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Protein Consumption, Muscle Health, and Sarcopenia in the Elderly Chinese Population

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ABSTRACT

The Chinese elderly population is at high risk of sarcopenia, a decline in strength and muscle mass that can lead to injury and poor health outcomes. More education and guidelines about protein consumption and muscle health are required. Protein is an essential part of our diet since it acts as the main building block of our body. One of the main health issues closely related to protein consumption is the prevalence of sarcopenia. There have been inconsistent diagnostic criteria regarding sarcopenia, but such issues have been improved by establishing consensus on standards. Three main aspects of protein consumption that should be considered with dietary recommendations are quantity, distribution, and the source. Quantity means the total daily intake, which should increase; distribution is the proportion of protein consumed each time of eating, which should be more balanced; source is where the protein comes from, which should contain a higher percentage of animal protein. The effect of exercise is another important factor. Physical activity, especially resistance training, promotes muscle health. This review summarizes past research and provide guidelines on how dietary patterns should be modified to promote muscle health in elderly Chinese people.

Keywords: protein, amino acid, consumption, sarcopenia, elderly, muscle growth

INTRODUCTION

Nutrients are vital substances we must consume to maintain the functioning of our body. Protein is a macronutrient which provides energy. For most people, providing energy is protein's least significant role since the human body will prioritize metabolizing fats and carbohydrates for energy provision. Almost every activity inside human body utilizes proteins. Protein is regularly spared from energy provision for its unique functions. Its components, the amino acids, are the building blocks of the human body, from our hair, bones and muscles to all the organs. Protein contributes to immunity; for example, antibodies are made from protein, digestion uses protein as

digestive enzymes, and muscles are built from protein and enable movement. These all emphasize the vitality of protein in the human body; therefore, adequate dietary protein consumption is essential.

Amino acids are linked by polypeptide bonds. These chains differ in length as well as sequences. One or multiple chains of amino acids cluster and form a specific structure which results in a protein and allows for its specific function. The variation in the structure of protein allows them to carry out many functions vital for the human body; for example, the globular shape of hemoglobin facilitates its role of carrying oxygen. Amino acids are also categorized into essential and non-essential (Hou & Wu, 2018). The essential amino acids such as leucine must be included in one's diet, while non-essential amino acids such as glycine are not. Each food varies in its essential amino acids content; thus, it is important to consume a varied diet rich in protein.

Protein is present in almost every kind of food, differing in amount and type of amino acids. Meat products contain a higher proportion of protein. The essential amino acids ratio contained within the meat products are more similar to the dietary requirement of human compared to other foods. Meat products such as beef, pork, and fish are high in protein. Some plant-based foods also contain relatively large amounts of protein, such as soy and beans. Discussion and research comparing protein sources, such as their amino acids composition and other effects on health, will be further discussed in this review.

About Sarcopenia

Sarcopenia, defined as the loss of muscle mass along with a decline in muscle function, usually occurs in older populations due to the effect of aging on muscle (G. Abellan Van Kan, 2009). However, there is a difference between simply having low muscle mass and functional quality and being sarcopenic. Sarcopenia is muscle mass and functional quality decreasing to an extent that negatively affects one's health. Primary sarcopenia is defined as the sarcopenia caused by the process of aging. In contrast, secondary sarcopenia is defined as those caused by other factors such as a lack of motor activity, disease, and malnutrition. Irwin Rosenberg initially described it in 1989, and it was officially defined as a disease in 2016 by World Health Organization. Consequences of sarcopenia include a decline in functional performance and the onset of mobility limitations (G. Abellan Van Kan, 2009). Not only are the symptoms concerning, but also the health care cost. Healthcare costs for sarcopenic people are significantly higher than those who are non-sarcopenic (Bruyère et al., 2019). For example, a study in 2004 focusing on healthcare cost of sarcopenia revealed that the direct health care cost of the condition in 2000 was about 18.5 billion dollars in the US, and a reduction of 10% of sarcopenia would save 1.1 billion (dollars adjusted to 2000 rate) per year (Janssen et al., 2004). Based on the estimation of WHO, there will be an increase of 38% of the population above 65 years old by 2025, which means there will be more elderly people and consequently more sarcopenia cases soon.

The general definition of sarcopenia has been made clear; however, specific diagnostic criteria remain in discussion. Multiple measurements and standards have been developed since 1989. There are two types of primary diagnostic tests; one aims to measure muscle mass (MRI, DXA, etc.), and the other aims to measure muscle function (handgrip dynamometer, 6m walk speed test, etc.). Currently, Dual-energy X-ray Absorptiometry is the most accepted approach to quantifying muscle mass, and one of the most common methods of measuring strength is testing handgrip strength (Hua et al., 2023). Due to the variation in measurements and standards, there has not been a consensus on the operational definition across clinics, research, and the broader population. As a result, there is a noticeable variation between sarcopenia prevalence investigated by different research groups.

The main factors affecting muscle mass are muscle atrophy, decreased mitochondrial function, increased oxidative stress, impaired satellite cell function and inflammation, which are all age-related (Distefano & Goodpaster, 2018). A person loses muscle at a rate of 0.3-0.8 percent every year after the approximate age of 30, along with a decrease in muscle strength with a rate ranging from 2-4 percent annually (Paddon-Jones & Rasmussen, 2009). This deterioration becomes significant after 50-60 years of age. The rate of decrease in strength is greater than the rate of decrease in muscle mass. As a result, this provides a justification that muscle strength can be a better predictor of disability and increased mortality rate than muscle mass (Distefano & Goodpaster, 2018).

Older Chinese people (generally above 60) are at high risk for sarcopenia. The Asian Working Group of Sarcopenia 2019 consensus (AWGS 2019) refined the definition of possible sarcopenia, sarcopenia, and severe sarcopenia: In general, possible sarcopenia is defined by low muscle strength; sarcopenia is diagnosed by low muscle mass and either low physical performance or muscle strength; severe sarcopenia is diagnosed by low muscle strength, low muscle mass and low physical performance (Chen et al., 2020). This allowed for the standardization of diagnosis and better comparative studies across research groups after 2019. A study in 2021 analyzed 6172 subjects from 28 provinces, and the results showed that the prevalence rate of possible sarcopenia is 38.5%; the prevalence rate of sarcopenia is 18.6%; the prevalence rate of severe sarcopenia is 8.0% (Wu et al., 2021). Shandong University published a meta-analysis in 2022 which states that Chinese people over the age of 65 have a sarcopenia prevalence of 23.2% (Xiaoyu et al., 2022). It also revealed a link between age and sarcopenia prevalence, showing that it is 10.4% for people aged 65-69, 22.4% for people between 70-79, and 40.6% for people over 80. It is hard to state the comparison between sarcopenia prevalence in China and other countries due to the differences in measurements and standards. However, considering the traditional dietary patterns in China tend to contain less protein, it is likely that the Chinese population are at higher risk of sarcopenia than the West.

Available methods for treatment and prevention of sarcopenia all focus on consuming suitable amounts of protein and resistance training, which compensate or even reverse the adverse effects of factors that cause sarcopenia (Cruz-Jentoft et al., 2020). Lean mass is positively correlated to overall health, and its maintenance positively influences the decline in muscle function due to aging (Mustafa et al., 2018). Meanwhile, to a lesser extent, gait speed and hemoglobin concentration, which are increased by engagement in physical activities, were positively associated with decreased risk of sarcopenia (Wu et al., 2021). These findings can be applied to the recommendation to promote muscle health of the Chinese elderly population.

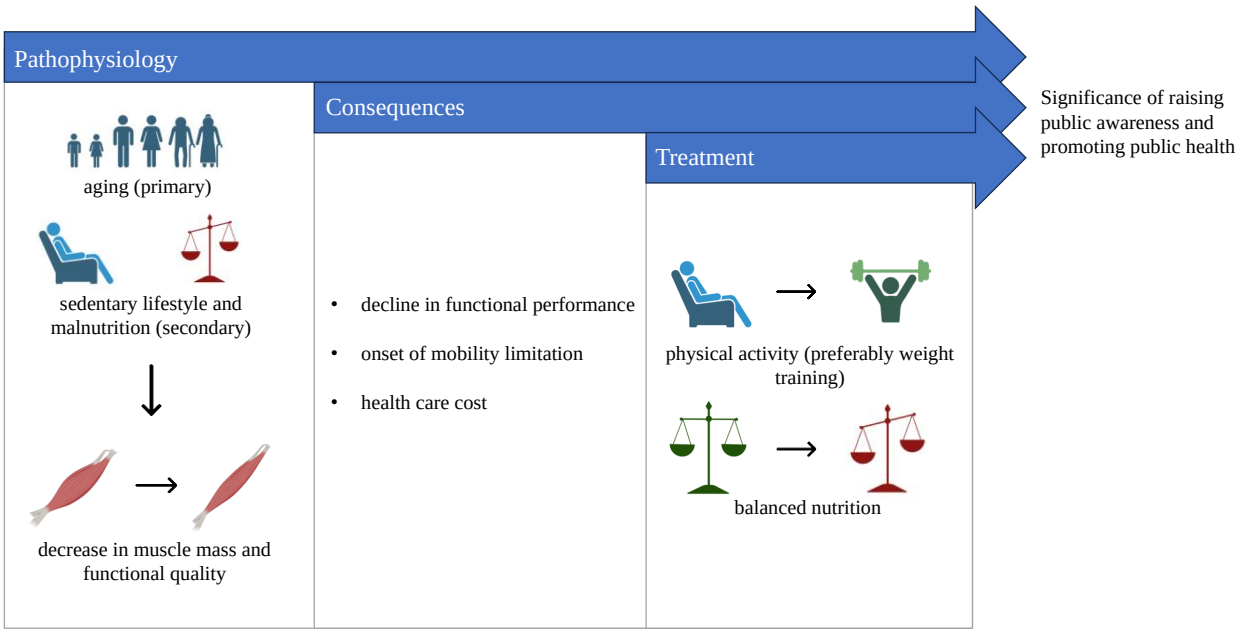

Figure 1. Pathophysiology, consequences, and treatment for sarcopenia. Sarcopenia primarily influences older adults with sedentary lifestyles. Sarcopenia can be treated by proper nutrition and participation in physical activity.

Patterns of Protein Consumption in Elderly Chinese People

Protein quantity, protein distribution, and protein source all impact on muscle protein synthesis.

In general, the protein intake in the Chinese elderly population is below the recommended amount, hence a relatively higher incidence of sarcopenia. The Dietary Reference Intake of China states that protein should account for 15% of the total energy consumption.

However, in 2015 the average protein energy percentage in all the four regions studied (northeast, east coast, central, and western) ranged from 11% to 13%, which were all below the recommended 15% (Xu et al., 2015). More than 80% of elderly Chinese people have intake levels below the recommended intake of protein, while the consumption of other two macronutrients, fats and carbohydrates, is more ideal (Xiaoyu et al., 2022). A longitudinal study summarized data from China Health and Nutrition Survey from 1991 to 2015. It concluded that the protein consumption among elderly Chinese (above 60) in the nine provinces investigated has decreased during these years. The protein seems to have been replaced by more fat in the diet. The average protein intake was 52.2 g/day in 2015, which is considered inadequate compared to the recommended intake of at least 1.0g per kg body weight (Wany et al., 2019). However, there is an urban-rural difference as people living in urban areas consume more protein than those living in rural areas. Since this study focused on only 9 provinces, more work will be necessary to explore other regions. Another study collected data from the China National Chronic Non-Communicable Disease and Nutrition Surveillance of adults in 2015, from 31 provinces and for people above 65 (Zhao et al., 2021). The average protein intake is 47.9 g/day, which is even less than previously reported. The consumption of protein, as well as other nutrients, varies according to region. People from high-income areas (urban) generally consume more protein and fat (Wany et al., 2019; Ren et al., 2022; Xu et al., 2015) - we do not know whether this is due to access to food, education, or preferences. Although these studies highlight differences, the trends indicate that the population is not getting enough protein, which emphasizes a need to promote more rural and low-income elderly people to have access to a more balanced diet.

Protein distribution is what percentage of protein intake is consumed during each meal, typically breakfast, lunch, and dinner. According to a native study in 2021, the protein distribution pattern of Chinese people is 25% in the morning and 35%-36% for both lunch and dinner (Ouyang et al., 2022). These results fluctuate since dietary pattern varies among different regions. However, this study applied a multistage sampling to minimize selection bias to the greatest extent. Although the exact distribution pattern varies accordingly, recommendations can still be offered since studies have proven that even distribution benefits protein synthesis.

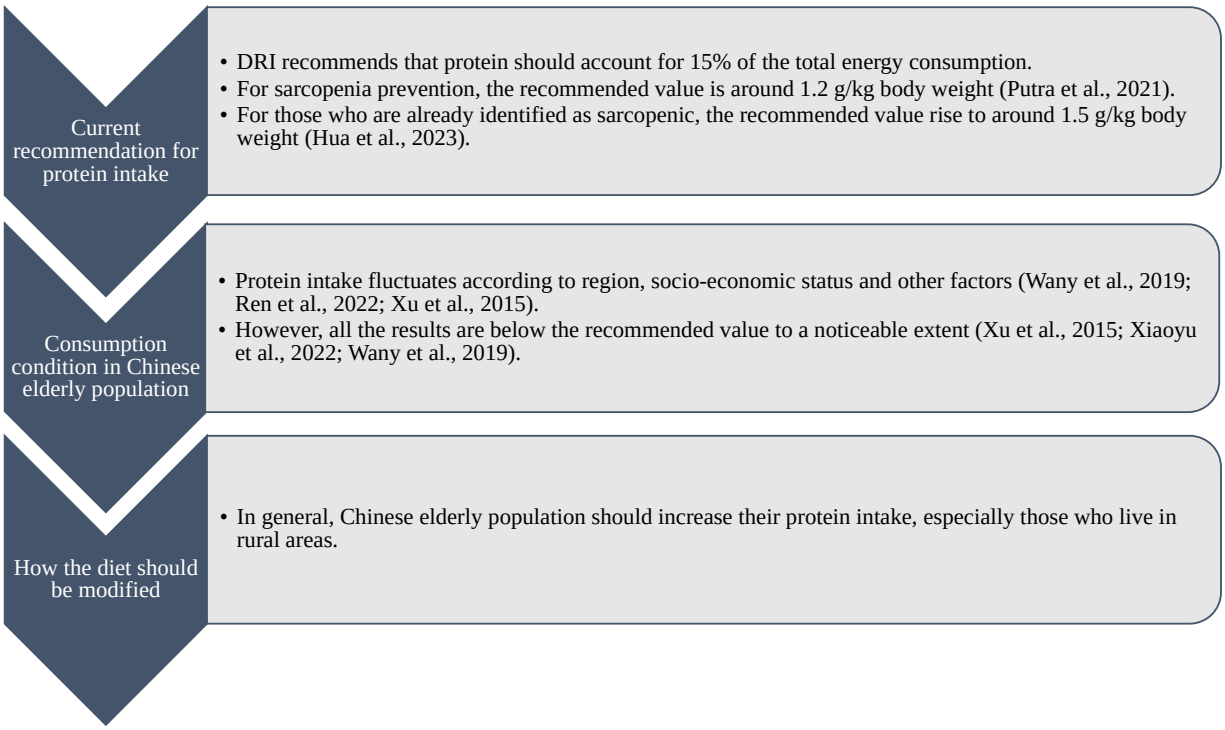

Figure 2. How the diet of the Chinese elderly people can be improved with respect to protein intake. Protein intake is the most determinant factor in one's diet that influences muscle. Chinese elderly population should consume more protein.

In the past, meat products and the processing industry in the East were not as well developed as those in the West. Although such issues have improved with economic growth and the import of Western food, culturally speaking, traditional eastern diets favor more grains and vegetables and deemphasize protein sources (Nam et al., 2010). The effects of these traditions are more evident in the elderly population and are less likely to change.

Dietary recommendations

Protein requirements for an individual varies according to age, gender, and physical activity. People over 50 should pay extra attention to protein consumption to prevent sarcopenia (Loenneke et al., 2016). Having inadequate protein contributes to incomplete muscle synthesis leading to an overall loss of muscle mass and a high risk of sarcopenia in the long term. Having too much protein does not further benefit muscle protein synthesis; instead, it might result in the excess energy being stored as adipose tissue, which contributes to sarcopenia. However, the discussion around the optimal amount of protein has not reached a consensus. The current international Recommended Dietary Allowance for protein is 0.8 g/kg body weight per day. However, some studies suggest that the current recommendation may be insufficient for muscle maintenance (Bauer et al., 2013; Deutz et al., 2014). A literature review from 2021 recommended a daily intake of 1.2 g/kg for older adults to prevent sarcopenia (Putra et al., 2021), and further according to the autoreactive nutritional science review published in 2023, which represents the consensus of Chinese nutritionists, the intake for sarcopenic individuals should reach as much as 1.5 g/kg body weight (Hua et al., 2023). Elderly people often are not reaching the lowest of these recommendations as they tend to have a decreased appetite through aging. Thus, then protein supplementation may be a tool to aid people in receiving sufficient nutrition.

Higher consumption frequency and even distribution are recommended since they promote protein synthesis and increase bulk muscle mass. Having most of the daily protein in a single meal leads to a greater lean mass retention compared to a more even distribution. Even distribution (protein per meals lies between 30 and 45 grams) appears to have the best effect on muscle growth (Schoenfeld & Aragon, 2018) and it is also proven that eating protein over two meals rather than 1 or zero gives you better knee strength and lean muscle mass (Loenneke et al., 2016). Therefore, to maximize muscle protein synthesis, people should distribute three meals evenly.

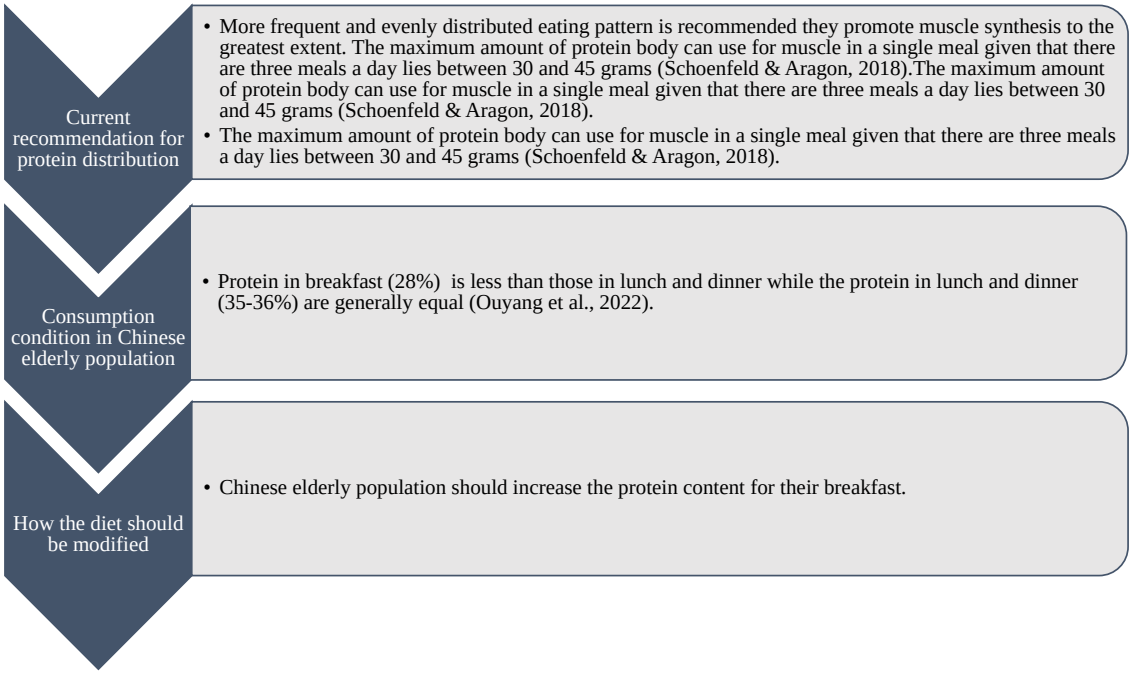

Figure 3. How the diet of the Chinese elderly people can be improved with respect to protein distribution. Protein distribution's influence on muscle appears to be less significant compared to intake and source. However, it is recommended to distribute protein intake more evenly, if possible, to maximize the positive effect on muscle.

Figure 4. Examples of different sources of protein. Animal protein includes meat and dairy products; plant protein includes vegetables and fruits; supplements such as whey protein powder are mostly pure protein and do not contain other nutrients.

Protein sources include animal, plant, and supplements. Each kind of food's constituents vary accordingly, from the type of amino acids present to its relative proportion. Animal sources contain a higher proportion of essential amino acids and fat (Hou & Wu, 2018). They also contain fat-soluble vitamins within them. Animal sources include red meat, white meat, and dairy products. Although they all provide a substantial amount of essential amino acids, red meat, such as beef, contains a higher proportion of saturated fatty acids. In comparison, white meat, such as fish, contains a higher proportion of unsaturated fatty acids. Dairy products contain a higher proportion of calcium and vitamin D. They contain all the essential amino acids. Plant protein contains less fat than animal protein but more fiber and water-soluble vitamins. Fiber is well known for its health benefits, and it is currently recommended to increase by the Chinese dietary guidelines. Most of them do not contain all the essential amino acids. The application of a highly plant-based requires careful planning to ensure the consumption of all types of amino acids in adequate amounts. However, a higher level of vegetable protein intake is positively associated with higher muscle mass (Ouyang et al., 2022). This is probably due to having less saturated fatty acids and more unsaturated fatty acids in the diet. Animal and plant provide different proportions of amino acids and other vital nutrients; therefore, a balanced consumption of both has complementary effects and is recommended. There are other nutrients that promote muscle synthesis, such as vitamin D, omega-3 fatty acids, magnesium, and antioxidants (Putra et al., 2021). Although they are beyond the scope of this article, this fact again emphasizes that a healthy diet comes from variation and balance.

Protein supplements are protein extracted from sources such as milk, egg, and soy. They do not contain other nutrients unless specifically fortified. Some supplements are categorized according to their production process, such as whey, while others are categorized according to the type of amino acids they contain, such as leucine.

Supplementary essential amino acids, especially leucine, benefit older adults by promoting muscle synthesis (Hua et al., 2023). However, increased protein intake alone is not sufficient to treat sarcopenia. If it is not combined with changes in behavior, namely participation in physical activities especially resistance training, there is not much change in muscle size, strength, and function (Mertz et al., 2021). The fact that protein supplementation alone does not benefit the preservation of muscle mass and strength emphasizes the that not only eating pattern contribute to muscle health, but lifestyle, which many elderly Chinese people neglect, plays an important role.

Exercise should accompany dietary changes

Besides adequate protein intake, exercise is required to promote healthy aging (Hua et al., 2023; Rogeri et al., 2022; Seo et al., 2021; Wu et al., 2021). The positive effects of exercise on muscles include better regeneration due to decreased fibrosis formation, less intermuscular adipose tissue which leads to a decrease in insulin sensitivity of mitochondria, and consequently promotes muscle growth and functional quality (Distefano & Goodpaster, 2018). As a result, exercise can moderate or even reverse the negative effects of aging on muscles.

Resistance training is more effective than other training methods in promoting muscle growth and increase in muscle strength; the pattern applies to people at all stages of life. It involves using self-body weight, elastic band, and equipment such as dumbbells, barbells, and resistance machines to offer resistance on muscle during motion. It is extremely effective at improving strength, power, and muscular endurance. According to the Sports Science Research Institute of the State Sports General Administration, the elderly Chinese tend to participate in physical activities such as jogging, speed walking, and square dancing, which are more aerobic than anaerobic hence having less positive influence on muscle growth (Sports Science Research Institute, 2020). Therefore, resistance training should be promoted in addition to these other activities to promote muscle health.

CONCLUSION

Protein consumption among elderly Chinese people is associated with an increased prevalence of sarcopenia. To prevent or treat sarcopenia, increased protein consumption, even distribution, and a more balanced diet which includes more high-quality protein sources are recommended. The change in lifestyle is also vital. Resistance training is the most suitable approach for sarcopenia prevention and treatment. Further education on the importance of a balanced diet and exercise is necessary to promote health and improved quality of life in older Chinese adults.

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