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VIEWPOINT

Potential benefits of improved protein intake in older people

Beryl DAWSON,[1] Jayne TAYLOR[1] and Emmanuel J. FAVALORO[2]

[1]Department of Nutrition & Dietetics, Balmain Hospital, Balmain, and [2]Institute of Clinical Pathology and Medical Research (ICPMR), Westmead Hospital, Westmead, New South Wales, Australia

Abstract

Ageing is associated with an increased incidence of diabetes, impaired immunity and numerous physiological, social and economic changes. Another under-recognised change to significantly impact on health outcomes and quality of life is the drastic loss of lean body mass. New concepts have recently emerged which indicate that different types of protein sources supply constituents differentially according to digestion rate, and that amino acids have roles additional to muscle synthesis. This review explores the benefits of higher protein intakes in older people and how the protein source may provide differential benefits. In particular, whey protein is more quickly digested than either casein or soy, and provides a faster and potentially greater net source of available nutrients and essential amino acids essential for maintaining better health.

Key words: whey, casein, supplementation, older people, frailty, muscle, protein, amino acids, sarcopaenia.

INTRODUCTION

Ageing is associated with many physiological, social and economic changes.[1] Additional to the increased incidence of diabetes and impaired immunity[2] is the drastic loss of lean body mass,[3] an often under-recognised cause of adverse health outcomes and quality of life. It has long been recognised that numerous dietary parameters (including amount and type of protein) affect protein metabolism.[4] New concepts have recently emerged which indicate additional roles for amino acids beyond muscle synthesis, and that different protein sources supply constituents differentially according to digestion rate.[5] The main aim of this review of the protein needs of older people is to evaluate the benefits of higher protein intake and the potential for differential provision of amino acids and other nutrients according to dietary protein source, and what affect this might have on health status.

METHOD

Literature searches conducted using the web, OVID, Medline and additional resources of the Cochrane Library, using various combinations of the following key words: whey, casein, supplementation, older people, frailty, muscle, protein, amino acids and sarcopaenia. These searches resulted in a number of relevant articles, which were subsequently reviewed for content to provide additional material.

AGEING, DECLINE OF MUSCLE MASS AND ROLE OF PROTEIN

The drastic loss of lean body mass that accompanies aging[3] is more serious than simply physical weakness. Muscle mass, in the absence of adequate amino acid ingestion or absorption, serves as the primary source of amino acids, which in turn maintains protein synthesis in vital tissues and organs, supports gluconeogenesis,[6] and ensures health maintaining systems such as immunity and wound healing.[7] Loss of protein stores may arise for several reasons, including reduced intake, and are often secondary to, or exacerbated by, illness or prolonged hospital admissions. The average adult gains ~500 g of fat, but simultaneously loses ~250 g of muscle, every year between the ages of 30 and 60 (Figure 1), and by 70, skeletal muscle accounts for only about 27% of total body weight, which may remain constant or increase but actually reflect a higher proportion of body fat.[8–10]

Wasting, cachexia and sarcopenia are the three main recognised causes of muscle loss in older people (Table 1). The prevalence of sarcopenia has been estimated to increase from 13% to 24% of persons under age 70, to over 50% of those aged over 80.[3] Cachexia is distinguished from wasting by the presence of an acute immune response,[11] and is frequently associated with many age-related diseases (e.g. cancer,

B. Dawson, Dip Nut Diet, APD, Clinical Nutritionist & Dietitian
J. Taylor, MND, APD, Acting Food Service Manager
E. Favaloro, PhD, MAIMS, Senior Hospital Scientist
Correspondence: Beryl Dawson, Booth Street Balmain, Balmain, NSW 2041, Australia. Email: beryl.dawson@optusnet.com.au

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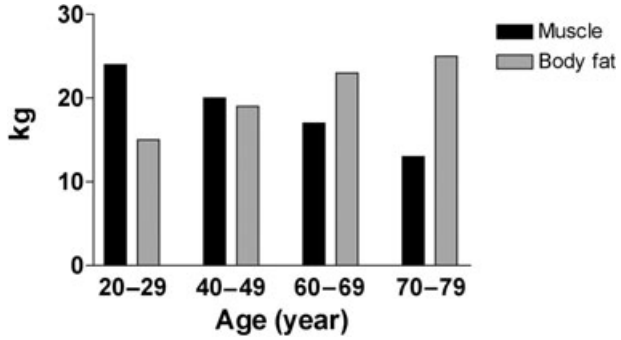

Figure 1 Body composition changes in normal male adults. Adapted from Phillips.[9]

chronic cardiac failure, periods of metabolic stress including infections and pressure ulcers). The release of cytokines results in increased resting energy expenditure, muscle breakdown and a shift from the production of albumin to acute phase proteins.[11] While weight loss frequently occurs with wasting or cachexia, sarcopenia is frequently, but contra-intuitively, associated with obesity, and is more often related to increasing levels of dependency, immobility and frailty.[11,12] Indeed, in older people, low nutrient intakes, including protein, are independently associated with frailty, and neither weight nor weight loss is a sensitive proxy measure of inadequate intake.[12] Frailty leads to an increased demand for medical and social care, which leads to increased economic costs. Indeed, the direct healthcare costs of sarcopenia were estimated at $18.5 billion in the USA in the year 2000.[13] As demographic trends indicate a rise in the older population, this healthcare burden will increase. Although energy needs often fall with ageing, few older people compensate by increasing the nutrient density of ingested foods.[14,15]

Lack of physical activity and sedentary lifestyles are certainly central to the development of sarcopenia. However, many other factors are also thought to be involved. Although not fully understood, these are likely to include disturbances in hormonal, neural and cytokine activity, which may be exacerbated by impairment in protein turnover rates and inadequate nutritional intakes.[11] Indeed, poor nutrition and in particular low protein intakes may directly participate in the loss of protein mass during ageing.

The consequences of reduced muscle mass are greater than simply loss of strength, and include an increased risk of dehydration, reduced metabolic rates and consequent lower energy needs. This may result in increased adiposity and impaired glucose tolerance. As skeletal muscle is responsible for ~80% of postprandial glucose uptake, the preservation of muscle lessens the burden of diabetes.[15] Furthermore, the depletion of body cell mass (mainly muscle) is both associated with poor survival and a frequent observation in cancer and cardiac cachexia.[16,17]

During hospitalisation, loss of muscle mass, strength and function causes sustained physical impairment and contributes to delayed recovery.[18] Pre-existing deficiencies of muscle mass before trauma may also push individuals over a threshold that prevents recovery to pre-morbid levels. As a stark example, ~50% of women older than 65 years who fracture a hip in a fall will never walk again.[19] While not all these would necessarily be related to low muscle mass, muscle strength and function are central to recovery.[6]

WHAT ARE THE PROTEIN NEEDS OF OLDER PEOPLE?

Dietary protein needs, established by the Recommended Daily Intake (RDI), are currently defined as the 'average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group'.[20] The Australian RDI of protein for (healthy) men and women aged 70 and over, is 1.07 g/kg and 0.94 g/kg, respectively.[20] However, these figures are based on a small number of inconsistent studies, with most actually performed in young healthy people.[21] Emerging evidence of additional metabolic roles for some amino acids suggests a need to increase required plasma and intracellular levels above currently recommended 'minimum' needs.[21] Indeed, the optimal protein intake based on estimates from acute metabolic studies of muscle metabolism, as proposed by one prominent group of workers, is close to 1.8 g protein/kg/day (i.e. nearly twice the currently reported RDI).[6] Although further studies are required to determine which target represents the true protein needs of older people, both within the community and within hospitals and other institutions, it might be wiser to err on the side of increased supply, than to potentially provide diets with insufficient protein.

Accommodation to low protein intakes does occur with serious adverse consequences and compromised functions of daily living, loss of lean tissue and impaired immunity.[22] Importantly, body weight can remain constant because of over-feeding of overall energy needs relative to expenditure.[22] The consequence of inadequate protein intake or even adequate by current (RDI) guidelines, during periods of illness, is therefore likely to be decreased rates of healing and a greater likelihood of infections, further reducing muscle mass and hastening functional decline.[6]

The estimated energy intake of older people in hospital is frequently less than 1500 kcals with around 15% of energy from protein.[23,24] Few older people compensate for this lowered energy intake by eating foods with higher nutrient density. Although this is especially true of those requiring a modified textured diet,[23] with most not meeting basic protein requirements, many other elderly hospitalised patients will similarly ingest only around half their energy needs.[24] Raising the proportion of protein in hypo-caloric diets improves body composition by increasing the relative loss of fat and reducing the proportional loss of muscle mass.[25]

There are several reasons why older people have inadequate intakes; some factors are simply remedied and others more complex and difficult to address. A combination of lack of choice, poor appetite, early satiety, poor dexterity, poor dentition and lack of awareness regarding better nutrient choices are some well-recognised reasons.[12,26] Within hospitals, food presentation may present additional

Table 1 Defining muscle loss

	Weight	*Fat*	*Muscle*	*Cause*
Wasting	↓	↓	↓	Usually inadequate intake; secondary to disease, psychosocial factors, cachexia and/or sarcopenia
Cachexia	↓	↓↓	↓↓	Catabolism, raised metabolic rate, protein degradation; characterised by presence of acute immune response
Sarcopenia	↔	↑	↓	Loss of muscle mass; exact aetiology unknown

Adapted from Hickson.[11]

Table 2 Origin, production method and source of proteins

Protein source	*Origin/production method/details*
Casein	Major (80% of) milk protein
Caseinates	Skim milk; protein fractions separated using calcium, sodium and/or potassium
Whey protein concentrate	Protein content 30–90%; contains fat and lactose
Whey protein isolates	Protein content >90%; contains very little fat/lactose
Milk protein isolate	Skim milk; casein and whey proteins isolated together
Skim milk powder	Dried skim milk; ~35% protein; contains lactose
Soy protein isolates	De-fatted soymeal; ~90% protein
Soy protein concentrates	Dehulled/defatted soybean; ~70% protein; some carbohydrate removed

Information sourced and summarised from: http://www.wheyoflife.org/faq.cfm#3, http://www.myhealthmanagement.com/proteinsources.html and http://www.soyabean.be/soy-protein.plp. Accessed: 16 April 2007.

challenges, with up to 10 (PC) items individually wrapped and requiring opening. Whatever the cause, common hospital intakes are often inadequate, both in protein and in micronutrients.[27,28] Indeed, inadequate nutrient intake is likely in up to half of all older people,[27] and up to twice as likely to occur in the obese.[28]

ORAL SUPPLEMENTS: BENEFITS AND PROTEIN SOURCES

Although animal proteins (e.g. lean meat, fish, chicken) are excellent sources of essential amino acids,[15] consumption of these in the elderly may be limited by poor dentition,[26] cost and reduced mobility (e.g. shopping, cooking). Nutritional supplementation offers an additional protein source to improve nutritional status, and is frequently used to assist rehabilitation. Supplementation can reduce the number of non-elective readmissions;[29] improve the rate of pressure ulcer healing;[7] and in conjunction with high-intensity resistance exercise, is a feasible and effective means of counteracting muscle weakness or physical frailty.[30] There are a variety of protein sources used in liquid or powdered commercial protein supplements (Table 2), with the most common based on milk (either whey and/or casein) or soy protein.

Whey protein, traditionally seen as a by-product of cheese making, is being recognised as an excellent source of amino acids, particularly for older people. The amino acid profile of whey protein is closer to that of human milk, and whey protein is more easily and rapidly digested than caseinates or soy-based protein.[31] Post intake, casein forms a clot in the digestive system, and results in a slow (pH dependent) and sometimes incomplete release of amino acids.[32] Additionally, soy protein results in lower nitrogen retention than milk protein does.[33] Many older people have achlorhydria or atrophic gastric[1] or are prescribed proton pump inhibitors, which act to raise the gastric pH (to greater than pH 4.0). This may further limit the availability of the amino acids provided by casein and soy-based protein.

Soy and milk proteins also differ in amino acid composition.[33] Soy contains lower levels of methionine, branched-chain amino acids, leucine and lysine and higher levels of aspartic acid, glycine and arginine than milk protein. Compared with caseinates, soy-protein or whole milk protein, whey protein concentrates are generally higher in the sulphur containing amino acids (methionine and cysteine) as well as tryptophan and leucine.

In elderly people, the duration and magnitude of elevated plasma amino acids are key factors responsible for positive protein metabolism, particularly at the muscle level, and ingestion of whey protein can stimulate greater muscle protein synthesis than ingestion of an equivalent amount of isolated essential amino acids.[34] Accordingly, supplements with a higher whey content are likely to be better utilised by older people, and are likely to yield a higher net source of nutrients and essential amino acids. Coupled with the common finding of smaller appetites and earlier satiety in older people, the provision of the right amount of amino acids within a smaller volume is likely to yield an improvement in both compliance and protein intake.

Effects on muscle

Muscle protein synthesis has been shown to double in the fed versus fasted state[15] with additional significant muscle

degradation in times of sepsis, infection and trauma. Timing of protein intake in older people is also important, both for protein retention and for insulin reponse,[35] with protein synthesis stimulated by increases in amino acid concentration and protein breakdown inhibited by postprandial hyperinsulinemia or a slight increase in amino acid concentration.[5] Thus, larger bolus intakes of protein appear more effective at stimulating muscle synthesis in older people than ingestion of similar amounts of protein spread over several small meals,[35,36] in apparent contrast to the young adult.[4,36–38] Evidence is also emerging that the amino acid profile of dietary protein, in particular branch-chain amino acids, may directly effect insulin secretion and work together to help stimulate protein synthesis in muscle.[39] Indeed, leucine is a regulator of translation initiation of protein synthesis, a substrate for production of alanine, glutamine and protein synthesis and a modulator of insulin action, and this activity is dependent on dietary intake and increasing leucine concentration in skeletal muscle.[39,40] Although it is currently not clear whether whole protein or composite amino acids is most relevant, it is known that some amino acids (e.g. leucine) are more important than others with respect to muscle anabolism[40] and that protein gain and muscle protein synthesis is greater with whey.[10] This may partly relate to better 'digestability' as well as its near identical amino acid profile composition to skeletal muscle. Further, whey protein is better than casein at improving postprandial plasma amino acid concentrations.[41]

Effect on immune system

Ageing is associated with reduced cell mediated immune responses, and under-nutrition, common in sick older people, induces further reduction,[2] exacerbated by micronutrient deficiencies such as zinc, selenium and vitamin B6. Ageing is associated with increased levels of oxidative stress, leading to damaged cell membranes and proteins, and thought to be responsible for many chronic diseases resulting from an inability of the immune response to initiate an adequate cellular defence. Also, tryptophan is degraded via the kynurenine pathway during times of stress or inflammation, making it unavailable for protein synthesis.[42] Glutathione is a major antioxidant, essential for the proliferation of lymphocytes, and plays a pivotal role in metabolic and cell-cycle-related functions in virtually all cells.[43] Cysteine is the rate-limiting step in the production of glutathione, but glutamate and glycine are also important. Low intakes of protein further inhibit the immune response, as rapid protein synthesis is required to initiate and maintain an immune response.[10] Furthermore, the RDI for protein, although sufficient for maintenance of nitrogen balance may be insufficient for maintenance of cellular glutathione,[43] particularly in times of stress and supplementation of whey protein, has been shown to increase plasma glutathione levels in deficient patients,[44] and prevent the relapse of Clostridium difficile-diarrhoea in prone individuals.[45] Accordingly, current research suggests that whey based protein supplementation might improve immune function, which is frequently impaired in older people.

Effect on adiposity and improved glycaemic control

While 48% of people are classified as either over-weight or obese at age 65, this decreases to 28% for people ≥85 years with around 10% of this group underweight in comparison with 3% of all older people.[46] Diets with total protein intakes of greater than 1.5 g/kg/day and carbohydrate intake less than 150 g/day are effective for treatment of obesity, type 2 diabetes and the Metabolic Syndrome.[39] These diets improve body composition and enhance glycaemic control.[39] During weight loss, provision of protein-rich diets will reduce the loss of lean tissue and increase the loss of body fat.[39] Addition of whey protein to meals with a high GI stimulates insulin response, and reduces postprandial blood glucose.[47] Thus, provision of a supplement high in available protein, but lower in carbohydrate, assists in the prevention of whole muscle loss while reducing insulin levels and assisting in reducing adiposity.[39] Thus, nutritional support for the elderly must aim to enhance muscle gain or retention and not simply weight gain.

CONCLUSION

Based on current clinical evidence, the protein needs of older people, particularly in ill health, are likely to be greater than generally appreciated. It becomes critically important, at low energy intakes, that high quality protein comprises a higher proportion of intake. Although animal protein is an excellent source of essential amino acids, consumption of these in the elderly may be limited. Oral supplementation is frequently used to assist rehabilitation in the elderly. Whey protein is more quickly digested than either casein or soy-based protein, and thus provides a better net source of available nutrients and essential amino acids. Supplementation with whey-based protein, comparatively rich in branch chain amino acids, may therefore provide the best health outcomes in those requiring supplementation, particularly those most at risk. Future research in the elderly should focus on clarifying what level of protein to energy ratio, with particular reference to branch chain amino acids, would best impact on muscle anabolism, immune function and glycaemic control, and thus what oral supplement composition would best prevent functional decline or aid rehabilitation.

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