

The Role of Nutritional Intervention in Preventing Muscle Decline Among Community-Dwelling Older Adults

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Abstract. Sarcopenia is a systemic condition that progresses with advancing age. Its characteristics are manifested by a decrease in skeletal muscle mass along with a decline in muscle strength. These changes bring about a deterioration in overall functional capacity. This condition represents a common degenerative disorder often seen in older adults. It significantly brings down the quality of life for those affected and can also hamper their ability to live independently. This review examines the role of nutritional interventions in preventing and managing sarcopenia among community-dwelling older adults, focusing on intake strategies for key nutrients including protein, vitamin D, leucine and its metabolite β -hydroxy- β -methylbutyrate (HMB), and n-3 polyunsaturated fatty acids, while emphasizing the synergistic effects of combining nutrition with exercise. In addition, this review analyzes challenges in current community-based nutritional interventions and proposes matching solutions. It aims to provide scientific evidence and practical guidance for improving muscle health in community-dwelling older adults.

Keywords: Sarcopenia; nutritional intervention; community-dwelling older adults; protein; combined intervention.

1. Introduction

The world's population is changing significantly. Aging is becoming one of the biggest social trends of the 21st century. According to the United Nations' World Population Prospects report, by 2050, 16% of the global population will be aged 65 or older, a rise from the current 9%. The aging challenges will be especially severe in East Asia and Europe. For China, as the nation with the world's largest elderly population, the number of individuals aged 65 and above reached 210 million by the end of 2022, accounting for 14.9% of the total population—a figure signifying China's official entry into a deeply aged society. This profound demographic shift has made elderly health issues a major challenge that the national public health system must confront.

As people age, muscle loss is becoming more common among the elderly, significantly harming their health and quality of life. Physiologically, muscle loss in older adults involves many factors and pathways. As you get older, body functions decline, and nutrition metabolism faces many challenges. Also, weakened digestion and reduced senses of taste and smell often lead to a poor appetite. This can narrow their dietary choices and cause deficiencies in key nutrients like protein, vitamins, and minerals. This nutritional imbalance harms multiple body systems, especially the maintenance and metabolism of muscle tissue [1]. In summary, muscle loss is a common degenerative condition in the elderly, affected by age, nutrition, and activity level, and it greatly impacts their health and quality of life.

Current nutritional programs for older adults in communities have notable problems. For example, primary care lacks easy-to-use nutritional assessment tools, and interventions are often not well-targeted. Existing methods are fragmented and lack a clear system, making it hard to meet the diverse health needs of the elderly. To address this, our study aims to create a ready-to-eat meal for community-dwelling older adults that is nutritionally enhanced. This paper will design its nutritional content and test how well it works to prevent muscle loss. Our goal is to offer scientific evidence and practical advice for community nutritional programs, helping to improve the health and quality of life for older adults.

Therefore, researching how nutrition can prevent and manage sarcopenia in community-dwelling older adults is very important. Studies confirm that sufficient protein intake is crucial for maintaining muscle mass and function, though requirements differ among seniors. Furthermore, nutrients such as Vitamin D, which regulate muscle metabolism and improve strength, show clear benefits in delaying sarcopenia. Research also indicates that combining nutritional interventions with suitable exercise produces better outcomes.

This study will systematically examine evidence-based intake approaches for key nutrients including protein, vitamin D, leucine and its metabolite β -hydroxy- β -methylbutyrate (HMB), and n-3 polyunsaturated fatty acids. It will analyze the synergistic effects of integrating nutrition and exercise, assess primary challenges encountered in current community-based nutritional interventions, and propose corresponding optimization strategies. The ultimate goal is to provide evidence for developing scientifically sound, effective, and feasible community-based muscle health promotion programs for older adults. This research aims to offer actionable recommendations for delaying muscle decline, helping older adults maintain functional independence, enhancing quality of life, and advancing healthy aging.

2. Pathophysiology and Nutritional Risks of Sarcopenia

Age-related muscle decline typically accelerates after middle age. Older adults also face increased malnutrition risks from factors like poor appetite, chewing difficulties, and chronic diseases.

From a pathophysiological perspective, harmful changes make muscle hard to maintain. Firstly, widespread anabolic resistance occurs, where muscle tissue loses sensitivity to dietary protein. This makes stimulating muscle protein synthesis challenging, even with sufficient protein. Secondly, endocrine function changes, with levels of muscle-building hormones like growth hormone and testosterone declining. This further impairs the body's ability to build muscle.

Concurrently, immune function progressively declines with age, making older adults more susceptible to persistent, low-grade inflammation—known as chronic inflammation. This compromised immunity substantially increases their risk of infectious diseases and inflammatory conditions like collagen diseases. Such chronic inflammation is characterized by mildly elevated blood concentrations of pro-inflammatory cytokines. C-reactive protein (CRP), an acute-phase protein produced by the liver in response to Interleukin-6 (IL-6) stimulation, also exhibits elevated levels during chronic inflammation [2]. Studies indicate that compared to healthy young adults, elderly individuals exhibit 2-4 times higher concentrations of Tumor Necrosis Factor-alpha (TNF- α), Interleukin-1beta (IL-1 β), and IL-6 in their blood, contributing to skeletal muscle degeneration in the elderly [3]. Furthermore, inflammatory cytokines cause problems in mitochondria. Mitochondria are parts of a cell that make energy. When they are damaged, they produce less Adenosine Triphosphate (ATP) (energy) and also make too much Reactive Oxygen Species (ROS). Excessive ROS worsens the damage to mitochondria and causes metabolic issues. It also activates the ubiquitin-proteasome system, which breaks down protein. This ultimately leads to skeletal muscle atrophy [4].

3. Core Nutritional Intervention Strategies

First, adequate and high-quality protein intake. Sufficient consumption of high-quality protein forms the cornerstone of nutritional intervention, particularly for older adults, whose protein requirements actually exceed those of younger individuals.

According to the Dietary Reference Intakes for Chinese Residents, the recommended protein intake for adults aged 65 and older is 1.17 g/(kg·d) [5]. However, an international research consortium recommends that to help older adults maintain and restore lean body mass and function, average daily protein intake should reach at least 1.0–1.2 g/kg body weight. Older adults with acute or chronic illnesses require even more (1.2–1.5 g/kg body weight/day) [6].

A randomized controlled trial demonstrated that frail older adults receiving protein supplementation (2×15 g/day) alongside 24 weeks of resistance training exhibited significant lean body mass gains (from 47.2 kg to 48.5 kg), whereas the placebo group showed no change. This study confirms the necessity of protein supplementation for muscle mass gains during resistance training [7].

Beyond focusing on total protein intake, obtaining high-quality protein and distributing it appropriately is equally important. Communities should ensure that high-quality protein constitutes at least 50% of the total daily protein intake for older adults. High-quality protein refers to sources that contain a complete set of essential amino acids in appropriate proportions and are readily absorbed and utilized by the human body, effectively supporting muscle synthesis and repair. Good sources primarily fall into three categories: first, animal-based foods such as lean meats, poultry, fish, eggs, and dairy products; second, plant-based foods, particularly high-quality plant proteins represented by soybeans and their products. Regarding intake patterns, it is recommended to distribute the daily protein requirement evenly across three meals, aiming for at least 20–30 grams of high-quality protein per meal. This distribution strategy maximizes stimulation of muscle protein synthesis, thereby counteracting age-related anabolic resistance [8].

Second, supplementation of key micronutrients. Vitamin D is crucial for maintaining muscle function and bone health. Older adults should maintain adequate serum levels through multiple approaches: consuming vitamin D-rich foods, getting appropriate daily sunlight exposure, and supplementing with vitamin D preparations under professional guidance. Second, leucine and its metabolite HMB play pivotal roles in muscle synthesis and anti-catabolism: Leucine, as the core amino acid activating the mTOR signaling pathway, effectively promotes muscle protein synthesis; its metabolite HMB exhibits dual functions of simultaneously promoting synthesis and inhibiting breakdown [9]. Studies indicate that daily supplementation with 3 grams of HMB for 24 weeks significantly enhances leg strength and muscle mass in older adults [10]. Furthermore, regular consumption of foods rich in n-3 polyunsaturated fatty acids (such as fatty fish) helps improve neuromuscular function and reduce inflammatory responses, thereby indirectly supporting muscle health.

4. Synergistic Effects of Nutrition and Exercise

Nutritional interventions work best when combined with exercise, particularly resistance training, to fight sarcopenia. Studies demonstrate that frail older adults who do 24 weeks of resistance training get stronger and function better, but they only gain muscle if they take a protein supplement [7]. This is because exercise provides the "stimulus" for muscle synthesis, while protein supplies the essential "materials" for growth.

Three exercise types are suitable for older adults. Resistance training is most effective for building muscle mass. Combined training (resistance plus aerobics) primarily enhances muscle strength, while aerobic training mainly benefits cardiorespiratory fitness and quality of life.

Exercise programs for older adults must be personalized and progress gradually. A safe approach is to start with low-intensity aerobic activities, then gradually introduce resistance training. Keeping exercise safe should be a primary focus throughout.

5. Challenges and Solutions for Nutritional Interventions in Community Practice

Although the effectiveness of combined nutrition and exercise interventions has been demonstrated in clinical trials, their implementation in real-world community settings still faces numerous barriers. At the individual level, older adults often experience poor appetite, difficulty chewing and swallowing, and cognitive decline, coupled with insufficient awareness of sarcopenia. At the environmental level, older adults lack family and social support, face limited access to healthy

foods, and have constrained economic resources. Finally, at the intervention level, administrative programs often adopt a one-size-fits-all approach, failing to account for individual needs and cultural dietary differences.

Therefore, we need to advance strategies through several methods. First, must harness and integrate intrinsic motivation with external support to inspire seniors' personal pursuit of healthy living while strengthening family and community backing. Second, personalized intervention plans should be developed, tailoring nutrition and exercise programs to each senior's specific circumstances. Simultaneously, optimizing community resources is crucial—must maximize existing human and physical assets to drive implementation. Finally, information and tools should be simplified, providing seniors with clear, understandable, and actionable dietary guidance.

6. Conclusion

In summary, nutritional interventions play an irreplaceable role in managing sarcopenia in older adults. This paper explains the pathophysiological mechanisms involved, including anabolic resistance, hormonal changes, chronic inflammation, and vitamin D deficiency. Therefore, scientific nutritional strategies are crucial for delaying muscle loss and maintaining function. Adequate, high-quality protein is the cornerstone. It is recommended that over 50% of protein comes from high-quality sources (e.g., lean meat, fish, eggs, dairy) and is evenly distributed across meals (20-30g per meal) to effectively overcome anabolic resistance. Furthermore, vitamin D supplementation is vital, via diet, sun, or supplements. Evidence confirms that leucine/HMB improves muscle strength and mass, while n-3 fatty acids benefit neuromuscular function and fight inflammation. It is critical to understand that single-nutrient interventions have limited impact. They must be combined with personalized physical activity, like resistance training, to achieve a true synergistic effect and effectively control sarcopenia.

Based on current evidence, I recommend that community health systems integrate muscle health into standard elderly care, using plans that combine nutrition and exercise. Key steps include starting nutrition education on protein, vitamin D, and HMB; offering community exercise programs like resistance training; and screening high-risk groups for early, personalized intervention. Future research should find the best dosage and timing for protein and HMB, develop better nutritional plans for Chinese seniors, and use digital health tools to improve intervention reach and adherence. Through collaboration between government, communities, families, and technology, we can advance healthy aging and significantly improve seniors' quality of life and independence.

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