

Nutritional Challenges in the Geriatric Population: A Review

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Abstract

The growing number of older people around the world is a challenge to health services, especially in the area of nutrition and chronic disease [1,2]. Poor or unbalanced dietary intake in geriatric patients increases the risk of chronic illnesses, sarcopenia, frailty, cognitive impairments and diminished quality of life [4-7]. This review critically assesses the existing evidence on dietary patterns, macronutrient and micronutrient needs as well as nutritional interventions that are specific to older adults. Much attention is given to the quality of proteins, the diversity of the diet, and functional foods. New ideas like individualized nutrition and microbiota regulation in the gut are discussed as well [8-10]. In addition, obstacles to best nutrition such as socioeconomic, physiological, and gaps in healthcare are addressed. The review gives evidence of the necessity of integrated and evidence-based dietary interventions as a means of enhancing healthy ageing and decreasing the morbidity of age-related diseases.

Keywords: Geriatric nutrition; Ageing; Sarcopenia; Dietary patterns; Malnutrition; Functional foods

Introduction:

One of the most important demographic trends of the 21st century is population ageing due to the increase in life expectancy and the reduction of fertility rates. The percentage of people over 60 years of age is increasing at an alarming rate especially in the low- and middle-income nations like India, which have significant burdens on the healthcare systems [1,2]. Nutrition is a critical area of intervention and research since it is a fundamental part of healthy ageing and prevention of age-related diseases.

The process of ageing is marked by progressive physiological and metabolic alterations, such as slow basal metabolic rate, changes in gastrointestinal activity, loss of appetite, and a decline in nutrient absorption [3,11]. Such alterations, as well as psychosocial conditions like isolation and inability to afford food because of their economic status, make older adults more vulnerable to malnutrition [4,5]. There is an indication that malnutrition is common in the community-dwelling and institutionalized elderly populations and is linked with higher morbidity and mortality and higher healthcare expenditures [5,12].

Ageing leads to one of the most serious problems, i.e., skeletal muscle mass and strength loss (sarcopenia), which substantially influences functional capacity and autonomy [6,13]. One of the key factors that lead to this is nutritional inadequacy, especially lack of proteins and micronutrients [7,14]. Research shows that due to decreased appetite, chewing problems, and chronic diseases, older adults do not consume the recommended dietary intakes [7,15].

The nutritional needs of the geriatric population vary with younger adults. Although energy needs decreases with age, some nutrients like protein, vitamin D, calcium, vitamin B12 require more or the same level of needs [14,16]. Protein consumption (1.012 g/kg/day) is especially significant in

preserving muscle size and frailty [7]. Likewise, micronutrients are essential to bone health, immune system and cognitive performance [16,17].

Over the past several years, the paradigm of looking at isolated nutrients has been changed to looking at the dietary tendencies. Mediterranean diet and DASH diet are among the dietary approaches that have been linked to better heart conditions, lowering inflammation, and longer life expectancy [8,18]. Such eating habits are focused on eating fruits, vegetables, whole grains, lean proteins, and healthy fats, which are in line with the healthy ageing suggestions.

New studies have shown the importance of the gut microbiota in the ageing process, indicating that diet influences microbial composition, which subsequently impacts on inflammation, immunity, and metabolic health [9,19]. Individualized nutritional interventions based on genetic, metabolic and lifestyle factors are becoming popular as effective methods of maximizing diets in the older adults [10].

Although the awareness has increased, there are several barriers to optimal nutrition among geriatric population. They are restricted availability of foods rich in nutrients, shortage of nutrition education, cultural eating habits, and insufficient geriatric-specific healthcare services [4,20]. The issues need to be tackled through a multidisciplinary strategy which incorporates clinical nutrition, public health policies and community-based interventions.

The purpose of this review is to critically synthesize the existing evidence on dietary requirements, problems and interventions within geriatric population with an aim of enhancing the health outcomes, functional ability and quality of life.

The Physiological Ageing and its Nutritional Implications.

The process of ageing influences almost all organ systems; therefore, alterations in ageing impact nutritional status [3]. A decrease in gastric acid secretion negatively affects vitamin B12, calcium and iron absorption [11,16]. Reduced salivation and tooth problems can reduce food options, which reduces dietary diversity [4].

Also, changes in hormones and lack of physical activity also lead to low energy expenditure [15]. Nevertheless, the decreasing caloric needs do not decrease the needs in essential nutrients but may even rise, posing a risk of micronutrient deficiencies [16,17].

Nutritional Needs of the Elderly

1. Macronutrients

The consumption of proteins is especially significant in elderly people [7]. Protein intake (1.0-1.2g/kg/day) should be adequate to sustain muscle mass and prevent sarcopenia [7,14]. Research indicates that greater protein consumption is linked with increased lean body mass in older adults [24].

Complex carbohydrates like whole grains are recommended as the main source of carbohydrates and they aid in glycaemic regulation and metabolic well-being [8]. Whole-grain fats, especially unsaturated fats, are also beneficial for the cardiovascular health and to lessen inflammatory conditions [18].

2. Micronutrients

Older adults are prone to micronutrient deficiencies, which have a major effect on health outcomes [17]. Vitamin D and calcium play a vital role in bone health and osteoporosis prevention [25]. Deficiency of vitamin B12 is related to neurological disorders and cognitive impairment [16].

Deficits in total energy intake or in one or more essential nutrients, such as vitamins A, B6, B12, C, E and folate, trace elements including zinc, iron, copper and selenium, as well as essential amino acids and fatty acids, can impair immune functioning and increase vulnerability to infectious diseases[30].

The undernourishment of the Elderly

Malnutrition is a significant issue among geriatric populations, and it is not usually diagnosed [5,12]. It is caused by a complex of physiological, psychological and social factors [4,20]. The effects are decreased muscle strength, a high risk of infection, an extended wound healing period, and mortality rate [31].

Poor nutritional status is tightly associated with frailty, which is loss of physiological reserve and exposure to stressors [28]. There is therefore a need to tackle malnutrition as a means of enhancing the health outcomes of older adults.

Eating Behaviour and Healthy Ageing

Recent studies have put the accent on the role of general eating habits, as opposed to specific nutrients [27]. Mediterranean diet has also been linked with decreased cardiovascular diseases and longer life span [8,18]. On the same note, the DASH diet can be used to control hypertension and metabolic health [18].

These eating habits focus on a high consumption of fruits, vegetables, whole grains, lean proteins, and healthy fats, which together will lead to improved health outcomes [26]. Traditional diets with whole grains and pulse in the Indian context have balanced nutrition and they maintain metabolic health.

Functional Foods and Trends

Functional foods are increasingly relevant in the nutrition of the geriatric population [28]. These are probiotics, prebiotics, foods rich in antioxidants which are sources of health advantages other than just food [9].

New studies are pointing at the microbiota of the gut, and its role in ageing, showing that diet also affects the microbial flora and systemic inflammation [9,19]. Individualized nutrition strategies that consider genetic and metabolic variations are becoming significant in maximizing dietary intervention [10].

Obstacles to Ideal Nutrition

There are a number of barriers to proper nutrition among the elderly, such as financial constraints, social isolation and low appetite [4,20]. Polypharmacy and chronic diseases also make it more difficult to eat and absorb nutrients [23].

In developing nations, there is a lack of access to healthcare facilities and nutrition education which intensify such difficulties [20]. To overcome these obstacles, there is need to have a multidisciplinary approach that incorporates the role of the healthcare providers, policymakers as well as the support systems within the community.

Discussion

The current review sheds more light on the multi factorial relationship between ageing, nutrition and health outcomes, with diet being one of the key modifiable determinants of healthy ageing [28,34]. The ageing process is also associated with physiological, metabolic, and functional changes, such as a decrease in appetite, a change in the gastrointestinal functioning, reduced sensory perception, and physical activity all of which lead to the decrease in dietary intake and nutrient absorption [3,11,15]. This means that not only are older people at a greater risk of macronutrient deficiency, but also of micronutrient deficiency [16,17].

Among the most important findings of the literature is the essential needs of protein consumption in the maintenance of muscle mass and the prevention of Sarcopenia [6,13]. Although established guidelines exist, the uptake of proteins among the aged populations is usually suboptimal due to factors including reduced appetite, difficulty in chewing, and socioeconomic status of the targeted populations [7,15]. It has been suggested that increased protein consumption (1.0-1.2 g/kg/day), whether through a high protein diet (HPD) or spread evenly across the diet, is related to enhanced muscle protein synthesis and functional outcome [7,14,24]. In addition, the quality of diet has been positively related with muscle strength and less frailty further supporting the use of balanced dietary intake [29,32].

Another significant issue in geriatric nutrition is the micronutrient deficiencies. Vitamin D, calcium, and vitamin B12 are all vitamins and nutrients that are often deficient because of lack of absorption, exposure to the sun, and restrictions in the diets [16,25]. These deficiencies are directly associated with negative consequences such as osteoporosis, impaired cognitive functioning and weakened immune response [17,30]. Especially in the ageing populations, the notion of hidden hunger, where people have enough calories but lack the necessary nutrients, is especially applicable [28].

The nutrition centric perspective to the diet pattern-based models can be seen as a major contribution to the field of nutrition science [27]. Dietary approaches like the Mediterranean diet and the DASH diet have shown to be consistent in their cardiovascular risk reduction, metabolic health promotion, and longevity [8,18]. These trends are in line with the whole, minimally processed foods, such as fruits, vegetables, whole grains, and healthy fats, which align well with the geriatric nutritional guidelines [26]. Their relevance to non-Western contexts, especially in India, however, needs to be culturally and economically adjusted.

The situation in the Indian context is that the traditional dietary practices are a valuable but underutilized opportunity to enhance geriatric nutrition. Whole grains, pulses and foods that are culturally accepted such as millets and barley have a balanced nutrient profile and are culturally acceptable. Not only are these foods nutrient-rich, but they are also cost-effective and thus can be used in large-scale public health intervention. The reinforcement of the importance of millets in the national programs is yet another factor that would support the incorporation of millets in geriatric nutrition plans.

New studies also reveal that the composition of the diet is associated with microbial diversity and systemic inflammation in relation to ageing [9,19]. High-fiber and vegetarian diets lead to a beneficial microbiota, which, in its turn, causes the enhancement of metabolic and immune functions. This has brought the significant interest of the use of functional foods and probiotics as intervention of geriatric nutrition [9].

Regardless of these advances, there are still a number of gaps. Majority of the available evidence is based on the Western populations, which limits its applicability to a variety of cultural and

socioeconomic contexts [34]. Also, long-term, big-scale intervention studies in the elderly are lacking, especially in developing countries. Also contributing to the inability to implement evidence-based dietary practices are socioeconomic disparities, a lack of access to healthcare, and a lack of nutrition education [4,20].

Notably, the nutritional issue in the elderly has to be dealt with in a multidisciplinary and holistic fashion. Treatment needs to incorporate dietary changes with physical exercise, social support networks, and access to health services to lead to significant changes in health outcomes [28]. Community based programs, culturally acceptable dietary prescriptions as well as policy level interventions are critical towards enhancing sustainable dietary changes among ageing populations.

Table: Recommended Nutrient Requirements in the Geriatric Population

Nutrient	Recommended Intake (≥60 years)	Physiological Role	Clinical Significance in Elderly	Key Food Sources (Indian Context)
Energy	~20–30 kcal/kg/day	Maintains basal metabolism	Reduced needs due to lower BMR	Whole grains, millets
Protein	1.0–1.2 g/kg/day	Muscle synthesis, repair	Prevents Sarcopenia and frailty	Pulses, legumes, dairy, soy
Carbohydrates	45–65% of total energy	Energy source	Supports glycemic control	Whole grains, barley, oats
Fats	20–35% of total energy	Hormonal balance, energy	Reduces cardiovascular risk (if unsaturated)	Nuts, seeds, vegetable oils
Calcium	1000–1200 mg/day	Bone mineralization	Prevents osteoporosis	Milk, curd, ragi
Vitamin D	800–1000 IU/day	Calcium absorption	Reduces fracture risk	Sunlight, fortified foods
Vitamin B12	2.4 µg/day	Neurological function	Prevents cognitive decline	Dairy, fortified cereals

Fiber	25–30 g/day	Gut health	Prevents constipation, improves microbiome	Fruits, vegetables, whole grains
Iron	8–10 mg/day	Hemoglobin synthesis	Prevents anemia	Green leafy vegetables, legumes
Antioxidants (Vit C, E)	Variable	Reduces oxidative stress	Supports immunity, delays ageing	Citrus fruits, nuts

Source: Adapted from Wellman (1994); Volkert et al. (2018); Deutz et al. (2014); Bolzetta et al. (2015); Foote et al. (2000) [14,16,35,36,37].

Conclusion

Nutrition has played an important role in promoting healthy ageing as well as prevention of age related diseases [28]. The elderly require enough intake of macronutrients and micronutrients and adherence to balanced diets to promote functional autonomy and quality of life. In elderly, skeletal muscle has a decreased sensitivity to the anabolic influences of dietary protein. Increased protein consumption is thus commonly suggested as a means of overcoming this anabolic resistance and to aid in maintaining muscle mass [16,33]. Adequacy of high-quality protein intake is especially vital in preserving muscle mass and preventing Sarcopenia, whereas sufficient intake of micronutrients supports skeletal health, cognitive abilities, and immune responses [7,17].

The use of holistic dietary patterns, not isolated nutrient supplementation, seems to be the most effective strategy in improving the health outcomes of older adults [27]. Dietary systems like the Mediterranean and DASH diets offer good evidence-based systems of reducing chronic disease risk and improving longevity [8,18]. Nevertheless, their adaptation to local eating habits is critical to enhance compliance and sustainability.

An effective and culturally sensitive solution to geriatric diets is traditional Indian diets, which are distinguished by the presence of whole grains, pulses, and functional foods into their preparations. These dietary practices, along with the current nutritional science, can be used to help close the gap between research evidence and practical implementation. Moreover, there are new opportunities to investigate and introduce interventions in the future, including the regulation of gut microbiomes and personalized nutrition [9,10].

Overcoming considerable barriers such as socioeconomic barriers, lack of awareness, and lack of healthcare access are also necessary to address the nutritional needs of the ageing population [4,20]. To provide older adults with equitable access to healthy diets, it is necessary to support and utilize public health strategies, policy interventions, and targeted nutrition programs.

The priority of future research should be on longitudinal and intervention based studies in diverse populations to produce context specific evidence [34]. Incorporation of nutrition as part of overall geriatric care models will be essential towards enhancing overall health outcomes and the quality of

life. Finally, the need to promote the best nutritional habits in the elderly on both clinical and public health fronts has far-reaching implications.

Future studies are needed on:

1. Personalized nutrition strategies [10]
2. Prolonged diet intervention studies [34].
3. Combination of traditional and contemporary diets.
4. Geriatric nutrition policy-level interventions.

Conflict of Interest

The author declares no conflict of interest.

References:

1. World Health Organization. (2021). *Decade of healthy ageing (2021–2030)*.
2. United Nations. (2020). *World population ageing report*.
3. Chandra, R. K. (1991). Nutrition of the elderly. *Canadian Medical Association Journal*, 145(11), 1475–1487.
4. Curran, J. (1990). Overview of geriatric nutrition. *Dysphagia*, 5(2), 72–76.
5. Agarwal, E., Miller, M., Yaxley, A., & Isenring, E. (2013). Malnutrition in the elderly. *Maturitas*, 76(4), 296–302.
6. Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, S. M., Sieber, C. C., Topinkova, E., Vandewoude, M., Visser, M., Zamboni, M., Ewgsop, W. G. F. T. E. W. G. O. S. I. O. P. 2. A. T. E. G. F., Bautmans, I., Baeyens, J., Schols, J. (2018). Sarcopenia: revised European consensus on definition and diagnosis. *Age And Ageing*, 48(1), 16–31. <https://doi.org/10.1093/ageing/afy169>
7. Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., Phillips, S., Sieber, C., Stehle, P., Teta, D., Visvanathan, R., Volpi, E., & Boirie, Y. (2013). Evidence-Based Recommendations for Optimal Dietary Protein Intake in Older People: A Position Paper From the PROT-AGE Study Group. *Journal of the American Medical Directors Association*, 14(8), 542–559. <https://doi.org/10.1016/j.jamda.2013.05.021>
8. Sofi, F., Cesari, F., Abbate, R., Gensini, G. F., & Casini, A. (2008). Adherence to Mediterranean diet and health status: meta-analysis. *BMJ*, 337(sep11 2), a1344. <https://doi.org/10.1136/bmj.a1344>.
9. O'Toole, P. W., & Jeffery, I. B. (2015). Gut microbiota and aging. *Science*, 350(6265), 1214–1215.
10. Ordoas, J. M., Ferguson, L. R., Tai, E. S., & Mathers, J. C. (2018). Personalised nutrition and health. *BMJ*, 361, bmj.k2173. <https://doi.org/10.1136/bmj.k2173>
11. Morley, J. E. (2001). Anorexia of aging. *American Journal of Clinical Nutrition*, 66(4), 760–773.
12. Kaiser, M. J., Bauer, J. M., Rämisch, C., Uter, W., Guigoz, Y., Cederholm, T., Thomas, D. R., Anthony, P. S., Charlton, K. E., Maggio, M., Tsai, A. C., Vellas, B., Sieber, C. C., & Group, F. T. M. N. a. I. (2010). Frequency of malnutrition in Older adults: A Multinational perspective using the Mini Nutritional Assessment. *Journal of the American Geriatrics Society*, 58(9), 1734–1738. <https://doi.org/10.1111/j.1532-5415.2010.03016.x>
13. Landi, F., Cruz-Jentoft, A. J., Liperoti, R., Russo, A., Giovannini, S., Tosato, M., Capoluongo, E., Bernabei, R., & Onder, G. (2013). Sarcopenia and mortality risk in frail older persons aged 80 years and older: results from ilSIRENTE study. *Age And Ageing*, 42(2), 203–209. <https://doi.org/10.1093/ageing/afs194>

14. Deutz, N. E., Bauer, J. M., Barazzoni, R., Biolo, G., Boirie, Y., Bosy-Westphal, A., Cederholm, T., Cruz-Jentoft, A., Krznarić, Z., Nair, K. S., Singer, P., Teta, D., Tipton, K., & Calder, P. C. (2014). Protein intake and exercise for optimal muscle function with aging: Recommendations from the ESPEN Expert Group. *Clinical Nutrition*, 33(6), 929–936. <https://doi.org/10.1016/j.clnu.2014.04.007>
15. Roberts, S. B., & Rosenberg, I. (2006). Nutrition and aging. *Journal of Nutrition*, 136(9), 2257–2260.
16. Volkert, D., Beck, A. M., Cederholm, T., Cruz-Jentoft, A., Goisser, S., Hooper, L., Kiesswetter, E., Maggio, M., Raynaud-Simon, A., Sieber, C. C., Sobotka, L., Van Asselt, D., Wirth, R., & Bischoff, S. C. (2018). ESPEN guideline on clinical nutrition and hydration in geriatrics. *Clinical Nutrition*, 38(1), 10–47. <https://doi.org/10.1016/j.clnu.2018.05.024>
17. Chernoff, R. (2005). Micronutrient requirements in older women. *American Journal of Clinical Nutrition*, 81(5), 1240S-1245S. <https://doi.org/10.1093/ajcn/81.5.1240>
18. Estruch, R., Ros, E., Salas-Salvadó, J., Covas, M., Corella, D., Arós, F., Gómez-Gracia, E., Ruiz-Gutiérrez, V., Fiol, M., Lapetra, J., Lamuela-Raventos, R. M., Serra-Majem, L., Pintó, X., Basora, J., Muñoz, M. A., Sorlí, J. V., Martínez, J. A., Fitó, M., Gea, A., . . . Martínez-González, M. A. (2018). Primary Prevention of Cardiovascular Disease with a Mediterranean Diet Supplemented with Extra-Virgin Olive Oil or Nuts. *New England Journal of Medicine*, 378(25), 1388–1389. <https://doi.org/10.1056/nejmoa1800389>
19. Claesson, M. J., Jeffery, I. B., Conde, S., Power, S. E., O’connor, E. M., Cusack, S., ... & O’toole, P. W. (2012). Gut microbiota composition correlates with diet and health in the elderly. *Nature*, 488(7410), 178-184.
20. Ahmed, T., & Haboubi, N. (2010). Assessment and management of nutrition in older people. *Clinical Interventions in Aging*, 5, 207–216.
21. Thompson, M. (1980). Geriatric nutrition. *Journal of the National Medical Association*, 72(8), 795–803.
22. Roe, D. A. (1990). Geriatric nutrition. *Clinics in Geriatric Medicine*, 6(2), 319–334.
23. Morley, J. E. (2012). Undernutrition in older adults. *Family Practice*, 29, i89–i93.
24. Houston, D. K., Nicklas, B. J., Ding, J., Harris, T. B., Tylavsky, F. A., Newman, A. B., Lee, J. S., Sahyoun, N. R., Visser, M., & Kritchevsky, S. B. (2008). Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. *American Journal of Clinical Nutrition*, 87(1), 150–155. <https://doi.org/10.1093/ajcn/87.1.150>
25. Mithal, A., Wahl, D. A., Bonjour, J., Burckhardt, P., Dawson-Hughes, B., Eisman, J. A., Fuleihan, G. E., Josse, R. G., Lips, P., & Morales-Torres, J. (2009). Global vitamin D status and determinants of hypovitaminosis D. *Osteoporosis International*, 20(11), 1807–1820. <https://doi.org/10.1007/s00198-009-0954-6>
26. Huang, C., Okada, K., Matsushita, E., Uno, C., Satake, S., Martins, B. A., & Kuzuya, M. (2020). Dietary Patterns and muscle mass, muscle strength, and Physical Performance in the elderly: A 3-Year Cohort study. *The Journal of Nutrition Health & Aging*, 25(1), 108–115. <https://doi.org/10.1007/s12603-020-1437-x>
27. Milte, C. M., & McNaughton, S. A. (2016). Dietary patterns and successful ageing. *Nutrition Reviews*, 74(9), 609–627.
28. Shlisky, J., Bloom, D. E., Beaudreault, A. R., Tucker, K. L., Keller, H. H., Freund-Levi, Y., Fielding, R. A., Cheng, F. W., Jensen, G. L., Wu, D., & Meydani, S. N. (2017). Nutritional Considerations for healthy aging and Reduction in Age-Related Chronic Disease. *Advances in Nutrition*, 8(1), 17-26. <https://doi.org/10.3945/an.116.013474>
29. Bloom, I., Shand, C., Cooper, C., Robinson, S., & Baird, J. (2018). Diet quality and sarcopenia in Older Adults: A Systematic review. *Nutrients*, 10(3), 308. <https://doi.org/10.3390/nu10030308>

30. Yaqoob, P., & Calder, P. C. (2003). Nutrition and immune function. In *CABI Publishing eBooks* (pp. 349–367). <https://doi.org/10.1079/9780851996790.0349>
31. Morrone, A., Donini, L. M., Scardella, P., Piombo, L., Pinto, A., Giusti, A. M., ... & Cannella, C. (2011). Malnutrition in the elderly: clinical features, psychological and social determinants. Preliminary results. *Annali di Igiene: Medicina Preventiva e di Comunita*, 23(2), 161-172.
32. Robinson, S., Granic, A., & Sayer, A. A. (2019). Nutrition and muscle strength, as the key component of sarcopenia: An overview of current evidence. *Nutrients*, 11(12), 2942. <https://doi.org/10.3390/nu11122942>
33. Kiesswetter, E., Sieber, C. C., & Volkert, D. (2020). Protein intake in older people. *Zeitschrift Für Gerontologie Und Geriatrie*, 53(4), 285–289. <https://doi.org/10.1007/s00391-020-01723-4>
34. Granic, A., Mendonça, N., Hill, T., Jagger, C., Stevenson, E., Mathers, J., & Sayer, A. (2018). Nutrition in the very old. *Nutrients*, 10(3), 269. <https://doi.org/10.3390/nu10030269>
35. Wellman, N. S. (1994). Dietary guidance and nutrient requirements of the elderly. *Primary Care*, 21(1), 1–18.
36. Bolzetta, F., Veronese, N., De Rui, M., Berton, L., Toffanello, E. D., Carraro, S., Miotto, F., Inelmen, E. M., Donini, L. M., Manzato, E., Coin, A., Perissinotto, E., & Sergi, G. (2015). Are the Recommended Dietary Allowances for Vitamins Appropriate for Elderly People? *Journal of the Academy of Nutrition and Dietetics*, 115(11), 1789–1797. <https://doi.org/10.1016/j.jand.2015.04.013>
37. Foote, J. A., Giuliano, A. R., & Harris, R. B. (2000). Older adults need guidance to meet nutritional recommendations. *Journal of the American College of Nutrition*, 19(5), 628–640. <https://doi.org/10.1080/07315724.2000.10718961>
38. Linus Pauling Institute (Oregon State University). Nutrient recommendations for older adults.