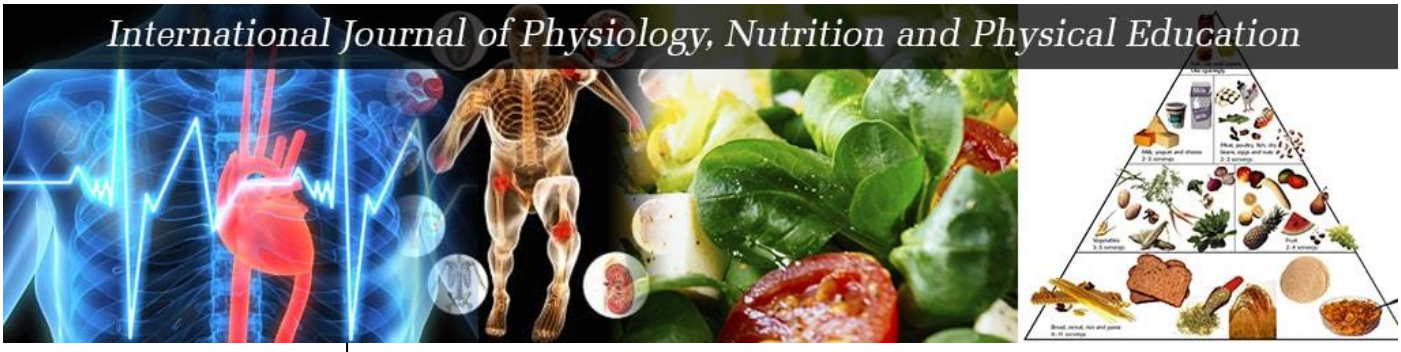

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Nutritional requirements in soccer players: A review

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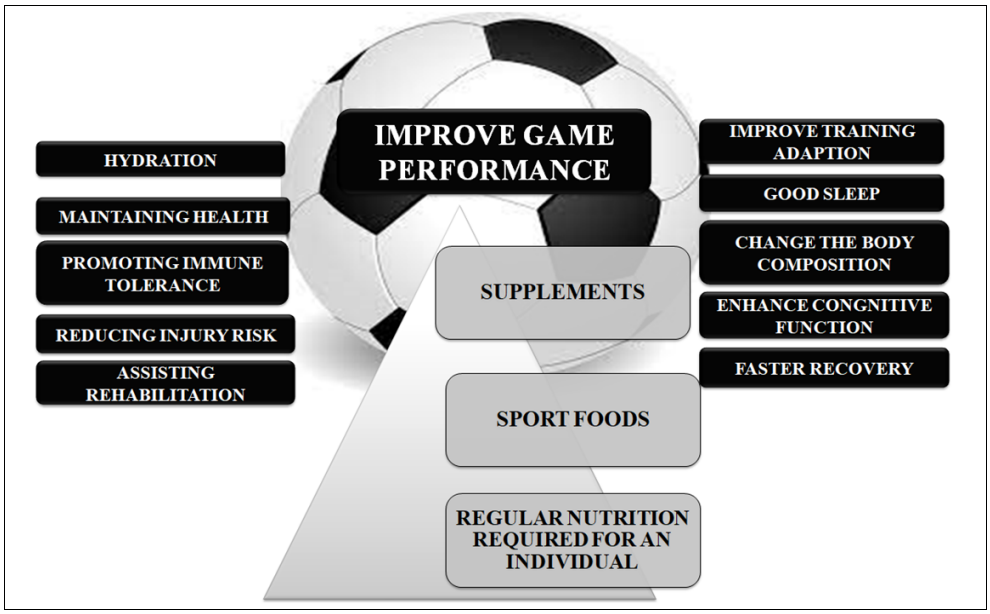
Abstract
Soccer, or football, is a very popular team sport that may be characterized as strength and power-contact sport that calls for hard training and competition. This review's objective is to critically evaluate the reported scientific literature that is now in the public domain and that relates to the energy needs of young people and professional soccer players, both male and female. The purpose of this study is to offer practitioners evidence-based dietary solutions to use in order to enhance soccer performance. Therefore, the focus of this examination is on the nutritional guidelines that athletes must adhere to in order to increase their high-intensity movements throughout the game.

Keywords: Nutrition, soccer, macronutrients, CHO (Carbohydrates), proteins, fats

Introduction
Football, often known as soccer, is a highly well-liked team activity that may be categorized as a strength and power-contact sport that requires intense practice and competitiveness [1]. Soccer games contain sporadic bursts of high-intensity running interspersed with periods of jogging and strolling, as well as recurrent physical contact [2]. Large distances travelled at sub-maximal aerobic levels, alternating with times of higher intensity, define the physiological burden placed on soccer players [3]. During a game, the football layers travel between 10 and 12 kilometers, with the midfielders travelling a little further than other positions [4, 5]. Depending on the positional role, roughly 1150 m of the entire distance travelled is covered at speeds over 20 km/h with about 60 sprints [6]. Players engage in more than 1200 unexpected changes in activity overall, including 30 to 40 leaps and tackles and about 700 rotations [7]. When compared to the first 15 minutes of the game, soccer players' distance travelled during high-intensity play is much less during the final 15 minutes [7]. Additionally, the participants experience a brief drop in physical output after the match play's most physically taxing 5 minutes [8]. Soccer players often run 3 to 7 km during practice, covering 100 to 600 m above 20 km/h and 50 to 400 m above 25 km/h, depending on the training day's proximity to the following game [9, 10, 11].

There aren't many studies that look at soccer players' eating habits and how they affect their performance. Soccer puts a lot of strain on the anaerobic and aerobic systems to operate at their best from an energy standpoint [12]. According to studies, the typical oxygen consumption is close to 70% of VO2max [13]. The majority of energy is produced by the aerobic energy system, and over 90% of match play is conducted at a low to moderate intensity. Jumping and other high-intensity sports like acceleration need the activation of anaerobic systems to produce energy [14]. It should be noted that the preceding five minutes of activity have a significant impact on these values. These high intensity actions lead to crucial match-play moments, such as straight-line sprinting during goal-scoring situations [15]. They also produce elevated levels of lactic acid, which are typically 2 to 12 mM during soccer matches. Since anaerobic glycolysis and carbohydrate (CHO) oxidation are the major energy sources, it has been discovered that muscle glycogen is depleted after match play to around 43% of pre-match levels and remains significantly lower up to and beyond 24 hours post-match [16]. As a result, soccer players must be ready to satisfy their energy needs from a training and dietary viewpoint.



Benefits of dietary supplements for soccer players

This review aims to critically analyze the reported available scientific literature that concerns about the energy requirements in case of professional soccer players, men and women as wellas young adults. The objective of this study is to provide evidence-based nutritional strategies for practitioners to implement in order to improve soccer performance. Consequently, this review focuses on the dietary practices that have to be followed by professionals to improve their high intensity actions during the match.

General Nutrition Principles

The soccer players require a specific nutritional strategy which should include energy, macronutrients (Carbohydrates, proteins and fats), vitamins, minerals and water. The professional male and female football players need an adequate energy supply from a wide variety of food sources for maintaining appropriate weight for their age. In case of children and young adults, they require energy for growth as well as for exercise, while older adults require focusing on nutrient-dense foods that provide less energy [17]. The football players need sufficient energy supply to support their daily training needs and for maintaining their body weight. The two factors that influence the daily energy consumption are the amount and quality of training. The soccer players are often considered as athletes who require training at moderate to high intensity, so their energy requirements has to compensate their expenditure [18]. Studies indicate that most of the athletes are in good energy balance within the limits of the techniques used for evaluating their performance and it is expected that the women players are to have a low body weight that is, with low body fat content [19].

It is mandatory that the players has to avoid skipping meals and are advised to eat regularly at the right time. This can give significant reduction in the opportunities for carbohydrate ingestion. Protein intake is also very vital along with the carbohydrate intake. Adequate amount of protein required for the training has to be attained from dairy products, meats, grains, and vegetables. The Recommended Daily Allowance (RDA) for protein is 0.8 g kg^{-1} per day. But, some studies proved that football players could benefit from intakes closer to 1.4 to 1. 7 g kg^{-1} per day. Players have to consume adequate amounts of fats too and it is advised that the players have to consume less than 30% of their total energy needs from fat sources [20]. But, it was found that the athletes have an urge to take more fat and so it was advised by the nutrition professionals that the players should not only reduce fat intake but also to reduce body fat.

Nutritional Requirements in Professionals

The specific athletic aims of each athlete reveal their unique energy requirements. As a result, estimating energy requirements should take into account a player's specific physical activity as well as their basic metabolic rate and diet-induced thermogenesis. This should be done in accordance with the player's personal goals, which will change over the course of the season, their career, as well as in response to unforeseen injuries and breaks in the training period.

The match-play intensity profile affects energy expenditure and the dietary approaches necessary to meet these energy needs. In comparison to the effect of genetic endowment, talent, training, motivation, and other factors, nutrition plays a little but crucial role in success [21]. However, a well-thought-out dietary plan that satisfies total energy expenditure requirements should maximise energy reserves, decrease tiredness, support training, attain and maintain appropriate body mass and physical condition, promote quick recovery, and provide enough hydration. This may have further connected advantages in addition to giving you a competitive edge. In order to give evidence-based recommendations for macronutrient and fluid consumption, this review will investigate and assess the nutritional needs and eating patterns of professional soccer players

Male Soccer Players

Nutritional requirements for males and women are different. Numerous dietary guidelines have observed distinct guidelines for each sex. A specialized dietary plan that includes calories, macronutrients (Carbohydrates, proteins, and fats), vitamins, minerals, and water is necessary for professional soccer players. Players need to be mindful of difficulties with their CHO intake in terms of amount, quality, and timing [22]. Given that endogenous CHO reserves are heavily used in soccer and that only enough CHO can be stored to endure for one day of intense training [23], the main requirement for players is to ingest adequate CHO-rich complex dietary sources. High-CHO diets have been shown to

optimize muscle glycogen, lower net glycogen depletion, postpone the onset of tiredness, and enhance soccer performance [24]. A continuous training load and intensity may be achieved with such a plan, and it will also make it easier to recuperate between games [25, 26]. According to the CHO guidelines for soccer players, between 60 and 70 percent (TDEI) [22] of daily caloric intake should come from CHO. In accordance with more detailed recommendations, soccer players should consume a high CHO diet from nutrient-rich complex CHO food sources that ranges from a minimum of 7 g/kg BM daily [27, 28] to 10 g/kg BM daily [29], and up to a maximum of 12 g/kg BM daily for intense training or maximum glycogen refueling [30]. Instead of simple CHO foods with refined sugars that aren't very nutrient-dense, the majority of CHO intake should come from nutrient-dense CHO-rich or complex foods [31].

Few studies have explicitly assessed the protein requirements of soccer players, despite the significant study on many aspects of protein consumption [32], although Packer *et al*. [33] found that trained men' daily protein requirements rose after a soccer match simulation. Other studies [34, 35] have indicated that these athletes generally consume enough quantities, occasionally at the price of CHO. Players should aim for a daily protein intake of between 1.3 and 1.75 g/kg BM, rising to 2.0 g/kg BM during periods of heavy training [36]. This is because being prematurely CHO deficient may increase the dependence on protein as an energy source. These suggestions are based on intakes of 0.25 to 0.40 g/kg/meal [37] and 0.55 g/kg/pre-sleep [38]. Players must pick lean meat, low-fat milk, and dairy products while making sure those meals are cooked with little additional fat because certain protein-rich foods are also high in saturated fat. In order to satisfy needs and provide diversity to the diet, additional sources of protein should also be taken, including vegetables, morning cereal, soy milk, nuts, seeds, tofu, legumes, and lentils [39]. Fish is generally regarded as the finest animal source of protein.

It was recommended for soccer players to take less than 30% of their TDEI from fat, with 7% coming from saturated fat, 10% from polyunsaturated fats, and 13% coming from monounsaturated fats [22]. Omega-3-rich foods, such as oily fish like salmon, mackerel, and sardines, may also help to lessen inflammation after exercise and delayed onset muscle pain [40]. Even the leanest players will have enough fat accessible as an energy source during activity, so while this may be a valuable supplement to the diet, players should concentrate on meeting acceptable protein and CHO daily requirements.

Within an hour of kickoff, a pre-game snack containing a modest quantity of CHO that is quickly digested and absorbed, such as dried fruit or CHO energy bars [31], may help preserve liver and muscle glycogen and sustain blood glucose [41]. The higher the dependence on liquid-form CHO, such as fruit smoothies, yoghurt drinks, fresh or canned fruit, or sports drinks [42], the closer the time of CHO consumption is to kick-off.

The halftime break is the player's greatest chance to replace some of the fluid and CHO they have lost throughout the game. In this regard, consuming an isotonic sports drink that has been properly designed and contains 6-8% CHO [43, 44] or CHO supplementation at a rate of 30-60 g/h is the most efficient and practical approach to consume a mix of fluids, CHO, and electrolytes. This choice of intake is quickly digested and absorbed, aids in maintaining hydration status, offers substrate to postpone exhaustion, and preserves skill and cognitive function, minimizing deteriorating performance near the end of a match. Other sources might include fruit juices that have been diluted, high-CHO energy snacks, fruit, water, and gels. However, they are less advised because they have been linked to gastrointestinal problems unless the athletes have expressly trained their stomach to be accustomed to this tactic [45]. Due to the significant increases in energy needs associated with extended exercise lasting more than one hour, Smith *et al*. [46] emphasized the significance of isotonic hydration. By encouraging glycogen storage, this supplementation has been found to enable the maintenance of energy during the full session.

A high GI CHO source, such as a portion of fresh fruit or juice, morning cereal, oats, or CHO-based sports nutritional supplements in solid or liquid form, should make up the majority of the nutrients consumed after exercise [31]. Increasing muscle protein synthesis for training adaptation and the healing of injured muscle is one of the additional benefits of including a protein dosage. Depending on the quality of the protein and the athlete's age, the recommended protein intake to maximize increase muscle protein synthesis is estimated to be at least 20-25 g or 0.3 g/kg BM [47]. However, some people may consume as much as 40 g of protein (For a more detailed review of these factors, readers are referred to the paper by Phillips *et al*.) [48]. Nedelec *et al*. [49] recommended timely co-ingestion of foods with a CHO to PRO ratio of around 3:1, such as flavor-enhanced milk and chicken, honey, and peanut butter sandwiches. When the main objective is recuperation and refueling, a post-match meal taken within 4 hours after the final whistle should consist of a low-fat PRO source, such as chicken, mixed with potatoes and vegetables to fulfill suggested co-ingestion ratios [50, 49].

Table 1: Recommended intakes for certain macronutrients in various circumstances for male soccer players.

Situation	Recommendations
Daily Requirements	CHO: 5 to 10 g/kg/day
	Protein: 1.2 to 2.0 g/kg/day
Pre-training and matches	CHO: 1 to 4 g/kg
	Protein: 0.25 to 0.4 g/kg
After training	CHO: 1.0 to 1.2 g /kg/h
	Protein: 0.25 to 0.4 g/kg
	Hydration: ingest 125-150% of fluid lost.
During Competition	CHO: 30 to 60 g/h or small amounts
After Competition	CHO: 1 to 1.2 g/kg/h OR 0.8 g/kg
	Protein: 0.4 g /kg/h

Female Soccer Players

Women have frequently been neglected in this sport since men significantly dominate it. Few researches on the dietary needs of football players have included women. The diets of and nutritional advice for female soccer players have not been the subject of much investigation. It is important to note that women may have lower energy requirements owing to their lower body weight and less rigorous exercise [51]. The following are suggestions for female soccer players with regard to their energy requirements:

- The energy demands should be assessed using equipment with high measurement precision.
- The energy intake should be periodized with training macro- and micro-cycles, individually tuned with exercise intensity, and targeted at each and every training session.
- The calorie intake should be coordinated with the ideal lean body mass and low fat percentage for the player's physical condition.

- The energy value of the diet shouldn't be less than 30 kcal/kg of fat-free mass/day to avoid the harmful effects of low energy availability on health and performance.

A sufficient quantity of CHO consumption is seldom attained despite several recommendations. In a study group of 16 women, Martin *et al*. found that the average daily intake of CHO was 4.1 1.0 g/kg body mass [52]. In a sample of female U-21 soccer players, Mullinix *et al*. noted intake at a somewhat higher level: 4.7 g/kg body mass/day [53]. In a group of female soccer players, Clark *et al*. likewise found similar results (4.3 1.2 g/kg body mass/day) after the football season; however, when the study was done before the commencement of the season, the acquired results were higher (5.2 1.1 g/kg body mass/day) [54]. Gibson *et al*. found 5 1.6 g/kg body mass/day of intake [55]. Female soccer players consumed 3.28 1.2 g/kg body mass/day of carbohydrates, according to our own study [56]. According to the literature, inadequacy or intake that is below what is advised has thusly frequently been seen. Poor energy levels in the diet may be the cause of low CHO intake. However, insufficient glycogen resynthesis is very definitely responsible for failing to fulfill the minimum CHO suggested consumption.

Protein should be consumed around exercise at the proper times, much like carbs. The time following training is when particular demands are most prevalent. Protein controls muscle protein synthesis and prevents protein breakdown as a stimulator of regeneration processes. Studies have demonstrated that consuming 20 g of protein or 9 g of EEA during and up to 2 hours after exercise enhances the process of muscle protein synthesis [57]. Additionally, Levenhagen *et al* research's shown that having a meal right after engaging in physical exercise has stronger restorative benefits than eating the same meal three hours later [58]. Therefore, consuming protein immediately following exercise is essential for healing processes. Additionally, the post-exercise consumption of protein (0.2-0.4 g/kg body mass/h) and carbs (0.8 g/kg body mass/h) sped up the resynthesis of glycogen. When the post-workout supply of carbohydrates surpassed a level of 1.2 g/kg body mass/h, these connections, however, were not seen [57]. To improve muscular response to exercise, it is advised to eat 0.3 g of protein per kilogram of body mass after significant training sessions and then every 3-5 hours in the form of many meals [59]. Unfortunately, the majority of research on post-workout muscle regeneration and the impact of protein supplementation on muscular strength has been done in connection to resistance training, and there are relatively few studies that focus on team sports. We are unaware of any research that has been done on female football teams.

Aside from serving as an extra energy source, fats are also a vital component of cell walls and a source of fat-soluble vitamins, such as vitamin D, one of the nutrients of special relevance. Despite the fact that fat plays a significant function in the human body, proteins and carbohydrates are far more vital in an athlete's diet; thus, female football players should first meet the demands of these macronutrients, with fats serving as a supplement to the food's energy content.

Table 2: Recommended intakes for certain macronutrients in various circumstances for female soccer players.

Situation	Recommendations
Daily Requirements	CHO:
	5 to 7 g CHO/ kg body mass/ day
	7 to 12 g CHO/kg body mass/day
	Protein:
	1.2 to 1.7 g/kg body mass/day
	20 to 40 g of proteins
Before training	CHO:
	1 to 4 g CHO/kg body mass 10 to 12 g CHO/kg body mass/day
During training	CHO:
	30 g CHO/h for training lasting 1 to 2 hours.
After Training	CHO:
	1 to 1.2 g CHO/kg body mass/h
	Protein:
	20 g of proteins
	0.3 g of proteins/kg body mass

Nutritional Requirements in Young Adults

Finding the physical, physiological, and psychological characteristics that may be useful in the early identification of outstanding soccer players has recently attracted a lot of attention in the literature [61, 62]. However, as is true for male teenage athletes in general, there is limited evidence available on the nutritional status and eating habits of adolescent soccer players [63, 64]. It is generally established that healthy eating habits and regular exercise are essential for adolescent development and growth, as well as for maintaining both immediate and long-term excellent health. Adolescence has the highest energy and food requirements of any other stage of life [65, 66]. Due to the increased demands of training and competition, adolescent athletes have unique nutritional needs. As a result, individuals who routinely exercise will need optimal nutrition and dietary intake considerably more than other adolescents.

The young soccer players has to consume the following food groups: cereals and derivatives; meat, fish, and eggs; milk and dairy products; biscuits and confectionery; and oil, butter, and margarine, which contribute 78% of the total daily energy intake, 85% of the proteins, 64% of the carbohydrates, 90% of the lipids, 90% of the saturated fats, and 47% of the fiber. An additional 47 percent of fiber has to be obtained from vegetables, fruit, natural fruit juices, legumes, and nuts; however, only 11 percent of total energy was obtained from these sources. When compared to the Dietary Reference Intakes for Vitamins and Minerals, the average daily consumption of micronutrients (Food and Nutrition Board, 2002). With the exception of folate, vitamin E, calcium, magnesium, and zinc, all vitamins and minerals were above guidelines. None of the soccer players in this study acknowledged using dietary supplements during the time when their meals were being recorded. However, 76% of them reported to occasionally taking vitamin, mineral, or vitamin-mineral supplements, particularly iron supplements

(64% of people), either on the recommendation of a doctor (72%), at their own will (16%), or for both of these reasons (12 percent) [67].

Adolescent endurance athletes, particularly females, who have a higher need for iron during times of fast growth, are concerned about an iron shortage. More iron must be consumed throughout adolescence than at any other period in life due to the growing hemoglobin mass (About 1.5 times that of adults) [67, 68]. The lethargy and poor performance of young athletes may be caused by underlying iron deficits, which coaches should be aware of. However, it should be understood that lowered biochemical levels, primarily in the serum ferritin, may not always indicate anemia [69].

Although further study is required to ascertain the precise nutritional needs and recommendations for teenage soccer players, high-level adolescent soccer players who live in their homes do not adhere to the dietary guidelines for age and physical activity. Adolescent soccer players were evaluated during a training session had dietary consumption that was more in line with current recommendations than those who lived at home. The nutritional status and eating habits of teenage athletes must thus be understood in the context of typical situations, and proper evaluation should be encouraged. This knowledge is helpful for developing nutrition education programs that may be very interesting for these teenagers, in order to maximize performance and especially to encourage good eating habits, taking into consideration the fact that only a small percentage of high-level adolescent athletes achieve the top adult level.

Future researches with children are unlikely to involve muscle biopsies or other invasive procedures due to ethical concerns. Therefore, non-invasive techniques for studying energy metabolism in the exercising youngster should be developed. Young soccer players, especially those competing at the highest levels, may play in as many as 150 games year. To find the best meals to meet their high nutritional demands and support performance and recuperation, research is required. The effectiveness and safety (short- and long-term) of carbohydrate loading should get special consideration. Techniques for estimating the energy consumption during youth soccer matches and practice sessions should be created and improved [70].

Conclusion

In terms of nutrition, athletes don't have to be perfect academics. However, their performance and general health will improve the better fuel they ingest. Protein helps in the construction and repair of muscular tissues as well as in strengthening the immune system, whereas carbohydrates provide the brain and working muscles with the much-needed fuel they require. Fat supplies vital fatty acids and aids in the absorption of vitamins that are fat-soluble. Players should try to include the following on their meals, even if calorie demands differ based on age, gender, size, and degree of activity:

- 1/4 grains
- 1/4 protein
- 1/2 vegetables and fruit (Encourage regular vitamin, mineral, and antioxidant intake with a spectrum of hues.)

Future studies should look into whether these suggestions hold true for female soccer players and younger soccer players, as they may have different dietary requirements. Although these suggestions appear to be the most current and pertinent, it is important to keep in mind that nutrition is a science that is always changing. Future study will likely reinforce some of the techniques that are now in use, disregard others, and bring new and improved nutritional approaches. The optimization of soccer performance will undoubtedly be impacted by all of those in the desired and significant ways.

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Highlights

- This review's objective is to critically evaluate the reported scientific literature that is now in the public domain and relates to the energy needs of young people and professional soccer players, both male and female.
- The purpose of this study is to offer practitioners evidence-based dietary solutions to use to enhance soccer performance.

Therefore, this examination focuses on the nutritional guidelines that athletes must adhere to to increase their high-intensity movements throughout the game.

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