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Recent Perspectives on the Role of Dietary Protein in Physically Active Individuals

Commentary

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Abstract

Introduction: Whether it is the athletic population or the general population, it is essential to understand considerations regarding the amount of protein consumed daily. Protein, often referred to as the body's building blocks, is an integral part of the diet. This macronutrient plays a vital role in developing and maintaining skeletal muscle mass. This paper aims to discuss protein intake at low (<1.2 g/kg/day), medium (1.2-2.2 g/kg), and high (>2.2 g/kg/day) levels that should be consumed with consideration of physically active populations and potential benefits or detrimental effects on body composition and performance.

Methods: Searches of electronic databases PubMed and Google Scholar were undertaken to identify peer-reviewed journal articles that reported on dietary protein intake on body composition, and performance/strength.

Discussion: Low protein intakes may not meet the needs of all physically active individuals. Medium and high protein intakes positively influenced body composition. Medium protein intakes can benefit strength and performance; however, these effects are not consistently reported with higher intakes.

Conclusions: The minimum protein requirement for active individuals is 1.2 g/kg, and higher intakes are safe and effective for healthy, physically active individuals.

Key Words: Protein; Exercise; Athletes

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Introduction

Protein, often referred to as the building blocks of the body, is an essential part of the diet. This macronutrient plays a vital role in the development and maintenance of skeletal muscle mass. Protein intake can have either beneficial or detrimental effects on the human body. If protein intake is high enough, protein synthesis will be higher than protein turnover, thus, maintaining or building lean mass can occur[1, 2]. If protein breakdown exceeds protein synthesis, the result will be muscle atrophy[1, 2]. This is of particular importance to athletes and recreationally active individuals who require protein intakes greater than the recommendation for the general population (0.8 g/kg/day)[3].

The International Society of Sports Nutrition and the Academy for Nutrition and Dietetics recommend individuals engaged in regular physical activity consume at least 1.2 g/kg/day of dietary protein intake [3, 4]. It has been suggested that dietary protein below 1.2g/kg/day is not sufficient to maximize muscle protein synthesis (MPS) in active

population[5]. Aside from enhancing muscle strength and size, greater protein intakes promote favorable changes in body composition. Numerous studies have demonstrated the beneficial effects of exceeding this minimal requirement. However, controversies around the safe and efficacious amount of protein intake persist. The demands of physical exertion mean that protein requirements for athletes and active adults should be higher; this is, of course, dependent on the demands of the sport or activity [1, 6, 7].

The term high protein is often confusing as it is a relative term. For some, anything exceeding the general population recommendation is considered high, yet, in some cases athletes and recreationally active individuals have consumed five times that amount. This review focuses on the chronic effects of dietary protein intake in physically active individuals. For the purpose of this review, protein intake is categorized as the following: Low (<1.2 g/kg), Medium (1.2-2.2 g/kg), and High (>2.2 g/kg).

Scientific Methods

In the present review, we used studies using exercise or/and resistance training and those investigating dietary protein intake related to body composition, physical fitness, and overall health. A comprehensive literature review was performed via electronic search using three databases: PubMed and Google Scholar. The following combination of search terms for each individual database was used:

1. “protein” OR “diet” OR “hypertrophy."
2. “resistance training” OR “protein” OR “body composition."
3. “protein" OR "weight loss."
4. “protein" OR "weight gain" OR "metabolic health."
5. “diet” OR “nutrition” OR “protein” OR “lifestyle modification”
6. “protein” OR "physical activity."
7. "dietary protein intake" OR "strength."

The reference lists of selected articles were manually searched for additional literature. Articles were included if they fulfilled the following criteria: being peer-reviewed and/or original research, subjects engaged in physical activity and interventions lasting a minimum of four weeks.

Discussion

Low Protein Intake (<1.2 g/kg/day)

Loss of muscle equates to the loss of strength in all populations and an increased risk of falls in the elderly population[8]. In a study following elderly women on a low protein diet, muscle wasting was estimated to be 6% below baseline only three weeks into the study[9]. Maintaining or building muscle mass and strength is dependent on the ability to consume enough protein to synthesize more protein than the amount of protein turnover[1, 2, 8, 9]. Not only is muscle strength impaired during low protein consumption[1], but contraction relaxation characteristics of muscle are impaired by low protein diets [9]. The Max Rate of muscle relaxation (MRR) was 23% slower at nine weeks into the elderly women trial[9]. The women on the low protein diet also saw a 12% reduction in 1RM chest press in comparison to the control group over the time of the study[9]. Muscle function and strength are impaired by low protein consumption[8, 9].

Inadequate protein intake negatively affects MPS, thus muscle strength; however, it is unclear if increasing protein intake beyond 1.2 g/kg/day results in additional strength gains. After engaging in 4 weeks of resistance training, Campbell et al. (2018)[10] observed increases in strength for both groups and no significant differences in strength when comparing high to low protein intake. Josse et al. (2009)[11] reported greater increases in measures of strength and fat-free mass in women consuming protein via milk post-workout compared to the control.

Studies evaluating the effects of protein intake on body composition reported differences between low (<1.2 g/kg) to medium-high intakes. Following a supervised eight-week training intervention, Campbell et al. (2018) reported a loss of fat mass and increases in fat-free mass in both low and high intakes. However, increases in FFM were significantly greater in the high protein group compared to the low protein group[10]. Fat and carbohydrate intake for these physique athletes were not controlled. Longland et al. (2016)[12] observed greater increases in fat-free mass with higher protein intakes compared to low intakes despite both groups following a hypocaloric diet for four weeks. Samuel et al. (2010)[13], observed greater reductions in total body mass and lean body mass in subjects consuming 1.0 g/kg compared to those

consuming 2.3 g/kg. No differences in fat mass or measures of strength were reported. It should be noted that only protein intake was controlled in this study.

Low protein diets also showed a loss in cellular immune response [9]. Low protein intake in athletes has been shown to cause a negative nitrogen balance in athletes, which does not meet the demands necessary for the stress responses of the neuroendocrine, hypothalamic, adrenal, and gonadal systems[14]. The alterations in these systems lead to decreases in catecholamine, glucocorticoid, and testosterone levels[15]. Diets very low in protein have shown impairment in phagocytic activity[16]. Amino Acids must be adequately supplied for the production of proteins such as immunoglobulins, cytokines, and acute-phase proteins [17]. Low protein intake, similar to other forms of malnutrition, can lead to the deterioration of health [14-16].

Medium Protein Intake (1.2-2.2 g/kg)

Knowing the possible effects of a low protein diet, one can speculate that a higher, or perhaps, medium protein diet (1.2 g-2.2 g/kg/d) can have beneficial effects on the body and reduce detrimental effects as discussed in lower protein diets. Unlike the low protein diet, the medium protein diet can improve muscle protein synthesis and reduce the risk of reaching a higher protein turnover rate [1]. A study observing active adults who consumed 1.2-2.2 g/kg/d saw a positive increase in lean body mass (LBM) when paired with resistance exercise, supporting the need for higher protein synthesis when protein turnover is higher [6]. Rozenek et al. (2002)[18], reported increases in strength and fat-free mass in trained male subjects who consumed 1.3-1.8 g/kg of protein and engaged in a resistance training program. However, no differences in strength and body composition were observed between carbohydrate supplementation and carbohydrate and protein supplementation groups. Protein intakes that fall within the medium range are advantageous to preserving lean body mass during a calorie deficit. When comparing slow (weekly reduction of 1.4% body mass) and fast (weekly reduction of 0.7% body mass) weight loss programs, protein intakes of 1.6g/kg/day.

For older populations, a low-protein diet may not be beneficial and could contribute to the ailments brought on with age. Increasing protein intake to 1.2-2.2 g/kg/d could help improve performance and quality of life in older populations [19, 20]. A study observing elite senior athletes consuming 1.05-1.58 g/kg/d of protein saw improvements in strength and skeletal muscle [19]. A limitation to this study was not having subjects' previous protein consumption compared to the study consumption. As people age, there is a progressive and generalized skeletal muscle disorder known as sarcopenia, involving the accelerated loss of muscle mass and function. It occurs commonly as an age-related process in older people [21]. With age-related muscle loss increasing protein to a higher intake when compared to the lower standard (<1.2 g/kg/d) can help reduce muscle loss by improving muscle protein synthesis and promoting hypertrophy when combined with resistance training [1, 19, 20, 22].

In the athletic population, the recommended daily intake (RDI) is known to be too low (0.8 g/kg/d) for the demands of most sports and would benefit from a higher intake. A study observing collegiate male athletes and their perceived needs for protein intake found that most participants recognized that their protein needs were higher than the RDI and favored a protein intake closer to 2.0 g/kg/d [23]. Garthe et al. (2011)[24] examined the effects of slow versus fast weight loss in elite athletes. Lean body mass increased in the slow weight-loss group and was maintained in the fast weight-loss group despite a decrease in caloric intake. Protein intake was not controlled in the weight loss groups; however, the reported protein intake is categorized as medium. These studies further support that a lower protein intake may not be adequate when the protein turnover is higher than muscle protein synthesis, and a larger intake is needed [7, 20, 23]. Medium levels of protein intake can improve body composition and help reduce age-related skeletal muscle loss, all while showing no deleterious effects on renal function [6, 19].

High Protein Intake (>2.2 g/kg/day)

Results from studies consistently report consuming higher protein intake minimizes the loss of skeletal muscle during hypocaloric diets. This is well documented in studies involving overweight and obese individuals. Similar results are reported in active individuals. Although few studies examined the chronic (>4 weeks) effects of high protein intake during energy restriction. During hypocaloric diets, both lean body mass and fat mass are lost. In active individuals, especially elite athletes, preserving lean body mass is important for health and performance. Pasiakos et al. (2013)[25] reported the effects of various protein intakes (0.8 g/kg, 1.6 g/kg, and 2.4 g/kg) on body composition in subjects following a 40% energy deficit. All subjects lost weight. Both protein groups lost significantly more fat mass and lower skeletal muscle compared to the standard protein RDA. Contrary to the previously mentioned studies, Roth et al. (2021)[26], subjects following a hypocaloric diet lost significantly more body mass, lean body mass, and fat mass when compared to the control group. It is worth noting that both groups abstained from resistance training during this study.

The lack of activity could have contributed to a loss in lean body mass in both groups. Only the intervention group followed an energy-restricted diet, but all subjects in this study consumed 2.4 g/kg of lean body mass.). Thus the authors were unable to ascertain if greater losses of lean body mass would have occurred with a lower protein intake.

High protein intakes are shown to mitigate increases in fat mass despite an increase in overall caloric intake. Antonio et al. (2014)[27], reported no significant differences in fat free mass and fat mass despite an increase in energy intake due to increasing protein consumption to 4.4 g/kg/day. A follow up study was conducted, where 48 men and women engaged in a resistance training program and consumed a high protein diet (3.4 g/kg/d) or normal protein diet (2.3 g/kg) [28]. Both groups experienced increases in body mass and no significant differences in body composition were reported. Antonio et al. (2016)[29], conducted a randomized crossover trial where male subjects were instructed to increase their protein intake to >3 g/kg/day for eight weeks. No significant differences were reported in body composition. It is interesting to note that the habitual intake of protein (2.6 ± 0.8 g/kg) in this study is categorized as high. In a 6-month study, female subjects were instructed to follow a high protein diet (2.8±1.1 g/kg) [30]. No significant differences were observed in body composition. Once again, the habitual intake of these subjects (1.5±0.2 g/kg) was well above the general recommendation of 0.8 g/kg. A follow-up study was conducted by Antonio and colleagues in which female subjects followed a high (>2.2 g/kg/day) protein diet for one year [31]. In line with the previous study, no significant differences were observed in body composition or bone density for the duration of the study. The increased caloric intake reported in these studies was primarily the result of increasing dietary protein intake. It has been theorized the lack of statistically significant differences in body composition and body mass during a hypercaloric diet is due to the thermic effect of protein [27-32]. Diet-induced thermogenesis is greatest for protein which contributes to an increase in total daily energy expenditure [32-34]. Research suggests this increase in energy expenditure offsets or lessens the effects of increased caloric intake. A limitation of these studies was that dietary intake was self-reported via MyFitnessPal. However, it would be difficult to assess dietary intake for a prolonged period of time using other methods. Also, increasing protein during a hypocaloric diet sometimes results in a decrease in fat and/or carbohydrate intake and may be a contributing factor in fat loss. Nonetheless, these studies demonstrate that high protein intakes during chronic hypercaloric states do not cause excess accumulation of fat tissue.

The beneficial effects of consuming protein and engaging in physical activity is well documented. MPS is elevated after exercise, and sufficient amount of protein must be consumed to support the anabolic response. Inadequate intakes negatively impair muscle size and strength in active individuals leading to a "more is better" outlook on protein[35]. Pourabbas et al. (2021)[36], examined the effects of protein intake derived from dairy on indices of power and strength. Higher protein intakes (2.3 ± 0.2 g/kg) resulted in significant improvements in upper and lower body lean mass, strength, and power compared to the control (1.4 ± 0.1 g/kg). Hoffman et al. (2009)[37] examined the effects of protein timing in conjunction with resistance training and markers of strength. Male subjects were randomly assigned to pre/post (2.28 ± 0.78 g/kg/day), am/pm (2.16 ± 0.67 g/kg/day) protein ingestion, or control (1.58 ± 0.72 g/kg/day). All groups increased 1RM squat; however, only the subjects consuming protein supplementation increased 1RM bench press and peak power for squat. Higher protein intakes paired with resistance training contribute to increases in strength and offset decreases in MPS during energy-restricted diets.

Conclusions

Athletes and individuals engaged in regular physical activity require dietary protein intakes greater than the general recommendation of 0.8 g/kg/day. Based on the reviewed literature, low protein intakes, or those that fall below 1.2 g/kg, are insufficient to stimulate maximum MPS; thus recovery may be negatively affected as well as gains in lean body mass. Therefore, the minimum protein requirement for active individuals is 1.2 g/kg. Medium to high protein intakes are not only safe for healthy individuals but are beneficial for preserving lean body mass during weight loss. It is our recommendation that active individuals, particularly competitive athletes, consume protein at the higher end of the spectrum (i.e., 2.2 g/kg/day). The aforementioned studies suggest there are no health issues with higher protein intakes in healthy, active individuals and in all likelihood, a benefit vis a-vis body composition.

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