

NUTRITIONAL STRATEGIES FOR IMPROVING PERFORMANCE AND RECOVERY IN ATHLETES

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ABSTRACT

Purpose: This study provides a comprehensive overview of the dietary habits and nutritional requirements of athletes competing. The research aims to address the diverse scenarios athletes face, particularly in competitive sports, and explore recent advancements in sports nutrition accordingly. **Research Methodology:** A qualitative review was conducted, synthesising data from existing literature and evidence-based practices in sports nutrition. Key elements such as pre-race dietary strategies, energy replenishment protocols, and nutrient requirements for athletes in weight-specific sports were analysed. Additionally, metabolic pathways critical to athletic performance were examined to identify the most effective nutrients and supplements. **Findings:** The study highlights that optimal nutrition enhances athletic performance and recovery. Pre-race diets that emphasise easily digestible carbohydrates and rapid energy replenishment strategies post-exercise were found effective. Athletes in weight-categorised sports must carefully manage body weight while maintaining energy levels to sustain high performance. Supplements such as branched-chain amino acids, maltodextrin, and vitamins E and B12 were identified as beneficial in improving recovery and performance when integrated into a balanced diet. **Managerial Implications:** The findings underscore the importance of personalised dietary plans for athletes, tailored to the demands of specific sports and individual metabolic needs. Sports organisations and coaching teams can adopt these insights to develop effective nutritional protocols, optimising performance and recovery. Nutritionists working with athletes should also consider the unique challenges of weight maintenance and rapid energy replenishment in different sporting contexts.

KEYWORDS: Nutrition, Carbohydrates, Fats, Proteins, Sports Nutrition, Amino Acids.

INTRODUCTION

Many individuals ask themselves, "What should I eat while playing any sport?" The answer to this question is not basic, as it depends on several parameters. Understanding the physical traits of an individual and the type of sport they desire to play is the first step in determining the right food for them, and whether they have previously participated in this sport or others—in other words, the status of their metabolism and the type of training they require (Burke et al., 2011). Even more so, a preventative visit is necessary for individuals who compete in sports (amateur or professional) to specify the proper eating routine to adhere to before and after physical activity and during interval times. If there are no specific medical conditions for special considerations, general guidelines can help understand how to maintain a nutritious diet for different scenarios (Kerksick et al., 2018; Serra-Majem et al., 2018).

PERFORMANCE-DRIVEN NUTRITIONAL APPROACHES FOR ATHLETES

1. The food we consume and the fluids we drink provide us with all the energy we require for everyday functioning and physical activity. The basic components included in the meals—carbohydrates, fats, and proteins—are essential to our systems in the right proportions during digestion. The link between these nutrient groups and how much we should consume should not be random; rather, it should be determined based on the type of activity, particularly in sports. The amount of time spent exercising and its intensity determine whether the body uses fats or carbohydrates as its primary energy source (Jeukendrup & Gleeson, 2019). Regardless of the sport being played, athletes mostly rely on carbohydrates for energy since they fuel the contraction of their muscles (Kerksick et al., 2018). Although they have the maximum percentage of energy of all nutrients and are the primary source of energy when we talk about endurance sports (Burke et al., 2019).
2. Fats also supply energy for activity. They are less accessible for quick and strenuous workouts, though. Athletes require proteins to maximise the utilisation of carbohydrates in the glycogen form and rebuild and repair muscle damage occurring during exercise. However, it is important to determine how much protein an athlete requires for strength and duration exercises because carbohydrates also additionally fulfil these functions (Tipton & Wolfe, 2004). Furthermore, studies have not shown that

high-protein diets are particularly beneficial for players (Hector et al., 2018). To gain muscle, do power sports athletes truly require specific diets? If so, how can they get the maximum out of it? The fundamental reason why power sports athletes require more protein than athletes of other sports is to repair and replenish their muscles, yet this demand is frequently exaggerated (Kerksick et al., 2018). Given that they offer the energy necessary for muscular contraction, carbohydrates are unquestionably an athlete's primary source of energy, especially for those who require strength and power (Burke et al., 2019). In sports, the right amount of liquids is as necessary as the right food. The requirement to consume the proper kind of liquids increases with the length and intensity of the training type (Oliveira et al., 2017).

3. Many athletes believe they are adding more muscle mass to their bodies, hence they have a propensity to consume too much protein. This is somewhat accurate, but high-protein diets likely lead to dehydration, this is true for even the most skilled athletes (Phillips, 2004). This is particularly true for those who compete in endurance sports, who have a higher threshold for dehydration than the average person due to their individualised training. Therefore, it is suitable to supply drinks, salts, and easily and rapidly digested carbohydrates to battle sweat losses and tiredness acidosis and ultimately restore the proper blood sugar or maybe, maltodextrin (Thomas et al., 2016).
4. It is crucial to avoid consuming sucrose (common sugar) before a competition since doing so raises blood sugar levels, which triggers the release of insulin and causes subsequent hypoglycaemia that might jeopardise the race (Maughan et al., 2018). As a result, it is advised to stay away from drinks in cans and those with additional flavoured juices.
5. The small holds of two amino acids, alanine and glutamine, that are initially available in muscle fibres during a demanding or prolonged workout are utilised after the glycogen content is decreased, leading to the fragmentation of the proteins that build the muscle. For this reason, under strict medical supervision, consuming amino acids with branched chains is recommended because they can be converted through a series of reactions into glucose, the energy source for the body (Shimomura et al., 2004; Kerksick et al., 2018).

RECOVERING IN QUICK TIME WITH THE RIGHT NUTRITION

The athlete feels exhausted after a race, a game, or a challenging training session and has collected many metabolites that result in an acidic environment. Post-intensive nutrition must support the process of cleansing, rebuilding, and replenishing (Burke & Mujika, 2014). In reality, the body may lose water, and salt, accumulate acidic materials, deplete its sugar stores, and suffer from tissue usury (Kerksick et al., 2018). Therefore, a diverse dietary intake of liquids, nutrients, vitamins, carbohydrates, proteins, and fats helps the body return to normal. Following intense physical activity, the body enters an acidic state. In such conditions, consuming an alkaline beverage containing salts can aid in replenishing lost minerals and glucose, promoting glycogen synthesis post-exertion (Burke et al., 2019). The next step is to consume 200–250 grams of maltodextrin with plenty of fluids to begin replenishing the glycogen stores. The meal will be ingested no sooner than two hours after the exertion since the body has to be alkalinised to overcome acidosis and quickly discharge the building up of toxins before the body is exhausted for digestion (Oliveira et al., 2017).

Figs, dried apricots, beets, carrots, celery, lettuce, pineapple juice, potatoes, apricots, whole pineapple, strawberries, bananas, oranges, tomatoes, cauliflower, peaches, grapefruit, lemon juice, mushrooms, apples, grapes, milk, onions, and fresh peas are among the foods that are listed in decreasing order of their alkalinising influence (Serra-Majem et al., 2018).

ENERGY METABOLISM AND BODYWEIGHT MANAGEMENT IN ATHLETES

In the daily energy computation, with qualitative aspects, it is vital to consider all the extra caloric expenditure associated with physical activity. Athletes have different dietary requirements than sedentary people, especially when it comes to numbers. The routine activities of the athlete influence how much energy they require each day. It also depends upon the training they engage in, which establishes the intensity and duration of their physical activity; and their thermogenesis, which is the unique dynamic action of food and represents the amount of calories needed for digestion (Burke et al., 2019; Kerksick et al., 2018). To be precise, proteins make up 10–35%, glycodes 5–10%, and fats 2–5%. The body uses basal metabolism to develop its basic processes. (Such as breathing, heart rate, digestion, excretion, and maintaining a normal body temperature of 37 °C) (Hargreaves & Spriet, 2020).

Basal metabolic rate is affected by age, race, ethnicity, climate, and the kind of activity one performs. The body expends more calories to maintain a stable body temperature in the cold, and worry can cause this increase to rise by up to 50% (Shimomura et al., 2004). The metabolism gradually declines once an athlete crosses the 30-mark, reaching a maximum reduction of 30% after 70 years. It decreases by roughly 7% when you're asleep. The body uses around 1 calorie per kg according to your body weight (0.9 for women) each hour while at rest, therefore, a quick and rough calculation of the basal metabolism may be done in 24 hours (Hector et al., 2018). Here are some samples of how many calories are required for each activity per kilogramme of body weight and hour: Single tennis is 5.2; double tennis is 4.1; sleeping is 0.93; driving is 1.90; slow dancing is 4.3; calcium is 11.7; gymnastics is 5.9; recreational swimming is 9.1; and competitive swimming is 25. As we can observe, there are significant variances in how many calories are used for each activity compared to the effort put forward. The distinction between competitive and leisure swimming, which demands more than twice the energy, is particularly intriguing (Wickham et al., 2018).

It can be difficult for athletes to reduce body weight because doing so also affects their physical efficacy, particularly in sports that require muscular effort. In addition to fats, muscle proteins and mineral salts are also removed. Theoretically, one needs to eat roughly 800-900 calories to shed 100 grams of subcutaneous fat, composed of 90% fat and 10% water (Boon et al., 2007). In the first few days of a dietary regimen for weight reduction, most liquids are lost (Due to the cellular ratio of 2.8:1 between glycogen and body water, a loss in carbohydrate intake leads to the loss of water from the body). As a result, subcutaneous fat is affected, but "savings"—a defence mechanism—is also created. This defensive mechanism entails consuming considerably fewer calories (up to 20%) to maintain the basal metabolic rate, fewer calories for the same amount of effort, and greater food absorption (Serra-Majem et al., 2018). Subcutaneous fat intake shouldn't exceed 2-2.5 kg every 15 days to maintain optimal organic and muscle efficiency during weight loss. 1% of the actual weight every week, should be precise. All meal ingredients must be present and balanced at all times, as fats transport fat-soluble vitamins, glycerides inhibit ketosis after ingesting subcutaneous fat, and proteins are required for their plasticity. (Burke & Mujika, 2014).

The weight-loss dietary regimen is not being appropriately followed when symptoms of anxiety, insomnia, and excessive physical and mental tiredness become apparent. The endurance run is one of the most popular methods for losing weight, it only works if it lasts longer than 20 to 30 minutes since the mobilisation of fats after the initial consumption of

glycides doesn't start until then (Burke et al., 2019). A skilled runner burns roughly 0.9 calories per kg of body weight for every kilometre, independent of run pace, which calculates the number of calories used throughout the race quite easily. A solid dietary plan for weight reduction must consider the calories consumed throughout the day and a week (following the criteria provided at the beginning) and the caloric efficiency of the foods consumed. Weighing the athlete daily, monitoring weight variations after 10 to 15 days, and making adjustments as necessary is a simple method to go forward. It should also be made clear that the nutritional procedures for losing weight entail consuming subcutaneous fat while also transporting ketone bodies, which are acids made from acetoacetic acid that raise blood acidity in addition to exercising (Hector et al., 2018).

In reality, neglecting the inclusion of glycides in the daily diet is a big error that is frequently committed by athletes. Glycides are the main sources of energy, and in the specific situation of weight reduction, they do so by reducing the amount of ketone bodies produced, which in turn lessens the capacity of the blood to become acidic (Kerksick et al., 2018).

Finally, it's important to see that losing weight does not always translate into losing fat. Diuretics and saunas only briefly eliminate excess water and mineral salts like chlorine, sodium, and potassium. Cellular malfunction, agitation, cramping, and a decrease in athletic ability might result from this. Diuretics are on the list of drugs that are prohibited from doping (Wickham et al., 2018). Massages merely aid the recovery from muscular exhaustion and have no bearing on subcutaneous fat stores. Synthetic suits create the appearance of more sweating since they do not drain perspiration. They may irritate the skin and impair the skin's ability to regulate its internal temperature if they come into contact with it.

Some sportspeople might have to put on weight, especially if they compete in sports with weight divisions. They may also need to add muscular mass. With the right diet and workout methods that encourage protein synthesis, this "active" weight gain can be achieved. The nutritional protocol must be based on consuming a small amount of fat, preferably raw extra virgin olive oil, and a lot of highly energising and easily absorbed glycides (such as potatoes, biscuits, pasta, rice, different kinds of jams, etc.) (Burke et al., 2019). Protein synthesis is encouraged by the availability of vitamins E and B12 and proteins high in branched-chain amino acids. A teaspoon of glucose mixed with fruit juice can be taken 30 minutes before meals to enhance appetite. Since too much protein can even make it difficult to replace and reconstruct new cellular structures, a high-protein dietary plan requires consideration for the proper amount

of glycerides and water, vitamin B1, and potassium to promote the disposal of nitrogen waste (Hector et al., 2018). In particular, the by-products of protein breakdown can bring to light several issues, including an increase in the load of toxic waste, digestive disorders, exhaustion of the kidneys and liver, blood acidosis, and hypercholesterolemia. To better comprehend the motivations behind the decisions to be made for the requirements of metabolic processes, it is time to go deeper into certain pathophysiological ideas.

Foods are broken down into basic components (proteins, fats, and carbohydrates) during digestion. The gut then absorbs these nutrients and makes them available to the metabolic pathways. We have seen how consuming carbohydrates significantly impacts muscular contraction and helps improve sports performance. To enable the body to maintain muscular performance over an extended period, these nutrients are not metabolised immediately following absorption. (Shimomura et al., 2004). If they were, we would need to consume food regularly to not run out of "fuel." To get beyond this, the energy produced by utilising glucose is preserved in ATP or adenosine triphosphate. ATP can then be used to contract muscles by releasing phosphate groups. Previously, to get around the need for a constant supply of glucose, it was stored in the form of glycogen, which is then mobilised and broken down into glucose once more for ATP production as per the requirement. Therefore, there are two consecutive levels of storage for carbohydrates: long-lasting glycogen and short-lasting ATP (Burke et al., 2019).

ENERGY PATHWAYS: ATP SYNTHESIS AND METABOLIC PROCESSES

Since there is no ATP backup in the body and whatever amount is stored is quickly depleted, ATP synthesis must continue during any physical activity. Aerobic metabolism—which occurs in the presence of oxygen—and Anaerobic metabolism—which occurs in the absence of oxygen—are the two basic processes by which nutrients are converted into energy (ATP). There are many ways to separate these two metabolic processes. The majority of the time, a mix of energy systems provides the fuel required for operation; which system is employed depends on the intensity and length of the activity (Hargreaves & Spriet, 2020).

- **The route of ATP and CP (Creatine phosphate):** For intense sports like the 100-metre dash, this pathway, also known as the phosphate system, delivers energy for around 10 seconds. To produce ATP, this metabolic process does not need oxygen. It initially utilises the ATP already available in the muscle (often for a duration of 1-2 seconds)

and then re-synthesises ATP using creatine phosphate (CP) until the CP finishes (about 6–8 seconds) (Haff & Triplett, 2016). The body switches to anaerobic breakdown (glycolysis) to continue producing ATP and supply energy for activity when both ATP and CP are depleted (McArdle, Katch, & Katch, 2015).

- **Glycolysis in Anaerobic breakdown:** The anaerobic metabolic pathway, commonly referred to as glycolysis, relies exclusively on carbohydrates to generate ATP and lactic acid. In the absence of oxygen, this process involves the partial breakdown of glucose to produce energy. (Westerblad et al., 2010). Anaerobic metabolism generates energy for brief, strong bursts of activity; however, this only lasts for a short time before the level of lactic acid generated hits the lactate threshold, which makes it impossible to maintain the pace (Fox et al., 2011).

ENERGY DYNAMICS: AEROBIC AND ANAEROBIC METABOLISM

The majority of the energy required for prolonged exercise is produced by aerobic metabolism, where oxygen is used to convert food into ATP. This system, primarily employed in lower-intensity but prolonged activities, is a bit slow compared to the anaerobic because the cardiovascular system must supply oxygen to the muscles before it produces ATP. The athlete passes through each of the previously mentioned metabolic pathways when exercising. Anaerobic metabolism is used to make ATP initially; when respiratory and heart rates rise, oxygen becomes more readily accessible, allowing aerobic metabolism to begin and continue until the threshold for lactate is achieved (Hawley et al., 2014). If this threshold is crossed, aerobic metabolism kicks in because the body cannot produce oxygen rapidly enough to produce ATP (Brooks et al., 2020). The athlete must reduce the intensity of the activity to eliminate the lactic acid created since this process is brief and the amount of lactic acid grows, making it impossible to maintain an intensive workload (Seiler & Tønnessen, 2009). Depending on the pace and duration of the exercise, the nutrients are transformed into ATP, with carbs serving as the primary energy source for both short- and long-term activities and fats for less strenuous ones (Jeukendrup, 2017). While essential for endurance activities, fats are unsuitable for high-intensity workouts like jerks or repeats. Even if you perform some workout at a relatively small intensity (or, in any case, at less than 50% of your maximal heart

rate), you can still burn enough fat to keep working out for several hours or even days (Romijn et al., 1993).

The metabolism of carbohydrates ceases when the level of exercise rises. While it is more effective than fats, its energy reserve is constrained. For two hours of both high- and moderate-intensity workouts, glycogen can provide the energy needed; after that, glycogen reserves begin to deplete, and if this energy is not replenished, the athletes risk "crashing into the barrier" (Cermak & van Loon, 2013). This is why it is crucial to consume readily digested carbohydrates when engaging in moderate activity lasting a few hours. An athlete may continue the workout, which can be moderate and vigorous, by simply refilling the carbohydrate stores during the exercise.

You will be compelled to lessen the intensity of the workout and go back to the fat-burning process to get the energy you need if you don't consume enough carbohydrates (Hargreaves & Spriet, 2020). Anaerobic metabolism takes over since the body cannot generate and circulate oxygen rapidly enough to use the fat metabolism or carbohydrates interchangeably (Brooks et al., 2020). As a result, the efficiency of using carbohydrates decreases noticeably with an increase in activity levels. In reality, if carbohydrates are metabolised in an environment with enough oxygen during strenuous activities, they can create around 20 times more fuel (in the ATP form) per gram than in an oxygen-free, anaerobic state (Jeukendrup, 2017).

THE ROLE OF AMINO ACIDS AND SUPPLEMENTS IN ATHLETE PERFORMANCE

Proteins are made up of amino acids, necessary for replenishing muscles. Following a balanced nutritional routine ensures that the athlete consumes the right quantity of protein and all the amino acids he requires. Different meals contain proteins and, consequently, amino acids, in variable amounts. But as we've seen, the athlete's needs are not simply more varied than those of a sedentary person. It requires branched-chain proteins in particular. Leucine, isoleucine, and valine are amino acids that are particularly significant in protein synthesis as they take part in the process through which proteins are converted into energy (Boon et al., 2007; Shimomura et al., 2004). Due to their structure, these three amino acids are known as branched-chain amino acids. Branched amino acid supplements are not required for recovery after an activity that is not performed continuously and sufficiently for a prolonged time (at least 50 minutes) (Burke et al., 2019).

For instance, if we look at the physiological requirements of running, collaboration is only justifiable if it lasts more than 20 kilometres. Adequate nutrition offers sufficient nourishment to all those "runners" who eat well (with high protein intake) but are not marathon runners, given that 10 grams of branched amino acids are present in 250 grams of chicken (Shimomura et al., 2004). Amino acids, whether branched or not, are not particularly useful for enhancing performance, even if they are significant during the recovery period. Unfortunately, branched-chain amino acids are misused by many athletes who think they would benefit from them without any adverse effects (Hector et al., 2018). This is untrue since excessive dosages can cause renal overload by drastically raising blood urea nitrogen levels (Kerksick et al., 2018). The habit of taking amino acids and protein supplements to maximise the body's anabolic potential stems from the beliefs of bodybuilders, who claim that since muscle has a high protein content, more proteins would lead to the development of more muscles. Three things restrict this belief:

1. A stimulus, such as a maximal effort or the presence of chemicals that support anabolism and utilise the proteins consumed (testosterone, insulin production, growth hormone), causes anabolism. Leaving aside this second possibility, the anabolic stimulus determined by the maximum effort only affects athletes who participate in power sports and not the other athletes, particularly because in numerous athletic activities a bodybuilder's development would be completely contraindicated because hormone intake is harmful to health and prohibited by doping (Burke et al., 2019).
2. As anabolism has a well-defined restriction, even for bodybuilders, protein consumption prohibits increasing muscle mass beyond a specific point. The nitrogen balance illustrates the distinction between nitrogen absorbed in the protein form and utilised for anabolic processes and nitrogen lost through protein breakdown (Tagawa et al., 2021). It is obvious that for there to be growth, there must be a positive balance, meaning that more nitrogen must be incorporated into tissues—in this case, muscle tissue—than can be excreted in urine, faeces, or sweat as a result of catabolism reactions, or the breakdown of proteins. However, a negative ratio denotes tissue loss. For bodybuilders, the proper coordination for sustaining balance had to be 1.2 grams per kilogram weight and 1.6 grams for cross-country athletes (Tagawa et al., 2021). These findings, which might surprise non-experts, may help explain why, in many bodybuilders, it is the consumption of anabolic compounds—whether it is natural or

synthetic—rather than protein that increases lean mass (Phillips et al., 2020). It is important to remember that protein catabolism only becomes a factor when the effort is hard enough to warrant it, that explains why in normal circumstances (without anabolic drugs), a bodybuilder has a lower protein demand than a high-level runner. The athletic gesture can still be intense if it is time-constrained (many bodybuilders' workouts only last a half-hour or less because of the lengthy rest periods between exercises), since the quantity of catabolised protein is still minimal, reintegration is not required (Morton et al., 2018).

3. Consuming amino acids (such as lysine, glutamine, tyrosine, arginine and others) does not improve aerobic capacity, performance in maximum activities, or growth hormone levels. Cortisol and testosterone levels are also constant (Serra-Majem et al., 2018). Amino acids like glutamine, arginine, glycine, lysine and ornithine raise levels of growth hormone, but none of these studies were conducted on samples of the general population or athletes; rather, they were all conducted on a handful of hospitalised subjects, or the ill and/or elderly (Darmaun et al., 2004). The delivery of an amino acid was linked to favourable outcomes, and the amount of HGH rose by a range of three to ten. If these findings were accurate, providing, 2 grams of lysine, 2 grams of glutamine, 6 grams of glycine, 5 grams of ornithine, and 5 grams of arginine should result in a 100-fold rise in HGH levels, although certain amino acids are antagonists (for example, the pair arginine and lysine). This is not the case, and the reason for this is that some therapeutic outcomes (such as those obtained when operating on elderly and inactive patients) are attained in settings of great inadequacy (Okamura et al., 2023). The organism constantly retains control levels. Integration functions up until certain levels are reached, at which point it is terminated.

POST-TRAINING RECOVERY FOR ATHLETES

Athletes are aware of the value of nutrition before physical activity; nevertheless, after exercise, what you eat and when you consume it are as crucial, particularly during intense competition in several sports. Nutrition after exercise is important for recovery, to enhance the capacity to return to training. While the meal before exercise enables appropriate glycogen stores to be utilised for the best performance, nutrition after exercise is vital for repair and to increase the ability. What should we consume to replenish muscle glycogen after exercise? The restoration

of lost fluids is the dietary priority following exercise. In general, weighing oneself before and after exercise is the best method to determine the amount one should consume (water or other particular beverages), and you should take in roughly 500 ml of fluids for every 500 grams of weight lost (Sawka et al., 2017). To help replenish glycogen, intake of carbohydrates (such as fruit or juice) within 15 minutes of exercising becomes crucial. To rebuild sufficient glycogen reserves and resume training, 100–200 grams of carbohydrates intake within two hours of a resistance workout.

In reality, eating carbohydrates increases the creation of insulin, which in turn aids in the regeneration of muscle glycogen, and if the two-hour window is surpassed, the amount of glycogen that is rebuilt in the muscle is decreased by 50%. Whatever the case, taking more carbohydrates is pointless because of their impact on glycogen storage plateaus (Boon et al., 2007). In the two hours after exercise, consuming a moderate quantity of protein and carbohydrates may double the insulin reaction, causing more glycogen to be stored. Four grams of carbohydrates should be consumed for every gram of protein to achieve this effect (4:1). Athletes who consume carbohydrates and proteins have a 100% higher glycogen reserve than those who consume only carbohydrates (Serra-Majem et al., 2018). Those who drink a liquid blend of proteins and carbohydrates also have increased insulin levels. But be careful—eating more protein than required might have a negative effect since it affects the recovery of glycogen and rehydration (Evans et al., 1985).

For replenishing the stored energy after an intense resistance workout, a composition of 4:1, carbohydrates to protein, is the ideal option. Both liquids and solid foods are effective, but adhering to the proper ratio and the two-hour interval, a drink is simpler to consume and digest (Kerksick et al., 2018). The source of calories is just as important as getting the right number; in fact, calories may be produced by breaking down fats (9.0 g), proteins (4.0 g), and carbohydrates (4.0 g) (Shimomura et al., 2004).

CONCLUSION

Optimal nutrition is a cornerstone of enhancing athletic performance and supporting recovery (Jeukendrup & Gleeson, 2019). Following physical exertion, the replenishment of glycogen stores through the intake of carbohydrates and the repair of muscle tissue via high-quality protein consumption are fundamental processes (Burke et al., 2011). Equally critical is maintaining hydration levels, as adequate fluid intake not only improves performance but helps

prevent fatigue and reduces the risk of injury (Sawka et al., 2007). While dietary supplements, such as creatine, have been shown to offer performance-enhancing benefits when used appropriately, their role is supplementary and they cannot replace the importance of a balanced, nutrient-dense diet (Kreider et al., 2017). A personalised approach to nutrition, tailored to an athlete's physiological needs, activity levels, and specific sporting demands, is paramount for achieving peak performance (Thomas et al., 2016). Strategic meal planning, including the optimal timing of nutrient intake, plays a significant role in ensuring sustained energy levels and recovery efficiency (Ivy, 2004). By focusing on integrating nutrient-rich foods, appropriate supplementation, and evidence-based nutritional principles, athletes can not only maximise their performance potential but also support their long-term health and well-being (Phillips & Van Loon, 2011). This holistic perspective underscores the importance of aligning nutritional strategies with the dynamic and unique demands of athletic pursuits to achieve sustainable excellence in performance.

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