



The Science of Healthy Aging: Essential Nutrient Needs for Older Adults

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ABSTRACT

Population ageing is a phenomenon that has worldwide repercussions with clinical and socioeconomic consequences. Aging is defined by a gradual loss of physiological reserve, changes in metabolic processes and high prevalence of chronic comorbidities. The nutritional status of older people is an important modifiable health outcome, functional status and quality of life factor. This review summarizes the latest evidence about the physiological mechanisms underlying the nutritional vulnerability in older adults, sets new guidelines for essential macronutrients and micronutrients, and examines the impact of aging gut microbiome, and recommends evidence-based recommendations for dietary interventions to combat sarcopenia, cognitive impairment, and immunosenescence.

Keywords: Sarcopenia, Anabolic resistance, Inflammaging, Hypoalbuminemia, Immunosenescence.

INTRODUCTION

The global demographic picture is rapidly changing, with the share of older people (60 years and above) rising to 2.1 billion in 2050 (WHO 2022). Aging well, often described as healthy aging, requires a precise understanding of the molecular and physiological changes that occur with aging and longevity (Kirkland & Tchkonja, 2020). Part of this is through maintaining nutritional homeostasis.

Malnutrition in older people is expressed as undernutrition and overnutrition (often combined with sarcopenia, and referred to as sarcopenic obesity). Nutrient bioavailability and requirements change systematically with age due to changes in body composition, metabolic rate, sensory perception and gastrointestinal function (Paddon-Jones et al., 2024). Therefore, the typical dietary recommendations set for younger age groups are not necessarily suitable for older age groups. The purpose of this review is to elucidate exactly how much and what type of nutrients are needed to ensure repair of the cells, preserve lean mass, maintain cognitive integrity and minimize the risk of chronic metabolic diseases in the older person.

Physiological Barriers to Nutritional Homeostasis

There are a number of systemic changes that occur during the aging process that directly affect dietary intake, digestion, absorption and assimilation.

Anorexia of Aging and Sensory Decline

The anorexia of aging is a term used to describe a natural decrease in appetite and eating that occurs with aging (Landi et al., 2022). It is attributed to a decreased response to ghrelin, the hunger peptide, and an elevated basal level of satiety hormones such as cholecystokinin (CCK) and leptin (Pilgrim et al., 2021). Moreover, as the number of olfactory bulb neurons decreases, so does the hedonic drive to eat, as does the number of taste buds, which limits one's appreciation of food (Hummel et al., 2023).

Gastrointestinal and Metabolic Alterations

Chronic atrophic gastritis can lead to achlorhydria (hypochlorhydria), which diminishes the digestive ability of the stomach to break down food components particularly micronutrients such as vitamin B12, iron, and calcium (Rizvi et al., 2025). At the same time, the villi in the intestine are atrophied and the activity of brush border enzymes is diminished, which interferes with active transport systems. The systemic effect of a reduction in basal metabolic rate (BMR) as a result of loss of

metabolically active skeletal muscle mass, however, decreases overall energy expenditure and restricts the number of calories available to support higher demands for micronutrients (Volpi et al., 2023).

Macronutrient Requirements: Preserving Mass and Function

Protein and Metabolic Inefficiency

Sarcopenia or age-related loss of skeletal muscle mass, strength and function is one of the main causes of frailty and dependency (Cruz-Jentoft et al., 2019). In older skeletal muscle, there is an "anabolic resistance"—meaning the complex requires a greater amount of amino acids in the ECF to activate mammalian target of rapamycin complex 1 (mTORC1) signaling and myofibrillar protein synthesis (MPS) than in younger muscle (Wolfe, 2023)..

Metric / Parameter	Standard Adult RDA	Recommended Older Adult Intake	Rationale
Daily Protein Intake	0.8 g/kg/day	1.2 to 1.5 g/kg/day	Overcomes anabolic resistance and preserves lean skeletal mass (Bauer et al., 2019).
Per-Meal Distribution	Evenly variable	30 to 45 g per meal	Triggers the "leucine trigger" threshold required for maximal MPS initiation (Paddon-Jones et al., 2024).

Clinical trials reveal much greater muscle retention and physical performance scores in frail populations when protein intakes are elevated, including protein from branched-chain amino acids (BCAA), especially leucine (Deutz et al., 2020).

Carbohydrates, Fiber, and Glycemic Regulation

Insulin resistance is also a natural process of aging, as glucose transporter type 4 (GLUT4) translocation to the cell surface of skeletal muscle decreases with age (DeFronzo et al., 2021). The main focus of dietary strategies is avoiding postprandial hyperglycemia and the resulting accumulation of advanced glycation end-products (AGEs).

Recommended dietary fibre intake is high (25 g/day for women and 30 g/day for men), to maintain gastrointestinal motility, reduce constipation in aging and to produce short-chain fatty acids (SCFAs) from microbial fermentation (Slavin, 2022).

Dietary Lipids and Inflammatory Pathways

Total fat intake may need to be reduced to suite lower energy needs and it is important to consider the lipid profile of the fats. One of the hallmarks of senescence (Franceschi et al., 2018) is chronic low-grade systemic inflammation ("inflammaging"). Long chain omega-3 polyunsaturated fatty acids (PUFAs) (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)) have strong anti-inflammatory effects, displacing arachidonic acid (AA) from cell membranes and acting as precursors to resolvins and protectins (Calder, 2021). Recent studies have also shown that omega-3s increase muscle protein synthesis in response to amino acid supplementation (Smith et al., 2022).

Micronutrient Critical Demands and Deficiencies

Vitamin D and Calcium Homeostasis

The ability of the skin to produce vitamin D3 through conversion of cholecalciferol decreases by about 40% as age increases, as the epidermis thins and the amount of 7-dehydrocholesterol (Holick, 2021) in the skin decreases. With the decline in 1- α -hydroxylase activity in the kidneys, vitamin D deficiency is often subclinical or clinically significant in older people.

A lack of vitamin D can decrease intestinal calcium absorption, worsening the secondary hyperparathyroidism and accelerating bone mineral resorption, and thus increasing the risk for osteopenia and osteoporosis (Bikle, 2022). The recommended intake is 800-1000 IU of Vitamin D3 + 1200 mg of elemental calcium per day for fracture prevention (Weaver et al., 2024).

Vitamin B12 (Cobalamin) and Neurological Integrity

In older people, vitamin B12 deficiency is extremely common and is more likely to be due to malabsorption of crystalline B12 complexed to food proteins as this is not absorbed in the diet, than by low food intake (unbound or synthetic B12 is absorbed in the diet) (Allen, 2020). This is due to the reduced amounts of gastric acid and pepsin secreted. Uncontrolled B12 deficiency leads to hyperhomocysteinaemia, which is a risk factor for cardiovascular disease and cognitive impairment (Smith & Refsum, 2021). When it is very bad, it affects the posterior and lateral columns of the spinal cord (subacute combined degeneration).

Antioxidant Micronutrients: Vitamins C, E, and Zinc

The free radical theory of aging suggests that over time, there is an accumulation of oxidative stress that is causing damage to cells (Gladyshev, 2024). Superoxide dismutase is an important endogenous antioxidant enzyme that is activated by zinc. Additionally, zinc deficiency has been found to impact T-cell differentiation, leading to immunosenescence and the vulnerability to infectious diseases (Prasad, 2023). Optimal vitamin C and vitamin E intake offers synergistic lipid- and water-soluble radical scavenging functions and helps to maintain cell membrane integrity and vascular endothelial integrity from lipid peroxidation.

Hydration Dynamics and Electrolyte Balance

Dehydration is a particular risk for older people. This is mainly due to a diminished sensitivity of hypothalamic osmoreceptors to the increase in plasma osmolality (De Luca et al., 2023). At the same time, the old kidney has decreased concentrating ability, as a result of reduced glomerular filtration rate (GFR) and down-regulation of renal AQP2 channels (Feilscher et al., 2021).

In older cohorts, the clinical manifestations of dehydration include acute cognitive confusion, orthostatic hypotension, falls, increased risk of acute kidney injury (AKI) and increased drug toxicities because of decreased volumes of distribution of water-soluble pharmaceuticals (Thomas et al., 2022). Strict monitoring of minimum fluids, which should be no less than 30 mL/kg/day is required.

The Gut Microbiome, Inflammaging, and the Nutrient Nexus

In recent years, researchers have discovered specific changes in the gut microbiota of older adults, such as a decrease in microbial diversity, fewer saccharolytic species (e.g., *Bifidobacterium*) and increased pathobionts (e.g., *Enterobacteriaceae*) (Biagi et al., 2020). This dysbiosis state damages the tight junctions of the intestinal epithelium and causes a 'leaky gut' phenotype.

Chronic gut-derived translocation of lipopolysaccharides (LPS) leads to chronic stimulation of toll-like receptor 4 (TLR4) signaling pathways and plays a major role in the pathogenesis of inflammaging (O'Toole & Jeffery, 2021). Efforts to restore microflora equilibrium, enhance nutrient assimilation and reduce systemic inflammatory cytokine cascades (IL-6, TNF- α) through dietary measures using prebiotics (e.g., inulin, fructooligosaccharides) and probiotic strains have shown to be effective (Ratsika et al., 2023).

Clinical Applications and Disease Prevention Strategies

Cognitive Decline and Dementia Mitigation

There is strong support in the field of nutritional epidemiology for certain dietary patterns to have a neuroprotective effect. The Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet, which emphasizes polyphenols, anthocyanins (found in berries) and green leafy vegetables, has been found to greatly slow down cognitive decay and reduce the occurrence of Alzheimer's disease (Morris et al., 2015; Scarmeas et al., 2023). The various micronutrients and bioactive compounds exert their effects through the mechanisms of decreasing neuroinflammation, lowering cerebral amyloid-beta deposition, and optimizing cerebral blood flow.

Metabolic Syndrome and Cardiovascular Health

Treatment of cardiovascular disease and type 2 diabetes mellitus (T2DM) in older adults should be tailored to balance control of these conditions with the avoidance of nutritional deficiencies. Dietary Approaches to Stop Hypertension (DASH) model with less than 2,300 mg/day of sodium intake lowers both systolic blood pressure (SBP) and arterial stiffness (Appel et al., 2021). Nutrient-dense, low caloric matrix options must be the focus of interventions to maintain elastin in the cardiovascular system while avoiding rapid lean mass loss.

CONCLUSION

Healthy ageing science has emphasised the importance of moving away from broad-based adult nutrition guidelines and towards highly targeted nutrition interventions. There is a need to consider physiological changes such as anabolic resistance, sensory loss, gastrointestinal malabsorption and changes in hydration mechanisms when meeting the nutritional requirements of older adults.

There are four key dietary principles for optimizing health span: increasing the relative amounts of protein in the diet (1.2–1.5 g/kg/day), Vitamin D3 and B12 supplementation, calcium and zinc supplementation, and an emphasis on anti-inflammatory omega-3 fatty acids and complex fibers. These evidence-based nutrition strategies may help providers decrease the rates of frailty, maintain functional status and enhance quality of life for an aging population.

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