

Is the Optimal Level of Protein Intake for Older Adults Greater Than the Recommended Dietary Allowance?

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Background. Protein is a macronutrient essential for growth, muscle function, immunity and overall tissue homeostasis. Suboptimal protein intake can significantly impact physical function and overall health in older adults.

Methods. This article reviews the literature on the recommendations for protein intake in older adults in light of the new evidence linking protein intake with sarcopenia and physical function. Challenges and opportunities for optimal protein nutrition in older persons are discussed.

Results. Recent metabolic and epidemiological studies suggest that the current recommendations of protein intake may not be adequate for maintenance of physical function and optimal health in older adults. Methodological limitations and novel concepts in protein nutrition are also discussed.

Conclusion. We conclude that new research and novel research methodologies are necessary to establish the protein needs and optimal patterns of protein intake for older persons.

Received July 3, 2012; Accepted October 15, 2012

Decision Editor: Stephen Kritchevsky, PhD

MANY studies have focused on energy, fat, fiber, and micronutrient intake as modifiable dietary factors for prevention and treatment of diseases and conditions commonly associated with aging, such as hypertension, obesity, diabetes, cancer, and osteoporosis. Although dietary protein is well known to be an essential macronutrient for growth, muscle function, immunity, and overall tissue homeostasis, research on protein requirements has been given a lower priority under the assumption that protein intake is more than adequate, particularly in Western societies. In this perspective, we will discuss the possibility that some older adults may, in fact, consume an insufficient amount of dietary protein for maintenance of physical function and optimal health and call for new research to determine protein needs and optimal patterns of protein intake for older persons.

Challenges and Opportunities for Optimal Protein Intake in Older Adults

Older adults are at increased risk of suboptimal protein intake. [Table 1](#) summarizes the risk factors for suboptimal

protein intake in older adults along with the potential causes and impact.

Although food insecurity among older adults is notable, on average, older people spend more on food than younger individuals (10). Among home bound older adults, convenience (59%), sensory appeal (56%), price (48%), weight control (40%), familiarity (38%), and health (30%) were rated as “very important” motivations underlying food choices (2). Well-designed and evidence-based nutritional interventions can improve food choices and other health behaviors even in low-resource older adults (11). However, diversity in age, socioeconomic status, functional status, health, and culture makes it challenging to communicate and to improve food choices for optimal health in older people, particularly when there is some uncertainty about the optimal intake of some nutrients, such as protein.

Current Recommendations

Nutrient requirements for Americans are set by the Food and Nutrition Board, National Academy of Sciences and

Table 1. Risk Factors for Reduced Protein Intake in Older Adults

Risk Factors	Causes and Impact
Reduced energy needs	The majority of older persons consume the same proportion of their energy intake from protein as do young adults. Thus, the quantity of dietary protein progressively declines with advancing age due to reduced energy needs and intake (1).
Physical dependence	Difficulty acquiring and preparing food. About 20% of homebound older adults had protein intakes less than the Recommended Dietary Allowance (2).
Anorexia	Overall reduction in energy and protein intake, mainly due to underlying disease, neurosensory changes in appetite and food preference, as well as poor dentition (3,4).
Change in food preference	Preferential consumption of protein-rich foods may decrease with aging, potentially reducing protein intake in favor of carbohydrate and fat-rich foods (5,6). Thus, reduced protein intake may coexist with normal or relatively high energy intake.
Food insecurity	Limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire foods in socially acceptable ways, which is associated with inadequate nutrition and poor health. Approximately 4 million adults aged 60 and older and about 8% of households with older adults had experienced food insecurity (7). The prevalence is high among older adults receiving or requesting congregate meals, home-delivered meals, and other community-based services (8). It is paradoxically associated with both obesity (9) and poor-quality diets low in protein and other nutrients (7). It is also associated with poorer self-reported health, depression, limitations in activities of daily living, and diabetes.

published as the Dietary Reference Intakes. The current Recommended Dietary Allowance (RDA) for protein is 0.8 g/kg-d of good quality protein, which is set at two standard deviations above the Estimated Average Requirement (EAR, 0.66 g/kg-d) and is the same for healthy adult men and nonpregnant women of all ages, including older adults. The evidence available when protein recommendations were established was not viewed as sufficient to alter the requirement for physical activity level. At the RDA, the needs of most (97%–98%) of the adult population should be met. National Health and Nutrition Examination Survey data indicate that mean protein intakes of Americans, including those more than 70 years of age, meet or exceed the RDA. However, variability is large. A significant proportion of older adults (approximately 10%–25%) eat less protein than the RDA and approximately 5%–9% of older persons, particularly women, consume less than the EAR of protein (1). Considering that the EAR is the mean protein intake at which the needs of the healthy population are met (ie, the EAR is insufficient for about half of the population), the proportion of older adults at risk of inadequate protein intake, based on the DRIs, is potentially large, and even larger for older patients with chronic or acute illnesses.

The EAR and RDA are calculated based on the results of nitrogen-balance studies. Using this methodology, the EAR is taken to be the average minimal amount of protein

(nitrogen) intake to balance nitrogen excretion and avoid progressive loss of body protein over time in healthy persons. The RDA is assumed to be sufficient to meet the dietary needs of virtually all healthy adults. However, rigorously controlled, nitrogen-balance studies are necessarily small. Moreover, low-protein diets can induce adaptations to spare nitrogen (12,13), making it difficult to determine the level of intake for optimal function, rather than the lowest tolerable protein intake to avoid deficiency. Over the past 30 years, a modest number of short-term nitrogen-balance experiments have been conducted to estimate the protein needs of older adults. The results of these studies are mixed and inconclusive, some supporting that the current RDA is adequate (14–16), whereas others indicating that higher intakes are needed (13,17,18) to meet the dietary needs of virtually all healthy older adults. Regardless, prevention of nitrogen loss may be an inadequate outcome for older adults, many of whom already present a significant lean mass loss (sarcopenia). However, nitrogen-balance studies have not addressed the possibility that protein intake well above the RDA could prove beneficial in healthy individuals. Conversely, limited data suggest that chronic ingestion of the RDA for protein results in reduced skeletal muscle size in weight-stable older adults, whereas muscle function was unaffected (19). Data from the Health, Aging and Body Composition (Health ABC) cohort indicate that a lower energy-adjusted protein intake in healthy older adults is associated with a larger loss of lean body mass over a period of 3 years of observation (20). These initial observations have been corroborated by more recent data from the InChianti and the Women's Health Initiative cohort studies, supporting the notion that a higher protein intake is also associated with reduced risk of strength loss and incident frailty (21,22).

Notably, if the RDAs for protein, carbohydrate, and fat are added, only approximately one third of the energy requirement is satisfied, underscoring the minimalistic nature of these parameters in the context of a complete diet. For planning intakes to minimize chronic disease risk, the Food and Nutrition Board also expresses dietary recommendations as the Acceptable Macronutrient Distribution Range (AMDR), which is based on a variety of data, including epidemiological studies. The AMDR for protein is set between 10% and 35% of energy deriving from protein, with the lower end of the distribution being approximately at the current RDA and the upper end of the distribution being at approximately 3 g/kg-d. However, older adults (especially women) may consume protein intakes within the AMDR, yet below the EAR (1). The broad AMDR range reflects the current uncertainty regarding the optimal level of protein intake in any population. Given the limitations underlying both RDA and AMDR, it becomes important to define and evaluate novel and more sensitive measures to determine the optimal protein intake for maintenance of health and independence in older persons.

New Evidence

An important concept to keep in mind is that adequate protein intake is critical for muscle homeostasis as it provides essential amino acids to replace those lost via catabolic pathways and support protein accretion and growth. Unlike glycogen for glucose and triglycerides for fatty acids, there are no inactive storage compounds for amino acids, which must be incorporated into functional proteins. Skeletal muscle contractile proteins are the largest functioning storage system for essential amino acids, making the muscle susceptible to significant losses in conditions of need, such as fasting and critical illness (23). Maintenance of muscle mass thus is critical not only for adequate function but also for disease outcomes. For example, muscle wasting in cancer and chronic obstructive pulmonary disease is associated with increased morbidity and mortality (24,25). Large cohort studies have also shown that muscle strength and measures of function, such as gait speed, can predict mobility decline, disability, and mortality (26–28).

Essential amino acids, particularly leucine, can directly stimulate muscle protein synthesis by activating translation initiation via the mammalian Target Of Rapamycin (mTOR) pathway (29). The stimulatory effect of an amino acid or protein meal on skeletal muscle protein synthesis is large and occurs rapidly, but lasts only a few hours (2–3 hours) (30,31). Metabolic studies have demonstrated that utilization of dietary amino acids for skeletal muscle protein synthesis in healthy older adults is impaired compared with younger persons when the dose of essential amino acids, leucine in particular, is low (31–35). The threshold dose of leucine for stimulation of muscle protein synthesis in older adults appears to be approximately 3 g (36), corresponding to approximately 25–30 g of a high quality protein. From these data, we can infer that any meal containing less than the threshold dose of leucine would be less anabolic for skeletal muscle in older adults. National Health and Nutrition Examination Survey III data show that older adults consume approximately 50% of their daily protein at dinner and have a mean daily intake of about 0.9 g/kg-day (37). Thus, we can extrapolate that an average 70-kg older person would consume enough protein to maximally stimulate skeletal muscle protein synthesis only with dinner (approximately 31 g). The other meals and snacks would contain insufficient protein to maximally stimulate synthesis, possibly leading to utilization of dietary amino acids through other pathways, for example oxidation and lipogenesis. Redistribution of protein intake so that older adults consume approximately 30 g protein at multiple meals has been proposed as a countermeasure to sarcopenia (36), but this hypothesis must be tested in randomized controlled trials to establish its validity.

Diversion of dietary amino acids toward lipogenic pathways under conditions of high energy intake may also be responsible for development of sarcopenic obesity. Sarcopenic obesity is characterized by obesity with muscle

mass loss and impairment in function (38), increasing the risk of disability (39). Depending on the working definition and methods, the prevalence of sarcopenic obesity in older populations has been estimated to be as high as 20% (40). Inflammation-promoted declines in muscle mass, and a vicious cycle of decreased physical activity and accumulated disease burden, are likely key factors in the development of sarcopenic obesity (41). There is still debate in the community of geriatricians regarding the appropriateness of weight loss in older adults due to the association of involuntary weight loss with adverse outcomes and findings that overweight and mild obesity are associated with lower mortality rates (42). There have also been concerns for potential losses of muscle and bone mineral during weight reduction. However, recent studies suggest that weight loss may be feasible and beneficial in older adults with obesity, particularly when associated with an exercise program for maintenance of muscle and bone mass (43). Additionally, hypocaloric diets for sarcopenic obesity in older persons should supply adequate protein, which may help prevent muscle loss (44) and improve adherence to low energy intake (45).

Physical activity level may significantly impact the muscle ability to retain dietary amino acids in older persons, and should probably be considered when determining the optimal protein intake. Exercise enhances the ability of skeletal muscle to synthesize more contractile proteins in young and older adults (46) and improves the muscle protein anabolic response to a meal in older adults (47). Conversely, profound inactivity, such as bed rest, significantly impairs muscle protein synthesis in response to amino acid stimulation in older adults (48). However, excess amino acids during inactivity can help maintain muscle mass in older adults (49).

Should the Guidelines for Protein Intake in Older Adults Be Revised?

Although the RDA of protein is probably sufficient for most sedentary or low-active adults to avoid protein inadequacy, it may not provide a measure of optimal intake to maintain health and maximize function in older adults. Avoidance of net nitrogen losses may be an inadequate outcome for older sarcopenic individuals, for whom net lean mass gains are desirable. Moreover, when the RDAs for macronutrients are added, only about one third of energy requirements are met. It is unclear how much protein should comprise the two thirds of energy intake above and beyond the sum totals of the RDAs.

The growing evidence that levels of protein intake greater than the RDA may benefit older individuals has not been yet considered by recent committees deliberating recommendations for dietary nutrient intake. Table 2 summarizes the agenda for future research. In addition to well-designed longitudinal studies, there is also the need for randomized

Table 2. Agenda for Future Research to Determine the Optimal Level of Protein Intake for Older Adults

Action	Objective
Develop novel methodologies	Establish innovative outcome measures to determine the impact of protein intake on functional and health outcomes in older adults.
Design innovative longitudinal studies	Expand the current notion of total daily protein intake to examine the associations between protein intake distribution across meals on health and functional outcomes in older adults.
Randomized clinical trials	Design novel nutritional interventions to optimize protein intake aimed at improving function and health outcomes in older adults, including the hypothesis that timing of protein intake across meals has an impact on the health and functional status of older adults. Independent studies will also be needed to address the needs of healthy and frail older adults and to address the needs of older persons with chronic and acute illnesses.

controlled trials to determine the optimal protein intake for better health and functional outcomes in older adults and to test the hypothesis that timing of protein intake across meals in older adults has an impact on these parameters. It is necessary to develop novel methodologies and establish new endpoints, including functional outcomes, which would be deemed universally acceptable for determination of the optimal level of protein intake in older adults. Until this type of research is designed and performed, it will remain difficult to reach a consensus regarding the optimal level of protein intake for older people to consume.

FUNDING

This article summarizes the conclusions of an expert panel discussion organized and funded by the American Federation for Aging Research (AFAR). This article was also supported in part by the National Institute on Aging grant number P30 AG024832.

CONFLICT OF INTEREST

E. Volpi: travel support from Abbott and Nestle. W. Campbell: member of the Whey Protein Advisory Panel for the National Dairy Council. R.R. Wolfe: consultant for the National Cattlemen's Beef Association

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