Clinical Nutrition Guidelines

Chinese expert consensus on dietary nutrition prescriptions and exercise intervention for sarcopenia (2025)

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Sarcopenia, characterized by an age-associated decline in skeletal muscle mass and strength/function, is associated with multiple adverse clinical outcomes. Dietary nutrition and exercise interventions are effective ways to prevent and improve sarcopenia. Therefore, Huadong Hospital affiliated to Fudan University, Shanghai Elderly Nutrition and Health Quality Control Center, together with the Geriatric Nutrition Branch of China Nutrition Society convened experts from nutrition, geriatrics, sports medicine, rehabilitation medicine, traditional Chinese medicine and general practice medicine to jointly set up a working group to supplement and revise the 2015 edition of China Expert Consensus on Nutrition and Exercise Intervention for Sarcopenia based on evidence-based medicine evidence in the past ten years to form this consensus. The aim is to provide practical guidelines to prevent and treat the disease.

Key Words: sarcopenia, consensus, nutrition, exercise, prescriptions

INTRODUCTION

Sarcopenia, also known as muscle wasting-syndrome, is an age-related progressive skeletal muscle disorder characterized by reduced muscle mass, decreased muscle strength, and/or impaired physical performance. It is associated with aging, nutritional deficiencies, physical inactivity, and various chronic diseases, classified under ICD-10 code M62.84.[1] In China, sarcopenia prevalence is notably high: 12.9% among older men and 11.2% among older women in community settings, rising to 26.3% in institutionalized older men and 33.7% in women, with up to 65.9% of older adults in care facilities at risk of sarcopenia.[2-3] The insidious progression of sarcopenia increases risks of adverse clinical outcomes such as falls, frailty, and mortality in older adults. Rational nutrition and proactive physical exercise are the most effective strategies for preventing and managing sarcopenia. Therefore, developing evidence-based consensus guidelines for dietary nutrition prescriptions and exercise interventions is critical to enhancing the scientific rigor and standardization of non-pharmacological therapies for sarcopenia in older adults, holding significant importance for its prevention and treatment.

Huadong Hospital Affiliated to Fudan University, Shanghai Elderly Nutrition and Health Quality Control Center, and jointly organized by the Elderly Nutrition Branch of the Chinese Nutrition Society, experts from fields such as nutrition, geriatric medicine, sports medicine, rehabilitation medicine, traditional Chinese medicine, and general practice were invited to form a working group. Based on the 2015 version of the "Consensus on Nutrition and Exercise Intervention for Sarcopenia," and in accordance with evidence based medical standards, the latest domestic and international research findings from the past decade were incorporated. After repeated discussions and modifications by the experts, the "Chinese Expert Consensus on Dietary Nutrition Prescriptions and Exercise Intervention for Sarcopenia (2025)" was developed.

The "Chinese Expert Consensus on Dietary Nutrition Prescriptions and Exercise Intervention for Sarcopenia (2025)" adopts the GRADE grading principles for level assessment and combines the grading scheme of the "China Resident Dietary Guidelines 2022.[4-5] The recommendation strength is ultimately divided into three

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levels: A (strong recommendation), B (moderate strength recommendation), and C (weak recommendation).[6] This consensus categorizes sarcopenia into three major types: age-related sarcopenia, special population sarcopenia (such as the elderly and vegetarians), and disease-related sarcopenia (combined with malnutrition, obesity, diabetes, or chronic kidney disease). It provides twelve consensus statements on dietary nutrition prescriptions and exercise interventions for each category (Figure 1).

1. DIETARY NUTRITION PRESCRIPTIONS AND EXERCISE INTERVENTION FOR AGE-RELATED SARCOPENIA

The consensus on dietary nutritional prescriptions and exercise interventions for age-related sarcopenia includes six statements (Figure 2).

Consensus 1: Follow the "Dietary Guideliens for Chinese Elderly"

-Apply the "Chinese Dietary Pagoda for the Elderly" to guide your diet choices, ensuring adequate energy and protein intake. (A)
-Include more animal-based foods rich in high-quality protein, such as fish, shrimp, lean meat, eggs, and dairy, as well as soybean products. (A)
-Increase the intake of deeply colored vegetables, fruits, and beans rich in antioxidant nutrients. (A)
-Increase the intake of foods rich in n-3 polyunsaturated fatty acids, such as deep-sea fish oil, seafood, flaxseeds, flaxseed oil, and perilla oil. (B)
-Recommend a healthy dietary pattern, such as the Eastern Healthy Diet, Mediterranean diet, and anti-inflammatory diet. (B)

A varied diet is the cornerstone of adequate and balanced nutrient supply. Meta analyses have shown that elderly individuals with sarcopenia tend to have lower protein intake.[7] A cross-sectional survey in Henan Province, using the Chinese Dietary Balance Index to assess dietary quality among adults, revealed that insufficient intake of vegetables, fruits, dairy products, and soy foods is a risk factor for reduced gait speed.[8] Consuming adequate amounts of protein, vitamin D, vitamin E, vitamin K, potassium, magnesium, phosphorus, iron, and n-3 polyunsaturated fatty acids is beneficial for maintaining muscle mass.[9-10] Some studies suggest that increasing the intake of foods rich in antioxidant substances (such as fruits and vegetables) and combining supplements of vitamins, vitamin D, and protein may be an effective intervention for sarcopenia.[11] A randomized, double blind, controlled trial (RCT) showed that supplementing with n-3 polyunsaturated fatty acids (fish oil at 4 g/day) for six months can improve body composition, muscle strength, and physical function in Chinese elderly individuals.[12] Overall, dietary factors associated with a reduced risk of sarcopenia include sufficient intake of fish and shellfish, lean meat, eggs, dairy products, soy foods, vegetables and fruits, and moderate amounts of whole grains,[13] such as the Eastern healthy diet,[5] the Mediterranean diet,[14] and anti - inflammatory diets (Table 1).[15]

Consensus 2: Ensure adequate high-quality protein intake and distribute evenly across three meals

-The recommended protein intake is 1.2-1.5 g/kg/day, increasing to 1.5-2.0 g/kg/day for individuals with malnutrition and severe trauma. For special conditions such as chronic kidney disease, follow the specialized medical treatment principles (A)
-The proportion of high quality protein should range from 50%-75% and be evenly distributed across three daily meals (B)
-If dietary protein intake is insufficient, supplement with an additional 20-40 g/day of high-quality protein, with whey protein as the first choice, and isolated whey protein being more effective (B)

High quality proteins have a higher content of essential amino acids and superior protein digestibility compared to other plant based proteins. Adequate intake of high quality proteins is fundamental to maintaining muscle health and should be ensured in the diet. Data from the 2015 China Chronic Disease and Nutrition Monitoring Survey showed that the average protein intake among the elderly was 47.9±0.6 g/day,[16] which is much lower than

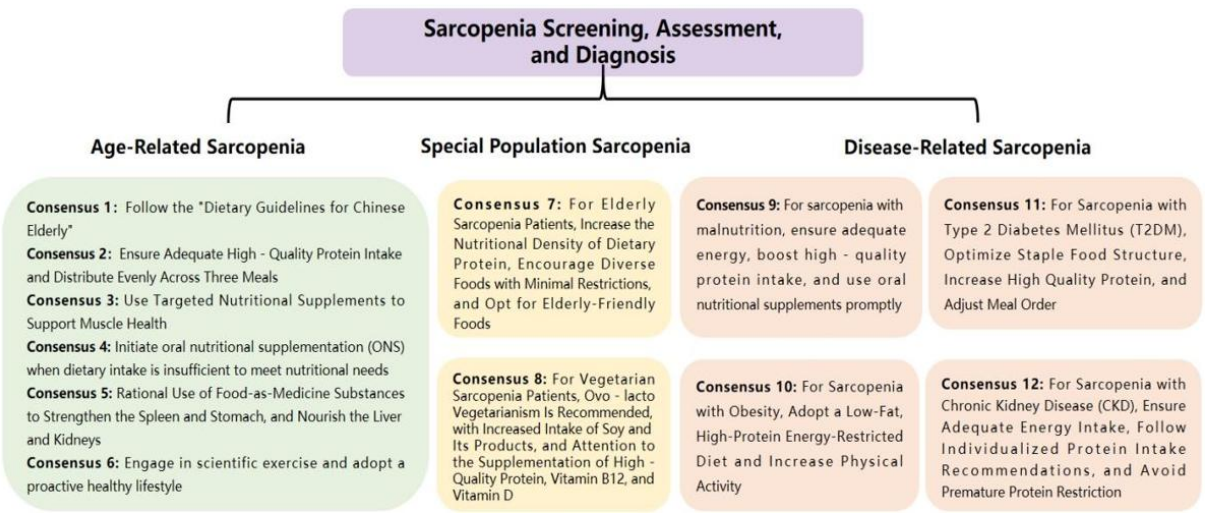

Figure 1. Overview of the Chinese expert consensus on dietary nutrition prescriptions and exercise intervention for sarcopenia (2025).

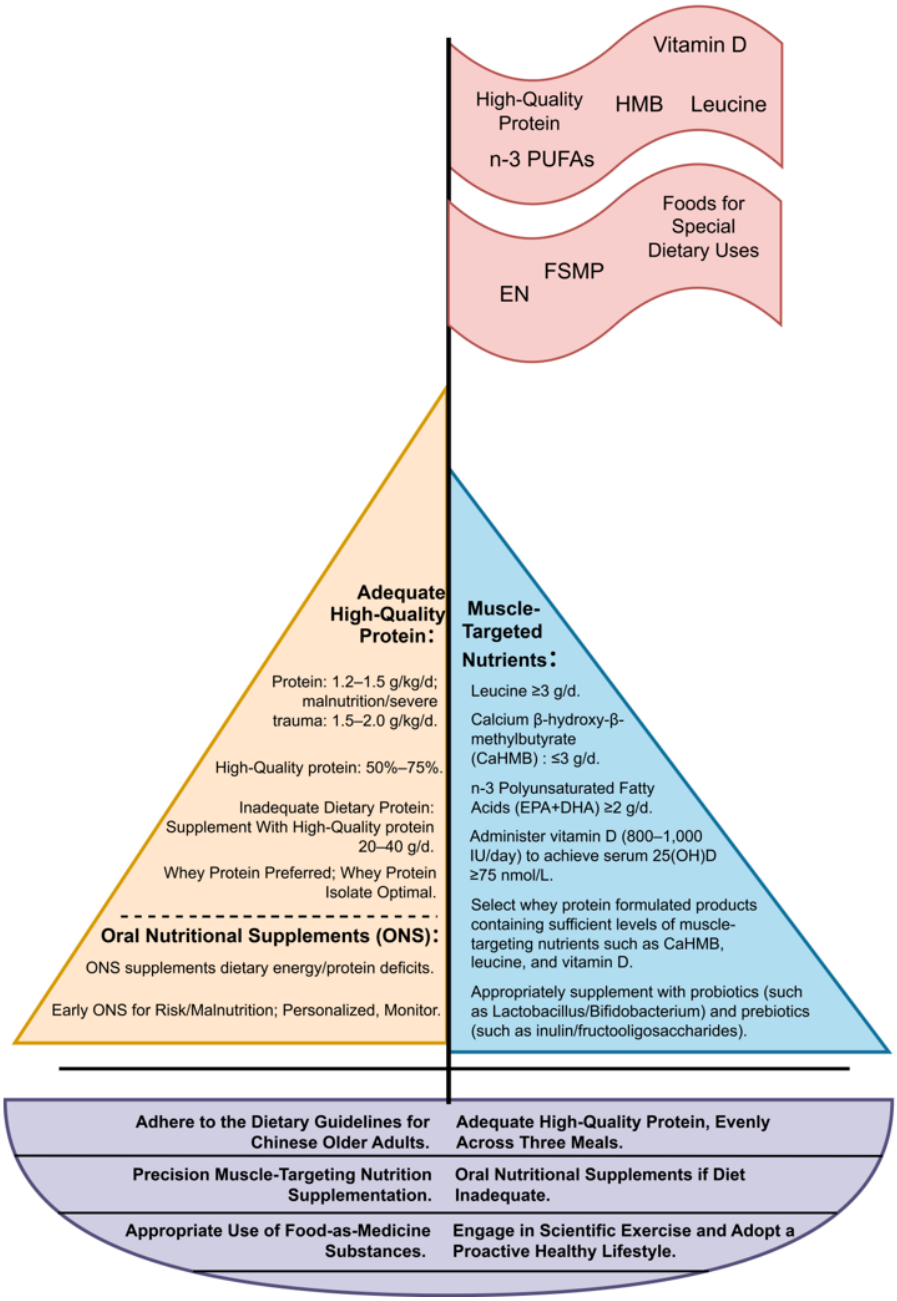

Figure 2. Consensus on dietary nutrition prescriptions and exercise intervention for age-related sarcopenia

the recommended intake. The insufficient part of dietary intake should be supplemented with high quality protein. A Meta analysis of 38 RCTs (n=3,869 individuals aged ≥65 years) showed that additional protein supplementation [median 30.0 (13.0 - 44.0) g/day] has a positive impact on muscle mass in community-dwelling elderly individuals.[17] The 2023 edition of the "Chinese Residents' Dietary Nutrient Reference Intakes" increased the recommended dietary allowance (RNI) for protein intake for Chinese adults aged 65 and above from 1.0 g/kg/day to 1.17 g/kg/day.[18] The Chinese Consensus on Nutrition and Exercise Intervention for Sarcopenia suggests that protein intake for the elderly should be maintained at 1.0-1.5 g/kg/day and evenly distributed across three meals.[6] During illnesses (such as inflammation and infection), protein requirements further increase. The PROT-AGE Study Group, led by the European Society for Clinical Nutrition and Metabolism, recommends a protein intake of 1.2-1.5 g/kg/day for elderly individuals with acute or chronic diseases.[19] The ESPEN expert group suggests that protein intake can reach up to 2.0 g/kg/day for individuals with malnutrition or severe trauma.[20] A cross - sectional study based on the Chinese elderly population showed that elderly individuals with a more even distribution of protein intake across three meals have higher appendicular skeletal muscle mass.[21]

Consensus 3: Use targeted nutritional supplements to support muscle health

- Supplement with ≥3 g/day of leucine (B)
-Supplement with ≤3 g/day of calcium β-hydroxy β-methylbutyrate (CaHMB), especially for sedentary or bedridden elderly individuals (B)
-Supplement with vitamin D (800-1,000 IU/day) to achieve a serum 25(OH)D level of ≥75 nmol/L (B)

Table 1. Healthy diets to reduce the risk of sarcopenia

Dietary pattern	Characteristics
Mediterranean diet	Abundant in fruits, vegetables, legumes, nuts, whole grains, fish, and olive oil, with moderate amounts of dairy products and limited consumption of meats
Eastern healthy diet	Diverse foods, grains-based, rich in vegetables and fruits, frequent consumption of fish and shellfish, soy products, and dairy products, and lightly salted cooking
Anti-inflammatory diet	Includes fruits, vegetables, whole grains, lean meats, and foods rich in n-3 polyunsaturated fatty acids, healthy fats, and spices

-Supplement with n-3 polyunsaturated fatty acids (EPA and DHA) at no less than 2 g/day (B)
-Choose whey protein formula products that contain sufficient levels of muscle-targeted nutrients such as CaHMB, leucine, and vitamin D (B)
-Supplement with probiotics (lactic acid bacteria/bifidobacteria, etc.) and prebiotics (inulin/ fructooligosaccharides, etc.) (C)

The treatment and prevention of sarcopenia rely not only on comprehensive dietary nutrition but also on targeted supplementation of specific nutrients based on existing evidence to meet the special needs of muscle metabolism and function in the elderly. Muscle-targeted nutrition refers to precision nutritional intervention strategies designed according to the metabolic characteristics and pathophysiological mechanisms of muscle tissue. Its core lies in prioritizing the action of specific nutrients on muscle tissue to optimize absorption, metabolism, and utilization efficiency, thereby improving muscle health.[22-23] Muscle-targeted nutritional components include whey protein, leucine, CaHMB, vitamin D, n-3 polyunsaturated fatty acids, and probiotics.[22-23] Whey protein is an important component of muscle - targeted nutrition, with isolated whey protein having the highest protein content (≥90%), which can better activate muscle protein synthesis. Branched-chain amino acids like leucine play a key role in promoting muscle protein synthesis, not only improving the muscle protein synthesis rate but also enhancing serum insulin levels, thereby improving glucose uptake by skeletal muscles. The stimulating effect of leucine on muscle protein synthesis declines with age. Elderly individuals can tolerate 1.2-6 g/day of leucine supplementation well.[24] Meta analysis results indicate that protein supplementation rich in leucine (≥3 g/day) is beneficial for muscle mass, strength, and physical function in subjects.[25] CaHMB, a natural compound produced during leucine metabolism, promotes muscle protein synthesis and slows down muscle protein breakdown. Meta analyses have shown that CaHMB supplementation is beneficial for improving muscle mass and strength in the elderly.[26] Vitamin D, by binding to its receptors, promotes calcium ion influx, myoblast differentiation, and enhances insulin sensitivity in muscles, thereby promoting muscle contraction.[27] The Western China Health and Aging Trends Study showed that serum vitamin D levels <50 nmol/L increase the risk of sarcopenia.[28] The Asian Working Group for Sarcopenia recommends supplementing vitamin D at 800-1,000 IU/day for elderly individuals with insufficient vitamin D.[29] N-3 polyunsaturated fatty acids have anti-inflammatory properties, and Meta-analyses have shown an inverse relationship between dietary n-3 polyunsaturated fatty acid levels and the prevalence of sarcopenia. Consuming over 2 g/day of n-3 polyunsaturated fatty acids can increase muscle mass and improve walking speed.[30-31] The composition and diversity of gut microbiota may be significant factors affecting skeletal muscle metabolism and function. Meta analyses have shown that probiotics containing lactic acid bacteria and bifidobacteria can improve muscle mass and strength in subjects,[32] while prebiotics containing inulin and/or fructooligosaccharides can effectively reduce the frailty index, enhance muscle strength, and increase skeletal muscle index.[33]

Muscle-targeted oral nutritional supplements (MT-ONS) refer to the use of products containing muscle-targeted nutritional components for oral nutritional supplementation to intervene in individuals with sarcopenia or at high risk of developing it. Studies have shown that MT-ONS can rapidly be digested and absorbed, increasing serum essential amino acids and insulin concentrations. Compared to other proteins and nutrients, it can more effectively enhance muscle protein synthesis efficiency, thereby maintaining or improving muscle mass, strength, and physical function.[22-23] A multicenter RCT in Europe involving 380 sarcopenic patients (average age 77.7 years) showed that, compared to an isocaloric placebo control group, the intervention group consuming two daily servings of MT-ONS (each containing 20 g of whey protein, 3 g of leucine, 800 IU of vitamin D, 3 g of fat, 9 g of carbohydrates, and other trace nutrients) for 13 weeks demonstrated significant improvements in muscle mass and physical function in sarcopenic patients.[34] This study was the first to demonstrate the benefits of muscle-targeted nutritional interventions for sarcopenia treatment.[34] A domestic multicenter RCT involving 110 sarcopenic patients (average age 79.7 years) randomly assigned participants to an intervention group and a control group. The intervention group received MT-ONS (16.8 g of isolated whey protein, 1 g of CaHMB, and 400 IU of vitamin D daily) combined with rehabilitation exercises for 12 weeks. The results showed that, compared to the control group, MT-ONS combined with exercise rehabilitation significantly improved muscle mass, grip strength, physical function, and quality of life in sarcopenic patients.[35] Based on existing clinical evidence, Emanuele Cereda et al. proposed that MT-ONS be used as a first-line nutritional treatment for sarcopenic patients or as a preventive measure for high-risk groups.[22]

Consensus 4: Initiate oral nutritional supplementation (ONS) when dietary intake is insufficient to meet nutritional needs

- Use appropriate nutritional screening/assessment tools to identify individuals at nutritional risk or with malnutrition, and initiate oral nutritional supplementation as early as possible (A)
-Select formula foods or preparations rich in high-quality protein and either complete or incomplete in nutrition (A)
-Ensure ONS provides 200–600 kcal and 15–20 g of high-quality protein daily(A)
-ONS should follow individualized principles, with regular follow up and assessments to adjust the supplementation plan as needed (A)

ONS aims to increase energy and nutritional intake by providing liquids, semisolids, or powders that supply various macronutrients and micronutrients, which can be consumed as drinks or added to beverages and foods. ONS helps prevent muscle wasting in frail elderly individuals and improves muscle mass, strength, and body composition in sarcopenic patients.[36] When sarcopenic patients exhibit significant protein deficiencies or reduced appetite and food intake, making it impossible to obtain adequate protein through diet alone, timely ONS should be provided. Oral nutritional supplements can include special medical-purpose formula foods, special dietary foods, or enteral nutrition agents, such as full - nutrition/specific full-nutrition formulas or short-peptide-based formula foods or agents. The "Chinese Expert Consensus on Oral Nutritional Supplementation for Elderly Sarcopenia (2019)" recommends daily ONS of 400-600 kcal and 15-20 g of high-quality protein rich in essential amino acids or leucine, which can be consumed between meals or in multiple doses.[37] For individuals with comorbidities, ONS should be conducted under the guidance of specialized physicians and clinical nutritionists

Consensus 5: Rational use of food-as-medicine substances to strengthen the spleen and stomach, and nourish the liver and kidneys

- In traditional Chinese medicine (TCM), the spleen is considered the "root of muscles." The dietary principle for sarcopenic patients is to strengthen the spleen and stomach and nourish the liver and kidneys (B)
-Follow the "food-as-medicine" theory and reasonably select and apply food as medicine substances (C)

In TCM, sarcopenia is categorized as "withered syndrome" and "deficiency syndrome." The "Suwen· Generation of the Five Zang Organs" records: The spleen is responsible for transforming and transporting the essence of food and drink to nourish the muscles, hence it is the master of muscles. Elderly individuals should pay special attention to regulating the spleen and stomach.[38] Classic TCM formulas for strengthening the spleen and qi, such as *Bu Zhong Yi Qi Tang* (Tonify the Middle and Augment the Qi Decoction), *Ba Zhen Tang* (Eight Treasure Decoction), and *Si Jun Zi Tang* (Four Gentlemen Decoction), have shown good efficacy in treating sarcopenia.[38] Studies have found that *Bu Zhong Yi Qi Tang* combined with basic interventions is superior to basic interventions alone for elderly sarcopenia.[39] *Ba Zhen Tang* combined with basic interventions for three months can effectively improve muscle mass, strength, and physical function in elderly sarcopenic patients, enhancing clinical treatment outcomes and quality of life.[40] Furthermore, *Si Jun Zi Tang* combined with resistance band training for eight weeks can significantly increase muscle mass and physical function in sarcopenic patients with spleen and stomach qi deficiency.[41] Common food as medicine substances include astragalus, Chinese yam, jujube, codonopsis, and tangerine peel. Typical spleen - strengthening and muscle - nourishing recipes include *Huangqi* and Chinese Yam Stewed Pigeon, Chinese Yam and Chestnut Pork Tripe Soup, and Spleen - Strengthening and Qi - Boosting Porridge.

Consensus 6: Engage in scientific exercise and adopt a proactive healthy lifestyle

- Reduce sedentary/bedridden time and increase daily physical activity (A)
-Increase resistance training or multi component exercise that includes resistance training (A)
-Develop personalized exercise prescriptions, including exercise type, frequency, intensity, and duration (A)
-Combined nutrition and exercise interventions yield better results (A)
-Quit smoking, limit alcohol consumption, ensure adequate sleep, and maintain a positive mood (A)

Sedentary behavior is independently and positively correlated with the occurrence of sarcopenia, while physical activity is negatively correlated with it.[42-43] Higher levels of physical activity and lower levels of sedentary behavior are associated with greater skeletal muscle strength and power.[44] The World Health Organization's 2020 Guidelines on Physical Activity and Sedentary Behavior recommend that older adults limit sedentary time and replace it with physical activity of any intensity, including light - intensity activities.[45]

Based on evidence clinical practice guidelines strongly recommend exercise as a primary method for the prevention and treatment of sarcopenia. Common exercise modalities include resistance training, aerobic exercise, and multi component exercise.[46] Meta analyses have shown that resistance training can significantly improve muscle quality, muscle strength, and quality of life. It is recommended to perform resistance training two to three times per week, with two to three sets per session, each consisting of eight to ten exercises, with each exercise repeated eight to twelve times. The intensity should be 60% to 80% of one-repetition maximum (1RM) (for frail elderly individuals, start with an intensity of 40% to 60% and gradually increase), with each session lasting 30 to 60 minutes (including warm up and cool down, with actual exercise time ranging from 20 to 45 minutes) and sustained for at least 12 weeks of moderate intensity resistance training.[47] Aerobic exercise has limited direct effects on muscle quality but can significantly improve functional activity capacity. It is recommended to perform aerobic exercise three to five times per week, for 20 to 60 minutes per session, at an intensity of 50% to 70% of maximum heart rate (HRmax) for moderate intensity

aerobic exercise.[48] Multi component combined exercise interventions, involving different types of exercise, can improve muscle quality, muscle strength, and physical function through synergistic effects. Multi component exercise can comprehensively enhance muscle strength, physical function, and quality of life, yielding better results than single component exercise. It is recommended to perform multi-component exercise two to three times per week, for 45 to 60 minutes per session, with resistance training as the foundation and moderate intensity integrated multi component exercise.[49-50] Combined nutrition and exercise interventions can significantly enhance the effects of resistance training on muscle quality and strength.[50-51] Given the diversity of the elderly population, who often have multiple chronic diseases, exercise programs should be tailored to individual circumstances, with safety as a priority. Personalized exercise plans can enhance intervention effectiveness and reduce exercise related risks. Additionally, unhealthy lifestyles can accelerate the development of sarcopenia. Long term smoking, excessive alcohol consumption, late bedtime, or poor sleep quality can increase the risk of sarcopenia.[52-53] As physical function declines and social adaptability decreases in the elderly, they are more prone to depression, which in turn can reduce muscle mass, strength, and physical function.[54]

2. DIETARY NUTRITIONAL PRESCRIPTIONS FOR SARCOPENIA IN SPECIAL POPULATIONS

Consensus 7: For elderly sarcopenia patients, increase the nutritional density of dietary protein, encourage diverse foods with minimal restrictions, and opt for elderly-friendly foods

-Ensure energy intake of 30 kcal/kg/day and protein intake of 1.2–1.5 g/kg/day. For those with malnutrition: energy intake should be 30-35 kcal/kg/day, and protein intake at ≥1.5 g/kg/day. For patients with abnormal liver/kidney function and blood sugar, adjust the intake goals of energy or protein according to their condition (A)
-Eat more fish, poultry, meat, eggs, and dairy; keep your diet diverse and avoid overly restrictive limits; try varied eating approaches. (A)
-Prepare foods that are finely textured and rich in flavor (B)
-Adopt a meal pattern of three meals and two snacks or three meals and three snacks (B)
-Regularly use ONS, including specialized medical foods, high-quality protein powders/agents, fortified foods and dietary supplements (A)

Adequate energy and protein intake are essential for maintaining muscle quality. However, elderly individuals aged 80 and above often have significant gaps in energy and protein intake. Data from the 2015 China Chronic Disease and Nutrition Monitoring Survey showed that 75.8% of elderly individuals had energy intake below the Estimated Energy Requirement (EER), and 82.7% had protein intake below the Recommended Nutrient Intake (RNI).[20] The "Dietary Guidelines for Chinese Elderly (2022 Edition)" recommends that elderly individuals consume a diverse range of foods, encourage various eating methods, and reduce unnecessary food restrictions.[5] A six year follow up study in Denmark revealed a significant association between higher levels of dietary protein intake (1.25 g/kg/day) in individuals aged 65 and above and the maintenance of lean body mass (LBM).[55] For elderly individuals with impaired chewing and swallowing functions, elderly friendly foods with modified textures can reduce swallowing difficulties, facilitating increased nutrient intake for those with dysphagia.[56] Elderly individuals with sarcopenia often have high rates of malnutrition, anemia, muscle loss, osteoporosis, and frailty, requiring more refined nutritional support and medical nutrition supplementation. Specialized medical foods, enteral nutrition, high-quality protein powders, and nutritional supplements are all important sources of nutrition. When dietary nutrient intake is insufficient in elderly individuals, it is recommended to initiate regular ONS as early as possible to ensure adequate nutrition, maintain physical function, and delay muscle decline.

Consensus 8: For vegetarian sarcopenic patients, recommend ovo-lacto vegetarianism, increase soy intake, and monitor high-quality protein, vitamin B12, and vitamin D levels

-Ensure energy intake of 30-35 kcal/kg/day and protein intake of 1.2-1.5 g/kg/day (A)
-Recommend ovo-lacto vegetarianism, with one egg and 1-2 cups of milk or equivalent dairy products daily (B)
-Increase the intake of soy and its products, moderately consume fermented soy products (B)
-Regularly consume nuts, seaweed, and mushrooms (B)
-Use cooking oils rich in n-3 polyunsaturated fatty acids, such as flaxseed oil and perilla oil (B)
-Timely supplementation of nutrients that may be deficient in the diet and regular monitoring of nutritional status and sarcopenia conditions (B)

Vegetarian populations, who refrain from consuming meat, poultry, fish, and other animal - based foods, primarily consist of vegans and ovo-lacto vegetarians. Although evidence on the impact of vegetarianism on sarcopenia is limited, it is important to note that most vegetarians rely on plant-based protein sources, which have lower amino acid scores and utilization rates compared to animal-based proteins. This can increase the risk of sarcopenia in vegetarian populations. Studies have shown that vegetarians are at risk of deficiencies in protein, vitamin B12, vitamin D, calcium, iron, and zinc. Therefore, vegetarian sarcopenia patients should pay attention to the supplementation of high - quality protein and other nutrients, participate in outdoor activities, and increase sun exposure to ensure energy intake of 30-35 kcal/kg/day and protein intake of 1.2-1.5 g/kg/day.[5-6] Supplementation methods can refer to Consensus 2 and Consensus 3. It is also recommended that vegetarian sarcopenia patients regularly monitor their nutritional status and sarcopenia conditions, assess the effectiveness of nutritional supplementation, and adjust their nutritional prescriptions accordingly.

3. CONSENSUS ON DIETARY NUTRITIONAL PRESCRIPTIONS FOR DISEASE-RELATED SARCOPENIA

Consensus 9: For sarcopenia with malnutrition, ensure adequate energy, boost high-quality protein intake, and use oral nutritional supplements promptly

-Ensure energy intake of 30-35 kcal/kg/day and recommend protein intake of 1.5-2.0 g/kg/day (A)
-When dietary intake is insufficient, provide ONS and choose complete formula products rich in high-quality protein. Daily intake should be at least 400-600 kcal (400 to 600 mL) (A)
-On the basis of oral nutrition, supplement 20-30 g/d of high - quality protein to meet the protein intake target (A)
-If comorbidities are present, appropriate diagnosis, treatment, and nutritional management should be guided by a specialist physician or clinical dietitian (A)

Malnutrition plays a significant role in the development of sarcopenia and interacts with it in a vicious cycle. A prospective, multicenter parallel survey found that the prevalence of malnutrition and malnutrition risk among hospitalized elderly individuals aged 65 and above in 30 major hospitals across 14 major Chinese cities was approximately 50%.[57] ONS is the preferred option for elderly sarcopenia patients with malnutrition or at risk of malnutrition. Meta analyses have shown that ONS can improve the time it takes for elderly individuals to perform five sit to stand movements and enhance grip strength.[58] For elderly patients with malnutrition, low body weight, or stress conditions, energy intake can be increased to 30-40 kcal/kg/day.[59-60] Protein intake for elderly patients with acute/chronic diseases or sarcopenia is recommended at 1.2-1.5 g/kg/day, and for those with severe malnutrition or critical illness, it can be increased to 2.0 g/kg/day.[17,61] For elderly patients with malnutrition or at risk of malnutrition, it is suggested to provide ONS of 400-600 kcal/day and/or 30 g/day of protein.[59] Nutritional supplementation should be sustained for at least 2-3 months based on the improvement of individual malnutrition and sarcopenia conditions.

Consensus 10: For sarcopenia with obesity, adopt a low-fat, high-protein energy-restricted diet and increase physical activity

-Restrict total energy intake by reducing daily consumption by 300-500 kcal (A)
-Recommend protein intake of 1.2-1.5 g/kg/day and increase leucine intake (A)
-Supplement with 1000 IU of vitamin D daily to maintain serum vitamin D levels at ≥75 nmol/L (B)
-Increase aerobic and resistance exercises (A)
-Regularly assess body composition (A)

Sarcopenic obesity (SO), a clinical syndrome characterized by the coexistence of sarcopenia and obesity,[62] has a reported clinical prevalence of 7.9% to 23% and a community prevalence of 7.1% to 9.6%.[63] Compared to sarcopenia or obesity alone, SO poses a higher risk of metabolic diseases and functional impairments, causing greater harm to the elderly.[64] Nutritional and exercise interventions are fundamental to treating SO. Studies suggest that a high protein, low fat, low energy diet can help build muscle while reducing weight. By controlling total energy intake to reduce body weight, adequate protein and micronutrient intake can be ensured.[65] The Chinese Expert Consensus on Obesity Prevention and Control recommends reducing daily energy intake by an average of 30% to 50% or by 500 kcal, or restricting daily energy intake to 1000 to 1500 kcal.[66] It is advisable to set reasonable energy restriction targets based on the physiological and metabolic characteristics of SO patients. Systematic reviews recommend increasing protein intake to 1.2 to 1.5 g/kg/day for elderly SO patients with multiple comorbidities to help maintain and restore muscle mass and function. 65 RCT studies have shown that supplementing with 2.0 to 2.5 g of leucine daily can increase muscle protein synthesis in the elderly.[67] In SO patients, vitamin D supplementation can improve muscle function.[68] The American Geriatrics Society Workgroup recommends providing 1000 IU of vitamin D_3 daily for individuals aged 65 and above to ensure adequate serum vitamin D levels.[69] RCT results indicate that for SO patients, interventions involving resistance exercise or combined supplementation of whey protein can significantly reduce fat mass and increase lean tissue.[70] It is necessary for SO patients to regularly assess body composition, monitor changes in body composition, and promptly evaluate the effectiveness of nutritional and exercise treatment strategies

Consensus 11: For sarcopenia with type 2 diabetes mellitus (T2DM), optimize staple food structure, increase high quality protein, and adjust meal order

-On the basis of blood glucose control, ensure adequate energy intake and increase high-quality protein consumption, avoiding unnecessary dietary restrictions (A)
-Calculated based on ideal body weight, it is recommended to consume 30 kcal/kg/day of energy, with protein intake reaching 1.2-1.5 g/kg/day, If necessary, supplement with high quality protein powder (B)
-Optimize staple food structure by selecting whole grains with low glycemic indices and rich in dietary fiber as high - quality staple sources, and control the intake of high-sugar fruits and their products (B)
-Eat vegetables first, followed by meat dishes, then staple foods.(B)

The incidence of sarcopenia in patients with T2DM ranges from 18.0%-47.1%.[71] Insulin resistance can inhibit protein synthesis metabolism through multiple pathways, leading to reduced muscle mass and function, thereby causing sarcopenia. Conversely, sarcopenia can decrease the efficiency of glucose uptake and utilization mediated by insulin, reduce glycogen storage capacity, and impair blood glucose regulation, resulting in elevated fasting and postprandial blood glucose levels.

Prospective cohort studies have shown that low energy intake is significantly associated with a decline in muscle mass in elderly patients with sarcopenia and T2DM, emphasizing the importance of ensuring adequate energy intake.[72] Current research on the correlation between protein intake and skeletal muscle reduction in patients with T2DM remains inconclusive. Cross sectional studies indicate a significant positive correlation between protein

intake and muscle strength or function. However, prospective and intervention studies have not observed such associations.[73] Meta analyses suggest that a high-protein diet (with a protein energy ratio >25%) is more favorable for glycemic and lipid metabolism in patients with T2DM. When whey protein is used as the protein source, it is more beneficial for weight, postprandial blood glucose, and glycosylated hemoglobin levels.[74] Based on existing clinical evidence and guidelines, it is recommended that patients with sarcopenia and T2DM consume 30 kcal/kg/day of energy and 1.2-1.5 g/kg/day of protein.[73,75-76]

Consensus 12: For sarcopenia with chronic kidney disease (CKD), ensure adequate energy Intake, follow individualized protein intake recommendations, and avoid premature protein restriction

- Ensure adequate energy intake of 30-35 kcal/kg/day (A)
-Avoid premature restriction of total protein intake, with high - quality protein accounting for 50-75% (A)
-Follow individualized principles for protein intake control. For CKD patients with metabolic instability, low-protein or very low - protein diets are not recommended. Adults with CKD at risk of progression should avoid high-protein intake (>1.3 g/kg/day). For non-dialyzed CKD patients in stages 3-5, it is recommended to maintain protein intake at 0.8 g/kg/day (A)
-Peritoneal dialysis patients should achieve a protein intake of 1.2-1.3 g/kg/day, and hemodialysis patients should reach 1.0 - 1.2 g/kg/day (A)
-When patients exhibit significant loss of appetite and fail to meet target nutritional intake, ONS should be conducted under the guidance of physicians and clinical nutritionists (B)

Chronic kidney disease (CKD) patients often experience reduced skeletal muscle mass and impaired physical function, with a prevalence of sarcopenia ranging from 4%-42%.[77] The 2024 edition of the Chinese Expert Consensus on Diagnosis, Treatment, and Prevention of Sarcopenia in CKD recommends that adults with normal body weight consume adequate energy at 30-35 kcal/kg/day.[78] The 2024 KDIGO Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease advises CKD patients to adopt healthy and diverse diets, with daily protein intake individualized based on the degree of renal impairment and treatment methods. Since low - protein diets have not been shown to improve mortality or glomerular filtration rates in CKD patients stages 3-4, the guideline recommends maintaining protein intake at 0.8 g/kg/day for adults with CKD stages 3-5.[79-80] For CKD patients with metabolic instability, low-protein or very low-protein diets are not recommended. However, adults with CKD at risk of progression should still avoid high-protein intake (>1.3 g/kg/day).[79] When patients exhibit significant loss of appetite and fail to meet target nutritional intake, ONS should be conducted under the guidance of specialized physicians and clinical nutritionists.

CONCLUSION

This project has organized multidisciplinary experts, referencing the latest domestic and international research on sarcopenia prevention and treatment, and combining them with the realities of population aging and sarcopenia prevention practices in China. The aim is to form expert consensus and provide scientific, standardized, and easily implementable technical solutions to reduce the incidence of sarcopenia and improve clinical outcomes for patients. It is hoped that experts in preventive and clinical medicine in the field of sarcopenia prevention and treatment will join forces to enhance the nutritional health and quality of life for the elderly, and to achieve healthy aging.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURES

The authors declare no personal or financial conflicts of interest.

REFERENCES

1. Chen L, Woo J, Assantachai P, Auyeung T, Chou M, Iijima K, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. J Am Med Dir Assoc. 2020;21:300-7.e2. doi:10.1016/j.jamda.2019.12.012.
2. Chen Z, Li W, Ho M, Chau P. The Prevalence of Sarcopenia in Chinese Older Adults: Meta-Analysis and Meta-Regression. Nutrients. 2021;13. doi:10.3390/nu13051441
3. Sun J, Yuan W, Chen M, Chen Y, Xu D, Li Z, et al. Possible sarcopenia and its risk factors in a home for seniors in Shanghai. Asia Pac J Clin Nutr. 2023;32:70-6. doi:10.6133/apjcn.202303_32(1).0011.
4. Balshem H, Helfand M, Schunemann HJ, Oxman AD, Kunz R, Brozek J, et al. GRADE guidelines: 3. Rating the quality

of evidence. J Clin Epidemiol. 2011;64:401-6. doi:10.1016/j.jclinepi.2010.07.015.
5. Chinese Nutrition Society. Dietary Guidelines for Chinese Residents-2022: People's Medical Publishing House, 2022. (in Chinese).
6. Sun J, Zhang J, Chang C, Zhu H, Huang C, Cao W, et al. Chinese Expert Consensus on Nutritional and Exercise Interventions for Sarcopenia (Excerpt). Acta Nutrimenta Sinica. 2015;37:320-4. doi:10.13325/j.cnki.acta.nutr.sin.2015.04.006. (in Chinese).
7. Coelho-Junior HJ, Calvani R, Azzolino D, Picca A, Tosato M, Landi F, et al. Protein Intake and Sarcopenia in Older Adults: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2022;19. doi:10.3390/ijerph19148718.
8. Ran X, Zhai J, Xu M, Zhu X, Ullah A, Lyu Q. Association of diet quality with the risk of Sarcopenia based on the Chinese diet balance index 2016: a cross-sectional study among Chinese adults in Henan Province. BMC Public Health. 2023;23:2017. doi:10.1186/s12889-023-16933-9.
9. Yokoyama Y, Kitamura A, Seino S, Kim H, Obuchi S, Kawai H, et al. Association of nutrient-derived dietary patterns with sarcopenia and its components in community-dwelling older Japanese: a cross-sectional study. Nutr J. 2021;20:7. doi:10.1186/s12937-021-00665-w.
10. Calvani R, Picca A, Coelho-Junior HJ, Tosato M, Marzetti E, Landi F. Diet for the prevention and management of sarcopenia. Metabolism. 2023;146:155637. doi:10.1016/j.metabol.2023.155637.
11. Besora-Moreno M, Llaurado E, Valls RM, Tarro L, Pedret A, Sola R. Antioxidant-rich foods, antioxidant supplements, and sarcopenia in old-young adults >/=55 years old: A systematic review and meta-analysis of observational studies and randomized controlled trials. Clin Nutr. 2022;41:2308-24. doi:10.1016/j.clnu.2022.07.035.
12. Xu D, Lu Y, Yang X, Pan D, Wang Y, Yin S, et al. Effects of fish oil-derived n-3 polyunsaturated fatty acid on body composition, muscle strength and physical performance in older people: a secondary analysis of a randomised, double-blind, placebo-controlled trial. Age Ageing. 2022;51. doi:10.1093/ageing/afac274.
13. Bloom I, Shand C, Cooper C, Robinson S, Baird J. Diet Quality and Sarcopenia in Older Adults: A Systematic Review. Nutrients. 2018;10. doi:10.3390/nu10030308.
14. Mazza E, Ferro Y, Maurotti S, Micale F, Boragina G, Russo R, et al. Association of dietary patterns with sarcopenia in adults aged 50 years and older. Eur J Nutr. 2024;63:1651-62. doi:10.1007/s00394-024-03370-6.
15. Diao H, Yan F, He Q, Li M, Zheng Q, Zhu Q, et al. Association between Dietary Inflammatory Index and Sarcopenia: A Meta-Analysis. Nutrients. 2023;15. doi:10.3390 nu15010/219.
16. Zhao Fi, Fang H, Zhao L, Mudie, Guo Q, Ju L, et al. Intakes of dietary energy and macronutrients among the elderly aged 65 and above in China in 2015. Journal of Hygiene Research. 2021;50:37-45. doi:10.19813/j.cnki.weishengyanjiu.2021.01.007. (in Chinese).
17. Hettiarachchi J, Reijnierse EM, Kew N, Fetterplace K, Tan S, Maier AB. The effect of dose, frequency, and timing of protein supplementation on muscle mass in older adults: A systematic review and meta-analysis. Ageing Res Rev. 2024;99:102325. doi:10.1016/j.arr.2024.102325.
18. Chinese Nutrition Society. Chinese residents 'dietary nutrient reference intake: People's Medical Publishing House, 2023. (in Chinese).
19. 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. 2013;14:542-59. doi:10.1016/j.jamda.2013.05.021.
20. 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. 2014;33:929-36. doi:10.1016/j.clnu.2014.04.007.
21. Song X, Wang H, Su C, Zhang M, Zhang L, Meng J, et al. Distribution of daily protein intake and appendicular skeletal muscle mass in healthy free-living Chinese older adults. Eur J Nutr. 2024;63:1747-57. doi:10.1007/s00394-024-03364-4.
22. Cereda E, Pisati R, Rondanelli M, Caccialanza R. Whey Protein, Leucine- and Vitamin-D-Enriched Oral Nutritional Supplementation for the Treatment of Sarcopenia. Nutrients. 2022;14. doi:10.3390/nu14071524.
23. Cereda E, Veronese N, Caccialanza R. Role of muscle-targeted nutritional therapy: new data. Curr Opin Clin Nutr Metab Care. 2022;25:142-53. doi:10.1097/MCO.0000000000000822.
24. Martinez-Arnau FM, Fonfria-Vivas R, Cauli O. Beneficial Effects of Leucine Supplementation on Criteria for Sarcopenia: A Systematic Review. Nutrients. 2019;11. doi:10.3390/nu11102504.
25. Lee SY, Lee HJ, Lim J. Effects of leucine-rich protein supplements in older adults with sarcopenia: A systematic review and meta-analysis of randomized controlled trials. Arch Gerontol Geriatr. 2022;102:104758. doi:10.1016/j.archger.2022.104758.
26. Bear DE, Langan A, Dimidi E, Wandrag L, Harridge SDR, Hart N, et al. beta-Hydroxy-beta-methylbutyrate and its impact on skeletal muscle mass and physical function in clinical practice: a systematic review and meta-analysis. Am J Clin Nutr. 2019;109:1119-32. doi:10.1093/ajcn/nqy373.
27. Dirks-Naylor AJ, Lennon-Edwards S. The effects of vitamin D on skeletal muscle function and cellular signaling. J Steroid Biochem Mol Biol. 2011;125:159-68. doi:10.1016/j.jsbmb.2011.03.003.
28. Luo S, Chen X, Hou L, Yue J, Liu X, Wang Y, et al. The Relationship between Sarcopenia and Vitamin D Levels in Adults of Different Ethnicities: Findings from the West China Health and Aging Trend Study. J Nutr Health Aging. 2021;25:909-13. doi:10.1007/s12603-021-1645-z.
29. Chen L, Arai H, Assantachai P, Akishita M, Chew STH, Dumlao LC, et al. Roles of nutrition in muscle health of community-dwelling older adults: evidence-based expert consensus from Asian Working Group for Sarcopenia. J Cachexia Sarcopenia Muscle. 2022;13:1653-72. doi:10.1002/jcsm.12981.
30. Huang Y, Chiu W, Hsu Y, Lo Y, Wang Y. Effects of Omega-3 Fatty Acids on Muscle Mass, Muscle Strength and Muscle Performance among the Elderly: A Meta-Analysis. Nutrients. 2020;12. doi:10.3390/nu12123739.
31. Zhang Y, Guo H, Liang J, Xiao W, Li Y. Relationship Between Dietary Omega-3 and Omega-6 Polyunsaturated Fatty Acids Level and Sarcopenia. A Meta-Analysis of Observational Studies. Front Nutr. 2021;8:738083. doi:10.3389/fnut.2021.738083.
32. Prokopidis K, Giannos P, Kirwan R, Ispoglou T, Galli F, Witard OC, et al. Impact of probiotics on muscle mass, muscle strength and lean mass: a systematic review and meta-analysis of randomized controlled trials. J Cachexia Sarcopenia Muscle. 2023;14:30-44. doi:10.1002/jcsm.13132.
33. Buigues C, Fernandez-Garrido J, Pruimboom L, Hoogland AJ, Navarro-Martinez R, Martinez-Martinez M, et al. Effect of a Prebiotic Formulation on Frailty Syndrome: A Random-

ized, Double-Blind Clinical Trial. Int J Mol Sci. 2016;17. doi:10.3390/ijms17060932.
34. Bauer JM, Verlaan S, Bautmans I, Brandt K, Donini LM, Maggio M, et al. Effects of a vitamin D and leucine-enriched whey protein nutritional supplement on measures of sarcopenia in older adults, the PROVIDE study: a randomized, double-blind, placebo-controlled trial. J Am Med Dir Assoc. 2015;16:740-7. doi:10.1016/j.jamda.2015.05.021.
35. Sun J, He M, Chen M, Chen Y, Yuan W, Song F, et al. Effects of combined nutritional supplementation and exercise on proxy measures of muscle mass, strength, and function in older adults with sarcopenia: a 12-week multicentre RCT. Nutr J. 2025;24:180. doi: 10.1186/s12937-025-01244-z.
36. Shen Y, Hao Q, Zhang M, Xian H, Yue J, Huang J, et al. Comprehensive intervention for sarcopenia among older adults: an evidence-basedclinical practice guideline. Chinese Journal of Evidence-Based Medicine. 2024;24:378-84. doi:10.7507/1672-2531.202306172. (in Chinese).
37. Geriatrics Branch Chinese Medical Association, Editorial Board of the Chinese Journal of Geriatrics. Chinese expert consensus on oral nutrition supplementation for sarcopenia of the elderly (2019).Chinese Journal of Geriatric Medicine. 2019:1193-7. doi: 10.3760/cma.j.issn.0254-9026.2019.11.001. (in Chinese).
38. Sun S, Huang J. Diseussion on the Pathogenesis and Treatment of Sarcopenia based on the Theory of Spleen Deficiency. Clinical Journal of Traditional Chinese Medicine 2023:2345-2349. doi:10.16448/i.citcm.2023.1219. (in Chinese).
39. Chen Y, Wen C, Jiao J. Effect of Buzhong Yiqi Decoction on inflammatory factors in elderly patients with sarcopenia. China Medicine and Pharmacy. 2021;11:13-6. (in Chinese).
40. Liang Q, Wang Z, Liu R, Diao Y. Clinical Effect of Modified Bazhen Decoction Combined with Nutrition Support on Elderly Sarcopenia. Chinese Journal of Integrated Traditional and Western Medicine. 2019;39:821-5. doi: 10. 7661/j. cjim. 20190404. 006. (in Chinese).
41. Wang Q, Bai J, Liu Z, Liu F, Li G, Wei L. Effect of Modified Sijunzi DecoctionCombined with Elastic Band Training on Elderly Sarcopenia with Spleen and Stomach Deficiency Syndrome. Guiding Journal of Traditional Chinese Medicine and Pharmacy. 2022;28:39-44. doi:10.13862/j.cn43-1446/r.2022.04.010. (in Chinese).
42. Mo Y, Zhou Y, Chan H, Evans C, Maddocks M. The association between sedentary behaviour and sarcopenia in older adults: a systematic review and meta-analysis. BMC Geriatr. 2023;23:877. doi:10.1186/s12877-023-04489-7.
43. Sanchez-Sanchez JL, He L, Morales JS, de Souto Barreto P, Jimenez-Pavon D, Carbonell-Baeza A, et al. Association of physical behaviours with sarcopenia in older adults: a systematic review and meta-analysis of observational studies. Lancet Healthy Longev. 2024;5:e108-e19. doi:10.1016/S2666-7568(23)00241-6.
44. Ramsey KA, Rojer AGM, D'Andrea L, Otten RHJ, Heymans MW, Trappenburg MC, et al. The association of objectively measured physical activity and sedentary behavior with skeletal muscle strength and muscle power in older adults: A systematic review and meta-analysis. Ageing Res Rev. 2021;67:101266. doi:10.1016/j.arr.2021.101266.
45. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54:1451-62. doi:10.1136/bjsports-2020-102955.
46. Dent E, Morley JE, Cruz-Jentoft AJ, Arai H, Kritchevsky SB, Guralnik J, et al. International Clinical Practice Guidelines for Sarcopenia (ICFSR): Screening, Diagnosis and Management. J Nutr Health Aging. 2018;22:1148-61. doi:10.1007/s12603-018-1139-9.
47. Chen N, He X, Feng Y, Ainsworth BE, Liu Y. Effects of resistance training in healthy older people with sarcopenia: a systematic review and meta-analysis of randomized controlled trials. Eur Rev Aging Phys Act. 2021;18:23. doi:10.1186/s11556-021-00277-7.
48. Wang H, Huang WY, Zhao Y. Efficacy of Exercise on Muscle Function and Physical Performance in Older Adults with Sarcopenia: An Updated Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2022;19. doi:10.3390/ijerph19138212.
49. Shen Y, Shi Q, Nong K, Li S, Yue J, Huang J, et al. Exercise for sarcopenia in older people: A systematic review and network meta-analysis. J Cachexia Sarcopenia Muscle. 2023;14:1199-211. doi:10.1002/jcsm.13225.
50. Negm AM, Lee J, Hamidian R, Jones CA, Khadaroo RG. Management of Sarcopenia: A Network Meta-Analysis of Randomized Controlled Trials. J Am Med Dir Assoc. 2022;23:707-14. doi:10.1016/j.jamda.2022.01.057.
51. Hou L, Lei Y, Li X, Huo C, Jia X, Yang J, et al. Effect of Protein Supplementation Combined with Resistance Training on Muscle Mass, Strength and Function in the Elderly: A Systematic Review and Meta-Analysis. J Nutr Health Aging. 2019;23:451-8. doi:10.1007/s12603-019-1181-2.
52. Lucassen EA, de Mutsert R, le Cessie S, Appelman-Dijkstra NM, Rosendaal FR, van Heemst D, et al. Poor sleep quality and later sleep timing are risk factors for osteopenia and sarcopenia in middle-aged men and women: The NEO study. PLoS One. 2017;12:e0176685. doi:10.1371/journal.pone.0176685.
53. Prokopidis K, Witard OC. Understanding the role of smoking and chronic excess alcohol consumption on reduced caloric intake and the development of sarcopenia. Nutr Res Rev. 2022;35:197-206. doi:10.1017/S0954422421000135.
54. Yanagita M, Willcox BJ, Masaki KH, Chen R, He Q, Rodriguez BL, et al. Disability and depression: investigating a complex relation using physical performance measures. Am J Geriatr Psychiatry. 2006;14:1060-8. doi:10.1097/01.JGP.0000224364.70515.12.
55. Mcdonald CK, Ankarfeldt MZ, Capra S, Bauer J, Raymond K, Heitmann BL. Lean body mass change over 6 years is associated with dietary leucine intake in an older Danish population. Br J Nutr. 2016;115:1556-62. doi:10.1017/S0007114516000611.
56. Zhang J, Zhao W, Chen J. The concept and development direction of elderly oriented food. Chinese Journal of Preventive Medicine. 2023:1915-1917. doi:10.3760/cma.j.cn112150-20230705-00509. (in Chinese).
57. Cui H, Zhu M, Chen W, Shi H, Cao W, Dong B, et al. Nutritional status of elderly inpatients in China:a multicenter survey. Chinese Journal of Geriatrics. 2021:364-9. doi: 10.3760/cma.j.issn.0254-9026.2021.03.019.
58. Veronese N, Stubbs B, Punzi L, Soysal P, Incalzi RA, Saller A, et al. Effect of nutritional supplementations on physical performance and muscle strength parameters in older people: A systematic review and meta-analysis. Ageing Res Rev 2019;51:48-54. doi:10.1016/j.arr.2019.02.005
59. Geriatric Nutrition Support Group, Society of Parenteral and Enteral Nutrition, Chinese Medical Association. Guidelines for the application of parenteral and enteral nutrition in elderly Chinese patients. Chin J Geriatr. 2020:119-32. doi: 10.3760/cma.j.issn.0254-9026.2020.02.002. (in Chinese).
60. Mao Y, Wu J, Liu G, Yu Y, Chen B, Liu J, et al. Chinese expert consensus on prevention and intervention for the elderly with malnutrition (2022). Aging Med (Milton) 2022;5:191-203. doi:10.1002/agm2.12226

61. Liu J, Ding Q, Zhou B, Liu X, Liu J, Liu Y, et al. Chinese expert consensus on diagnosis and treatment for elderly with sarcopenia (2021). Chin J Geriatr. 2021:943-952. doi: 10.3760/cma.j.issn.0254-9026.2021.08.001. (in Chinese).
62. Donini LM, Busetto L, Bischoff SC, Cederholm T, Ballesteros-Pomar MD, Batsis JA, et al. Definition and Diagnostic Criteria for Sarcopenic Obesity: ESPEN and EASO Consensus Statement. Obes Facts 2022;15:321-35. doi:10.1159/000521241
63. Benz E, Pinel A, Guillet C, Capel F, Pereira B, De Antonio M, et al. Sarcopenia and Sarcopenic Obesity and Mortality Among Older People. JAMA Netw Open 2024;7:e243604. doi:10.1001/jamanetworkopen.2024.3604
64. Donini LM, Busetto L, Bauer JM, Bischoff S, Boirie Y, Cederholm T, et al. Critical appraisal of definitions and diagnostic criteria for sarcopenic obesity based on a systematic review. Clin Nutr 2020;39:2368-88. doi:10.1016/j.clnu.2019.11.024
65. Prado CM, Batsis JA, Donini LM, Gonzalez MC, Siervo M. Sarcopenic obesity in older adults: a clinical overview. Nat Rev Endocrinol 2024;20:261-77. doi:10.1038/s41574-023-00943-z
66. Chinese Nutrition Society Obesity Prevention and Control Section, Chinese Nutrition Society Clinical Nutrition Section, Chinese Preventive Medicine Association Behavioral Health Section, Chinese Preventive Medicine Association Sports and Health Section. Expert Consensus on Obesity Prevention and Treatment in China. Chinese Journal of Epidemiology. 2022:609-26. doi: 10.3760/cma.j.cn112338-20220402-00253. (in Chinese).
67. Devries MC, Mcglory C, Bolster DR, Kamil A, Rahn M, Harkness L, et al. Protein leucine content is a determinant of shorter- and longer-term muscle protein synthetic responses at rest and following resistance exercise in healthy older women: a randomized, controlled trial. Am J Clin Nutr 2018;107:217-226. doi:10.1093/ajcn/nqx028
68. Beaudart C, Buckinx F, Rabenda V, Gillain S, Cavalier E, Slomian J, et al. The effects of vitamin D on skeletal muscle strength, muscle mass, and muscle power: a systematic review and meta-analysis of randomized controlled trials. J Clin Endocrinol Metab 2014;99:4336-45. doi:10.1210/jc.2014-1742
69. Adults AGSW. Recommendations abstracted from the American Geriatrics Society Consensus Statement on vitamin D for Prevention of Falls and Their Consequences. J Am Geriatr Soc 2014;62:147-52. doi:10.1111/jgs.12631
70. Nabuco HCG, Tomeleri CM, Fernandes RR, Sugihara Junior P, Cavalcante EF, Cunha PM, et al. Effect of whey protein supplementation combined with resistance training on body composition, muscular strength, functional capacity, and plasma-metabolism biomarkers in older women with sarcopenic obesity: A randomized, double-blind, placebo-controlled trial. Clin Nutr ESPEN 2019;32:88-95. doi:10.1016/j.clnesp.2019.04.007
71. Yuan S, Larsson SC. Epidemiology of sarcopenia: Prevalence, risk factors, and consequences. Metabolism 2023;144:155533. doi:10.1016/j.metabol.2023.155533
72. Kawano R, Takahashi F, Hashimoto Y, Okamura T, Miki A, Kaji A, et al. Short energy intake is associated with muscle mass loss in older patients with type 2 diabetes: A prospective study of the KAMOGAWA-DM cohort. Clin Nutr 2021;40:1613-20. doi:10.1016/j.clnu.2021.02.049
73. Hashimoto Y, Takahashi F, Okamura T, Hamaguchi M, Fukui M. Diet, exercise, and pharmacotherapy for sarcopenia in people with diabetes. Metabolism 2023;144:155585. doi:10.1016/j.metabol.2023.155585
74. Yu Z, Nan F, Wang LY, Jiang H, Chen W, Jiang Y. Effects of high-protein diet on glycemic control, insulin resistance and blood pressure in type 2 diabetes: A systematic review and meta-analysis of randomized controlled trials. Clin Nutr 2020;39:1724-34. doi:10.1016/j.clnu.2019.08.008
75. Shalit A, Gerontiti E, Boutzios G, Korakianiti E, Kanouta F, Vasileiou V, et al. Nutrition of aging people with diabetes mellitus: Focus on sarcopenia. Maturitas 2024;185:107975. doi:10.1016/j.maturitas.2024.107975
76. Araki E, Goto A, Kondo T, Noda M, Noto H, Origasa H, et al. Japanese Clinical Practice Guideline for Diabetes 2019. J Diabetes Investig 2020;11:1020-76. doi:10.1111/jdi.13306
77. Chatzipetrou V, Begin M, Hars M, Trombetti A. Sarcopenia in Chronic Kidney Disease: A Scoping Review of Prevalence, Risk Factors, Association with Outcomes, and Treatment. Calcif Tissue Int 2022;110:1-31. doi:10.1007/s00223-021-00898-1
78. Ding W, Yu C. Expert consensus on the diagnosis, treatment, and prevention of sarcopenia in chronic kidney disease (2024). Chin J Nephrol. 2024:592-606. doi: 10.3760/cma.j.cn441217-20240126-00136.
79. Kdigo. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney Int 2024;105:S117-S314. doi:10.1016/j.kint.2023.10.018
80. Hahn D, Hodson EM, Fouque D. Low protein diets for non-diabetic adults with chronic kidney disease. Cochrane Database Syst Rev 2020;10:CD001892. doi:10.1002/14651858.CD001892.pub5.