Synergy in Motion: Combining Nutrition and Exercise for Optimal Physical Function

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Satellite Symposium Proceedings
34th ESPEN Congress

8 September 2012
Barcelona, Spain
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Sarcopenia, which is the accelerated loss of skeletal muscle mass and strength that occurs with advancing age or during chronic disease, is now widely recognized as a condition associated with high rates of morbidity and healthcare expenditure. The rate of decline in muscle function may vary among the elderly population, suggesting that modifiable factors, such as diet and lifestyle, largely influence the individual trajectory of muscle dysfunction in older age. A Nestlé Nutrition Institute-sponsored satellite symposium was held in conjunction with the 34th European Society for Clinical Nutrition and Metabolism (ESPEN) Congress in Barcelona, Spain, on 8 September 2012. This event, comprising a faculty of renowned experts in the field of geriatric medicine and nutrition, focused on the pertinent roles of nutrition and physical activity in optimizing physical function and preserving muscle mass in the elderly.

The role of nutrition in optimizing strength and function

Sarcopenia, which is characterized by the progressive and generalized loss of skeletal muscle mass, strength and function, plays an important etiologic role in the frailty process of elderly subjects. Screening and diagnosis of sarcopenia requires the documentation of low muscle mass and strength, and diminished physical performance. In identifying subjects with sarcopenia, the algorithm developed by the European Working Group on Sarcopenia in Older People (EWGSOP) begins with gait speed measurement (using 4-meter walking speed) as an easy and reliable way to test physical function (Figure 1). Using the EWGSOP algorithm, sarcopenia was shown to be especially prevalent among elderly in care settings (affecting 33% of nursing home residents), particularly among males (odds ratio [OR] 13.39; 95% confidence interval [CI] 3.51–50.63). A 6-month follow-up study went on to demonstrate that sarcopenia increased the risk of all-cause death more than two-fold among nursing home residents (adjusted hazard ratio [HR] 2.34; 95% CI 1.04–5.24), while another study in that population observed that those with sarcopenia were more than three times more likely to fall during a follow-up period of 2 years (adjusted HR 3.23; 95% CI 1.25–8.29).

The age-related and multifactorial etiology of sarcopenia

Multiple factors lead to the development of sarcopenia and the associated decline in physical function. Muscle mass is strongly associated with good nutritional status and physical activity in the elderly. The age-associated loss of appetite and consequent decrease in food intake that commonly occurs in the elderly is known as anorexia of aging. Anorexia of aging may lead to malnutrition and impaired physical function. In the prospective cohort Aging and Longevity in the Sirente geographic area (SIRENTE) study, physical performance, muscle strength and functional parameters showed significant associations with the presence of anorexia. A study in healthy older adults demonstrated that physical inactivity reduced skeletal muscle protein synthesis by 30% within 10 days of bed-rest.
Anorexia of aging contributes to under-nutrition in the elderly

The link between anorexia and sarcopenia is clear; subjects with anorexia have higher risk of sarcopenia than non-anorexic individuals (HR 1.88; 95% CI 1.01–3.51). Among other factors, the physiological change in taste and smell perception that occur with advancing age can lead to poor appetite. Over time, subclinical nutrient deficiencies can develop and directly impact function. Indeed, anorexia is strongly associated with higher risk of selective malnutrition (of nutrients that include protein and specific amino acids, vitamins and minerals important for musculoskeletal health) due to insufficient food intake. In a prospective cohort study, low protein consumption was found to increase the risk of incident frailty in older women. It could therefore be hypothesized that early intervention for selective malnutrition, with regards to intake of specific macro- and micronutrients, may be important for the prevention of frailty and associated disability.

The role of dietary protein in mitigating sarcopenia

Sarcopenia is a modifiable cause of frailty in older adults. Nutritional supplements and physical activity (eg, resistance exercise) therefore have the potential to improve skeletal muscle function in at-risk individuals. Increasing amino acid consumption via protein supplementation may be an effective strategy for limiting sarcopenia and preventing frailty in the elderly. In older adults subjected to 10 days of bed-rest, essential amino acids (EAA) supplementation has the potential to overcome inactivity-mediated reduction in muscle protein synthesis and preserve muscle function. Furthermore, in a pre-clinical study in which aging rats were fed a diet enriched in the amino acid leucine, plasma leucine concentration was positively correlated with the rate of muscle protein synthesis. Based on this protective effect for muscle, enriching the diet with leucine, an EAA naturally abundant in whey protein, is an intervention of particular relevance to older people at risk for sarcopenia. It is also notable that the speed of absorption of dietary amino acids by the gut varies according to the type of ingested protein. In contrast with casein and animal protein, whey protein is a ‘fast’ protein that can deliver a rapid increase in amino acid availability to support an anabolic response.

Aging does not impair the ability to synthesize muscle protein immediately following a protein-rich meal. In the young and elderly alike, muscle protein synthesis increases with the provision of dietary protein, based on studies supplementing 25–30 g protein. However, aging results in a diminished anabolic response, as older adults will require more protein than younger adults to stimulate robust muscle protein synthesis (Figure 2).

While the current recommended dietary allowance is 0.8 g/kg body weight for the general adult population, higher dietary protein intake (eg, ≥1.0 g/kg body weight) may enhance muscle protein anabolism and mitigate age-related muscle mass loss. In addition, dividing the daily amount of protein (90 g per day) equally across three balanced meals (to consume about 30 g of protein in each meal) could support maximum and continuous muscle protein synthesis throughout the day.

Resistance exercise combats sarcopenia

Resistance exercise training is a useful intervention for the prevention and treatment of sarcopenia. However, there is diminished anabolic response to resistance exercise in elderly compared with younger subjects. Resistance exercise training can act in synergy with amino acid supplementation to increase muscle protein synthesis higher than either intervention alone (Figure 3). The Arthritis, Diet and Activity Promotion Trial (ADAPT) demonstrated that while single interventions of diet and exercise can reduce disability to a greater extent than a healthy lifestyle, the combination of diet and exercise provides better overall improvements in disability scores.

**Figure 2. When supplemented with less than 15 g of protein, older adults demonstrated a less robust anabolic response than younger adults**

**Figure 3. Resistance exercise training can be synergistic with EAA supplementation in increasing muscle protein synthesis**
The power of combining nutritional and physical activity interventions

Studies have shown that supplemental intake of protein, EAs, and leucine can stimulate robust muscle protein synthesis. Whey protein is a natural source of EAA and leucine; and as a ‘fast’ protein, can deliver a rapid increase in plasma amino acids to support an anabolic response. It has been proposed that the combination of nutritional and physical activity interventions can additively combat sarcopenia. Currently, although there is clear evidence of a synergistic effect between nutritional supplementation and exercise, further long-term randomized controlled trials are needed to explore and define an optimized approach to treating sarcopenia. Recent trials have confirmed the benefits of this synergistic approach in frail patients on a long-term basis.19

Functional decline and nutritional status in the older adult

Nutrition is one of the main determinants of health in older adults. Good nutrition is imperative to maintaining function, as well as preventing the development of chronic diseases, disability and dependence. However, the relationship between nutrition and longevity is still not well understood. Even though there is a clear correlation between caloric restriction and longevity expansion in some species, this relationship has not been proven in humans.1 Malnutrition in older adults is a multifactorial problem and has been associated with cancer, dementia and cardiovascular diseases. Therefore, accurate identification and management of the underlying problems are essential.

Physical function is the main indicator of health in older adults

The World Health Organization (WHO) stated in the 1950s, that health in older adults must be measured in terms of function, since function is the principal health metric in this population. Frailty is highly prevalent and leads to disability, hospitalization and mortality in the elderly. Fried’s frailty criteria define frailty as a clinical syndrome in which three or more of the following criteria are present: unintentional weight loss greater than 4.5 kg, self-reported exhaustion, weakness, slow walking speed and little physical activity. These criteria provide a systematic method to identify frailty among at-risk individuals.2

Nutritional status can predict disability and mortality risk in older adults

Although there is currently no consensus on the ideal method for identifying malnutrition in older adults, several parameters are often used to indicate risk, including involuntary weight loss, low body-mass index (BMI), specific vitamin deficits and low dietary intake. The BMI cut-off points in older adults are, however, controversial. The prospective Survey in Europe on Nutrition and the Elderly: a Concerted Action (SENeca) study, carried out in about 58,000 adults aged between 70 and 75 years, demonstrated that a BMI of 27 was associated with the lowest all-cause mortality risk; while in the general adult population, a BMI of over 25 is considered overweight and associated with poor health outcomes (Figure 4).3

References

Figure 4. An average BMI of 27.1 kg/m² conferred the lowest mortality risk in older people in the SENECA study

- Mortality and BMI in older adults
  - Belgium, Denmark, France, Greece, Hungary, Italy, Holland, Portugal, Spain, Switzerland and Poland
  - Follow-up 10 years
  - BMI 27.1 (range 21.1-31.4 kg/m²) confers the lowest risk for mortality

- All-cause mortality
- 95% CI
Similarly, in the Frailty and Dependency in Albacete (FRADEA) study (n=840), BMI was shown to be associated with mortality, in which a BMI of 27–29 kg/m² conferred the lowest risk of mortality and incident disability, marked by functional ability in the basic activities of daily living (BADL). The FRADEA study also utilized a validated method of nutritional screening in elderly – the Mini Nutritional Assessment Short Form (MNA-SF). Nutritional risk identified by the MNA-SF was shown to be a better predictor of incident disability than BMI, especially when associated with frailty (Figure 5). Further studies are needed to ascertain the link between BMI and disability and mortality risk in the elderly, as well as the specific BMI thresholds for overweight in older adults.

\[\text{BMI} = \text{body mass index}; \text{CI} = \text{confidence interval}; \text{MNA} = \text{Mini Nutritional Assessment Short Form}; \text{BADL} = \text{basic activities of daily living}; \text{IADL} = \text{instrumental activities of daily living}; \text{HR} = \text{hazard ratio}; \text{FRADEA} = \text{Frailty and Dependency in Albacete}\]

**Figure 5. FRADEA study: MNA-SF was a better predictor of incident disability in BADL than BMI**

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<th>Incidence disability risk in BADL</th>
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<td>BMI &lt;23</td>
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<td>Pre-frailty</td>
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Adjusted for age and gender
BADL, basic activities of daily living; BMI, body mass index; CI, confidence interval; MNA-SF, Mini Nutritional Assessment Short Form; HR, hazard ratio; FRADEA, Frailty and Dependency in Albacete

**Key points**

- Increasing amino acid consumption via protein supplementation may be an effective strategy for limiting sarcopenia and preventing frailty in at-risk older adults
- Dividing the daily amount of protein (90 g per day) equally across three balanced meals (to consume about 30 g of protein in each meal) could support maximum and continuous protein synthesis throughout the day
- Correct diet or nutritional supplements can help reduce the incidence, severity and progression of frailty, disability and age-associated chronic illnesses

**References**


**iSIRENTE and FRADEA study results link anorexia to functional decline and disability**

There is increasing evidence to show that anorexia of aging is associated with impaired physical function. In the iSIRENTE study (n=364), incident disability risk was greater in older adults with anorexia (HR 2.25; 95% CI 1.15–4.39). Furthermore, the FRADEA study has shown that anorexia, weight loss and mobility impairment are the MNA-SF items most strongly correlated with incident disability. The FRADEA study also observed that frailty was associated with incident disability in basic and instrumental activities of daily living (IADL) (OR 2.5 and OR 1.3, respectively), mobility impairment (OR 2.7) and mortality (OR 5.3).

**Prioritizing the identification of nutritional risk to manage the threat of disability**

Frail older adults are likely to have special needs with regards to diet composition (macro- and micronutrients) than the rest of the population, and frequently suffer anorexia of aging and under-nourishment. Given that screening is the first step to improve the quality of life and to better manage frailty, clinicians should routinely screen older individuals for functional decline and nutritional risk. Identifying those at risk for functional decline early and sequentially initiating proper interventions play a crucial role in preventing frailty. Correct diet or nutritional supplements can also help reduce the incidence, severity and progression of frailty, disability and age-associated chronic illnesses. Nonetheless, further investigation is needed to better elucidate the pathophysiologic processes involved and the potential for nutritional interventions to impact the etiology of frailty.