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Research on Protein Intake for the Recovery of Athletes in Different Sports

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Abstract. Protein serves as a key nutrient for recovery and muscle repair, and the exercise science community has overly focused on post-exercise recovery protein intake, overlooking the unique differences in metabolism and injury recovery mechanisms across sports. This study elucidates the significant differences in protein requirement patterns among strength, endurance, and interval athletes, and lays the theoretical foundation for the development of targeted supplementation programs. The study confirms that scientific protein supplementation not only increases muscle mass in athletes, but also significantly improves key performance indicators such as explosive strength and endurance. This is of great practical value in preventing athletic fatigue and optimizing athletic performance. Adjusting protein intake according to different types of sports can significantly enhance athletes' recovery, improve their athletic performance, reduce the risk of sports injuries, and prolong their athletic careers. This study provides a personalized plan for protein intake in athletes, which is an important reference for improving athletic performance and promoting medical development.

Keywords: Protein, Athlete, Fatigue, Sleep

1. Introduction

The research on protein intake for muscle recovery of athletes in different sports events has always been an active research topic. The muscle recovery speed of athletes is influenced by many external factors, such as the way and intensity of training, sleep quality, rest level, individual differences, relaxation after exercise, and protein intake. Athletes need protein as it facilitates muscle repair, growth, and recovery. The speed of muscle recovery directly determines an athlete's training efficiency and competitive performance. Rapid recovery can shorten the training period, increase the intensity and frequency of training, and accelerate the improvement of sports qualities such as strength and endurance. Conversely, delayed recovery can easily lead to accumulated fatigue, increase the risks of muscle strain, and stress fractures, and even trigger overtraining syndrome. In addition, the recovery efficiency of muscles also affects competition performance, insufficient recovery between races will reduce explosive power and movement accuracy, while chronic poor recovery will weaken the long-term competitive state. However, Muscle damage requires sufficient protein for repair, different sports have different metabolic and mechanical stipulations which means protein requirements may differ greatly between endurance, strength, and team sport athletes. In

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relation to protein consumption in athletes, while it is undoubtedly beneficial in many ways, an unhealthy level of protein intake may indeed be detrimental. With the global development of sports and the widespread acceptance of health concepts, there has been exponential commercialization of sports supplements, leading to the phenomenon of “protein worship”.There is a social misconception when it comes to protein: on one hand, the media and marketing exaggerate the claim that“more protein means better results,” and this is now being adopted indiscriminately by casual gym-goers. Such misinformation leads to the further wastage of social resources but also poses serious long-term health consequences for athletes, such as impaired kidney function [1]. It has been shown that a high-protein diet is linked with elevated levels of microalbumin excreted in urine. At the same time, the metabolism of protein aggravates the risk of stone formation in uric acid excretion. Some factors include animal protein consumption which increases the risk of developing calcium oxalate stones. Moreover, hyperproteinemia is associated with excess uric acid production. The decrease in glomerular filtration rate coupled with heightened tubular reabsorption results in hyperuricemia which, in turn, leads to the accelerated decline of kidney function and metabolic disorders creating a cycle with kidney dysfunction and worsening metabolism [2]. Insufficient protein intake for athletes is also absolutely unacceptable. Inadequate protein intake will accelerate the occurrence of physical fatigue, seriously hinder the recovery from fatigue, reduce athletic performance, and increase the risk of injury. Thus, it becomes valuable to consider powerful protein consumption associated with exercise to adapt to the requirements of various types of exercises. Such considerations help in optimizing training and improving performance as well as recovery for competitive athletes. This paper uses domestic and foreign literature data to explore the causes of exercise fatigue and analyze the differences in protein intake between different types of exercise.

2. Protein intake strategies for different project types

2.1. Strength sports

Some familiar strength competitions include: weightlifting, sprinting, wrestling, and so on. During high-intensity strength training, muscle tissue primarily uses energy from glycogen stores. When performing high-intensity training continuously, the body’s glycogen reserves are depleted rapidly. If energy remains inadequately resupplied in time, the condition will lead to insufficient energy supply which will subsequently lead to obvious fatigue. This condition causes the central nervous system to lose its control over muscles and the athlete will find it difficult to maintain precision and stability during his subsequent movements. Furthermore, the extremely high training intensity results in increased active muscle tissues undergoing metabolic activities in an oxygen-deficient setting leading to the significant formation of lactic acid.

Protein is the foundation of muscle repair and growth. Therefore, timely supplementation of protein can effectively promote muscle repair and reduce damage. For sports like weightlifters, which require a large amount of protein and other nutrients to maintain strength levels and athletic performance, adding an appropriate intake of protein-rich functional foods to the daily diet can accelerate the synthesis of skeletal muscle protein, promote muscle metabolism and recovery, and enhance strength quality. The latest scientific research shows that when the human body is in a stage of reduced protein intake, the secretion of endogenous growth hormone will increase significantly, up to ten times the normal level. The improvement effect of this hormone level is persistent and can be maintained even after resuming a high-protein diet. This physiological change not only helps to reduce the metabolic burden on the kidneys and liver caused by a high-protein diet but also has a positive impact on athletic performance and muscle maintenance. Weightlifters usually have well-

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developed muscle tissues and consume a large amount of energy during daily training. Their protein metabolism also far exceeds that of normal people. This makes their demand for protein and carbohydrates significantly higher than that of the general population. To promote muscle growth, maintain normal muscle function and ensure the coordinated operation of the neuromuscular system, athletes also need to supplement various vitamins, minerals and other micronutrients in addition. It is recommended that weightlifters consume 20 to 30 grams of high-quality protein within one hour after training. This not only promotes the synthesis of muscle protein but also relieves muscle soreness and speeds up recovery. Foods rich in essential amino acids are ideal choices for muscle repair. Studies show that evenly distributing the protein intake throughout the day to each meal can significantly improve the efficiency of protein utilization. Maintaining a balanced intake of protein at each meal and snack helps keep the amino acid levels in the body stable, thereby continuously stimulating the synthesis of muscle protein. For athletes who train frequently, controlling protein intake is particularly crucial. It is recommended to supplement at a standard of 1.6 to 2.2 grams per kilogram of body weight [3]. However, for wrestlers, they need to consume an adequate amount of high-quality protein every day to support muscle repair after high-intensity training and competitions. High-quality protein should contain essential amino acids and be easily absorbed. This is the key to enhancing physical fitness and improving strength and endurance. Supplementing protein before training can store amino acids in the muscles and reduce muscle consumption during training. Timely supplementation of protein, such as protein powder or high-protein foods, within 30 minutes after training can quickly repair muscle damage and prepare for subsequent training. An appropriate amount of protein at 0.25-0.30 g·kg-1 each time can effectively activate the repair mechanism and enhance strength and explosive power reserves. Special attention should be paid to the control of intake thresholds. If it exceeds 0.30 g·kg-1 at a single time or the total daily intake is higher than 2.00 g·kg-1, it will not only fail to enhance exercise performance, However, it also increases the metabolic pressure on the liver and kidneys, because the nitrogen-containing waste produced by protein breakdown needs to be transformed by the liver and excreted by the kidneys [4]. Wrestlers need to manage their weight before the event to meet the competition requirements. They keep their body fat percentage at the best competitive stage through periodic dietary management. Therefore, rapid weight loss can lead to the loss of many nutrients, thereby affecting the athlete's mental state, physical strength and athletic performance. Therefore, how wrestlers quickly and effectively replenish their nutrition after losing weight is a key factor for them to perform at their best in competitions. Promote muscle repair by consuming high-quality protein and ensure that muscles have an appropriate amount of glycogen reserves by supplementing an appropriate amount of carbohydrates [5].

2.2. Endurance sports

In the field of sports competition, endurance quality plays a crucial role in the performance of athletes. Whether it is endurance events such as long-distance running and football, or comprehensive sports, good endurance is the cornerstone for athletes to exert their strength and persist until the end. For example, in endurance sports, football players need to repeatedly perform high-intensity running, sprinting, back pressing and competing for 90 minutes or longer. Stable physical fitness is the decisive factor in ensuring that players and all endurance athletes can maintain their athletic ability, technical stability and tactical execution at the end of the game. Unlike strength sports, many long-distance runners we usually see are slender and not as muscular as wrestlers or bodybuilders. This is because there are significant differences among them in terms of sports goals, training methods, and diets. The research found that it includes approximately 85% of elite track and

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field athletes. Commonly used supplements include vitamins, minerals, proteins, creatine and various "synergistic" compounds. In certain circumstances, some supplements may be helpful to athletes, especially when food intake or food choices are restricted. Vitamin and mineral supplements should only be used when there are no food solutions available. Sports drinks, energy bars and protein and carbohydrate shakes can all be useful and convenient at specific times [6]. For endurance exercise lasting 30 minutes or longer, the most likely causes of fatigue are dehydration and carbohydrate consumption, while gastrointestinal problems, high body temperature and hyponatremia can reduce the performance of endurance exercise and may threaten health.

As a typical endurance sport, the energy supply of a marathon mainly relies on the aerobic metabolic system (accounting for about 95%), while the mixed metabolism only accounts for 5%. The high concentration of muscle and liver glycogen before exercise is considered crucial for optimal performance. Muscle glycogen and blood glucose, as the key energy supply substances for muscle contraction, exhaustion and a decrease in blood glucose are the main factors leading to fatigue during long-term exercise [7,8]. During the competition, muscle glycogen breakdown provides continuous energy for athletes. However, as glycogen reserves are consumed, the proportion of energy provided by fat gradually increases. However, the energy supply efficiency of fat is relatively low, often accompanied by inhibition of exercise capacity and a decrease in running speed [9]. However, protein also plays an extremely important role and holds a significant position in endurance sports. As a core component of an athlete's nutritional system, research shows that adequate protein intake is not only a key factor in enhancing athletic performance but also the foundation for maintaining the body's optimal functional state. As an important functional nutrient, protein not only participates in energy metabolism during exercise but also enhances muscle contraction ability by regulating the excitability of the central nervous system, while effectively preventing the occurrence of exercise-induced anemia. It is worth noting that during the high-intensity training phase when glycogen reserves are insufficient, the proportion of energy provided by protein oxidation will increase significantly, which is particularly important for endurance athletes, especially marathon runners. More crucially, protein supplementation after training can promote the repair of damaged muscle fibers and significantly enhance mitochondrial function and the rate of muscle protein synthesis, which is also crucial for the recovery and adaptation process of marathon runners [9]. Evidence suggests that endurance athletes should advocate a daily protein intake of approximately 1.8 g·kgBM−1·day−1. However, it should be noted that during carbohydrate-restricted training periods and rest days, the protein requirement may further increase by more than 2.0 g·kgBM−1·day−1 [8]. After high-intensity marathon training, athletes' bodies will have a very high demand for protein intake. A series of carefully controlled studies conducted in the laboratory of Dr. Daniel Moore from the University of Rendo and his colleagues used IAAO technology to estimate the protein requirements of endurance athletes. The studies show that: Endurance sports significantly increase the protein requirement on training days and recovery days, which is significantly higher than the 1.2 grams of protein required per kilogram of body weight per day for non-exercising young men [9]. On the training day for men undergoing endurance training to complete a 20-kilometer treadmill run, the average protein requirement was estimated to be 1.83 g·kgBM−1·day−1, which was 2.3 times higher than the RDA currently designed among non-exercise adults [10,11]. Interestingly, the metabolic requirements of different endurance sports may vary, and thus the protein requirements of endurance athletes will also differ [12]. As the world's most watched sport, football, as a high-intensity intermittent sport, requires athletes to possess both explosive power and endurance in a 90-minute match. Existing research indicates that the protein requirement of football players may exceed the regular recommended intake, mainly based on two

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considerations: First, appropriately increasing protein intake can help promote muscle strength development; Secondly, it can replenish the amino acid reserves lost due to the increased oxidation of amino acids during training and competitions. Based on the current research evidence in sports nutrition, it is recommended that the protein intake of football players be maintained within the range of 1.4-1.7 grams per kilogram of body weight per day. This intake level can already meet their specific sports metabolic needs. A controlled study was conducted on 44 male football players, age 22.81 ± 2.76 years old, height 177.90 ± 6.75 cm, weight 67.42 ± 8.44 kg. Studies show that when football players consume casein and probiotics simultaneously before going to bed, it can significantly enhance the anaerobic capacity, isobaric strength and lower body muscle endurance of male football players. It can be seen that the intake of protein at any time is crucial for football players [13]. Football players inevitably suffer from dehydration during the game. Studies show that adult male professional players cover an average distance of 9 to 12 kilometers in a 90-minute regular game, maintaining a high level of exercise intensity at around 80% of their maximum oxygen uptake, VO2max. This kind of long-term and high-intensity exercise causes athletes to lose body fluids through excessive sweating and eventually enter a state of dehydration. It should be particularly pointed out that even mild dehydration can significantly affect an athlete's athletic performance [13].

3. Conclusion

Adjusting protein intake according to different types of exercise can significantly enhance athletes' recovery ability. For sports such as weightlifting and wrestling that require a large amount of muscle participation, during the period when protein intake is reduced, it is recommended to replenish an appropriate amount of protein immediately after training to minimize muscle loss to the greatest extent. Meanwhile, during this period, a relatively light training load should be adopted, but the total training volume should be appropriately increased. This training method can further stimulate the secretion of growth hormone, working in synergy with the already elevated hormone levels, which is particularly beneficial for maintaining and increasing muscle volume. Protein intake at different times plays a crucial role in athletes' athletic performance. Although endurance athletes do not consume protein first during training and competition, protein acts like an oxidant, constantly helping athletes complete their training and competition tasks. Timely supplementation of an appropriate amount of protein after training is also beneficial for physical recovery. This study clarified the significant differences in protein requirement patterns among strength athletes, endurance athletes and interval athletes, laying a theoretical foundation for establishing targeted nutritional supplementation programs. Research has confirmed that scientific protein supplementation can not only increase the muscle mass of athletes but also significantly improve key performance indicators such as explosive power and endurance. This has important practical value for preventing exercise-induced fatigue and optimizing competitive state. However, this study has several limitations: The subject group is mainly limited to professional male athletes, lacking consideration for special groups such as women and teenagers. The research period is relatively short, making it difficult to assess the impact of long-term protein supplementation on sports careers. At the same time, interfering factors such as sleep quality and psychological state have not been completely excluded, and most of the detection methods adopt indirect indicators, which may affect the accuracy of the results. These limitations point out the direction for improvement for the subsequent research. This study points out several important directions for future sports nutrition research. First of all, larger-scale multicenter longitudinal studies need to be carried out, including diverse groups such as female, adolescent and disabled athletes, to establish more universal protein

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supplementation guidelines. Secondly, attention should also be paid to the positive impacts and limitations brought about by the combination of protein and other nutrients, so that the data can more accurately describe the intake plans of athletes of different sports types, and better promote the development of sports nutrition in a more humanized and precise direction.

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