



PRACTICAL CONSIDERATIONS IN ELITE FOOTBALL

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KEY POINTS

- The diet for football must first meet the energy needs of day-to-day training. Carbohydrate intake should be prioritized to ensure players have appropriate energy for intense training and match performances. Protein-based recovery strategies allow players muscles to adapt to the training stimulus.
- Match days regularly provide the greatest challenge. Players need to practice strategies in training before adopting in competition. With congested fixture schedules, post-match recovery is vital and some innovation is required to meet nutrient targets whilst in transit.
- The physique of a footballer can influence performance. Maintaining body fat and muscle mass within an optimal range can preserve power to mass ratio, allowing for more efficient movement during training and matches.
- Appropriate use of sports nutrition products to meet fuelling and recovery needs should be governed by a robust sports nutrition policy.
- Ongoing education is an integral part of the sports nutrition service. This should consist of face-to-face work with players, coaches and other educational touch points to create the nutritional culture at the club.

INTRODUCTION

Nutrition plays an important part in maintaining players' health and positively affecting performance. At the elite level, top professionals can play up to 50 games a season, which for some, includes substantial worldwide travel for Champions League or national team fixtures. Elite players will typically play 1-2 games a week. Thus, training cycles are carefully periodised to stress energy systems and maintain fitness levels, whilst preventing accumulation of fatigue, which could lead to an increased risk of illness and injury (Dupont et al., 2010; Carling et al., 2012).

Football is an intermittent sport, with elite players performing low-intensity movements for more than 70% of the game, interspersed with approximately 150-250 intense actions (Rampinini et al., 2007). Elite players can cover distances up to but rarely exceeding 13 km in a competitive match (Mohr et al., 2003). Both anaerobic and aerobic energy systems are heavily utilized, with an overall energy cost of approximately 2,000 kcal during a match depending on individual body composition and distance covered (Bangsbo, 2014; Bangsbo et al., 2006). Interestingly, the last five seasons have seen an increase in distance covered at high-intensity during Champions League matches. Furthermore, of note, is that the Champions League has resulted in a greater incidence of fixture congestion and consequently a higher rate of muscle injury (Bengtsson et al., 2014).

Due to the unique physical demands of football, carbohydrate stores (liver and muscle glycogen) are the most important for energy production. Appropriate carbohydrate intake before, during and after exercise ensures players have appropriate energy for training and matches. Consistent recovery strategies allow players' muscles to recover quickly in the hours post-exercise and adapt to the training stimulus longer term. Food and fluid intake at the right timing can

improve player "robustness" decreasing the risk of illness and injury. During periods of fixture congestion, players with limited recovery time are at risk of not fully restoring various physiological parameters affected by match play, such as muscle glycogen content, sarcoplasmic reticulum function and maximal voluntary contraction force (Krustrup et al., 2011). This will ultimately limit the players' ability to sprint, jump and perform repeated intense exercise (Yo-Yo intermittent recovery test level 2) (Rollo et al., 2014a). During mid-season, the strain of domestic and international matches with travel can reduce recovery time and negatively impact the players' "readiness to perform." This is where nutrition strategies need to be integrated with other recovery modalities to have a pivotal role in muscular recovery and must take into account the stresses of training and competition. Thus, the sports nutritionist or sports dietitian has a varied role working within professional football. Understanding the key scientific principles helps to deliver nutrition support in team sports. However, understanding the cultural landscape of football is of utmost importance if the nutritionist is to ultimately impact on behaviour change and performance.

Fundamentally, the nutritionist determines the overall sports nutrition philosophy at the club, which supports the club's training and performance outcomes. From a team perspective, nutrition strategy encompasses match/training day preparation/recovery, hydration, body composition, travel, food service and supplementation. On an individual level the sports nutritionist consults with players, working to shape their diet to support their health and performance. Primarily, this involves educating and up-skilling players to understand the science behind their dietary strategies (e.g., timing, type and quantity of food). As part of the ongoing support with players, effective monitoring of outcomes of dietary status is crucial. This is because any ongoing issues in these areas, i.e., nutrient status, recovery, body

composition and hydration can negatively impact a player's training adaptation or match performance. To this end, the following article will aim to provide an insight into how sports nutrition is implemented to improve football performance through the lens of practitioners working in the professional game.

CHALLENGES

At the elite level, football squads are commonly composed of players from many different countries. Players from different countries have their own tastes and cultural beliefs regarding food. These need to be taken into account when planning food service and servings for the team. This may mean using innovative ways for players to achieve nutrient targets to support player health and performance. Ramadan is an example of when Muslim players' training diets will change. During this holy month, players will avoid food and fluid during daylight hours (Drust et al., 2012). Planning is therefore important for the rest of the day to help achieve nutrient intake targets.

At a more strategic level, nutrition will only have greatest impact on performance if integrated with the multidisciplinary support team at a club. This team will include coaches, fitness coaches, doctors, physiologists, physiotherapists, masseurs and psychologists. It is vital that staff understand nutrition policies and strategies at clubs, so that they can reinforce key messages and incorporate nutritional strategies into their day-to-day practice. An example of this is a physiotherapist understanding when to engage nutrition support during a long-term injury, such as during various phases of rehabilitation.

THE TRAINING DIET

For an elite footballer, nutrition is fundamentally important to provide energy to meet the challenges of high-intensity, intermittent exercise. At the elite level, the athletic demands on players are greater than ever before, due to the increased high-intensity work (Mohr et al., 2005). This, combined with the total volume of matches in a season, results in recovery nutrition taking on prime importance. The training diet consists of several key components to support both health and performance of a player. The first consideration should be that players consume enough energy to meet daily energy expenditure from training and matches (Ciarke et al., 2005). Daily energy expenditure for an elite footballer will depend on the time of the season, single or double session training days and number of matches in a week. There are large changes in expenditure depending on the type of training (e.g., hard day consisting of field-based training session and resistance training vs. an indoor recovery session) (Bangsbo, 1994). Players must balance overall energy (calorie) intake to stay in energy balance, whilst reaching key macronutrient targets, discussed below.

Carbohydrate is the backbone of a player's training diet and the dietary intake should always be sufficient to ensure adequate muscle glycogen stores to support training. Practitioners often modify the intake of carbohydrate to match the demands of training and matches. Dietary strategies should assess the training volume

and match the player's needs to the metabolic costs associated. It is interesting to note that guidelines concerning carbohydrate intake for intensive training days are between 7-10 g of carbohydrate/kg of the player's body mass (Rollo, 2014b; Williams & Serratos, 2006). In practice, the intake of carbohydrate by professional players is often noted to be at the lower end of this spectrum. The timing of carbohydrate is particularly important to provide the metabolic fuel for training performance. Breakfast and post-training recovery (snacks and lunch) are prioritized for carbohydrate based intake, to restore liver and muscle glycogen pre and post training, respectively (Ivy et al., 1988; Burke et al., 1996). The composition of the evening meal will be determined by the following days planned activity. For a routine training day, the carbohydrate content of the evening meal is typically reduced, which may have important implications for weight management, especially when training volume or intensity is low. Immediately following training, the use of higher glycemic index carbohydrates is preferable, at a time when the muscle is primed to absorb glucose and store it as glycogen (Burke et al., 1993). Fluids and smaller snacks are commonly used here, often in combination with a high-quality source of protein.

Consistent with other sports, protein ingestion has become more important to a footballer's training diet in recent years. Football has varied training demands ranging from endurance to strength and power-based training. At the elite level, an increased emphasis is placed on strength and power development. Research in this area has also highlighted the feeding pattern of protein, which is important to promote a positive muscle protein balance (McGlory et al., 2013). Adequate protein intake can easily be achieved by including servings of protein in regular meals and snacks throughout the day (lean meat, eggs, fish, etc.) which provides the player with approximately 1.6 g of protein/kg/BM/day.

It is important to note that the intake of protein should reflect the training stimulus. For example, a recovery snack/drink is advised following intensive, prolonged or resistance exercise. Protein intake is advised immediately after training to provide a source of amino acids for growth and repair. In particular, leucine appears to be an important amino acid to trigger muscle protein synthesis and adaptation (Koopman et al., 2005). Current research suggests that 20-25 g protein is required in the "recovery" meal or beverage (Moore et al., 2009). For field based training, this is often in the form of a carbohydrate/protein drink, so that carbohydrate needs can begin to be met simultaneously (Res, 2014). In a practical sense, combining both carbohydrate and protein immediately post-training is an easy strategy for players at all levels. Good options include milk-based drinks, fruit smoothies, cereals with low-fat yogurt or milk and sandwiches with lean meat. Finally, players may also benefit from ingesting a high-quality protein source prior to sleep to promote a positive net protein balance overnight (Res et al., 2012).

Dietary fat is often overlooked but also has an important role in a player's diet. Fats are an important component of cell membranes

(including the brain) and are vital to absorb fat-soluble vitamins A, D, E and K. Timing of fat intake is not believed to be as sensitive to football performance as carbohydrate and protein. Furthermore, there is no evidence to suggest that ingesting fat prior to exercise has any performance implications. Nevertheless, players are reminded that the ingestion of monounsaturated and polyunsaturated fats is associated with positive health benefits, whilst reducing saturated and trans fats is encouraged (Jouris et al., 2011). Strategies to obtain the right balance of dietary fats include eating oily fish three times a week, cooking using plant based oils and eating lean cuts of meat and low fat dairy products.

BODY COMPOSITION

Body composition within football mainly consists of monitoring body fat and muscle mass. Maintaining a body fat within an optimal range can preserve power to mass ratio, allowing for more efficient movement during training and matches. Research has highlighted that the typical body fat percentage of elite players can range between 7% and 19% (Wittich et al., 2001; Reilly et al., 2009). However, measurements also taken via DEXA suggest that professional players can have body fat percentages as low as 6% in isolated cases. It is well documented that there are position-specific differences in body composition, with goalkeepers consistently maintaining a higher body fat. Research also suggests significantly lower body fat in non-Caucasian players (Sutton et al., 2009). It is useful for practitioners and coaches to provide target zones for body composition for players to maintain an optimal physique. However, the sports nutritionist needs to ensure that these targets are individualised, as there may be large variation in what is possible to achieve without negatively affecting energy availability for growth and repair. Differences in individual players' genetic makeup may result in some players being able to consistently maintain a low body fat percentage without an increased risk of illness and injury. For others constant dietary and training manipulation are required to maintain an optimal physique. Of note, the measurements of muscle mass are becoming a critical marker for the sports nutritionist. This is because inappropriate training loads can result in undesirable changes in physique, for example, excess increases in upper body muscle mass may not have functional benefit for performance. In elite players, body composition is monitored at regular intervals during the season. Seasonal trends reflect an increase in body fat levels during the offseason, which are then reduced during the preseason, when training volume is highest (Carling & Orhan, 2010). Lean (muscle) mass is also reduced during heavy training volumes in some players.

Methods of assessing body composition will differ greatly depending on the club and the resources at its disposal. Consistent standardization protocols and the correct training (e.g., ISAK Kinanthropometry accreditation) are essential to reliably monitor and assess meaningful change. A recent position statement published in 2012 under the auspices of the IOC Medical Commission provides

a balanced guide for practitioners working in football (Ackland et al., 2012). Anthropometry provides a reliable in the field measurement allowing the practitioner to measure skinfold and muscle girths. Existing reference ranges exist across a number of sports. Although education of players and coaches is required when feeding back data as a “sum of 8” as opposed to a body fat percentage, which is often preferred. Dual-Energy X-Ray Absorptometry (DXA) is now commonly used at elite clubs. DXA provides an accurate assessment of fat mass, bone mineral content and lean mass. The popularity of DXA is most likely due to scans being relatively quick and easy to perform, whilst providing precise and attractive data feedback to players. It is important to note that DXA also has limitations. The error in DXA measurement of fat mass and muscle mass is approximately 1 kg. As a consequence, small differences of interest to the practitioner and player during routine monitoring are difficult to detect (Clarys et al., 2010; Nana et al., 2014). Thus, despite adhering to strict standardization procedures, errors will be present independent of method used. Therefore, all body composition results need to be interpreted with care.

In elite clubs, assessment of a player's optimal body composition is a collaborative effort between the fitness coach, player and sports nutritionist. Objective functional training data can help identify the most effective body composition for each player. Body composition also impacts the subjective feelings of a player, which can also contribute to his or her general level of performance. The practitioner should set a clear monitoring framework over the course of the season before determining the frequency of measurements. Measurements of the whole squad (often referred to as “screening”) should be conducted at regular intervals at key points of the season. In general, there are four key screening time points: start of preseason, end of preseason, mid-season Dec/Jan during heavy match volumes and season end. This screening data can help to provide important team trends in body composition (e.g., reductions in body fat during preseason), which can provide important feedback to coaches. These screenings can also highlight individuals that who fall outside of an acceptable range (too high/low body fat or muscle mass) and require dietary intervention and more frequent monitoring. In the field, the importance of regular weighing of players should not be overlooked (conducted in controlled conditions, e.g., minimal clothing, pre-training, euhydrated) as this can provide a “first line” of non-invasive monitoring. Often acute changes in body mass also highlight another problem. For example, a reduction in body mass may also coincide with reduced training performance and other subjective assessments of fatigue. Interestingly, weighing from or with a coach (working with the sports nutritionist) can also reinforce the importance of physical preparation to the squad. In summary, the use of body composition data can be a powerful tool for the sports science team. Feedback should be given to individual players whilst considering maturation and weight history. This can be a valuable tool to shape the training diet alongside overall training volume. Visual representation of the data is also recommended to

help to inform coaches. Finally, practitioners should be aware of body image issues within football and consider how sensitive information is shared with coaches and players.

SPORTS NUTRITION

Sports nutrition products are always a “hot topic” as clubs and players look to nutrition to gain performance advantages. Historically, sports drinks were the primary products, commonly used to meet carbohydrate, fluid and electrolyte requirements during matches and training sessions. More recently sports gels have become popular as a tool to top up blood glucose pre-match or at half-time, due to ease of use. Liquid meals in the form of recovery drinks now form a convenient way of meeting carbohydrate, protein and fluid replacement target post-training. Ergogenic aids with sufficient peer review evidence can also have a place (e.g., caffeine, creatine monohydrate) but prescribed on an individual basis (Morton, 2014; Balsom et al., 1995; Burke, 2008).

SUPPLEMENTATION

Micronutrient supplementation can form an important strategy when there is a known deficiency (e.g., iron, vitamin D) or at times when there is an extra physiological requirement (e.g., injury rehabilitation, long-haul travel). Within elite clubs, all supplement use should be governed by a robust sports nutrition policy to achieve the following aims:

- Evaluate potential supplements for health or performance benefit for the player.
- Conduct Quality Assurance (QA) on sports nutrition companies and products to reduce the potential risk of inadvertent doping.
- Develop protocols for product use in performance, recovery and health settings.

Inadvertent doping is a very real risk within sports with a recent survey highlighted that from the 114 products tested, 10% were found to be contaminated with banned substances (Russell et al., 2013). Considering the international makeup of elite clubs, there are many influences and beliefs on supplementation. Furthermore, players originating from different regions in the world may be at a greater risk of inadvertent doping (Guddat et al., 2012). Having a rigorous and progressive policy structure in place can provide players with the confidence that any recommended supplementation can safely support their health and performance. Importantly, practitioners should work to ensure that the players have an understanding of why they may need supplementation and this should be reviewed periodically.

MATCH DAY PREPARATION

Measures to increase muscle and liver glycogen stores start in the 24-48 h before kick-off. Getting this strategy right on the day of the match is also vital. General recommendations for elite players are to consume 1-4 g of carbohydrate/ kg BM in the 6 h before kick-off to optimize fuel stores (Williams & Serratos, 2006). In recent years, kick-off times have changed in conjunction with the growing

commercialization of the sport. For example, there are now more lunchtime and evening fixtures, which take planning to ensure that meals are provided at the appropriate times. Pre-match feeding should also ensure players are comfortable, having eaten foods that they are used to, so as not to cause gastrointestinal (GI) distress. To form a match day strategy, players should work backward from kickoff to plan meal times. For example, a traditional 3:00 pm kick-off will include a breakfast and pre-match lunch. For a lunchtime kickoff (e.g., 12:45 pm), breakfast will be the only pre-match meal. To this end, individual work with players is important in training to help refine and build confidence in match day strategies.

Hydration is another key element when preparing for a match. Just like carbohydrate intake for elite players this starts the day before, replacing fluid losses from the previous training session, to begin the match day in a hydrated state. This is where monitoring of individuals' hydration status using urine osmolality and body mass can help to guide players' hydration strategies. Appropriate hydration takes on extra importance for fixtures in warm environments i.e., major tournaments, early season fixtures (Laitano et al., 2014). As a basic hydration strategy, players should ensure they drink 5-7 ml/ kg BM 2-3 h prior to exercise to allow excess fluid to be passed as urine before kickoff. Another small bolus at the end of the warm-up (15 min before kick-off) is recommended to replace sweat losses during this period. During a match, as muscle glycogen stores become depleted and fluid lost as sweat, the 15-min halftime break can be crucial to replenish losses. Sports drinks can provide a convenient way to ingest both fluid and carbohydrate. Players should be careful to ensure that any snack is small and is high-glycemic to avoid gastrointestinal distress during the halftime period. Opportunities to refuel or rehydrate during the match are limited. There are a number of factors, including sponsorship rights that make it necessary to plan the use of carbohydrate-based products in advance.

Following the match, alongside the “recovery nutrients” (carbohydrate and protein), players should aim to drink 1.2-1.5 L of fluid for each kg of weight lost during the match/training (Shirreffs et al., 1996). Recovery drinks are often prominent for the first phase of recovery immediately post-match. In practice, this is also a time when other interventions may be considered to speed recovery. For example, it may be prudent to use antioxidant foods and products during periods of fixture congestion or limited recovery (Howatson et al., 2010; Howatson et al., 2012).

Recovery stations are then a good option to provide recovery foods post-match as players will either travel in cars home from a home game or on the team bus for away matches. Again, timing needs to be agreed with the coach on how this is set up. A buffet providing players with options of food containing carbohydrate/protein is a common strategy. This occasion also offers a time for food innovation, for example, introducing a reward element post-match. This can be achieved by making healthy variations on popular foods or having different international themes for player engagement.

Nevertheless, care should be taken on the messaging here as not to deviate too far from the overall nutrition philosophy and condone substandard nutrition practices.

International fixtures possibly provide the greatest recovery challenge. For example, for a team playing in the English Premier League and Champions League, it is not unusual to play a 7:45 pm kick-off in Europe on Wednesday, followed by a 12:45 pm kick-off on Saturday. National players are also expected to travel to international fixtures and return “ready” to play in their domestic league. Under these circumstances, nutritional strategies around travel and sleep take on extra importance. A consequence of late travel/games can be sleep deprivation, which may impair the cognitive function/decision-making of the player. These elements would have a clear impact on players’ performance and thus are of prime importance to practitioners and coaches. Thus, the timing of meals when travelling should also be planned in context of trying to promote good sleep patterns in players (Juliff et al., 2014).

EDUCATION

Ongoing education is an integral part of the sports nutrition service at most top football clubs. Creating a culture to promote good nutrition is vital in this process. Aside from face-to-face contact with the sports nutritionist, other “touch-points” around the training ground are vital to up-skill the players and coaching staff, such as visual displays in the changing rooms, gym and restaurant. The environment should also be shaped to “nudge” players to make better informed decisions around their nutrition – this includes the “flow” of the restaurant and availability of labelled sports nutrition products.

Interventions with players need to be considered carefully, appreciating how best to interact and give feedback to players. Regular contact with players allows interventions to be “drip-fed” with action points over a series of weeks to shape and reinforce behavior. At times the practitioner will need to motivate and influence the player as part of an ongoing program of work.

Working as part of a multidisciplinary team is crucial for the impact of a sports nutritionist in elite football. Collaboration with other practitioners within the club is also another way to strengthen a strategy or intervention. For example, a fitness coach, physiotherapist or performance manager may coordinate a player’s overall program so nutrition action points are often best delivered (and reinforced) by them (Medina et al., 2014). Primarily understanding the coaching beliefs and guiding philosophy are paramount when working in a club. Thus, a practitioner’s work plan should be shaped in combination with the coach. It is then possible to co-create areas to potentially affect the performance of the individual players and team. For example, elite coaches highly value individual work with players to refine their match day strategies and will want practitioners in the changing rooms to deliver and refine these strategies.

Most professional clubs will have an academy or youth development department. There has been much work recently to standardize the player development pathway. Fundamental to this is nutrition, which plays an ever-increasing role in the growth, maturation and performance of the young athlete (Jeukendrup & Cronin, 2011; Baker et al., 2013; Purcell et al., 2013). Finally, support at the youth level is often workshop-based. A syllabus of workshops can be scheduled regarding basic nutrition and how players can structure their training diets to use foods to support training and match day performance. However, with a low graduation of academy to senior players in many elite football clubs, nutrition is now recognized as a key factor in elite player development.

SUMMARY

Nutrition in football is important to ensure players have appropriate energy for training and matches. Individual work with players in training helps refine and build confidence for match day strategies. Consistent recovery strategies allow players muscles to adapt to the training stimulus. Body composition of players should be routinely monitored over the season, using appropriate methods and standardization procedures. A rigorous and progressive sports nutrition policy reassures players and coaches that any recommendation safely supports health and performance. Finally, the sports nutritionist should work closely with other science and medicine disciplines to maximize the impact of nutrition within a professional football club.

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