Varberg, Sweden) in the club's professional team's performance laboratory (at 10:00 AM).

To implement the measurements, the Wingate anaerobic power and speed parameter tests were assigned randomly using a numbered paper system, and the order was determined via laptop (PC) assignments. To eliminate the circadian rhythm effect, all athletes were tested at the same time of day. Players were instructed not to engage in any training the day before the tests and to refrain from eating at least 2 hours before testing.

Table 1. Timeline of the measurement

Days	Measurement
Sunday	Resting Day
Monday	(10:00) Height Measurement / Body Composition Analyse
	(16 :00) Sprint 10-30 meter tests
Tuesday	(10:00) Wingate Anaerobıc Power (*(WAnT) tests*
Wednesday	Resting Day
Thursday	Football Training
Friday	Football Training

The participation criteria for the study were as follows: players were required to have at least 5 years of active sports experience as licensed athletes in the development leagues of a professional football club and to participate in at least five training sessions per week. Additionally, players should not have a history of musculoskeletal, neurological, or cardiopulmonary injuries within the last six months. Before participating in the study, players were instructed not to use any supplements that could enhance performance. They were also informed that caffeine intake should be limited to one cup before the measurements, as excessive consumption could affect the metabolic process. Furthermore, in order to ensure resting metabolism, players were asked to avoid strenuous and performance-decreasing activities before the measurements, and to refrain from any intense physical activities within 24 hours prior to the tests.

Anthropometric and Body Composition Assessments

In this study, two anthropometric measurements were taken: body height and body weight. These measurements were complemented by three body composition assessment variables: body mass index (BMI), body fat percentage, and lean body mass. To evaluate the body composition, an InBody fat scale (InBody 270) was utilized. This scale works on the principle of bioelectrical impedance analysis (BIA), which involves the transmission of a low-level electrical signal through the body via electrodes placed on a standalone unit. By measuring the resistance encountered by the signal as it passes through different tissues, the scale provides an indirect estimate of body composition. The InBody 270 scale, specifically designed with an athletics mode, allows athletes to monitor not only their body weight but also critical health indicators such as body fat percentage, muscle mass, and hydration levels. This enables a comprehensive assessment of an athlete's physical condition, which is essential for tracking performance, optimizing training regimens, and preventing injuries. Through the use of this advanced technology, athletes can gain valuable insights into their health and fitness status, supporting informed decision-making regarding their training and recovery strategies [15, 38].

Height Measurement:

Height was measured using a stadiometer [Seca model 213, Germany (accuracy of ± 5 mm)]. Participants stood barefoot with their lower back, head, shoulder blades, buttocks, and heels in contact with the stadiometer, keeping their feet together. After assuming the correct position, height was measured vertically by the rod, which was placed above the head [16].

Body Weight and Body Fat Percentage:

Following the height measurement, the participants' body composition was assessed. Body weight (kg) and body fat percentage (BFP, %) were measured using the bioelectrical impedance analysis (BIA) method (Inbody 270 Body Composition Analyzer, model Plus 270). This method is based on the difference in electrical conductivity between fat and lean tissue [17]. Measurements were conducted between 08:30 and 12:00 on the morning of the testing day, following an overnight fast with no food or fluid intake, ensuring that participants had used the restroom beforehand. During the measurement, participants were asked to remove any metal accessories, jewelry, or items that could affect the measurement. The participants were dressed in shorts and a t-shirt, barefoot, and stood on the aluminum-metac mixture-based footplates of the Inbody 270 analysis device. They maintained an upright position and held the hand electrodes. The analysis process, which took between 0-2 minutes, was automatically completed, and the results were recorded in the device's digital storage system [18].

Team Performance Measurement

Sprint Testing (10 - 30 meter)

Participants' maximal sprinting speed was tested 30 meter. Times (in ms) were recorded by four infra-red timing gates (Fusion Sport Smart Speed, Fusion Sport, Australia) positioned at the start at 0 meter and end of 30 meter. Each participant carried out two maximal trials separated by five minutes of rest. At the start of each trial, the participants positioned their lead foot on a line 15 cm behind the first timing gate. Each test started from a static standing position, with the time recorded from when the participants intercepted the first timing gate [19]. The fastest time recorded 30 m was used for data analysis.

Wingate Anaerobic Power Test (WAnT)

For determining anaerobic power capacity, the Monark 894E Smart Impulse device (Monark, Varberg - Switzerland) was used. This test provides information about the average power and peak power components of anaerobic performance. Research conducted on the reliability of this test has shown a correlation coefficient between 0.89 and 0.98. During the test, the load application stages were based on 0.075 kg (75 grams) of weight per kilogram of body weight, and each participant was required to perform maximum pedal rotations for 30 seconds on the cycle ergometer. Information such as the player's age (years), body weight (kg), and height (cm) was entered into a laptop connected to the ergometer via software, and the system automatically recorded this data [20].

Statistical Analysis

For the statistical analysis of the data obtained in the study, SPSS 23 (SPSS Inc., Chicago, IL, USA) software was used. The homogeneity of variance was tested using the Levene Test, and the normality of distribution was analyzed using the Shapiro-Wilk Test. Pearson Correlation analysis was applied for the analysis of all parameters. Statistical significance was set at $p<0.05$ [21].

Table 2. Cohen correlation table

Correlation	Negative	Positive
Low	0.29 - 0.10	0.10 - 0.29
Medium	0.49 - 0.30	0.30 - 0.49
High	0.50 - 1.00	0.50 - 1.00

Cohen, (1998).

RESULTS

In this section, descriptive data for the selected parameters of the football players and the correlation analysis are presented.

Table 3. Descriptive statistics for the football players

Variables	n	$\bar{x}$	ss
Age (years)	23	17.73	0.54
Height (cm)	23	174.18	6.58
Body Weight (kg)	23	67.99	6.30
Body Fat Percentage (%)	23	22.38	1.01

$\bar{x}$: Mean, **ss**: Standard deviation

Table 3 presents the average age of the players as 17.73±0.54 years, the average height as 174.18±6.58 cm, and the average body fat percentage as 22.38±1.01% (Table 3).

Table 4. Descriptive data for sprint and anaerobic power parameters of football players

Variables	$\bar{x}$	ss
10m Sprint (s)	1.67	0.05
30m Sprint (s)	4.12	0.12
Peak Power ($W \cdot kg^{-1}$)	14.75	2.38
Anaerobic Power (W)	10.71	1.28
Anaerobic Capacity ($W \cdot kg^{-1}$)	8.45	0.62
Fatigue Index (%)	41.14	9.55

$\bar{x}$: Mean, **ss**: Standard deviation

Table 4 presents the average sprint speed for the 10-meter sprint as 1.67±0.5 seconds, and the average sprint speed for the 30-meter sprint as 4.12±0.12 seconds. The average peak power value for the Wingate Anaerobic Test (WanT) is 14.75±2.38 $W{\cdot}kg^{-1}$, the average anaerobic power is 10.71±1.28 W, the average anaerobic capacity is 8.45±0.62 $W{\cdot}kg^{-1}$, and the average fatigue index is 41.14±9.55% (Table 4).

Table 5 presents statistically significant negative moderate correlations between anaerobic power (W) and the 10-meter sprint parameter, as well as high-level significant correlations with the 30-meter sprint parameter ($r = -0.45$, $p = 0.03$; $r = -0.59$, $p = 0.01$, respectively). Additionally, significant positive relationships were observed between peak power and anaerobic power, anaerobic capacity, fatigue index, and the 30-meter sprint ($r = 0.86$, $p = 0.01$; $r = 0.52$, $p = 0.01$; $r = 0.77$, $p = 0.01$; $r = -0.47$, $p = 0.02$, respectively). Furthermore, statistically significant correlations were found between anaerobic capacity and both the 10-meter and 30-meter sprints ($r = -0.60$, $p = 0.01$; $r = -0.72$, $p = 0.01$, respectively) (Table 5).

DISCUSSION

This study aimed to examine the relationship between sprint performance and anaerobic power capacity in elite young football players. In modern football, particular attention needs to be paid to the importance of short-distance sprints, and due to the high intensity of the sport, the physiological characteristics of sprint speed should be studied. The high intensity, speed, and rapid directional changes, combined with the requirement for deceleration, highlight the importance of explosive power in one area of the field and modified power parameters in another area during both training and matches, compared to long-duration explosive efforts [22]. The relationship between anaerobic power and sprint performance is expressed as two key parameters affecting athletic performance in football. Anaerobic power, the ability to generate force in a short period without oxygen, is a key physiological parameter in football. Studies have shown that well-trained anaerobic power characteristics contribute to explosive strength development, which, in turn, improves sprinting abilities [23-24].

At the end of this study, moderate negative correlations were found between anaerobic power (W) and the 10-meter sprint parameter ($r = -0.45$, $p = 0.03$), with statistical significance. The obtained results align with the existing literature, showing consistency with previous findings. In the literature, Sliwowski et al. (2028), in their study examining lower extremity strength, anaerobic power, and sprint performance in elite football players, reported a positive relationship between anaerobic power and sprint performance [25]. Additionally, Irigoyen and Larumbe (2013), in their study on professional football players after completing their preseason training, found statistically significant relationships in anaerobic power and sprint parameters before and after the preparation period [26].

At the conclusion of this study, moderate negative correlations were identified between anaerobic power (W) and the 10-meter sprint performance ($r = -0.45$, $p = 0.03$), with statistical significance. This finding suggests that higher anaerobic power is linked with faster sprint times over the 10-meter distance, although the correlation is negative. This result aligns with existing literature, which has explored similar relationships

Table 5. Correlation analysis results of anaerobic power and sprint parameters of football players

	Anaerobic Power (W)	**Anaerobic Capacity ($W{\cdot}kg^{-1}$)**	**Fatigue Index (%)**	**10m Sprint (s)**	**30m Sprint (s)**
Peak Power ($W{\cdot}kg^{-1}$)	r 0.86	r 0.52	r 0.77	r -0.14	r -0.47
	p 0.01*	p 0.01*	p 0.01*	p 0.51	p 0.02*
Anaerobic Power (W)		r 0.76	r 0.79	r -0.45	r -0.59
		p 0.01*	p 0.01*	p 0.03*	p 0.01*
Anaerobic Capacity ($W{\cdot}kg^{-1}$)			r 0.26	r -0.60	r -0.72
			p 0.23	p 0.01*	p 0.01*
Fatigue Index (%)				r -0.13	r -0.21
				p 0.55	p 0.32
10m Sprint (s)					r 0.83

between anaerobic power and sprint performance, providing further validation of the current study's findings. In line with our results, Sliwowski et al. (2028), in their investigation of lower extremity strength, anaerobic power, and sprint performance in elite football players, reported a positive relationship between anaerobic power and sprint performance. They found that players with higher anaerobic power were able to perform better in sprint tests, particularly in shorter sprints, highlighting the importance of anaerobic conditioning for explosive performance in football. This study, similar to our findings, underscores the critical role of anaerobic power in enhancing sprint performance, albeit through different testing parameters. [25-39] Similarly, Irigoyen and Larumbe (2013) examined professional football players before and after completing a preseason training regimen. Their study revealed statistically significant improvements in both anaerobic power and sprint performance, suggesting that targeted preseason conditioning can significantly enhance anaerobic capacity and improve short-distance sprinting ability. Their findings further reinforce the notion that anaerobic power plays a fundamental role in sprint performance and that conditioning programs focusing on this aspect can yield substantial performance gains, as observed in their cohort of professional athletes [26].

Collectively, the studies by Sliwowski et al. (2028) and Irigoyen and Larumbe (2013), along with the present study, all demonstrate the strong link between anaerobic power and sprint performance. The consistency across these studies suggests that anaerobic power is a critical determinant of sprinting ability, particularly in high-intensity sports like football. These findings emphasize the importance of incorporating anaerobic training into athletes' conditioning programs to optimize sprint performance. The results also suggest that future research could focus on understanding how different anaerobic power training methods impact sprint performance across various sports disciplines

In a study focusing on professional football players' sprint times, a statistically significant negative and moderate correlation was found between the power values obtained from the Wingate test and sprint times [27]. In a study comparing aerobic and anaerobic power parameters in Saudi football players, significant improvements were found between peak power, average power parameters, and sprint performance [28]. Another study examining the relationship between the 30-second Wingate anaerobic power test and the sprint running test found a statistically significant correlation, indicating that both tests support each other [29].

Nikolaidis et al. (2016) stated in their study that there is a significant relationship between sprint times and anaerobic power values [13]. In a study examining the impact of anaerobic power and sprint performance on endurance in male football players, it was found that there is a significant relationship between the increase in anaerobic power and the number of sprints performed during the match, leading to improvements in endurance capacity [30]. Kamar et al. (2003) indicated a significant relationship between performance values tracked during a match using the Polar system and anaerobic power and sprint characteristics [31]. Marković and Mikulić (2010) found a positive correlation between sprinting and leg strength [32]. In a study involving female football players, it was reported that leg strength increased after sprint training [33]. Carr et al. (2015) observed that players with higher leg strength had shorter sprint times and found significant relationships between these two traits [34].

The findings of the current study are consistent with previous research, which has consistently highlighted the significant relationship between anaerobic power, sprint performance, and overall strength in football players. A thorough review by Haugen et al. (2022) examined the specific demands of sprinting in professional football, identifying anaerobic capacity as a critical factor that influences performance in high-intensity activities, including sprints, accelerations, and decelerations. Haugen et al. (2022) emphasized that anaerobic energy systems play a pivotal role during the short bursts of high-intensity efforts, which are characteristic of football movements, making anaerobic power a key component for optimizing performance in these demanding situations [40].

Similarly, Silva et al. (2023) conducted research focusing on the role of anaerobic power in improving speed and agility, two essential attributes for football players. Their study highlighted that players with greater anaerobic power exhibited faster reaction times and more efficient movements, particularly during short sprints and directional changes. Silva et al. suggested that anaerobic power is not only crucial for speed, but also for the ability to recover quickly between high-intensity efforts, which is vital for maintaining performance throughout a match. Both studies contribute to the understanding that anaerobic power is integral to various facets of performance in football, from sprinting to agility and overall match endurance [41].

Furthermore, the findings of this study contribute to a deeper understanding of the role of lower-limb strength in anaerobic performance. Research by Marković and Mikulić (2010) and Mendez-Villanueva and Buchheit (2021) has demonstrated that strength-oriented anaerobic training can significantly improve sprint performance. These studies emphasize the importance of incorporating neuromuscular conditioning into football training regimens to optimize outcomes related to sprinting and other high-intensity movements. Marković and Mikulić (2010) in their study emphasized that strength training not only enhances muscle power but also improves neuromuscular coordination, which is crucial for performance in sprinting. Their findings highlight that improving lower-body strength can lead to faster sprint times, as it enhances both the athlete's ability to generate force and their efficiency in utilizing that force during explosive movements [42]. Similarly, Mendez-Villanueva and Buchheit (2021) found that strength-based anaerobic training contributes to increased anaerobic capacity, which in turn improves the athlete's ability to perform high-intensity efforts, such as sprints, more effectively and with less fatigue. Both studies underline the critical role of anaerobic power and strength in high-performance sports like football, where quick accelerations, sprints, and decelerations are common. The integration of strength training focused on enhancing anaerobic power could therefore be seen as an essential element for improving sprint performance [43]. These findings highlight the need for football-specific conditioning programs to prioritize anaerobic energy system training, which not only enhances sprint performance but also helps athletes recover more efficiently between high-intensity efforts during match play and important as they reinforce the need for targeted anaerobic training in football conditioning programs. Given the dynamic and high-intensity nature of football, players must develop their anaerobic energy systems to perform optimally during critical moments of the game. The current study further strengthens this body of evidence by illustrating the direct impact of anaerobic power on sprint performance, further supporting the notion that anaerobic conditioning should be a key focus in football-specific training regimens.The findings obtained in this study are in line with and support the results of research in the literature.

A study conducted with youth development league football players (Elite U19) found a moderate negative correlation between sprint performance and anaerobic power ($r = -0.45$, $p < 0.05$). This result indicates that an increase in anaerobic power is associated with improvements in sprint performance, and that these two parameters are directly influencing each other. Specifically, in younger football players, anaerobic power and sprint performance have been observed to be interrelated and mutually influential characteristics. These findings highlight the importance of focusing on these two parameters in the developmental stages of football players.

To enhance anaerobic power, incorporating sprint training at age-appropriate levels in younger age groups could significantly contribute to the development of this key performance determinant. Sprint training plays a crucial role in improving anaerobic capacity, which is critical for acceleration, explosive strength, and short-distance sprinting. Additionally, evaluating the anaerobic performance profiles of youth players provides essential insights for creating individualized training programs. Tailoring training interventions to address individual needs ensures that players' weak areas are identified and targeted effectively, thereby facilitating optimal development. Furthermore, assessing the expected performance from players in lower age groups helps in identifying their strengths and weaknesses concerning anaerobic performance. Given that anaerobic performance requires rapid execution and explosive power, understanding these aspects is crucial for accurately evaluating players' overall performance. This understanding allows for the development of more effective training programs that can enhance the athlete's performance. For instance, players with lower anaerobic performance may benefit from targeted training to improve explosive speed and acceleration, which are vital for performance in competitive football.

CONCLUSION

In conclusion, this study underscores the importance of anaerobic training for youth football players. Properly designed training programs focusing on anaerobic power can significantly improve sprint performance and enhance overall athletic capabilities. By focusing on individualized and systematic approaches to training, players' strengths can be reinforced, and weaknesses addressed, optimizing their overall performance. Developing anaerobic performance is crucial not only for sprint performance but also for other high-intensity aspects of the game, which are essential in modern football.

Recommendations

This study was conducted to investigate the relationship between anaerobic power and sprint performance in football. For future research in this area, the following suggestions are provided: Performance tracking in this age group can be performed by organizing test protocols across periods, such as the beginning, middle, and end of the season. This would allow for a better understanding of performance dynamics over time. Due to the risk of injuries, individualized strength training programs can be implemented throughout the year, specifically targeting muscle strength development for football players. Coaches can adjust their annual plans and periodizations based on anaerobic power measurements, using these data to optimize training. To minimize the quick fatigue tendency often observed in this age group, it is recommended that test planning and protocols be spread across different days, ensuring that the tests are not performed all at once to avoid overload. These recommendations aim to enhance the effectiveness of training and testing protocols while supporting the overall development of young athletes' anaerobic performance.

Limitations

Sample Size: The study was conducted with a relatively small sample size (n = 23), which may limit the generalizability of the findings. A larger sample of players across different age groups and football leagues would provide a more robust representation of the relationship between anaerobic power and sprint performance. Cross-sectional Design: This study used a cross-sectional design, which means it only captures data at a single point in time. Therefore, causal relationships cannot be definitively established. Longitudinal studies that track players' development over time would be beneficial to observe how changes in anaerobic power influence sprint performance over extended periods. Lack of Control for Other Variables: Although the study focused on anaerobic power and sprint performance, other factors such as nutrition, psychological state, and prior training history were not controlled for. These factors could also influence sprint performance and anaerobic power, and future research should account for these variables. Gender and Position Variability: The study was conducted with male football players from the Elite U19 league, which limits the applicability of the findings to other populations, such as female football players or players in different positions. It would be important to examine how anaerobic power relates to sprint performance in different genders and football positions.

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Conflict of Interest: The authors declare that they have no conflicts of interest.

Informed Consent: The study was conducted on a voluntary basis, and informed consent was obtained from all participants prior to data collection. Participants were fully informed about the purpose and procedures of the study and were allowed to withdraw at any time. All data were collected and used in accordance with ethical standards and confidentiality principles.

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Ethical Approval: Ethical approval for this study was obtained from the Health Sciences Ethics Review Committee of Çankırı Karatekin University (Approval code: 2023/8, Date: 20.06.2023), and the study was designed and conducted in accordance with the World Medical Association's Helsinki Declaration protocol.

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