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Common Misconceptions Regarding Dietary Protein Intake in Active Individuals: A Narrative Review.

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ABSTRACT

Evans C, Mekhail V, Antonio J. Common Misconceptions Regarding Dietary Protein Intake in Active Individuals: A Narrative Review. **JEPonline** 2022;25(1):25-38. Nutrition strategies that ensure optimal protein intake are of paramount importance to physically active individuals. Dietary protein plays an essential role in skeletal muscle function, tissue repair, cell structure, regulatory functions, and immune health. The protein needs of individuals who engaged in regular physical activity are greater than the general population. The current evidence indicates that a protein intake above the RDA of 1.4 to 2.0 $g \cdot kg^{-1} \cdot day^{-1}$ are safe, enhance body composition, and support recovery following physical exercise. In spite of the aggregate of studies that support the safety and efficacy of higher protein intakes, misconceptions still exist. A few of the common misconceptions are as follows: (a) High protein intake causes kidney damage or renal failure; (b) Excessive protein intake is detrimental to bone health; (c) Only 30 g of protein can be absorbed at one time; (d) Excessive protein intake leads to weight gain; and (e) Only animal protein can help individuals meet their daily protein needs. The purpose of this paper is to address the misconceptions and to provide the evidence to refute them. Also, the evolutionary role of protein in the diet is highlighted.

Key Words: BMI, Exercise, Nutrition, Protein

INTRODUCTION

There have been continued efforts to advance the science and application of dietary protein intake for the benefit of athletes and fitness-minded individuals. Early research acknowledged that nutrient needs, specifically macronutrient recommendations, differ from the general population due to the physical demands of exercise (51,52). The current Recommended Daily Allowance (RDA) of protein is 0.8 $g \cdot kg^{-1}$ for the general or sedentary population (67). Active individuals and athletes are advised to consume greater amounts of dietary protein to support tissue repair, tissue remodeling, and protein turnover (5,6,37,57,67,72). An active individual is defined as any individual that regularly engages in the minimum physical activity requirements as put forth by the American College of Sports Medicine (66). According to the International Society for Sports Nutrition, protein intake in the range of 1.4 to 2.0 $g \cdot kg^{-1} \cdot d^{-1}$ is adequate for most exercising individuals. Moreover, the Academy of Nutrition and Dietetics recommends a slightly broader range of 1.2 to 2.0 $g \cdot kg^{-1} \cdot d^{-1}$ (37,67).

Exercise increases the rate of protein breakdown in tissues and protein intake aids in stimulating skeletal muscle protein synthesis and hypertrophy by promoting positive muscle protein balance (37,68,73). The role of protein in the body extends beyond tissue repair, including cell structure, regulatory functions, and immune health. Antibodies are comprised of proteins and needed for proper immune function. Protein malnutrition can impair the body's immune system and increase the risk of infection and healing (69). Unlike other macronutrients, the body does not store protein. Therefore, during times of inadequate (less than 0.8 $g \cdot kg^{-1} \cdot d^{-1}$) protein intake, the body will breakdown muscle tissue and other tissue proteins leading to compromised cellular function (57,72). The body is continually synthesizing and breaking down protein; this process is known as protein turnover (27,32,47,63,74). Whole body protein turnover is affected by dietary protein intake. Protein must continually be replaced through the diet to promote positive net muscle protein balance and support the optimal functioning of the body (57,68,72).

To promote an adequate intake of protein, strategies such as nutrient timing, using protein supplements, and choosing quality protein sources can be implemented (37,67,69,73). All essential amino acids are needed to sustain protein functions in the body. Animal protein sources contain all essential amino acids and are complete sources and superior to plant protein sources on a gram for gram basis (37,38,67). Most plant-based proteins are incomplete. Therefore, it is recommended to consume different plant sources to ensure all essential amino acids are being consumed (37,43,67).

Despite the plethora of literature available, controversies and misconceptions surrounding protein intake still exist. Some of the most common misconceptions are centered around the idea that high protein intakes can cause health issues, lead to fat gain, and those on a plant-based diet are unable to consume the necessary amounts of protein. Therefore, the purpose of this paper is to address the common misconceptions and to provide evidence-based interpretations of the literature pertaining to protein intake for active individuals.

DISCUSSION

Myth #1: Protein Intakes that Exceed the RDA May Cause Kidney Damage

It has long been purported that higher protein intakes (i.e., >RDA) cause kidney damage or accelerate renal failure. Older studies have reported elevated risks of microalbuminuria, kidney disease, increased glomerular filtration rate (GFR) and urinary nitrogen excretion (14,16,18,49). Brenner et al. (18) suggested deleterious effects of excessive protein intake are the result of increases in glomerular pressure and hyperfiltration. Furthermore, medical nutrition therapy for chronic kidney disease, stages 1-4 recommend protein intakes that differ from the RDA for the general population (15). It has been well documented that higher than normal protein intake can be harmful to individuals with existing renal issues or those predisposed to renal disease (15,18). Knight et al. (48) conducted a study assessing protein intake and kidney function via creatine concentrations in the blood. Female subjects completed food frequency questionnaires and various lab assessments over the course of 11 years. An increase in estimated GFR was associated with a 10 g increase in protein intake in subjects with mild renal insufficiency. In these studies, it is evident that protein intake is harmful for those with existing renal issues as opposed to causing renal issues.

Conversely, research in healthy individuals shows that higher protein intakes are not associated with adverse health effects. Resistance-trained men followed a diet that was up to four times greater than the RDA (i.e., 2.6 to 3.3 $g \cdot kg^{-1} \cdot d^{-1}$) for 8 weeks (8). Blood samples were collected following an overnight fast on three separate occasions. Renal function was assessed with the following labs: Blood Urea Nitrogen (BUN), globulin and Albumin/Globulin ratio. No changes were observed in the normal protein and high protein groups. Moreover, serum creatine levels, estimated GFR, BUN/creatine ratio, globulin and Albumin/Globulin ratio were all within normal range. In a follow up series of case reports, 5 male subjects were assessed for anthropometrics and potential adverse effects from following 2 years of a high protein diet. The subject’s average protein intake was 3.5 ± 1.4 $g \cdot kg^{-1} \cdot d^{-1}$. No significant changes in body composition were reported. Based on the group’s lab values (i.e., glucose, BUN, creatine, eGFR, ALT, and AST), a diet that on average was 4.4 times greater than the RDA did not have deleterious effects on liver and kidney function (7). Poortmans et al. (60) measured albumin excretion rate, nitrogen and calcium balance, and GFR in male athletes who normally consume greater than 1.35 $g \cdot kg^{-1} \cdot d^{-1}$ of dietary protein. Albumin excretion rates and eGFR were within normal ranges despite higher levels serum calcium concentrations. Similarly, Knight et al. (48) reported no changes in eGFR in healthy women with higher protein intakes. These studies confirm that higher protein intakes do not impair renal function in healthy individuals or those without renal issues. Some studies do report changes in eGFR, but these are attributed to the natural response of the kidneys (26). Renal functional reserve refers to the kidney’s ability to increase in GFR in response to stimuli such as an increase in dietary protein intake (26). Changes in GFR can also occur during pregnancy and later in life (26). In healthy individuals or those who are free of disease, changes in GFR are the body’s normal response to an increase in dietary protein rather than an increased risk for renal complications.

Summary: Higher protein intakes do not impair kidney function in otherwise healthy individuals.

Myth #2: Excessive Protein Intake is Bad for Bone Health.

A common misconception is high protein intakes can cause adverse effects on bone health. The acid-ash diet suggests an increase in dietary protein, specifically sulfur-containing amino acids creates an acidic environment in the body (30). In an effort to maintain homeostasis, the body pulls calcium from the bone to act as a buffer (26,30,44,45). Long-term reliance on bone to buffer the acidic environment is thought to lead to lower bone mineral density (BMD) and greater incidence of fractures (26,30,45). Previous studies have reported an increase in hip fractures in individuals consuming a western diet, which is typically higher in protein (21,33). However, these studies were observational and had numerous limitations such as methods for estimating protein intake, population type, and not accounting for other lifestyle factors (21,31). In fact, the literature suggests quite the opposite, that is, protein is essential for bone health (1). Adequate protein intake is necessary for developing and maintaining bone health (75).

Numerous studies have demonstrated higher protein intakes are not harmful to bone health (4,26,44,76). Kerstetter et al. conducted a crossover study where healthy female subjects 20 and 40 years of age were randomly assigned to moderate (1.0 $g \cdot kg^{-1}$) or high (2.1 $g \cdot kg^{-1}$) protein diets for 10 days with a 2-week adjustment period between each intervention. The subjects were provided with oral calcium supplements at each meal. Blood and urinary samples were collected for analysis and dual stable calcium isotopes were used to assess calcium kinetics. The high protein diet resulted in greater urinary calcium levels alongside intestinal calcium absorption. There were no significant differences in measures of bone formation, resorption, or balance between the diets. These results support the notion that hypercalciuria is not the result of bone resorption (44). Wright et al. (76) assessed the effects of whey protein (WP) supplementation on BMD in a double-blind, randomized, placebo-controlled study. Overweight and obese subjects 35 to 65 years of age consumed daily whey supplements. The subjects were randomly assigned to 1 of 4 doses of whey supplements (0 $g \cdot WP^{-1} \cdot d^{-1}$, placebo control, 20 $g \cdot WP^{-1} \cdot d^{-1}$, 40 $g \cdot WP^{-1} \cdot d^{-1}$ or 60 $g \cdot WP^{-1} \cdot d^{-1}$). Body composition and BMD were measured using Dual-energy X-ray absorptiometry (DXA). No changes in BMD and bone mineral content were reported. Antonio et al. (4) evaluated the effects of a high protein diet on bone mineral content in exercise-trained women (mean ± SD. Age years: control 36.0 ± 9.5, high-protein 37.3 ± 8.9). Subjects were randomly assigned to follow the control diet or high protein diet for 6 months (mean ± SD; control: 1.5 ± 0.3, high-protein: 2.8 ± 1.1 $g \cdot kg^{-1} \cdot d^{-1}$). DXA was used to measure body composition and BMD. The high protein group consumed significantly more than the control group, which was more than three times greater than the RDA of 0.8 $g \cdot kg^{-1}$ (67). However, no effect on bone mineral content (BMC) or BMD was found. A follow up investigation (i.e., protein intake of 2.3 ± 1.1 $g \cdot kg^{-1} \cdot d^{-1}$) that lasted 1 year also found no effect on BMD or BMC in trained females (39).

Summary: There is no evidence in active individuals that high protein intake adversely affects bone health.

Myth #3: Excess Protein Intake is Stored as Fat Mass.

Despite the plethora of literature that supports the efficacy of high protein diets (≥1.6 $g \cdot kg^{-1}$) in weight loss, the misconception that excess protein is stored as fat still remains. Three studies reported a positive correlation between high protein intakes and weight gain (2,34,39). In 2016, Hernandez-Alonso et al. (34) published a study assessing the effects of long-term high protein diets on body composition. The subjects (n = 7,124) were selected from an existing cohort and separated into 3 categories based on their protein intake (Low: >15% of energy intake; Normal: 15 to 20% of energy intake; High: <20% of energy intake), which was determined by food frequency questionnaires (34,55). Increased body mass, increased incidence of cardiovascular events, and higher risk of cancer related deaths were associated with higher protein intakes and lower carbohydrate intakes. But it is interesting to note that when protein intake was analyzed based on body weight rather (<1 $g \cdot kg^{-1}$, 1 to 1.5 $g \cdot kg^{-1}$, and 1.5 $g \cdot kg^{-1}$) than percentage of energy intake, no correlations between intake and weight were reported. The subjects had pre-existing risk for cardiovascular disease, which is a limitation of this study (34).

In an observational study carried out by Halkjær et al. (39), the effects of protein type and amount on weight status were evaluated. The subjects (n = 89,432) from other cohorts were followed for 6.5 years and anthropometric data were collected. Food frequency questionnaires were used to assess total protein intake and protein type (plant-based vs. animal). Higher protein intakes were not correlated with weight gain, however, protein intake from animal sources was associated with long term weight gain. In another prospective cohort study (2), anthropometric measures and FFQ were administered to subjects over the course of 5 years. A higher protein intake that appeared to replace carbohydrate intake was associated with weight gain. This trend was not observed in diets where protein replaced fat. A limitation in the aforementioned studies (2,34,39) was that the subjects were middle-aged or older (i.e., ≥36 to >50 years of age).

Recent studies (9,17) have found that a higher protein intake promotes favorable changes in body composition that includes a loss of fat mass and/or a gain in lean body mass. Bray et al. (17) conducted an overfeeding study evaluating the differences in protein intake on energy expenditure and weight. Healthy subjects were assigned to a low (5% energy intake), a normal (15% energy intake), or a high protein diet (25% energy intake), and 10 to 12 weeks in a metabolic chamber. After a weight stabilization period, the subjects were overfed during the last 8 weeks of the study. Resting energy expenditure was measured using a ventilation hood and doubly labeled water was used to measure total energy expenditure. Body mass increased in all groups. Interestingly, the low protein group gained less weight compared to the other groups and lost lean body mass. The normal and high protein groups gained lean body mass. As expected, increasing energy intake caused weight gain irrespective of protein intake. However, the higher protein intakes promoted an increase in lean body mass.

Similarly, Antonio et al. (9) observed the effects of a high protein diet in resistance trained men. Each subject consumed their normal protein intake for 6 months and a high protein diet for 6 months. Despite the 400-kcal increase in the high protein diet, the subjects did not experience an increase in fat mass. Also, protein is related to favorable changes in body composition in hypocaloric diets. Layman et al. (50) conducted a weight loss trial using a high protein and reduced carbohydrate diet compared to a low protein and high carbohydrate for 4 months. All subjects lost body mass. The high protein diet experienced a greater loss in body mass and decreases in body fat. A recent study conducted by Longland et al. (53) found that a high protein diet in conjunction with exercise not only preserved LBM, but increased LBM during a 40% energy deficit. In a review by Hector et al. (40), high protein intake, even in very low energy diet (VLED) were successful at preserving LBM and promoting greater fat loss.

These studies demonstrate that protein intake above the recommended amount leads to beneficial changes in lean body mass in both hypo- and hyperenergetic diets.

Summary: Current research demonstrates excess protein intake promotes increases in lean body mass and favorable changes in body composition in both hypo- and hypercaloric diets.

Myth #4: Only 30 g of Protein Can Be Absorbed at Each Meal.
It has been proposed that the maximum amount of protein the body can absorb in one meal is 30 g. Anything exceeding that amount is excreted, used for energy, or stored as fat (12,22,23,27,36,61). Previous studies have theorized that 20 to 30 g of protein provides the maximal benefit for muscle protein synthesis (MPS). Areta et al. (12) conducted a study evaluating the quality and timing of protein intake needed for MPS. Resistance trained subjects were assigned to 3 groups of varying protein intakes and timing distributions over the course of 12 hours: (a) 10 g of whey protein supplements every 1.5 hours; (b) 20 g of whey protein every 3 hours; and (c) 40 g of whey protein every 6 hours. Muscle biopsies and blood samples were collected pre-exercise and throughout the recovery phase. The authors concluded that 20 g of protein consumed earlier in the recovery phase was ideal for MPS. Moore et al. (58) observed similar results in a small study designed to identify protein dose response in MPS and albumin protein synthesis (APS). The subjects consumed 0, 5, 10, 20, or 40 g of whole egg protein drink. Only 20 g and 40 g of protein stimulated whole body leucine oxidation. Concentrations of essential amino acids (EAA) and branch-chained amino acids (BCAA) were greatest following the ingestion of 40 g of protein. It is important to note that these studies evaluated maximal anabolic response to protein intake. The authors did not evaluate utilization. It is common to conflate absorption with utilization. Certainly, there is sufficient evidence that demonstrates an increase in amino acid concentrations stimulate MPS to a point. Hence, dietary protein serves a purpose in the body outside of MPS.

Following an increase in protein consumption, rates of protein turnover increase, a greater amount of nitrogen is retained, and more amino acids, specifically leucine, are oxidized (32,63). After protein is broken down to amino acids, usually through hydrolysis, they can enter different metabolic pathways in the body. Excess protein consumed, beyond what is needed for biosynthesis, does not get excreted or stored without first being used. The surplus of amino acids can be oxidized for metabolic fuels like glucose through gluconeogenesis. Endogenous protein and other biological compounds such as transport proteins are synthesized from amino acids. Higher protein intakes result in greater rates of protein oxidation independent of whole-body protein synthesis. A lower protein intake may result in greater whole body protein synthesis because of the body's ability to efficiently use protein (32,74). Moreover, evidence suggests there is not a limit to the anabolic response to protein intake (15). Kim et al. (47) measured muscle protein turnover and MPS following the consumption of meals with different amounts of protein. The subjects who consumed 1.5 $g{\cdot}kg^{-1}$ of protein had greater levels of MPS and whole-body net protein balance compared to those who consumed 0.8 $g{\cdot}kg^{-1}$. In a follow up study, Kim et al. (46) measure whole body protein breakdown, synthesis, and net balance in response to meals containing 40 g or 70 g of protein. Net protein balance increased in both groups and was significantly higher in the high protein group (70 g). Both groups stimulated protein synthesis and protein breakdown, while the high protein group resulted in a significant increase in synthesis and breakdown. The authors attributed the results of both studies (46,47) to the decrease in muscle protein breakdown. These studies don not support the notion that the body can only absorb 30 g of protein in one sitting.

From an evolutionary perspective, the proposition that the body can only absorb a set amount of protein is likely erroneous. There is evidence to suggest that Hominins were consuming meat as early as ~2.5 million years ago (54). Meat (i.e., skeletal muscle) and organ meats (e.g., liver) are energy dense and provide vital nutrients, such as zinc, iron, b-vitamins, and protein (24). In hunter-gatherer and even paleolithic populations, food was not abundant as it is today. Seasonal fluctuations affected the availability of resources and created a food environment that is best described as feast or famine (24,29).

Despite the availability of certain edible plants year round, evidence shows preagricultural societies would still consume animal products due to their dense energy content (23). The consumption of animals even when plants were available demonstrate our innate need for protein. During times where meat was abundant, early humans likely gorged on animal meat. Unlike today, every part of the carcass was used or consumed (24). It can be speculated that more than 30 g of protein was consumed when feasting on animal carcasses. Protein intake during the paleolithic stage is estimated to have been $2.5 \pm 3.5\ g \cdot kg^{-1} \cdot d^{-1}$ (28). During times where survival was paramount, it is unreasonable to think the body will simply excrete protein in excess of 30 g. Rather, the body will use all energy and macronutrients in order to survive.

Summary: There is no evidence that humans have a 30-g limit of dietary protein in a single meal. Furthermore, it makes no evolutionary sense that such a limitation exists.

Myth #5: One Must Consume Animal Protein to Meet Daily Protein Needs.
There are multitude reasons why an active individual may choose to eliminate meat and other animal products from his or her diet. These reasons range from improving performance, strength, ethical, and moral issues to alleged health benefits purported by the social media (60,61,70). Numerous studies report micronutrient deficiencies and lower intake of protein in individuals who follow a vegetarian diet (70). Additionally, since digestibility of plant protein is lower than animal proteins, that is, apart from quinoa and tofu, plant-based foods do not have a complete amino profile (25,61,70). Therefore, vegetarians must consume different plant-based proteins throughout the day to consume the full amino acid profile. Studies (13,33,71) involving MPS have reported a superior response to whey protein compared to plant-based protein. Volek et al. (71) reported that after a 9-month consumption of a whey or soy protein supplement, despite similar protein intake in both groups, whey protein resulted in greater increase in lean body mass and increased plasma leucine. Hartman et al. (33) compared 5 weeks of post-workout consumption of a milk-base drink to a soy-based drink. Both soy and milk groups lost body fat, while the milk group experienced a greater loss of fat mass and a significant increase in lean body mass. Deficiencies associated with poorly constructed vegetarian diets and enhanced quality of animal protein compared to plant proteins perpetuate the notion that adequate protein intake is not possible when it is plant-based.

Research elucidating diets of vegetarian athletes confirm that it is possible to consume enough protein and, in some instances, the amount exceeds the RDA. Work by Nebel (68) compared the nutrient intake of omnivorous, lacto-ovo vegetarian and vegan runners. Both the lacto-ovo and vegan consumed more than the RDA of protein for the general population. Additionally, Banaszek and colleagues (13) highlighted different plant-based proteins that are comparable to whey protein. The authors examined the differences in whey and pea protein supplementation on body composition and measures of strength. The subjects were randomly assigned to consume pea protein or whey protein supplement for 8 weeks while engaged in a high-intensity functional training program. No significant changes in body composition, both pre and post and between groups, were reported. Both groups improved strength, specifically 1-RM in squats and deadlifts.

The abovementioned studies demonstrate the ability of plant-based protein to promote favorable changes in body mass and support overall muscle health during physical activity. The nutrient needs of the physically active population differ from their sedentary counterparts. Just as an active individual must increase his or her intake of energy and specific nutrients, special considerations are needed to minimize the risk of nutrient deficiencies vegetarians (37,57,67,72). It is clear that with careful planning, vegetarians can consume adequate protein in their diet.

Summary: Although multiple research studies demonstrate the superiority of milk-based protein compared to plant-based protein, it is clear from other research that plant-based protein promotes favorable changes in body mass and health when consumption exceeds the RDA.

CONCLUSIONS

The human body has experienced physiological and morphological changes. These changes occurred in response to changes in diet and the availability of animal foods. Early *Homo* needed to consume large amounts of plants, which have low digestibility to survive (56). As animal foods became a staple in the diet, our ancestors were able to obtain all essential amino acids and other nutrients from smaller amounts of animal foods compared to plant foods. The increase in animal consumption led to reduced gut size and increased absorption (20). There was minimal risk of digestive issues related to animal protein due to changes in gut anatomy and digestive kinetics (56) along with an increase in brain size. Two hypotheses are offered as an explanation for increase in brain size. Foraging strategies increased the consumption of energy and protein contributing to encephalization (20). Irrespective of increased cognitive demands (social brain hypothesis) or the brain to accommodate a larger body (ecological hypothesis), diet is a major contributing factor to brain growth.

Interestingly, the protein leverage hypothesis suggests that the body will increase energy intake as a means to consume protein when dietary protein intake in low (35,64). In times of protein scarcity, fibroblast growth factor-21 signals the body that more protein is needed and stimulates the appetite for protein-rich foods (41,65). Dietary protein aids in satiety and regulates appetite (10,19). Despite the history of evolution and our primal need for protein, myths related to protein intake still exist.

Protein is an important macronutrient in the diet of physically active individuals (5). It supports recovery, promotes the preservation of lean body mass, and can serve as an energy substrate when carbohydrates are unavailable. The safety and efficacy of protein is a much-discussed sports nutrition topic. In a time where research on protein intake in exercise abounds, common misconceptions still exist. Notwithstanding older studies that found higher protein intakes to exacerbate problems in individuals with existing renal issues, higher protein intakes do not cause renal failure or damage in healthy individuals. Excessive protein intake is not detrimental to bone health. On the contrary, an adequate intake of protein promotes greater bone mineral density and is essential for bone health. During hypo- and hypercaloric diets, higher protein intakes may promote favorable changes in body composition. More than 30 g of protein can be consumed at each meal. Excess protein can either be used for substrate utilization or enter the amino acid pool. Finally, although adequate protein can be consumed on a vegetarian diet, physically active individuals following a vegetarian diet must carefully plan their intake of nutrients to ensure that an adequate amount is being consumed. Protein intake is a part of our genetic framework, and it is still essential in today's diet.

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