Nutritional Recommendations for the Management of Sarcopenia

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The Society for Sarcopenia, Cachexia, and Wasting Disease convened an expert panel to develop nutritional recommendations for prevention and management of sarcopenia. Exercise (both resistance and aerobic) in combination with adequate protein and energy intake is the key component of the prevention and management of sarcopenia. Adequate protein supplementation alone only slows loss of muscle mass. Adequate protein intake (leucine-enriched balanced amino acids and possibly creatine) may enhance muscle strength. Low 25(OH) vitamin D levels require vitamin D replacement. **(J Am Med Dir Assoc 2010; 11: 391–396)**

Conventionally, sarcopenia is the loss of muscle mass that occurs with aging.[1,2] Lean muscle mass is lost at the rate of approximately 1% per year after 30 years of age.[3] Although originally it was assumed that lean muscle mass was directly proportional to muscle strength, it is now recognized that this is not always the case.[4–6] This has led to the suggestion that "dynopenia" should be used to signify loss of muscle power.[7,8] At present, the definition of sarcopenia is evolving, and the term sarcopenia is now often used to indicate the loss of muscle mass and function associated with chronic diseases.[9–12] Whereas sarcopenia was traditionally defined as loss of muscle mass, the inclusion of loss of muscle function in this definition should be considered. The rationale for such a wider definition of sarcopenia is that therapeutic approaches for both improvement of muscle mass and function are similar. This definition would, however, strongly overlap the definitions of "frailty."[13–16]

The loss of muscle mass in sarcopenic persons has been divided into physiological and pathological. Pathological levels of sarcopenia have been defined as being below 2 standard deviations of mean lean body mass for healthy young persons.[17,18] Rigorous definitions tend to use appendicular lean mass and correct for height. Pathological sarcopenia is associated with an extremely high rate of disability.[13] In the United States, sarcopenia has been estimated to have an economic burden related to health care expenditures of $18.5 billion per year. Sarcopenia is not necessarily associated with weight loss and therefore is distinct from cachexia.[19] Obese sarcopenic persons appear to have even worse outcomes.[20,21] Separate nutritional guidelines for cachexia have been developed.[22]

The second Cachexia Consensus Conference was convened by the Society for Sarcopenia, Cachexia, and Wasting Disorders in December 2008. The purpose of this conference was to develop consensus on the nutritional recommendations for persons with sarcopenia. This was done in parallel with the development of separate guidelines for cachexia.

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The literature for each of the nutrients was reviewed by 2 scientists and presented to the group together with draft recommendations. The reviewers gave precedent to meta-analyses over single studies. An open discussion and modified Delphi method were then used to create consensus on the recommendations. Following the meeting, the new recommendations were submitted to all panelists for further input. Finally, a systematic literature search on www.pubmed.gov was conducted using the term "sarcopenia" and various specific terms, eg, nutrition, amino acids, creatine, vitamin D, and so forth, with limits of "humans." The final search was done on January 16, 2010, and the results are given in Table 1. In addition, we also found articles based on references in review articles and on participants' knowledge of the literature. The final manuscript was then submitted to all panelists for alterations and approval.

All recommendations have been classified as follows (Table 2):

A. A minimum of a single randomized placebo-controlled trial or a meta-analysis
B. Small trials
C. Expert opinion

RECOMMENDATIONS

Aging is associated with physiological anorexia, decreased caloric intake, and weight loss,[23–27] which in turn is associated with a decline in muscle mass and increased mortality. These facts suggest that a balanced caloric supplement may be useful in preventing or reversing sarcopenia as part of a multimodal therapeutic approach. A number of studies and 2 meta-analyses in older persons with malnutrition and/or illness have shown positive effects of nutritional supplementation.[28,29] However, these persons had some degree of cachexia and, thus, no conclusion on the effect of supplements on physiological sarcopenia can be drawn. Persons with obesity and sarcopenia have very poor outcomes.[20,21] Although aggressive resistance exercise consistently mitigates sarcopenia, appropriate dietary approaches to this group are unknown.

Protein

Older persons have a high risk of inadequate protein intake.[30] Kerstetter et al[31] reported that 32% to 41% of women and 22% to 38% of men older than 50 years ingested less than the recommended dietary allowance for protein (0.8 g/kg/day). Virtually no older persons ingest the highest acceptable macronutrient distribution for protein of 35% of energy intake. In the Health, Aging, and Body Composition Study persons in the highest quintile of protein intake lost nearly 40% less appendicular lean mass than did those in the lowest quintile.[32] Other studies have also found a positive association between protein ingestion and muscle mass.[33,34]

Because of metabolic changes, older persons may produce less muscle protein than younger persons from the same amount of dietary protein.[31] However, larger amounts of protein (defined as protein or amino acid mixtures with more than 10 g of essential amino acids) produce responses equal to those in younger persons.[35,36] Many commentators have argued that the recommended daily allowance for protein, although sufficient for healthy individuals, fails to prevent muscle loss with aging.[35–38] In addition, it is recommended that the amount of protein ingested should be spread equally throughout the day, ie, equivalent amounts at breakfast, lunch, and dinner.[39] If additional protein supplementation is given it should be administered between meals.[40] Levels of protein intake as high as 1.6 g of protein/kg/d have been demonstrated to increase exercise-induced muscle hypertrophy in older persons.[41] Another study found that 1.0 g of protein/kg/d was the minimal amount required to maintain muscle mass.[42] For these reasons it is recommended that older persons ingest between 1.0 and 1.5 g of protein/kg/d.

Essential amino acids appear to be the primary stimulus of protein synthesis.[43] Leucine appears to be the most potent of these amino acids.[44] Leucine produces its anabolic effects in muscle by stimulating the mammalian target of rapamycin (mTOR) pathway.[45] mTOR is considered the nutrient sensor for leucine. Essential amino acids act synergistically with exercise to increase fractional protein synthesis.[46]

Supplementation with essential amino acids and carbohydrate prevents muscle protein loss in humans during bed rest.[47] A whey protein supplement has been shown to augment the muscle strengthening effects of resistance exercise.[48,49]

Solerte et al[50] studied 41 persons with sarcopenia with an age range of 66 to 84 years in a randomized trial. They provided 8 g of essential amino acids over 18 months. This treatment increased muscle mass, reduced tumor necrosis factor-alpha, and improved insulin sensitivity.

These findings led to our recommendation that a leucine-enriched balanced amino acid supplement should be used to slow muscle loss. This is particularly important when the older person is exercising.

Anabolic therapies such as growth hormone and testosterone have been shown to increase muscle mass and in some cases strength in older persons.[51–56] A calorie-protein supplement together with testosterone decreased hospitalizations in frail older men and women.[57] Thus, it would seem reasonable to consider protein supplementation in sarcopenic persons to enhance or maximize the effects of anabolic agents. There is a need for a reasonably powered clinical trial to test this hypothesis in sarcopenic patients.

Table 1. *Results of Systematic Review of PubMed for Sarcopenia and Specific Nutrients*

Sarcopenia and	Items	Review
Calories	3	2
Energy	147	51
Protein	282	149
Amino acids	49	28
Creatine	9	4
Vitamin D	19	10
n-3 fatty acids	0	0
Exercise	249	142
Nutrition	147	42

Search conducted on January 16, 2010.

Table 2. *Sarcopenia Recommendations*

- Aging is associated with a physiological anorexia, decreased protein and energy intake, and weight loss. This is associated with a decline in muscle mass and increased mortality.
- The metabolic efficiency in older persons is decreasing, requiring a higher protein intake for protein synthesis than in younger persons.
- This suggests that a balanced protein and energy supplement may be useful in preventing and reversing sarcopenia as part of a multimodal therapeutic approach. (A)
- Persons with obesity and sarcopenia have very poor outcomes. Appropriate dietary approaches for this group, other than aggressive resistance exercise, are unknown.
- As 15% to 38% of older men and 27% to 41% of older women ingest less than the recommended daily allowance for protein it is suggested that protein intake be increased. (B)
- It is recommended that the total protein intake should be 1 to 1.5 g/kg/day. (B)
- It is suggested that a leucine-enriched balanced essential amino acid mix may be added to the diet. (B)
- A trial of balanced amino acid supplementation alone and with exercise in sarcopenia is recommended.
- Creatine may enhance the effects of exercise in sarcopenic patients. (A)
- Long-term studies of the effect of creatine on sarcopenia need to be carried out.
- Based on treatment trials in patients with sarcopenia and on well-established human physiology, patients receiving anabolic therapies will have increased dietary energy needs to support increases in lean body mass. Whether the increase in dietary energy needs will require explicit nutritional support is an individualized decision. (B)
- Based on some treatment trials in patients with sarcopenia and on physiologic hypotheses, for optimal deposition of muscle mass, patients receiving anabolic therapies probably require adequate protein intake. Whether meeting dietary protein needs will require explicit nutritional support is an individualized decision. (B)
- There is a need for a reasonably powered clinical trial to test these hypotheses in sarcopenic patients.
- 25(OH) vitamin D levels should be measured in all sarcopenic patients. (A)
- Vitamin D supplementation in doses sufficient to raise levels above 100 nmol/L should be given as an adjunctive therapy. (A)
- Either vitamin D2 or D3 is an acceptable replacement. (A)
- Doses of 50,000 IU of vitamin D a week are safe. (A)
- Short-term resistance exercise improves strength and gait speed. (A)
- Aerobic exercise improves quality of life years (QALY) and is cost effective. (A)
- Epidemiology studies suggest positive effects of physical fitness on health.
- We recommend resistance and aerobic exercise for 20 to 30 minutes, 3 times a week. (A)

A = A minimum of a single randomized placebo-controlled trial or a meta-analysis; B = Small trials.

Creatine

Supplementation with creatine monohydrate increases the available phosphocreatine.[58] Phosphocreatine is a form of energy storage that is necessary for high-power exercise. Numerous studies have shown that creatine improves exercise performance in young persons.[59] Creatine supplementation during upper arm immobilization slows the loss of muscle mass and strength in younger men.[60]

Studies in older people have provided some evidence of positive effects of creatine. Chrusch et al[61] studied 30 men older than 70 in a double-blind placebo-controlled trial. These older men received either creatine plus resistance exercise or placebo with resistance exercise. Creatine supplementation increased lean tissue mass as well as increased leg strength, power, and endurance. In a study of men and women 65 to 86 years, creatine supplementation for 14 days increased maximal isometric grip strength and physical working capacity at fatigue threshold.[62] Creatine alone or with conjugated linolenic acid increased lean body mass and improved strength.[63,64] Low-dose creatine together with a protein supplement increased lean mass and upper limb strength.[65]

Mixed results have been reported in studies of creatine supplementation in other chronic catabolic conditions. In persons with Parkinson's disease, creatine improved upper limb strength and chair rise performance.[66] Creatine supplementation increased body weight and muscle strength in patients with congestive heart failure.[67] Creatine did not improve strength in persons with chronic obstructive pulmonary disease[68,69] or HIV infection.[70]

Overall, although short-term studies suggest some benefit of use of creatine in addition to exercise in sarcopenic patients, there is a need for long-term studies on the effects of creatine on sarcopenia.

Vitamin D

Levels of 25(OH) Vitamin D decline longitudinally with aging.[71] Numerous studies have reported extremely low vitamin D levels in older persons.[72–75] Low vitamin D levels are associated with low muscle strength.[76,77] Low vitamin D levels are associated with statin myopathy.[78,79] Replacement of vitamin D in persons with low levels increases strength and function and decreases falls.[80] Vitamin D replacement is associated with less mortality.[81]

Levels of 25(OH) vitamin D should be measured in all sarcopenic patients. Vitamin D should be supplemented in all persons with values less than 100 nmol/L. Holick et al[82] found both vitamin D2 and D3 are equally effective at maintaining 25(OH) vitamin D levels.

Exercise

Bed rest results in rapid loss of muscle mass and strength in older persons.[83,84] Resistance exercise improved strength and decreased frailty in very old persons.[85–89] These effects can be maintained for at least 1 year.[87,90,91] Strength training improved distance walked in 6 minutes and gait speed.[92] Resistance exercise increases type II muscle fiber size and improves satellite muscle recruitment in older persons.[93,94]

Aerobic exercise remodels myofibers and increases muscle strength.[95] In older persons, aerobic exercise improves gait speed, quality of life years (QALY), and is cost effective.[96–98] Vibratory exercise also improves performance in sarcopenic individuals.[99–101]

Overall, a minimum of 20 to 30 minutes of resistance and aerobic exercise 3 times a week is recommended to slow muscle loss and prevent sarcopenia.

CONCLUSION

Table 2 provides the recommendations for nutritional management of sarcopenia. Exercise (aerobic and resistance) represents the key intervention. Adequate protein intake (leucine-enriched amino acids and possibly creatine) has good evidence. Low vitamin D levels should be corrected.

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