



Sarcopenia and the Protein Threshold: Reconciling Requirement Estimates With What Older Patients Actually Eat

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Abstract

How much protein an older adult requires depends on how the question is asked. Nitrogen balance studies underpin the current allowance of 0.8 grams per kilogram daily, identical for all adults; indicator amino acid oxidation gives an average requirement of 0.9 and an allowance of 1.2 in the same age group, roughly 40 per cent higher. In nine older adults with sarcopenia the oxidation method returned an average requirement of 1.21 grams per kilogram daily, with a recommended intake of 1.54, though the confidence interval on that second figure runs from 1.13 to 1.95. Expert recommendation sits at 1.0 to 1.2 for healthy older people and 1.2 to 1.5 in illness. Measured intake has not moved with the recommendations: against the current average requirement of 0.66, between 20 and 24 per cent of older women and 5 to 12 per cent of older men fall below.

Keywords: Sarcopenia; Protein requirement; Older adults; Indicator amino acid oxidation; Dietary intake

Introduction

Sarcopenia is the age-related loss of skeletal muscle mass and function, associated with frailty, disability, loss of independence and death [1,2,3]. Loss of mass and function begins in the third and fourth decades of life, so the population in whom it matters is wider than the age group in whom it is diagnosed [4].

Protein intake is the principal modifiable nutritional determinant. Adequate intake supplies the amino acids that activate muscle protein synthesis and attenuate breakdown, and combined with exercise is considered optimal for maintaining function [5,6].

The recommended quantity is contested in a specific and instructive way. This review examines why estimates of requirement differ by around 40 per cent depending on the method used, what the sarcopenia-specific evidence adds, and how far measured intake in older populations falls short of either figure.

Objective

This review sets out to establish four things from the published literature. First, what the current dietary allowance for protein rests on and why it does not differ by age. Second, what alternative methodology returns for the same population. Third, what has been measured specifically in sarcopenia. And fourth, what older adults actually eat, and how the apparent size of the shortfall depends on which threshold is applied to it.

Literature Review

What the current allowance rests on: The recommended dietary allowance for protein is 0.8 grams per kilogram of body weight daily and the estimated average requirement 0.66, and both are the same for all adults regardless of age or sex [7,8]. These values derive from meta-analysis of nitrogen balance studies, and were set at the same level as for healthy young adults because evidence that ageing alters requirement on a body weight basis was judged insufficient [9]. The World Health Organization, working from substantially the same dataset, set average and population safe intakes at 0.66 and 0.83 grams per kilogram daily and reached the same conclusion about age [9].

What a different method returns: Using indicator amino acid oxidation, the protein requirement in elderly men and women was estimated at 0.9 and 1.2 grams per kilogram daily as average requirement and recommended intake respectively (Figure 1). These estimates are approximately 40 per cent higher than the current recommendations on a body weight basis, and also 40 per cent higher than the same investigators' estimates in young men when calculated against fat-free mass [9].

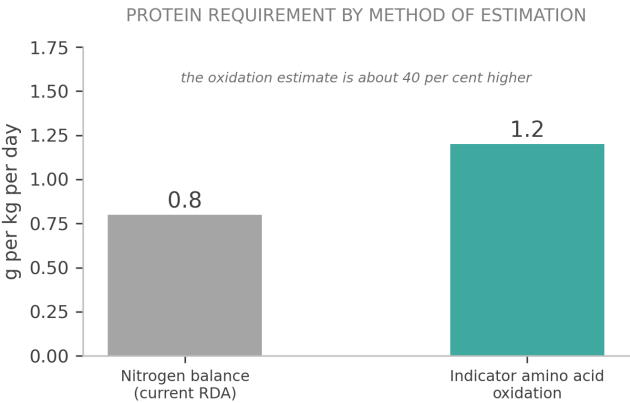


Figure 1: Protein requirement by method of estimation [7,9]

The sarcopenia-specific estimate: Nine older adults aged 65 to 81 with sarcopenia, four men and five women, were studied across protein intakes from 0.1 to 1.8 grams per kilogram daily using the same oxidation technique. The mean estimated average requirement was 1.21 grams per kilogram daily (95% CI 0.95 to 1.46) and the recommended nutrient intake 1.54 (95% CI 1.13 to 1.95) (Figure 2) [10]. The investigators describe this as the first such study in sarcopenia and conclude that this group may require higher intake [10].

Table 1: Requirement estimates by population and method, as published

What is recommended in practice: A workshop convened by the European Society for Clinical Nutrition and Metabolism recommended that the diet of healthy older people provide at least 1.0 to 1.2 grams of protein per kilogram daily, with higher intake for those malnourished or at risk because of acute or chronic illness (Figure 3) [5]. Review of practicalities sets the corresponding figures at 1.0 to 1.2 for healthy older adults and 1.2 to 1.5 for those with chronic or acute conditions, with kidney disease the stated exception [11,12].

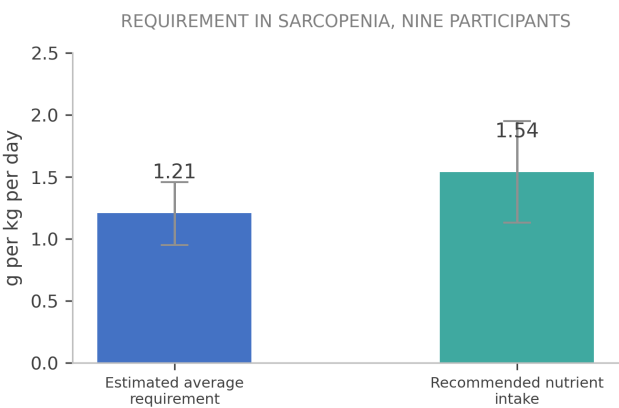


Figure 2: Requirement in sarcopenia by indicator amino acid oxidation [10]

Estimate	Method	Value, g/kg/day
Average requirement, adults	Nitrogen balance	0.66 [7,9]
Recommended allowance, adults	Nitrogen balance	0.8 [7,8]
Average requirement, elderly	Amino acid oxidation	0.9 [9]
Recommended intake, elderly	Amino acid oxidation	1.2 [9]
Average requirement, sarcopenia	Amino acid oxidation	1.21 [10]
Recommended intake, sarcopenia	Amino acid oxidation	1.54 [10]

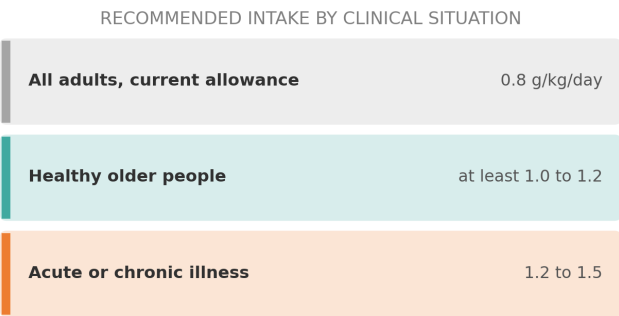


Figure 3: Recommended intake by clinical situation [5,11,12]

What older adults eat: National survey data showed that 20 to 24 per cent of older women and 5 to 12 per cent of older men consumed less protein than the estimated average requirement of 0.66 grams per kilogram daily (Figure 4) [7]. Since the average requirement is by definition sufficient for only half of a healthy population, the reviewing authors note that a greater proportion than this is at risk of inadequate intake [7].

The figure against the higher threshold: Reviewed against clinical rather than population thresholds, 30 per cent of men and 50 per cent of women over 71 consume inadequate dietary protein (Figure 5) [11]. The barriers described include changes in gut function, loss of appetite, tooth loss, financial concerns and social isolation (Figure 6) [11].

Table 2: Measured shortfall depends on the threshold applied

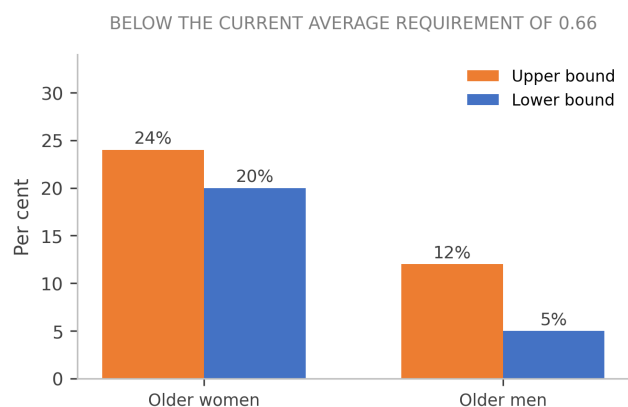


Figure 4: Proportion below the current average requirement [7]

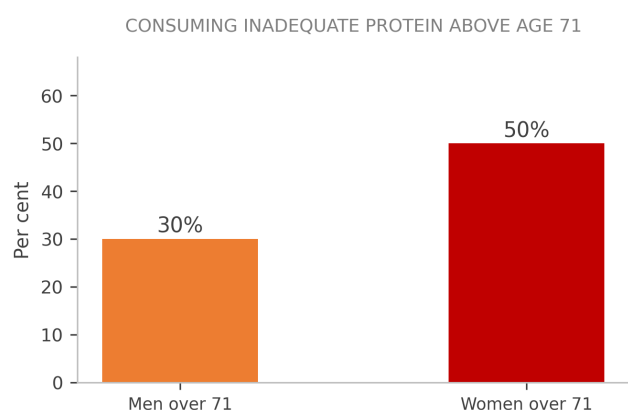


Figure 5: Inadequate protein intake above age 71 [11]

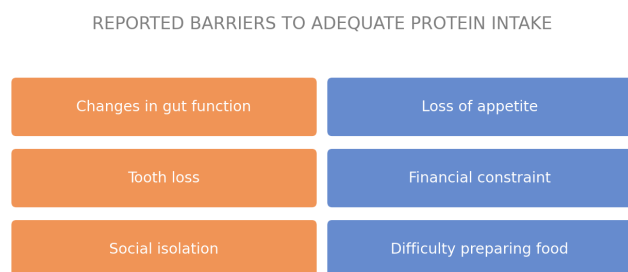


Figure 6: Reported barriers to adequate protein intake [11]

Intake relates to muscle measures: A study reporting a significant positive correlation between protein intake and skeletal muscle index ($r = 0.354$, $p < 0.001$) and between protein intake and handgrip strength ($r = 0.358$, $p < 0.001$) concluded that older individuals not meeting the recommended intake are more likely to lose muscle mass and strength than those who do [13]. The correlations are moderate rather than strong, which is consistent with protein being one determinant among several [13,14].

Population	Threshold applied	Below it
Older women	0.66 g/kg/day	20 to 24% [7]
Older men	0.66 g/kg/day	5 to 12% [7]
Men over 71	Clinical adequacy	30% [11]
Women over 71	Clinical adequacy	50% [11]

Distribution matters as well as total: Beyond total daily intake, the timing and distribution of protein across meals influences stimulation of muscle protein synthesis in older adults [7,15]. Protein source has also been examined, with recommendations to favour plant sources associated with physical performance while limiting processed and high saturated fat animal products [11,16].

The oxidation estimates are not a single study: The technique was first applied to reassess requirement in young men [21,22], then in octogenarian women [23], in women over 65 [24] and in men over 65 [25]. Each returned a figure higher than the current estimated average requirement, and the authors of the last two state that directly in their titles [24,25]. The consistency across those populations is the strongest argument in this literature, stronger than any single requirement estimate including the sarcopenia one [9,10].

The case for exceeding the allowance has been argued repeatedly: Position papers and reviews have asked whether optimal intake for older adults exceeds the recommended allowance and concluded that it does [17,18,32,33]. Nutritional recommendations for the management of sarcopenia were issued separately [19], and reviews have addressed protein requirements and recommendations for older people as a distinct question [32,34]. The nitrogen balance meta-analysis on which the current figure rests remains the reference point against which each of these argues [20].

Distribution and exercise modify the effect: Distribution of protein across meals rather than total amount has been associated with frailty [26], and per-meal dose and frequency with lean mass and muscle performance [27]. Meta-analysis shows protein supplementation augments the adaptive response of skeletal muscle to resistance training [28], and supplementation increased muscle mass gain during prolonged resistance training in frail older people [29]. Protein intake alone is therefore not the whole intervention [15,30], and effects on bone as well as muscle have been described [31].

Method

Search strategy: PubMed and the archives of the major clinical nutrition, geriatric medicine and muscle physiology journals were searched for studies of protein requirement and intake in older adults. Search terms combined protein requirement with sarcopenia, older adults, indicator amino acid oxidation, nitrogen balance and dietary intake. Reference lists of the workshop recommendations [5] and the requirement review [9] were screened by hand for primary sources.

Eligibility: Studies were included if they estimated protein requirement in older populations, measured intake against a stated threshold, or issued recommendations. Consensus and workshop documents are cited for their recommendations and identified as such.

Data extraction and handling: Population, method of estimation, the threshold applied and the reported value were extracted as published. The method is stated alongside every requirement figure and the threshold alongside every shortfall figure, because estimates differ by around 40 per cent between methods and the apparent size of the shortfall follows directly from which threshold is chosen. This review reports published findings and does not constitute dietary or protein intake guidance for any individual, which is a matter for the treating clinician, particularly where kidney function is impaired. No pooling or re-analysis was performed. Figures 1 to 6 and Tables 1 to 3 reproduce published values only. This is a narrative synthesis of published literature and was not registered as a systematic review.

Concluding Remarks

The disagreement in this literature is methodological before it is clinical. Nitrogen balance yields 0.8 grams per kilogram daily; indicator amino acid oxidation yields 1.2 in the same population [7,9]. Both are estimates of the same quantity in the same people, and they differ by around 40 per cent. Any statement about how many older adults eat enough protein inherits that disagreement before a single intake is measured.

The nitrogen balance figure carries a specific limitation its own reviewers identify. It rests on linear regression of data obtained at intakes close to or below zero balance, which is to say it was derived from the deficiency end of the range and extrapolated [9]. That is appropriate for a recommendation framed around preventing deficiency and less so for one framed around maintaining function, which is what sarcopenia demands [7,9].

The sarcopenia-specific estimate should be read with its interval attached. A recommended intake of 1.54 grams per kilogram daily sounds precise; the confidence interval runs from 1.13 to 1.95, and the study included nine participants [10]. That is the first such measurement in this population and it is a beginning rather than a threshold. Quoting the point estimate without the interval would misrepresent what has been established.

On the shortfall, the arithmetic deserves stating plainly because it is easy to overstate. Against the current average requirement of 0.66, 20 to 24 per cent of older women fall below [7]. Against clinical adequacy thresholds, 50 per cent of women over 71 do [11]. Both figures are correct and they describe the same eating. Raising the recommended threshold enlarges the measured shortfall without anyone's diet changing, and that effect should be separated from any real deterioration in intake.

What survives all of these caveats is a consistent direction. Every method that postdates the nitrogen balance work returns a higher requirement, expert recommendation sits above the statutory allowance at 1.0 to 1.2 grams per kilogram, and intake

correlates positively with skeletal muscle index and handgrip strength [5,9,13]. The case for older patients needing more protein than the allowance specifies does not rest on any single study.

The barriers listed are also the most actionable part of the literature and the least quantified. Tooth loss, appetite, cost and isolation are not addressed by revising a figure in a guideline [11]. An older patient who cannot chew, cannot afford protein foods or eats alone will not reach 1.2 grams per kilogram because the target moved, and no study reviewed here reports what proportion of the shortfall each barrier accounts for.

Three limitations belong with these conclusions. The sarcopenia requirement estimate derives from nine participants with wide confidence intervals and has not been replicated [10]. Intake surveys rely on self-reported dietary recall, which underestimates in older populations and does not capture distribution across meals [7,15]. And no trial reviewed here randomised older adults to intake at the higher against the lower threshold with muscle function as the primary endpoint, so the clinical benefit of the increment is inferred from requirement estimates and correlations rather than demonstrated [5,13].

A practical consequence follows for how a target is set in front of a patient. Recommendations expressed per kilogram of body weight behave awkwardly at the extremes of weight, and the oxidation work found requirement estimates 40 per cent higher than young men even when calculated against fat-free mass rather than total weight [9]. In an older patient whose body composition has shifted towards fat, a target computed from total weight and one computed from lean mass are different numbers, and the literature does not consistently say which is meant [9,17].

There is also a question of what the increment is for. The nitrogen balance recommendation was framed around preventing deficiency; the higher figures are argued on the basis of maintaining muscle mass and function [7,9,33]. Those are different endpoints with different evidence requirements, and the trials that would settle the second have largely combined protein with resistance training, which makes the contribution of protein alone difficult to isolate [28,29].

Finally, the ordering of the problem matters for practice. Given that half of women over 71 fall short of clinical adequacy and that the named barriers are chewing, appetite, cost and isolation, the binding constraint for most older patients is unlikely to be the number in the guideline [11]. Reconciling requirement estimates with what older patients actually eat, which is the question in the title of this review, is therefore only partly a question about requirement [11,13].

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Conflict of Interest

The authors declare no competing interests.

Ethics Statement

This article reviews previously published studies only. No new patient data were collected and no participants were recruited, so ethical approval was not required.

References

- Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyere O, Cederholm T, et al. "Sarcopenia: revised European consensus on definition and diagnosis". *Age Ageing* 48(2019):16-31.
- Cruz-Jentoft AJ, Sayer AA. "Sarcopenia". *Lancet* 393(2019):2636-2646.
- Beaudart C, Zaaria M, Pasleau F, Reginster JY, Bruyere O. "Health outcomes of sarcopenia: a systematic review and meta-analysis". *PLoS One* 12(2017):e0169548.
- Protein kinetics investigators. "Maximizing the dietary pattern of older adults: the effects of protein intake on protein kinetics". *ClinicalTrials.gov* NCT04830514 (2021).
- Bauer J, Biolo G, Cederholm T, Cesari M, Cruz-Jentoft AJ, Morley JE, et al. "Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group". *J Am Med Dir Assoc* 14(2013):542-559.
- Deutz NEP, Bauer JM, Barazzoni R, Biolo G, Boirie Y, Bosy-Westphal A, et al. "Protein intake and exercise for optimal muscle function with aging: recommendations from the ESPEN Expert Group". *Clin Nutr* 33(2014):929-936.
- Baum JI, Kim IY, Wolfe RR. "Protein consumption and the elderly: what is the optimal level of intake?". *Nutrients* 8(2016):359.
- Institute of Medicine. "Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids". National Academies Press, Washington DC (2005).
- Requirement review authors. "Protein requirements during aging". *Nutrients* 8(2016):492.
- Sarcopenia requirement investigators. "Dietary protein requirements of older adults with sarcopenia determined by the indicator amino acid oxidation technology". *Front Nutr* 12(2025):1486482.
- Practicalities review authors. "Protein and aging: practicalities and practice". *Nutrients* 17(2025):2461.
- Administration for Community Living. "Nutrition needs for older adults: protein". US Department of Health and Human Services, Washington DC (2020).
- Physical activity and protein investigators. "Physical activity and protein-intake strategies to prevent sarcopenia in older people". *Int Health* 17(2025):423-431.
- Houston DK, Nicklas BJ, Ding J, Harris TB, Tylavsky FA, Newman AB, et al. "Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition study". *Am J Clin Nutr* 87(2008):150-155.
- Paddon-Jones D, Rasmussen BB. "Dietary protein recommendations and the prevention of sarcopenia". *Curr Opin Clin Nutr Metab Care* 12(2009):86-90.
- Berrazaga I, Micard V, Gueugneau M, Walrand S. "The role of the anabolic properties of plant- versus animal-based protein sources in supporting muscle mass maintenance: a critical review". *Nutrients* 11(2019):1825.
- Volpi E, Campbell WW, Dwyer JT, Johnson MA, Jensen GL, Morley JE, et al. "Is the optimal level of protein intake for older adults greater than the recommended dietary allowance?". *J Gerontol A Biol Sci Med Sci* 68(2013):677-681.
- Wolfe RR, Miller SL, Miller KB. "Optimal protein intake in the elderly". *Clin Nutr* 27(2008):675-684.
- Morley JE, Argiles JM, Evans WJ, Bhasin S, Cella D, Deutz NEP, et al. "Nutritional recommendations for the management of sarcopenia". *J Am Med Dir Assoc* 11(2010):391-396.
- Rand WM, Pellett PL, Young VR. "Meta-analysis of nitrogen balance studies for estimating protein requirements in healthy adults". *Am J Clin Nutr* 77(2003):109-127.
- Humayun MA, Elango R, Ball RO, Pencharz PB. "Reevaluation of the protein requirement in young men with the indicator amino acid oxidation technique". *Am J Clin Nutr* 86(2007):995-1002.
- Elango R, Ball RO, Pencharz PB. "Indicator amino acid oxidation: concept and application". *J Nutr* 138(2008):243-246.
- Tang M, McCabe GP, Elango R, Pencharz PB, Ball RO, Campbell WW. "Assessment of protein requirement in octogenarian women with use of the indicator amino acid oxidation technique". *Am J Clin Nutr* 99(2014):891-898.
- Rafii M, Chapman K, Owens J, Elango R, Campbell WW, Ball RO, et al. "Dietary protein requirement of female adults >65 years determined by the indicator amino acid oxidation technique is higher than current recommendations". *J Nutr* 145(2015):18-24.
- Rafii M, Chapman K, Elango R, Campbell WW, Ball RO, Pencharz PB, et al. "Dietary protein requirement of men >65 years old determined by the indicator amino acid oxidation technique is higher than the current estimated average requirement". *J Nutr* 146(2016):681-687.
- Bollwein J, Diekmann R, Kaiser MJ, Bauer JM, Uter W, Sieber CC, et al. "Distribution but not amount of protein intake is associated with frailty: a cross-sectional investigation in the region of Nurnberg". *Nutr J* 12(2013):109.

27. Loenneke JP, Loprinzi PD, Murphy CH, Phillips SM. "Per meal dose and frequency of protein consumption is associated with lean mass and muscle performance". *Clin Nutr* 35(2016):1506-1511.
28. Cermak NM, Res PT, de Groot LC, Saris WH, van Loon LJ. "Protein supplementation augments the adaptive response of skeletal muscle to resistance-type exercise training: a meta-analysis". *Am J Clin Nutr* 96(2012):1454-1464.
29. Tieland M, Dirks ML, van der Zwaluw N, Verdijk LB, van de Rest O, de Groot LCPGM, et al. "Protein supplementation increases muscle mass gain during prolonged resistance-type exercise training in frail elderly people". *J Am Med Dir Assoc* 13(2012):713-719.
30. Beasley JM, Shikany JM, Thomson CA. "The role of dietary protein intake in the prevention of sarcopenia of aging". *Nutr Clin Pract* 28(2013):684-690.
31. Gaffney-Stomberg E, Insogna KL, Rodriguez NR, Kerstetter JE. "Increasing dietary protein requirements in elderly people for optimal muscle and bone health". *J Am Geriatr Soc* 57(2009):1073-1079.
32. Nowson C, O Connell S. "Protein requirements and recommendations for older people: a review". *Nutrients* 7(2015):6874-6899.
33. Traylor DA, Gorissen SHM, Phillips SM. "Perspective: protein requirements and optimal intakes in aging: are we ready to recommend more than the recommended daily allowance?". *Adv Nutr* 9(2018):171-182.
34. Phillips SM, Chevalier S, Leidy HJ. "Protein requirements beyond the RDA: implications for optimizing health". *Appl Physiol Nutr Metab* 41(2016):565-572.

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