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Anaerobic power analysis and training methods in professional soccer athletes

Abstract

Soccer is among the most complex sports because it needs several physical valences. The prevailing metabolism inside a game is aerobic but, in crucial moments of a match, part of the explosive movements from the anaerobic metabolism is activated. The maximal anaerobic power is a trainable variable that is extremely important for a soccer player and can be trained in different ways.

Objective: This study aimed to analyze some methods for maximal anaerobic power training and demonstrate their importance for professional soccer.

Method: This research is a literature review. We searched through books and research websites such as Pubmed and Scielo using the descriptors. The search returned 86 entries, from which 30 were filtered out and used in this review. Sprint, plyometric and interval training (game situation) are the models that stand out in the literature.

Conclusion: Through this research, it is possible to conclude that the training of this variable must be done with alternating methods within the proposals and needs of the team.

Keywords: anaerobic power, training, soccer, professional

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Introduction

Soccer is one of the most popular sports in the world. It is a modality of an intermittent character whose practice demands several physical valences. Actions such as jumping, running, kicking, heading, trotting, among others, are part of the game.[1] In this modality, physical capacities, in general, are extremely important, one depending on the other. Among them, there are variables such as aerobic power, aerobic resistance to endure the 90-minute game, flexibility to improve joint mobility, resistance strength, maximal strength seen at the completion, anaerobic resistance through the capacity of maintaining physical strain for a certain period, and anaerobic power, which is the object of study of this work.

During a match, the physical capacities depend on each other, as already mentioned. In a soccer game, most of the energy production comes from the aerobic system (90%).[2] However, the anaerobic power can be crucial in situations such as a move toward a goal, being dependent on other variables for post-effort recovering, so that both systems are integrated. A research study conducted in the 2017 Brazilian Championship regarding scored goals indicates that most occurred at the end of each period (last 15 minutes), when the athlete's recovery after exercises of anaerobic power becomes more difficult due to the athlete's condition after the efforts during the match, since the aerobic metabolism is also important for the recovery of intense actions during the game.[3]

During a match, the athletes often perform sprints or jumps with little time for recovery,[1] which makes the training of the anaerobic capacity extremely important. Most sprints in games take about 10 seconds and cover an average distance between 5 and 30m.[4]

Training strategies are essential for better development of intense activities,[5] as training leads to morphological, metabolic and functional changes in a human profile. In soccer, the physiological demands vary according to the team's playing system. The purpose of anaerobic power training is to make the athlete become faster and more powerful in a short time.[6]

Due to the short training time in the Brazilian calendar, the search for the most adequate training method is of utmost importance. Therefore, this study aimed to investigate, with a literature review, the training methods of alactic anaerobic power in professional soccer.

Anaerobic power

Anaerobic power (ANP) is understood as the performance of a work with maximal speed.[7] The explosive movement needs a fast energy production that occurs with the alactic anaerobic metabolism (ATP-CP). This energy comes almost exclusively from high-energy phosphocreatine in the muscles, each kg of muscle containing from 3 to 8 mmol of ATP.[8] This is characterized as a production system of immediate energy production for short-term actions (10 to 15 seconds) with high intensity that have phosphocreatine as a prominent substrate that is also characterized as a limited source.[7]

In soccer, moves such as sprint during counterattack situations, for example, highlight the anaerobic power. The maximum effort toward the goal or to intercept a move is notorious so that the anaerobic power becomes a very important variable during decisive moments of the match. Short accelerations are also highlighted in the anaerobic power and occur often during the game.

There is evidence that an athlete's performance decreases after a period of intense effort and the full recovery may take more than 5 minutes.[8]

After a maximum effort, the body attempts to restore the ATP that was depleted during the action. Fat and carbohydrates influence the reconstruction of phosphocreatine (phosphagen) and ATP resynthesis.[6,9] There is a quick demand for phosphagen restoration but for phosphocreatine, the pathway is slower (Table 1).

Table 1 Phosphocreatine recovery percentage after maximum effort.[6]

Phosphocreatine	Recovery
20 to 30 seconds	50 to 70%
2 minutes	85%
4 minutes	90%
8 minutes	97%

Plyometric training

Plyometric training is becoming prominent regarding the performance of athletes in sports. The use of this training method occurs in an efficient manner in relation to other training systems.[10]

Regarding soccer, there are few sources on the use of plyometric training. Basically, the work consists of stretching a muscle immediately before a rapid concentric contraction, named stretch-shortening cycle.[11]

The plyometric training aims the acquisition of explosive strength and uses jumping exercises to recruit motor abilities in a short time. Another important skill aimed is improve stretch-shortening cycle muscle action, using components of the muscle and tendon and the stretch reflex.[12,13]

In soccer, this type of training is often used with goalkeepers due to the training's specificity with the game. With outfield players, this training method is also important due to actions such as jumps and the need for power in the course of the match. There are several jump types used in the training. Directed to soccer, in-depth vertical jumps and exercises with a load of 40 to 60% have good results evaluated in countermovement and squat jumps.[12]

This training method seems to be a good option for athletes, but some precautions must be taken. The athlete's adaptation and improvement at the beginning of the training are factors that need to be considered. Variations in the methods also deserve attention and this fact depends on the athlete's current situation. It is thought that this type of exercise is extremely important for soccer as it aims for the explosive force of the lower limbs.

Sprint training

Sprint training is used to improve the explosive force of the lower limbs and, consequently, the anaerobic power in both elite adult athletes and young athletes.[14] This training is adaptable according to the physical trainer's objective, so that its intensity, volume and density can be altered according to the needs of the team and the athlete. A possible variation in sprint training is the use of purposes to encourage dispute and competition, thus allowing an athlete to reach its maximum during a training session.

Interval training (game situation)

The training must meet the game demands and the intensity must be equal to or greater than that of the match (respecting the basic principles). The model of game situation is indicated for preparation. Game situation is basically an interval training with the ball component directed to dispute and competition, decreasing the chances of the athlete not fully committing to the exercise.

This type of training directed to maximal anaerobic power must be a well-prepared strategy. Sprints with and without the ball occur in the training situation, thus improving this variable (interval training). However, it depends on the game rules imposed by the coach and physical trainer.[15]

A study compared the types of training with a ball in relation to external load using GPS. The studied training methods were: the adapted reduced field (30m x 20m) 4 vs. 4 with goalkeepers and without the ball going out of the field; the "German" (transitional) game of attack against defense; the mini-tournament with teams of seven or more players; the recreative game with dimensions of 60 m x 40 m; tactical work performed with 11 vs. 11 in whole field with interruptions; collective game 11 vs. 11 in whole field without interruptions with limited ball touches; ball possession work with 2 teams of 6 to 8 athletes without goalkeeper and training game. The results showed that the training game presents higher volumes of external load, followed by the mini-tournament and the German game (attack/defense transition).[16] Regarding anaerobic power, transitional training seems to be the one that better develops this variable due to the quick defense/attack exit.[17]

The complexity of physical capacities in soccer highlights the need for studies considering what disregards it. Every training occurs in order to let the athlete in his best form during the match. During a match, an athlete runs between 10 to 13km depending on his position. During most of this distance, the athlete is walking or trotting (40%) and remains still during 17%. In professional levels, an athlete performs an average of 1100 direction changes.[4] Sprints represent 11% of this distance. A sprint occurs every 90 seconds (on average) and, of them, 96% are performed over 15 meters or less and with 75 to 100% of the maximum speed,[2,11] so that there is a prevalence of anaerobic power.

The athletes' actions with the balls vary from 0.5 to 3% of the covered distance. In the second period, the actions tend to decrease up to 10% in relation to the first period. Inside the games, about 60 minutes include the ball rolling[4]. The actions of intense speed of an athlete vary from 18 to 27 km. Considering the distance covered in the field, forwards are the players that spend the most time in sprint, while full-backs spend most of the time with the ball. In recent years, VO_2 has been increasing due to improving recovery from high-speed actions (sprint).[18] The athlete's recovery after a high-intensity effort occurs in 72 seconds but, during the last 15 minutes of the match, this time can increase up to 28% (83 seconds). Therefore, more conditioned athletes endure these efforts better.[14]

In a work comparing the players' positions and the power during the RAST test in relation to the maximal power, full backs had the highest values followed by forwards (Figure 1).[19]

Fractioning the 90 minutes of the match, a study of the Premier League showed that, during high-speed runs (>19.8km/h) in a match, the actions decrease throughout the match due to the athletes' fatigue. The first 15 minutes of the match concentrate most of the intense moves. We can find some numbers referring to the position and actions (m) of the athletes in the game (Figure 2).[14]

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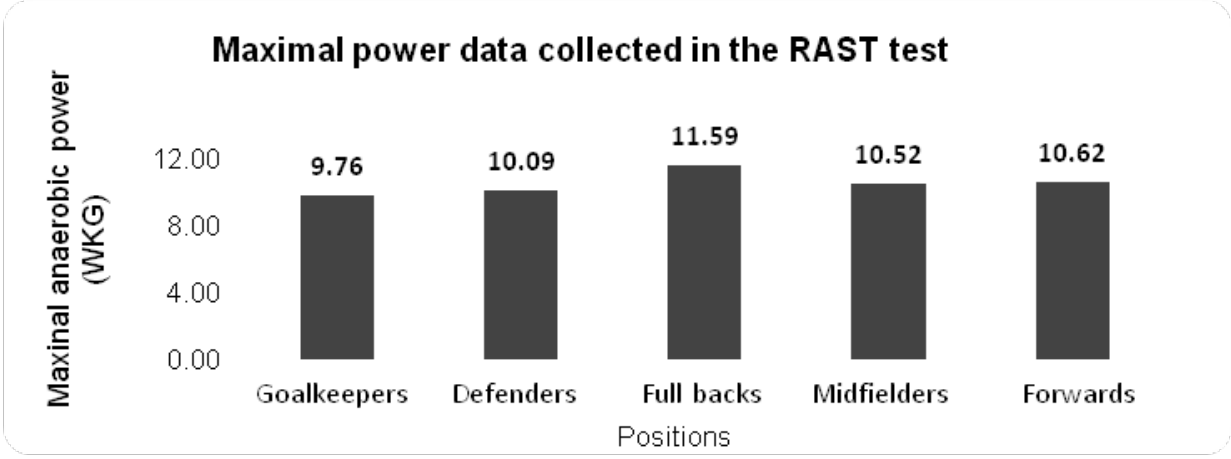

Figure 1 Maximal power data collected from the RAST test.[19]

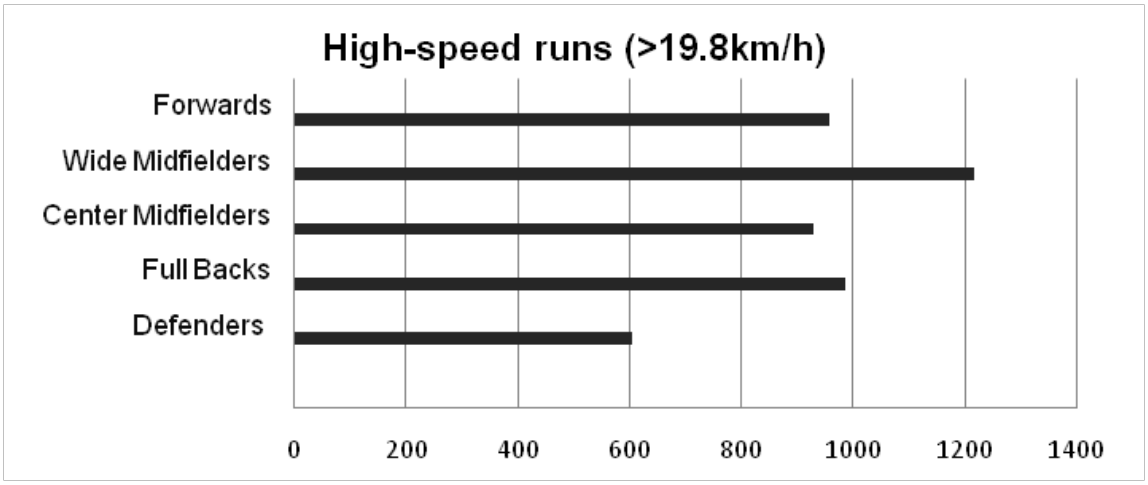

Figure 2 Analysis of high-intensity runs performed by players of the FA premier league soccer during a match.[16]

Literature review

Currently, there are few research studies on the maximal anaerobic power in soccer, although it is an extremely important variable for the performance and result of the match. Below there are the analyses of some studies regarding training methods.

To Buchheit High-intensity training (HIT) in soccer, including sessions with and without the ball. The study had a duration of 5 weeks with an athlete of the first-division league of Europe and showed that this training method improves the athlete's maximal sprint.[20]

Carling analyzed athletes during two seasons of the French Championship using a multi-camera computer tracking during observations of the match. Considering that part of the sprints (speed>19km/h) occurred with the ball, the specificity of the training becomes necessary.[21]

Impellizeri, in his study, highlights the importance of monitoring athletes during their training to control internal and external load, which can be measured indirectly using PSE. The adequate load for each athlete allows positive gains during the trainings.[22]

Ramírez-Campillo[23] compared bilateral and unilateral plyometric training in young athletes, which were divided into four groups. The first group received bilateral training, the second received unilateral training, the third received both and the fourth was the control group. They were evaluated in counter-movement jumps (unilateral and bilateral). The training was applied for 6 weeks, with two sessions per week. The results indicated that the combination of bilateral and unilateral training increased significantly the athletes' muscular power.[23]

Spineti et al.[24] compared the methods of traditional strength training with those of complex contrast training in sprint and other variables. They evaluated 22 soccer players during an eight-week period. The contrast training had high-power exercises together with high-speed exercises and the traditional training applied resisted exercises. The protocol of the contrast training was more adequate and presented several gains regarding sprint.[24]

Fanchini monitored 19 professional players in small games (reduced field): 3 versus 3 in three periods of 2, 4 and 6 minutes. Load monitoring was conducted through heart rate and PSE. Effort perception increased throughout the periods. The level remained high when the athletes completed their passes. Regarding anaerobic power, this training was not valid, showing improvements for anaerobic resistance (Table 2).[25]

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Table 2 Studies regarding training and monitoring

Author	Participants	Methodology	Conclusion
Buchheit et al.[14]	Players of the first division of a European league	Interval training with and without the ball	This training method improves sprints during the games
Carling[21]	Professional players of the French League.	Physical demands during soccer matches were monitored.	34% of the runs occur with the ball and surpass 19.8 km/h
Impellizzeri[22]	Literature review conceptualizing collective sports	Update article regarding monitoring of internal and external loads	Training methods must be varied, and the athlete's external and internal loads must be monitored to optimize the results.
Ramírez-Campillo et al.[23]	Young athletes (11.4±2.2 years old)	Comparison of combined plyometric training method (unilateral and bilateral) and bilateral and unilateral plyometric training separately.	The combined training method improved the players' muscular power levels.
Spineti et al.[24]	22 players (18.4± 0.4 years old)	Comparison of the complex contrast training method with the traditional strength method.	The contrast training improved significantly the sprint, jumps, speed and direction change of the athlete.
Fanchini et al.[25]	19 players (24±4 years old)	Training method of reduced field 3 versus 3, divided into 3 periods (2, 4, 6 minutes)	Training in reduced-field games does not lead to changes regarding anaerobic power but improves anaerobic resistance. This improvement was only found in games with successful passes.

Discussion

The studies showed that anaerobic power must be considered when a physical trainer elaborates the training, with some studies suggesting applied methods.

Markovic et al.[26] state that sprint training improves the athlete's performance in relation to the traditional plyometric training.[26] Villarreal shows that plyometric training together with sprint training is essential for the soccer athlete, improving the variable of maximal power.[27] For Buchheit, repeated sprint training once per week within the training program increases the athlete's fitness, improving the explosive strength and maximal power in soccer.[13]

In a study conducted with the four semifinalist teams of the World Cup 2010 showed that, in three of them, when the match had a positive result or the team were level, goals were marked by intense actions, mainly individual moves (running with the ball, dribbling) and by situations of transition from defense to attack where anaerobic power is highly used[28] and is trained in the model of game situation.

Dawson, after studies, states that a six-week training of repeated sprint increases part of the type II fibers, thus generating essential adaptations for the soccer athlete.[29] For Secco, plyometric training improves the muscular power of goalkeepers.[30] Haddad et al.[15] define that the player's chronological age and position affect the individual's speed[15] and that repeated sprint training is essential for an athlete's development.[31]

Conclusion

According to the authors mentioned in this review, during a soccer game, there are different variables that are important for the final score of the match, but the prominent players in a match may have a better influence in decisive situations (sprint, jumps, short accelerations). Therefore, training maximal anaerobic power is extremely important for this modality while still considering other variables. The training program must be well prepared, with adaptations of intensity, volume and density in the soccer training. Regarding maximal anaerobic power, it can be improved through training and neuromuscular adjustments.

For goalkeepers, plyometric training may be the most appropriate to improve this variable due to their demands during a soccer match. For outfield players, on the other hand, a mix of training methods seems to be more adequate, adapting the needs of the team. Training using the ball, thus being closer to the reality of the game, is a good strategy that increases competition and dispute during the training.

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Conflict of interest

The authors declare that there is no conflict of interest.

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