RESEARCH PAPER

Prevention and Management of Sarcopenia through Natural Foods and Dietary Patterns: An Evidence-Based Review.

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ABSTRACT

Background: Sarcopenia is a steady decline in strength, skeletal muscle mass, and physical performance connected with aging, resulting in heightened risks of frailty, disability, illness, and mortality among older people. Considering the increasing global elderly population, better preventive and management techniques are needed. Nutrition is a crucial changeable aspect, with a growing focus on natural foods and holistic dietary patterns instead than isolated nutrient supplementation.

Objective: This review aims to evaluate and synthesize current knowledge regarding the impact of natural foods and dietary patterns on the prevention and management of sarcopenia in the elderly.

Methods: A comprehensive review of the existing literature was conducted using major scientific databases, such as PubMed, Web of Science, Scopus, and Google Scholar. Included were relevant observational studies, randomized controlled trials, and intervention studies that examined dietary components, dietary patterns, and muscle-related outcomes in older adults. Evidence was qualitatively synthesized, highlighting muscle strength, muscle mass, and physical function.

Results: Research demonstrates that adequate intake of omega-3 fatty acids, vitamin D, antioxidants, high-quality protein, and other minerals is vital for maintaining muscle protein synthesis and reducing inflammation and oxidative stress. Dietary patterns, such as the Mediterranean diet, carefully organized plant-based meals with enough protein intake, and high-protein, low-glycaemic index diets, are consistently associated with improved muscle health and a reduced prevalence of sarcopenia. Furthermore, integrated nutritional protocols and resistance training exhibit synergistic benefits in preserving muscle mass and functional performance.

Conclusion: Dietary interventions focused on natural foods and adherence to healthy dietary patterns are effective strategies for preventing and managing sarcopenia in aging populations. Personalised nutritional methods, coupled with physical exercise, are vital for optimising musculoskeletal health. Further long-term and high-quality intervention studies are needed to create standardised dietary guidelines and clarify long-term consequences..

Keywords: Sarcopenia; dietary patterns; natural foods; protein intake; muscle health; ageing; Mediterranean diet; micronutrients

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INTRODUCTION

1.1 Definition and Classification of Sarcopenia

Sarcopenia is a gradual and generalized skeletal muscle condition marked by the loss of muscle mass, muscle strength, and athletic performance, mostly affecting older persons (Petermann-Rocha et al., 2022). Contemporary diagnostic frameworks emphasise muscular strength as the major measure, with low muscle quantity or quality and reduced physical performance used to validate severity (Sanchez-Tocino et al., 2024). The European Working Group on Sarcopenia in Older People (EWGSOP2) and the Asian Working Group for Sarcopenia (AWGS) have produced widely accepted diagnostic criteria, encompassing tests such as appendicular skeletal muscle mass, handgrip strength, and walking speed. Sarcopenia is roughly categorized into primary sarcopenia, which is primarily attributable to ageing-related physiological changes, and secondary sarcopenia, which originates from conditions such as chronic disease, malnutrition, physical inactivity, or extended immobilisation. This classification is vital for directing prevention and management efforts (Alhmly and Fielding, 2024).

1.2 Epidemiology and Global Burden

Sarcopenia represents a major public health concern due to rapid population ageing worldwide. Prevalence estimates vary based on diagnostic criteria, ethnicity, and population variables, but studies imply that sarcopenia affects around 10–27% of community-dwelling older persons, with higher rates observed among hospitalised and institutionalized individuals. The condition is highly

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connected with greater risks of falls, fractures, impairment, hospital admission, and mortality. Beyond individual health consequences, sarcopenia imposes a substantial economic burden on healthcare systems through increased medical costs, long-term care requirements, and reduced functional independence, underscoring the need for effective preventive strategies (Tseng et al., 2025; Jin et al., 2026).

1.3 Sarcopenia Pathophysiology

The pathophysiology is multifaceted and intricate. Age-related muscle loss results from an imbalance between muscle protein synthesis and degradation, causing a progressive decline in muscle mass and functionality (Tsai et al., 2025). Chronic low-grade inflammation, increased oxidative stress, and age-associated hormonal changes such as reduced levels of growth hormone, testosterone, and insulin-like growth factor-1 further aggravate muscle degeneration. Moreover, physical inactivity and inadequate nutritional intake, especially insufficient protein and minerals, exacerbate sarcopenic processes. These interconnecting pathways underscore the significance of treating both biological and lifestyle-related contributors to muscle loss (Feng et al., 2025).

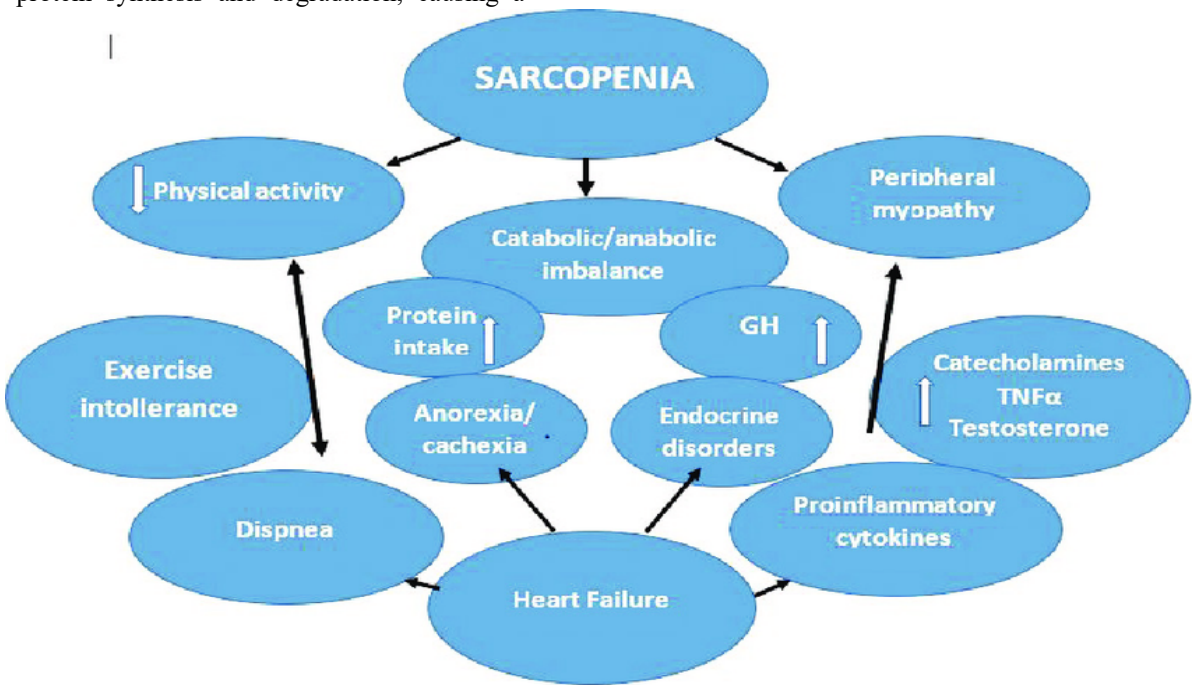

Figure 1: Pathophysiological mechanisms of sarcopenia and points of nutritional intervention (source: ResearchGate)

1.4 Rationale for Nutritional Interventions

Among the modifiable risk factors for sarcopenia, diet plays a vital role. Adequate intake of energy, high-quality protein, necessary fatty acids, vitamins, minerals, and bioactive compounds is fundamental for maintaining muscle protein synthesis and neuromuscular function. Increasing attention has switched from single-nutrient supplementation toward whole-food and dietary pattern approaches, which better represent real-world eating habits and potential synergistic effects of nutrients within foods (Barone et al., 2025).

1.5 Aim of the paper

To critically assess the role of dietary patterns and natural foods in the management and prevention of sarcopenia among older adults.

1.6 Objectives of the Review

2.1 Review To examine the evidence linking intake of natural foods and key dietary components with muscle mass, strength, and physical function in ageing populations.

To analyse the effects of major dietary patterns, with the Mediterranean diet and plant-dependent diets, on the risk and progression of sarcopenia.

To assess the interaction between nutritional strategies and physical activity, particularly resistance exercise, in preserving skeletal muscle health.

To identify research gaps and future directions to inform the development of evidence-based, food-based dietary recommendations for sarcopenia prevention and management.

2. Methodology of the Review

Design

This review was undertaken as a narrative review with systematic aspects to completely synthesise available evidence on the function of natural foods and dietary patterns in the management and prevention of sarcopenia. A structured strategy was established to decrease selection bias and promote reproducibility while allowing integration of multiple study designs,

including cohort studies, randomised controlled trials, and observational studies (Smela et al., 2023).

2.2 Literature Search Strategy

A full literature search was performed employing major electronic databases: Scopus, PubMed, Web of Science, and Google Scholar. The search approach integrated Medical Subject Headings phrases and free-text keywords relating to sarcopenia, nutrition, and dietary patterns. Examples of key terms included "sarcopenia," "muscle mass," "muscle strength," "dietary patterns," "natural foods," "protein intake," "Mediterranean diet," "plant-based diet," and "older adults," applying Boolean operators "AND" and "OR" for refining. The reference lists of eligible research were additionally manually searched to locate other relevant articles. All retrieved records were put into Mendeley Reference Manager to organise, deduplicate, and manage citations throughout the review process.

2.3 Inclusion & Exclusion Criteria

Studies were included if they: (i) were original research articles, including RCTs, cohort studies, and observational studies; (ii) involved participants aged ≥60 years; and (iii) examined associations between dietary components, food-based interventions, or dietary patterns and sarcopenia-related outcomes. Primary outcomes studied included muscular mass, muscle strength, and physical performance. Excluded were research on younger people, animal or in vitro studies, conference presentations, editorials, and articles without relevant dietary or muscle-related outcomes.

2.4 Data Extraction and Synthesis

A systematic data extraction methodology was utilized to collect research design, demographic characteristics, dietary assessment methodologies, and outcome measures. Muscle-related outcomes were appendicular handgrip strength, skeletal muscle mass, and gait speed. Dietary exposures were measured through reported intake of specific nutrients, food groupings, or adherence to prescribed dietary patterns. Due to variability in study designs and outcome measures, data were synthesised narratively (Antons et al., 2023).

2.5 Limitations of the Review Methodology

Potential limitations include publication bias and heterogeneity in study populations, nutritional assessment techniques, and sarcopenia diagnostic criteria. Additionally, being a narrative synthesis, quantitative pooling of results was not performed. Use of Mendeley helped to arrange citations systematically but does not decrease intrinsic study heterogeneity.

3. Role of Macronutrients in Sarcopenia

3.1 Protein Intake and Muscle Protein Synthesis

Protein intake is an important nutritional aspect in the case, since dietary protein offers critical amino acids required for muscle protein synthesis (MPS) and the preservation of skeletal muscle mass and strength (Chapple et al., 2022; Coelho-Junior et al., 2022).

Sarcopenia, linked age-related losses in muscle mass and function, is increased by low protein intake in older persons. This is substantiated by extensive cross-sectional data demonstrating that elevated protein consumption is significantly inversely associated with the prevalence of sarcopenia (OR 0.38; 95% CI 0.26–0.55) in older populations (National Health and Nutrition Assessment Survey data; 2011–2018) and that increased dietary protein is associated with enhanced skeletal muscle index and strength outcomes (OR 0.19; 95% CI 0.11–0.34) in individuals aged ≥50 years (Fan et al., 2025; Rogeri et al., 2022).

Quantity and quality of protein influence MPS and anabolic responses (Tezze et al., 2023). The current dietary protein RDA of 0.8 g/kg body weight per day has been judged insufficient for many older adults due to anabolic resistance whereby the aging muscle exhibits a reduced reactivity to amino acids. Evidence from meta analyses and observational research suggests that increased protein intakes (1.0–1.6 g/kg/day) boost enhanced muscle mass retention, strength, and functional performance in older adults (Journal of Nutritional Oncology) (Li et al., 2019).

Protein quality also matters. High grade proteins have necessary amino acids particularly leucine trigger MPS more efficiently than lesser quality sources. Whey protein, for example, has been found to boost anabolic signaling and strength improvements in older adults more than various lower leucine plant proteins during resistance training trials (Reid-McCann et al., 2025). Researchers have also underlined that protein distribution across the day (e.g., 25–35 g high quality protein per meal) maximises daily MPS compared with uneven consumption patterns (Journal of Clinical Medicine Research) (Yanai, 2015)

The source of protein animal vs plant carries extra implications. Animal proteins (dairy, meat, fish) often give complete amino acid profiles linked with stronger anabolic benefits, whereas plant proteins may require more total consumption or strategic combinations to produce equivalent effects (Reid-McCan et al., 2022). Epidemiological research reveals that diets high in fish and soybean products are connected to a lower sarcopenia prevalence and increased gait speed in older Japanese adults, underlining the positive impact of varied protein sources within dietary patterns (Yokoyama et al., 2021).

Furthermore, timing is crucial: pairing appropriate protein consumption with resistance exercise improves MPS, particularly when protein is consumed soon after exercise. This combinatorial impact exploits after exercise anabolic sensitivity, boosting muscular development signals that diminish with aging. Regular nutrition exercise scheduling techniques may therefore be crucial to musculoskeletal health in older populations.

3.2 Carbohydrates and Glycaemic Index

Carbohydrates do not directly promote muscle protein synthesis (MPS) to the same extent as protein; however, they substantially affect insulin sensitivity and muscle metabolism, which are crucial for muscle anabolism.

Adequate carbohydrate intake stimulates insulin release, facilitating amino acid transport into muscle cells and suppressing protein breakdown (NHANES study) (Fan et al., 2025; Zhang et al., 2024).

Evidence suggests that low glycaemic index (GI) carbohydrate sources like whole grains, legumes, and vegetables are correlated with enhanced metabolic profiles in older adults, potentially benefiting muscle maintenance by stabilizing blood glucose levels and preserving insulin sensitivity (Nicholls, 2022). Moderate carbohydrate consumption aids in maintaining energy equilibrium and facilitates muscle glycogen replacement, which is crucial for prolonged physical activity and recuperation in aging populations. High refined carbs may lead to insulin resistance and metabolic dysfunction, which hinder protein anabolism pathways, although direct longitudinal evidence are scarce (Nicholls, 2022).

3.3 Dietary Fats

Dietary lipids, notably omega-3 polyunsaturated fatty acids (PUFAs), demonstrate anti-inflammatory and anabolic effects that increase muscle health in older adults (Zhang et al., 2022). Omega-3 fatty acids contained in fish oil and particular plant oils have been demonstrated to promote muscle growth and strength, possibly via numerous biochemical processes (Sirago et al., 2022). This encompasses anti-inflammatory properties, improved mechanistic target of rapamycin complex 1 (mTORC1) signaling, reduced intracellular protein degradation, better mitochondrial function, and faster amino acid transport to muscle cells (Therdyothin et al., 2023).

Intervention study in elderly animal models suggests that fish oil derived omega 3 PUFAs mixed with other dietary ingredients improve muscle hypertrophy, reduce inflammatory infiltration, and boost muscle strength (Granic et al., 2023). These combined effects indicate possible application to human aging settings, however more clinical trials are needed to validate dose and duration procedures (Pan et al., 2024).

Mechanistically, omega 3 PUFAs lower systemic inflammation by blocking pro inflammatory pathways (e.g., NF κB), which in turn inhibits muscle protein breakdown and enhances anabolic signaling. They also displace omega 6 fatty acids in cell membranes, resulting in reduced generation of inflammatory mediators and better muscle repair capacity. These effects are particularly crucial in ageing, as chronic inflammation causes muscle atrophy. While saturated and trans fats may contribute to systemic inflammation and are less consistently associated with positive muscle outcomes, diets emphasising unsaturated fats within holistic dietary patterns such as the Mediterranean diet are related with lower sarcopenia risk in adults over 50 years (Papadopoulou et al., 2023).

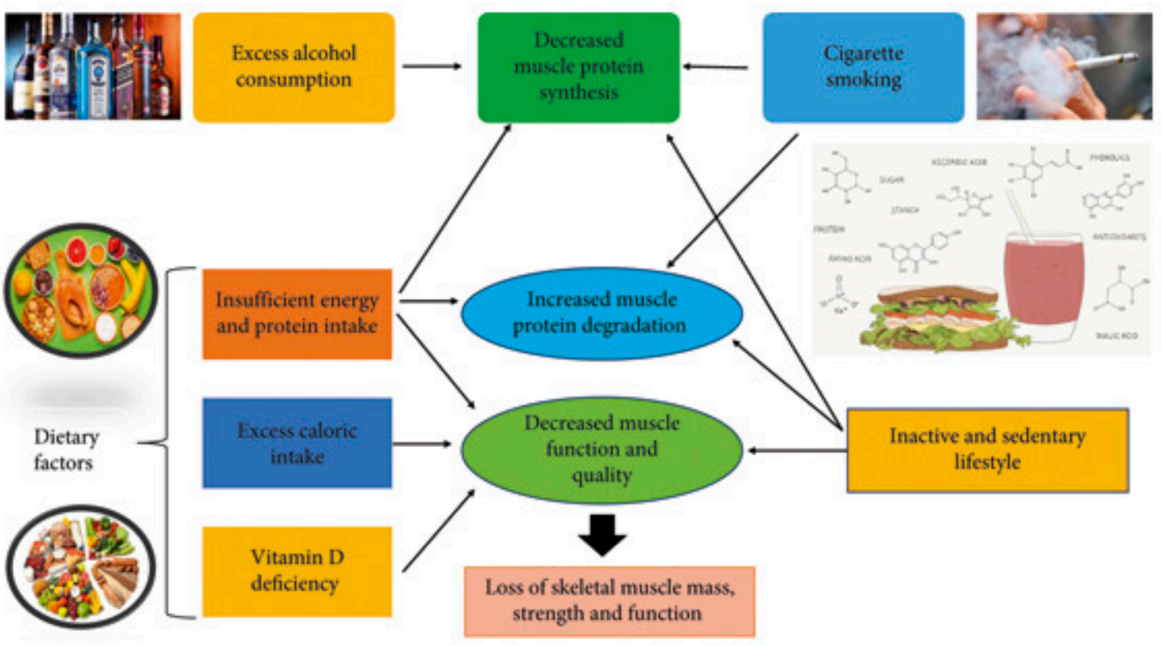

Figure 2. Proposed mechanisms linking natural foods and dietary patterns with sarcopenia prevention (source: Srivastava et al., 2024)

4. Role of Micronutrients and Bioactive Compounds

4.1 Vitamin D and Calcium

These are among the most investigated micronutrients in relation to musculoskeletal health and sarcopenia (Elvina et al., 2025). Vitamin D plays a critical role in muscle function by controlling calcium homeostasis, increasing muscle fibre development, and regulating neuromuscular control. Older adults often exhibit lower serum levels of 25 hydroxyvitamin D, which has been associated with reduced muscle strength, impaired physical performance, and increased risk of sarcopenia (Frontiers in Nutrition population based analyses report

inverse associations between micronutrient patterns including vitamin D and sarcopenia risk (Liu et al., 2024)

Calcium, intimately connected with vitamin D levels, is needed for excitation contraction coupling in muscle fibres. Insufficient calcium intake may affect muscular contraction efficiency and contribute to weakness (Zhang and Li, 2024; Chan and Yefimov, 2025). Cross sectional analyses reveal that older persons with sarcopenia tend to have lower daily calcium intakes compared with non-sarcopenic contemporaries, while some population studies report that calcium consumption correlates favorably with muscle mass and physical performance indices. Liu et al (2023) says, dietary patterns typified by higher vitamin D and calcium intake are connected with enhanced muscular function and reduced sarcopenia prevalence.

Despite these correlations, randomized controlled trials studying standalone calcium or vitamin D supplementation have generated conflicting outcomes, with many indicating modest influence on muscle strength when delivered alone. Hence, while vitamin D and calcium are crucial for musculoskeletal health, their benefits on sarcopenia outcomes may be increased when paired with other nutrients and resistance training.

4.2 Antioxidants (Vitamins C, E, Polyphenols)

Oxidative stress has a pivotal role in the pathophysiology of sarcopenia by hastening muscle protein degradation and diminishing mitochondrial activity (Medoro et al., 2024). Antioxidant micronutrients, such as vitamins C and E, along with bioactive plant compounds like polyphenols, might mitigate oxidative damage by neutralizing free radicals and enhancing endogenous antioxidant defenses. Numerous observational studies and clinical trials have demonstrated that diets abundant in antioxidant-rich foods, such as vegetables, fruits, tea, and whole grains, correlate with enhanced muscle mass, strength, and physical function in older adults (Besoro-Monero et al., 2022).

A recent systematic review and meta-analysis examining adults aged 55 and older demonstrated that increased intake of antioxidant-rich foods and antioxidant supplementation (including combinations of vitamin E with vitamin D, protein, magnesium, and tea catechins) significantly enhanced sarcopenia outcomes, such as decreased time for five stand tests and improved handgrip strength (Vanoh, 2025; Besoro-Monero et al., 2022).

Polyphenols bioactive compounds abundant in plant foods exert additional benefits beyond traditional vitamins by modulating inflammatory pathways, enhancing nitric oxide synthase activity, and improving vascular function, all of which create a favourable environment for muscle maintenance and repair. Their inclusion in Mediterranean and plant based dietary patterns has been connected with reduced prevalence of sarcopenia and better functional results, suggesting the significance of whole food antioxidant strategies in muscle health (Rodrigues et al., 2025).

4.3 Minerals (Magnesium, Selenium, Zinc)

Minerals such as magnesium, selenium, and zinc are crucial to several metabolic processes that impact muscular contraction, energy metabolism, and oxidative equilibrium. A systematic review summarising 45 observational studies found moderate evidence linking magnesium and selenium intake with more muscle mass, strength, and physical performance in older people, while evidence for calcium and zinc was less consistent (van Dronkelaar et al., 2023; Umarova et al., 2025; van Dronkelaar et al., 2023).

Magnesium works as a cofactor in over 300 enzyme processes, including those involved in ATP production and protein synthesis, making it crucial for muscle energy metabolism and contraction efficiency. Several cross sectional studies and controlled interventions demonstrate positive relationships between higher magnesium intake and grip strength, lower leg power, and overall physical performance in older persons (Ganapathy and Nieves, 2020; Liu et al., 2023).

Selenium, integrated into selenoproteins with antioxidant characteristics, may protect muscle tissue from oxidative injury and enhance redox equilibrium. While observational evidence suggests that reduced selenium level is related with poorer muscular function and higher sarcopenia risk, clinical data remain sparse, underlining the need for more randomized studies (Ogawa et al., 2024).

Zinc helps to immunological function, protein synthesis, and cellular repair mechanisms. Although molecular linkages to muscle health are physiologically feasible, existing evidence from epidemiological studies on zinc's direct influence on sarcopenia is weak and mixed, warranting further targeted investigation (Fekete et al., 2024).

4.4 Phytochemicals and Functional Foods

Beyond vitamins and minerals, phytochemicals non-nutritive bioactive molecules present in plant foods play a key role in muscle health. These comprise flavonoids, carotenoids, and other polyphenols, which have anti-inflammatory, antioxidant, and metabolic regulating actions. Phytochemical rich diets, such as those abundant in fruits, vegetables, legumes, tea, and whole grains, are consistently related with lower markers of oxidative stress, improved endothelial function, and higher muscle performance (Besora-Moreno et al., 2022).

Functional foods such as berries, green tea, chocolate, and extra virgin olive oil are rich sources of certain bioactive substances that may further assist muscle maintenance. For example, catechins in tea and polyphenols in olive oil have been found to reduce inflammation and increase mitochondrial function, both of which are critical for sustaining muscle performance in ageing populations (Yoon et al., 2025).

5. DIETARY PATTERNS AND SARCOPENIA

Dietary patterns, reflecting regular combinations of foods and nutrients, have a vital role in sustaining

muscle mass and role in aging populations. While individual macronutrients and micronutrients are significant, data increasingly underlines the synergistic benefits of overall dietary patterns on sarcopenia risk, covering protein adequacy, anti-inflammatory capability, and antioxidant potential. This section analyzes main dietary patterns Mediterranean, plant-based, high-protein, and traditional/regional diets and their links with sarcopenia prevention and management.

5.1 Mediterranean Diet

The Mediterranean diet (MedDiet) has been widely investigated for its significant benefits on muscle health and physical function. Characterised by high intakes of fruits, legumes, vegetables,whole grains, nuts, seeds, olive oil, and moderate consumption of fish and chicken, the MedDiet delivers a nutrient-dense, anti-inflammatory profile. Observational study from European populations reveals that older persons with higher adherence to the MedDiet demonstrate increased skeletal muscle mass, improved grip strength, and reduced prevalence of sarcopenia (Mazza et al., 2024). A multi-centre European study indicated that people in the highest tertile of MedDiet adherence had significantly lower risks of sarcopenia compared with those in the lowest tertile (OR=0.55, 95% CI: 0.41–0.73) (Papadopoulou et al., 2023).

Randomised controlled trials further confirm these conclusions. In intervention studies, older persons consuming MedDiet-style meals combined with structured resistance training reported improvements in gait speed, lower-limb strength, and physical performance relative to control groups on habitual diets (Dominguez et al., 2025).

Mechanistically, the MedDiet's effects are mediated through anti-inflammatory and anabolic mechanisms. omega-3 fatty acids in fish and Monounsaturated fats in olive oil diminish systemic inflammation, whereas polyphenols from plant sources ameliorate oxidative stress. Enhanced insulin sensitivity and better endothelial function further increase food supply to skeletal muscle, boosting protein synthesis and functional results.

5.2 Plant-Based and Vegetarian Diets

Plant-based diets (PBDs) and vegetarian patterns, stressing vegetables, fruits, legumes, whole grains, nuts, and seeds, offer alternative measures for sarcopenia prevention. Observational research suggests that nutrient-derived PBDs rich in plant protein and antioxidants are related with decreased prevalence of sarcopenia and better performance on functional measures such as gait speed and handgrip strength (Yokoyama et al., 2021).

Protein adequacy is a key consideration in PBDs. Plant proteins usually have lower levels of important amino acids, including leucine, which is crucial for promoting muscle protein synthesis. Combining complementary plant sources, such as legumes with grains or nuts, gives a balanced amino acid profile. Evidence indicates that well-planned PBDs with sufficient total protein intake may preserve muscle mass and function comparable to omnivorous diets (Liu et al., 2021).

Advantages of PBDs include anti-inflammatory and antioxidant effects, increased cardiometabolic health, and lower saturated fat intake. Challenges involve getting sufficient amounts of omega-3 fatty acids, vitamin B12, iron, and zinc, which are less plentiful in plant diets yet crucial for musculoskeletal health (Welch et al., 2025).

5.3 High-Protein Dietary Patterns

High-protein dietary patterns (HPDPs) focus on boosting protein intake above normal recommendations, often 1.2–1.6 g/kg/day in older persons. Epidemiological studies consistently suggest that HPDPs support higher muscle mass, strength, and functional capacity (Mazza et al., 2024).

These diets may contain both animal and plant protein sources, with intervention studies demonstrating that older persons consuming high-protein diets combined strength exercise achieve superior improvements in lean mass and functional outcomes compared with lower-protein groups. Safety precautions, particularly renal function monitoring, are required, but research indicates that high-protein intakes are generally well tolerated in healthy ageing populations when matched with proper water and micronutrient consumption (Ni Lochlainn et al., 2023).

5.4 Traditional and Regional Diets

Traditional and regional diets offer culturally relevant frameworks for sarcopenia prevention. In Asia, diets rich in fish, soy, vegetables, rice, and green tea typical of the Japanese diet are inversely associated with sarcopenia prevalence. Observational studies suggest that adherence to traditional Japanese dietary patterns corresponds with increased muscle mass, improved physical function, and diminished rates of mobility handicap (Cailleaux et al., 2024; Ran et al., 2023).

Nordic dietary patterns, defined by whole grains (rye, oats), root vegetables, berries, salmon, and rapeseed oil, are also connected with enhanced muscle outcomes. Longitudinal cohort studies reveal that older persons with high Nordic diet adherence exhibit higher lean mass retention and superior gait speed than those with low adherence (Bygi et al., 2024).

Indigenous dietary habits, frequently highlighting local biodiversity and minimally processed foods, have been related with beneficial body composition and functional markers in ageing populations. Diets rich in whole grains, native tubers, legumes, and wild fish or game provide nutrient-dense, anti-inflammatory, and protein-sufficient frameworks that may protect against age-related muscle loss (Mazza et al., 2024; Dominguez et al., 2022).

6. SYNERGISTIC EFFECTS OF DIET AND PHYSICAL ACTIVITY

Sarcopenia prevention and management require a multidisciplinary strategy, including both nutritional measures and physical activity. While proper diet

supplies the metabolic underpinnings for muscle maintenance, physical activity particularly resistance training stimulates muscle protein synthesis (MPS) and functional adaptation. Evidence increasingly indicates that the combination of nutrition and exercise exhibits synergistic effects on skeletal muscle, promoting both mass and strength outcomes in older persons (Hernandez-Lepe et al., 2023).

6.1 Resistance Training and Nutrition Interaction

Resistance exercise remains the most effective strategy for reducing age-related muscle loss, increasing hypertrophy, and boosting functional performance. When paired with adequate dietary protein intake, resistance training improves MPS via activation of the mechanistic target of rapamycin (mTOR) signaling pathway, counteracting anabolic resistance associated with ageing. Randomised controlled trials demonstrate that older adults who perform structured resistance training with higher-protein diets (1.2–1.6 g/kg/day) exhibit substantial improvements in lean mass and grip strength compared with counterparts consuming habitual protein levels or sedentary controls (Song et al., 2023; Zhao et al., 2022).

Meta-analyses further reveal that the anabolic benefits of protein are most prominent when combined with increasing resistance exercise, underscoring the importance of the protein–exercise synergy in clinical and community contexts. Moreover, including high-quality protein sources such as whey or soy enhances amino acid availability post-exercise, maximizing the hypertrophic response (Yang et al., 2025).

6.2 Timing of Nutrient Intake

The timing of nutrition intake relative to exercise is a significant factor of muscle adaptation. Post-exercise protein consumption ideally within 1–2 hours following resistance activity optimises the acute MPS response, capitalising on transiently improved anabolic sensitivity. Evidence suggests that evenly distributing protein throughout meals and aligning intake with training sessions generates improved long-term effects on muscle development and function compared with uneven or delayed consumption (Park et al., 2023; Polo-Ferreo et al., 2025).

Furthermore, co-ingestion of carbs with protein post-exercise can promote glycogen replacement and induce insulin secretion, thus promoting amino acid uptake and muscle repair. Such timing methods are especially crucial for older persons, in whom reduced anabolic responses demand deliberate nutrient–exercise coordination.

6.3 Lifestyle-Based Integrated Interventions

Integrated lifestyle therapies that incorporate food optimisation, resistance training, aerobic activity, and behavioural methods give comprehensive benefits for sarcopenia prevention. Randomised studies of multicomponent programs including structured exercise, high-protein meals, vitamin D supplementation, and educational support demonstrate gains in muscle mass, strength, mobility, and quality of life among community-dwelling older persons (Greco et al., 2025).

These interventions also address adherence and sustainability by customizing exercise intensity, food composition, and meal timing to individual preferences and capabilities. Holistic approaches underline that sarcopenia care extends beyond single dietary or exercise therapies, requiring coordinated efforts to optimize musculoskeletal health and functional independence in ageing populations (Kwon et al., 2025).

7. Clinical and Public Health Implications

The prevention and management of sarcopenia extend beyond individual food and exercise therapies, needing integration with clinical practice and public health policies. Translating knowledge from research into practical guidance is vital to decrease the functional decline, frailty, and healthcare burden associated with age-related muscle loss.

7.1 Dietary Recommendations for Older Adults

Evidence supports food-based, nutrient-dense regimens tailored to older persons for preserving muscle strength and function. Diets should prioritise high-quality protein sources including dairy, seafood, lean meats, and plant-based alternatives distributed equally throughout meals to improve muscle protein synthesis. In addition, micronutrients and bioactive chemicals such as vitamin D, calcium, magnesium, selenium, and polyphenols should be ingested regularly through different meals such leafy greens, nuts, legumes, and fortified goods. Incorporating anti-inflammatory dietary patterns, such as the Mediterranean diet, may further protect against sarcopenia by lowering oxidative stress and increasing anabolic signaling. Practical assistance should highlight affordable, culturally suitable diets to facilitate adherence in community and home settings (Pereira et al., 2025).

7.2 Implications for Community and Geriatric Care

Community-level interventions have a vital role in sarcopenia prevention. Programs incorporating food education, physical activity promotion, and routine screening can identify at-risk older persons early and apply targeted solutions. In senior care settings, routine nutritional assessments and tailored meal programs, combined with structured resistance and balance exercise, have been found to improve functional outcomes and reduce falls, hospitalisation, and reliance. Public health policies should encourage availability and affordability of nutrient-dense foods and promote education on dietary patterns conducive to musculoskeletal health (Rodrigues et al., 2022; Ren et al., 2022).

7.3 Role of Healthcare Professionals

Healthcare professionals including dietitians, physicians, physiotherapists, and nurses are crucial in translating findings into practice. They should analyze nutritional consumption, physical activity levels, and functional status to make individualized

recommendations. Multidisciplinary approaches, involving nutrition counselling, exercise prescription, and regular follow-up, boost adherence and effectiveness. Professionals also play a vital role in promoting awareness of sarcopenia, advocating preventative interventions, and supporting community-based efforts for healthy ageing (Liang et al., 2025; Yao et al., 2022).

8. META ANALYSIS

Author (Year)	Design & Population	Dietary Exposure	Outcome(s)	Key Results / Effect	Source
Mazza et al. (2024)	Cross-sectional; 528 adults ≥50 years (Italy)	Mediterranean diet adherence	Handgrip strength, appendicular skeletal muscle mass, sarcopenia prevalence	Highest MedDiet adherence linked with higher handgrip and lower sarcopenia odds (OR for sarcopenia lowest vs highest tertile 9.69)	PubMed
Mahmoodi et al. (2025)	Case-control; 80 sarcopenic vs 80 non-sarcopenic (Iran)	Plant-based diet index (PDI, hPDI, uPDI)	Sarcopenia odds	Highest PDI tertile: lower odds of sarcopenia (OR ~0.13); highest uPDI tertile: higher sarcopenia odds (OR ~3.69)	PubMed
Deng et al. (2025)	Cross-sectional; Yakumo study; 584 older adults (Japan)	Dietary intake vs sarcopenia	Sarcopenia prevalence, DVS	No significant differences in protein & vit D intake by sarcopenia status; higher calories, fiber, B1, B2, C in sarcopenia group	PubMed
Watanabe et al. (2022)	Cross-sectional; 9,080 adults ≥60 y (Japan)	Dietary diversity frequency (10 food categories)	Sarcopenia, severe sarcopenia	Poor dietary diversity related to sarcopenia (OR 1.46) and severe sarcopenia (OR 1.58)	ScienceDirect
Anti-inflammatory nutrient pattern study (2021)	Cross-sectional	Anti-inflammatory pattern (PUFA, omega-3, MUFA, vitamin E, minerals)	Sarcopenia, muscle strength	Top tertile: lower sarcopenia odds (OR 0.25) & low strength (OR 0.46) vs bottom	PubMed
ENHANce exploratory (BMC Geriatrics, 2023)	Exploratory analysis; 29 older sarcopenic adults	Omega-3 and PUFA intake/status	Appendicular lean mass, QoL, physical activity	DHA status positively with lean mass; some PUFA markers positively assoc with function	PubMed
EDI and Sarcopenia (2025)	Cross-sectional; 501 older adults (Iran)	Elderly Dietary Index (fruit/veg, fish, dairy)	Sarcopenia odds	Each unit higher EDI associated with lower sarcopenia odds (OR 0.798)	PubMed
NHANES Protein Intake Meta-Analysis (2024)	Systematic review/meta-analysis	Protein intake levels	Sarcopenia risk	Lower total protein intake associated with higher sarcopenia risk (pooled evidence)	OUP Academic
Mediterranean Diet Meta-Analysis (2023)	Meta-analysis; adults >50	Healthy dietary patterns incl. MedDiet	Sarcopenia risk	Healthy patterns reduced sarcopenia risk (OR 0.76), MedDiet strongest (OR 0.62)	PubMed
Fish/Oily Fish Intake Cohort (2025)	Longitudinal; 503 Korean older adults	Oily fish intake	Incident sarcopenia & gait speed	Oily fish inversely assoc with sarcopenia incidence and low gait speed (p =0.046)	Reddit

Protein + Resistance Study (2024)	RCT; cardiac rehab	High-protein Med-style diet + exercise	SarQoL score	12-week intervention improved SarQoL & Mediterranean diet score	Cambridge University Press & Assessment
Protein Enriched Soup Supplementation (2024)	Community older adults; 97 participants	Protein-enriched lacto-vegetarian soups	Physical performance (SPPB), chair rise, sarcopenia risk	Intervention improved performance & reduced SARC-F scores	Reddit
Vitamin D + High Protein (2025)	Intervention; elderly with T2DM & sarcopenia	Vit D (700–1000 IU/d) + high-protein	Muscle mass, strength, performance	Combined improved ASM, grip strength, SPPB, BMD	Reddit
Plant vs Animal Protein RCT Meta-Analysis (2025)	RCT meta-analysis	Plant vs animal protein	Muscle mass & strength	Animal protein slightly better muscle mass; no diff strength/performance	OUP Academic
Dietary patterns & sarcopenia in China (2023)	Cross-sectional; 1,059 adults ≥50	Diet structure (vegetable diet influence)	Sarcopenia prevalence	Vegetable diet & nutritional risk assoc with sarcopenia (higher prevalence with poor diet quality)	Frontiers

9. RESEARCH GAPS AND FUTURE DIRECTIONS

Despite accumulating data supporting the nutritional function in sarcopenia prevention, numerous key study gaps remain. First, long-term randomised controlled studies (RCTs) are scarce, particularly those assessing total food patterns rather than individual nutrients. Most known research are short-term or cross-sectional, reducing inferences about sustained effects on muscle growth, strength, and functional outcomes (Jeyaraman et al., 2025).

Second, population-specific dietary guidelines are largely lacking. Ageing trajectories, habitual diets, and cultural dietary practices vary greatly, although most recommendations are derived from Western cohorts. Future research should study context-specific therapies that reflect regional food habits, socio-economic status, and prevalent health issues (Tu et al., 2025).

Third, harmonization of dietary assessment techniques is needed. Current research use various methods including 24-hour recollections, meal frequency questionnaires, and dietary records leading to variations in nutrient and food pattern measurement. Harmonised, validated tools would enhance comparability across research and improve evidence synthesis (Zhang et al., 2025).

Finally, the convergence of nutrigenomics and individualized nutrition provides a potential prospect. Individual diversity in food metabolism, gene–diet interactions, and microbiome makeup may influence sarcopenia risk and response to dietary treatments. Incorporating omics technologies and precision nutrition techniques could enhance tailored recommendations, boosting adherence and clinical outcomes (Li et al., 2025). Addressing these deficiencies through rigorous, long-term, and multidisciplinary research will increase the evidence base, inform guidelines, and promote effective, culturally relevant therapies for sarcopenia prevention and management (D'Arcangelo and Zanetto, 2025).

10. Limitations of Existing Evidence

Current work on dietary therapy for sarcopenia reveals numerous limitations. First, variability in study design, intervention duration, sample populations, and outcome measures impedes direct comparisons and meta-analytic synthesis. Many research rely on cross-sectional or observational data, restricting causal inferences.

Second, confounding lifestyle factors including physical activity, smoking, alcohol use, and comorbidities are generally insufficiently controlled, thereby biasing observed relationships between diet and muscle outcomes. This complicates the evaluation of the independent impacts of food patterns (Chu et al., 2025).

Third, measurement constraints occur in both dietary evaluation and sarcopenia diagnosis. Self-reported nutritional intake is subject to recall bias, misreporting, and underestimating, while muscle mass and functional evaluations vary in methodology (e.g., DXA vs. bioelectrical impedance vs. grip strength tests), resulting to variations in sarcopenia classification.

Recognising these limitations is critical for contextualising findings and underscores the need for systematic, well-controlled studies to generate more solid and generalisable data for clinical and public health applications (Zhang et al., 2025).

11. CONCLUSION

Sarcopenia is a serious public health challenge, having severe implications for functional independence, quality of life, and healthcare burden in ageing populations. Evidence from observational studies, clinical trials, and mechanistic research highlights the critical importance of diet in sustaining muscle mass and function. Protein intake both in amount and quality alongside micronutrients, bioactive substances, and anti-inflammatory dietary patterns, like the Mediterranean or well-planned plant-based diets,

demonstrates significant potential in preventing and controlling sarcopenia.

The synergistic connection between food and physical activity, particularly resistance training, greatly enhances muscle protein production and functional consequences. Optimising post-exercise protein timing, spreading protein intake throughout meals, and combining lifestyle-based interventions boost the effectiveness of dietary regimens, supporting both clinical and community-based applications.

Early and customized therapies are crucial. Tailoring nutrition to individual needs, considering age, comorbidities, usual diet, and genetic diversity, maximises the impact of dietary solutions. Public health programs should promote food-based, culturally relevant guidelines, while healthcare professionals play a vital role in assessing risk, offering recommendations, and monitoring adherence.

In conclusion, natural foods and dietary patterns constitute a cornerstone in sarcopenia prevention and therapy. Evidence supports the integration of protein-rich, micronutrient-dense, and antioxidant-rich diets with regular physical activity as a sustainable and beneficial strategy. Future research addressing long-term effects, population-specific recommendations, and personalised nutrition approaches will increase the knowledge base and support complete, practical solutions. Prioritising early adoption of these techniques holds promise for lowering the burden of sarcopenia and promoting healthy ageing worldwide.

REFERENCE

1. Alhmly, H. F., & Fielding, R. A. (2024). A critical review of current worldwide definitions of sarcopenia. Calcified Tissue International, 114(1), 74-81.

2. Antons, D., Breidbach, C. F., Joshi, A. M., & Salge, T. O. (2023). Computational literature reviews: Method, algorithms, and roadmap. Organizational Research Methods, 26(1), 107-138.

3. Barone, M., Baccaro, P., & Molfino, A. (2025). An Overview of Sarcopenia: Focusing on Nutritional Treatment Approaches. Nutrients, 17(7), 1237.

4. Baygi, F., Buhl, S. F., Thilsing, T., Søndergaard, J., & Nielsen, J. B. (2024). Sarcopenia and sarcopenic obesity among older adults in the nordic countries: a scoping review. BMC geriatrics, 24(1), 421.

5. Besora-Moreno, M., Llauradó, E., Valls, R. M., Tarro, L., Pedret, A., & Solà, R. (2022). 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. Clinical Nutrition, 41(10), 2308-2324.

6. Cailleaux, P. E., Déchelotte, P., & Coëffier, M. (2024). Novel dietary strategies to manage sarcopenia. Current Opinion in Clinical Nutrition & Metabolic Care, 27(3), 234-243.

7. Chan, M. K., & Yefimov, S. (2025). Proactive Ageing: Comprehensive Strategies for Muscle Preservation and Sarcopenia Resistance in Bioregenerative Medicine. EUROPEAN WELLNESS ACADEMY.

8. Chapple, L. A. S., Kouw, I. W., Summers, M. J., Weinel, L. M., Gluck, S., Raith, E., ... & Chapman, M. J. (2022). Muscle protein synthesis after protein administration in critical illness. American journal of respiratory and critical care medicine, 206(6), 740-749.

9. Chu, R., Li, M., Xie, Y., Du, Y., & Ni, T. (2025). Exercise interventions and serum IGF-1 levels in older adults with frailty and/or sarcopenia: a systematic review and meta analysis. Frontiers in Public Health, 13, 1660694.

10. Coelho-Junior, H. J., Calvani, R., Azzolino, D., Picca, A., Tosato, M., Landi, F., ... & Marzetti, E. (2022). Protein intake and sarcopenia in older adults: a systematic review and meta-analysis. International journal of environmental research and public health, 19(14), 8718.

11. D'Arcangelo, F., & Zanetto, A. (2025). Frailty and Sarcopenia in Cirrhosis: Current Knowledge and Future Directions. Current Hepatology Reports, 24(1), 1-11.

12. Dominguez, L. J., Veronese, N., Baiamonte, E., Guarrera, M., Parisi, A., Ruffolo, C., ... & Barbagallo, M. (2022). Healthy aging and dietary patterns. Nutrients, 14(4), 889.

13. Dominguez, L. J., Veronese, N., Smith, L., Ragusa, F. S., Schirò, P., Di Bella, G., & Barbagallo, M. (2025). Associations Between Adherence to the Mediterranean Diet and Incident Sarcopenia in Prospective Cohort Studies. Nutrients, 17(2), 313.

14. Elvina, L., Chen, C. M., Nguyen, D. H. N., Wei, C. C., Su, C. T., Fang, T. C., ... & Li, S. C. (2025). Bioactive Nutritional Components Within the Planetary Health Diet for Preventing Sarcopenic Obesity and Diabetic Sarcopenia: A Systematic Review. Nutrients, 17(23), 3656.

15. Fan, X., Luo, Y., Li, X., Tan, W., Liu, S., & Zhao, J. (2025). The association between eight dietary factors and sarcopenia: evidence from NHANES data. Journal of Health, Population and Nutrition, 44(1), 400.

16. Fekete, M., Lehoczki, A., Csípő, T., Fazekas-Pongor, V., Szappanos, Á., Major, D., ... & Varga, J. T. (2024). The role of trace elements in COPD: Pathogenetic mechanisms and therapeutic potential of zinc, iron, magnesium, selenium, manganese, copper, and calcium. Nutrients, 16(23), 4118.

17. Feng, Z., Xia, J., Yu, J., Wang, J., Yin, S., Yang, J., ... & Sun, G. (2025). Pathophysiological Mechanisms Underlying Sarcopenia and Sarcopenic Obesity: A Systematic Review and Meta-Analysis of Biomarker Evidence. International Journal of Molecular Sciences, 26(11), 5113.

18. Ganapathy, A., & Nieves, J. W. (2020). Nutrition and sarcopenia what do we know?. Nutrients, 12(6), 1755.

19. Granic, A., Suetterlin, K., Shavlakadze, T., Grounds, M. D., & Sayer, A. A. (2023). Hallmarks of ageing in human skeletal muscle and implications for understanding the pathophysiology of sarcopenia in women and men. Clinical Science, 137(22), 1721-1751.
20. Greco, G., Petrelli, A., Fischetti, F., & Cataldi, S. (2025). Lifestyle-Based Approaches to Cancer Prevention and Treatment: Diet, Physical Activity, and Integrative Strategies. Pathophysiology, 32(4), 70.
21. Hernandez-Lepe, M. A., Miranda-Gil, M. I., Valbuena-Gregorio, E., & Olivas-Aguirre, F. J. (2023). Exercise programs combined with diet supplementation improve body composition and physical function in older adults with sarcopenia: a systematic review. Nutrients, 15(8), 1998.
22. Jeyaraman, M., Jeyaraman, N., Nallakumarasamy, A., Ramasubramanian, S., Muthu, S., Murugan, S., ... & Gangadaran, P. (2025). Sarcopenia in Aging: Pathogenesis, Diagnosis, and Emerging Therapeutic Frontiers. Molecular Imaging and Biology, 1-22.
23. Jin, K., Li, X., Ma, Y., Yang, D., Tan, X., Sun, Q., & Wang, R. (2026). Risk Factors Associated With Sarcopenia in Patients With Chronic Kidney Disease: A Systematic Review and Meta-Analysis. Journal of Cachexia, Sarcopenia and Muscle, 17(1), e70166.
24. Kwon, R. J., Mijan, M. A., Son, S. M., Yoo, W., & Kim, T. (2025). Combined Protein, Probiotics, and Exercise Therapy for Sarcopenia: A Comprehensive Review. Cells, 14(17), 1375.
25. Li, N., Wang, J. J., Lu, Z. L., Zhu, M. X., Xu, H. X., & Liu, J. (2019). Protein Supplementation for the Prevention and Management of Sarcopenia in the Elderly. Journal of Nutritional Oncology, 4(2), 74-84.
26. Li, Y., Xiang, Y., Yan, X., Lu, C., Huang, J., & Dai, L. (2025). Sarcopenia in liver transplantation: A comprehensive bibliometric study of current research trends and future directions. Open Life Sciences, 20(1), 20251197.
27. Liang, B., Wang, B., Liang, J., & Sun, X. (2025). Knowledge, attitude, and practice of healthcare professionals toward sarcopenia. Scientific Reports, 15(1), 19826.
28. Lin, C. C., Shih, M. H., Chen, C. D., & Yeh, S. L. (2021). Effects of adequate dietary protein with whey protein, leucine, and vitamin D supplementation on sarcopenia in older adults: An open-label, parallel-group study. Clinical nutrition, 40(3), 1323-1329.
29. Liu, S., Zhang, L., & Li, S. (2023). Advances in nutritional supplementation for sarcopenia management. Frontiers in nutrition, 10, 1189522.
30. Liu, Y., Liu, X., Duan, L., Zhao, Y., He, Y., Li, W., & Cui, J. (2024). Associations of micronutrient dietary patterns with sarcopenia among US adults: a population-based study. Frontiers in Nutrition, 11, 1301831.
31. Mazza, E., Ferro, Y., Maurotti, S., Micale, F., Boragina, G., Russo, R., ... & Pujia, A. (2024). Association of dietary patterns with sarcopenia in adults aged 50 years and older. European Journal of Nutrition, 63(5), 1651-1662.
32. Medoro, A., Scapagnini, G., & Davinelli, S. (2024). Polyphenol supplementation and sarcopenia: A systematic review and Meta-Analysis of clinical trials. The Journal of frailty & aging, 13(4), 432-440.
33. Ni Lochlainn, M., Bowyer, R. C., Welch, A. A., Whelan, K., & Steves, C. J. (2023). Higher dietary protein intake is associated with sarcopenia in older British twins. Age and ageing, 52(2), afad018.
34. Nicholls, J. (2022). Perspective: The glycemic index falls short as a carbohydrate food quality indicator to improve diet quality. Frontiers in Nutrition, 9, 896333.
35. Ogawa, M., Sato, Y., Nagano, F., Yoshimura, Y., & Kuzuya, M. (2024). Mineral supplementation in patients with frailty and sarcopenia a systematic review. Geriatrics & gerontology international, 24(9), 850-858.
36. Pan, D., Yang, L., Yang, X., Xu, D., Wang, S., Gao, H., ... & Sun, G. (2024). Potential nutritional strategies to prevent and reverse sarcopenia in aging process: Role of fish oil-derived ω-3 polyunsaturated fatty acids, wheat oligopeptide and their combined intervention. Journal of advanced research, 57, 77-91.
37. Papadopoulou, S. K., Detopoulou, P., Voulgaridou, G., Tsoumana, D., Spanoudaki, M., Sadikou, F., ... & Nikolaidis, P. (2023). Mediterranean diet and sarcopenia features in apparently healthy adults over 65 years: a systematic review. Nutrients, 15(5), 1104.
38. Park, J. E., Lee, S., & Kim, K. (2023). The effect of combining nutrient intake and physical activity levels on central obesity, sarcopenia, and sarcopenic obesity: a population-based cross-sectional study in South Korea. BMC geriatrics, 23(1), 119.
39. Pereira, M., Silva, A. C., Mapa, V., Peixoto, L., Lacerda, I., Ferreira-Júnior, J. B., ... & Coelho, D. B. (2025). Strength Training and Nutrition Help Prevent Sarcopenia in Older Adults. International journal of environmental research and public health, 22(7), 1118.
40. Petermann-Rocha, F., Balntzi, V., Gray, S. R., Lara, J., Ho, F. K., Pell, J. P., & Celis-Morales, C. (2022). Global prevalence of sarcopenia and severe sarcopenia: a systematic review and meta-analysis. Journal of cachexia, sarcopenia and muscle, 13(1), 86-99.
41. Polo-Ferrero, L., Recio-Rodriguez, J. I., González-Manzano, S., Martín-Vallejo, J., Barbero-Iglesias, F. J., Montero-Errasquín, B., ... & Méndez-Sánchez, R. (2025). Nutritional intake as a determinant of

high-speed resistance and multicomponent training efficacy on strength in older women at risk of sarcopenia. A randomized clinical trial. Clinical Nutrition, 47, 103-111.
42. Ran, X., Zhai, J., Xu, M., Zhu, X., Ullah, A., & Lyu, Q. (2023). 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, 23(1), 2017.
43. Reid-McCann, R. J., Brennan, S. F., McKinley, M. C., & McEvoy, C. T. (2022). The effect of animal versus plant protein on muscle mass, muscle strength, physical performance and sarcopenia in adults: protocol for a systematic review. Systematic Reviews, 11(1), 64.
44. Reid-McCann, R. J., Brennan, S. F., Ward, N. A., Logan, D., McKinley, M. C., & McEvoy, C. T. (2025). Effect of plant versus animal protein on muscle mass, strength, physical performance, and sarcopenia: a systematic review and meta-analysis of randomized controlled trials. Nutrition Reviews, 83(7), e1581-e1603.
45. Ren, X., Zhang, X., He, Q., Du, L., Chen, K., Chen, S., & Pan, Y. (2022). Prevalence of sarcopenia in Chinese community-dwelling elderly: a systematic review. BMC Public Health, 22(1), 1702.
46. Rodrigues, F., Domingos, C., Monteiro, D., & Morouço, P. (2022). A review on aging, sarcopenia, falls, and resistance training in community-dwelling older adults. International journal of environmental research and public health, 19(2), 874.
47. Rodrigues, G. D. S., da Silva, L. S. L., Sobrinho, A. C. D. S., Benjamim, J., Abud, G. F., Ortiz, G. U., ... & Bueno Junior, C. R. (2025). Dietary Polyphenols and Sarcopenia: Epigenetic Mechanisms and Geroscience Perspectives for Muscle Health in Aging. Frontiers in Aging, 6, 1696473.
48. Rogeri, P. S., Zanella, R., Martins, G. L., Garcia, M. D., Leite, G., Lugaresi, R., ... & Lancha, A. H. (2022). Strategies to prevent sarcopenia in the aging process: role of protein intake and exercise. Nutrients, 14(1), 52.
49. Sanchez-Tocino, M. L., Cigarrán, S., Ureña, P., González-Casaus, M. L., Mas-Fontao, S., Gracia-Iguacel, C., ... & Gonzalez-Parra, E. (2024). Definition and evolution of the concept of sarcopenia. Nefrología (English Edition), 44(3), 323-330.
50. Sirago, G., Picca, A., Calvani, R., Coelho-Júnior, H. J., & Marzetti, E. (2022). Mammalian target of rapamycin (mTOR) signaling at the crossroad of muscle fiber fate in sarcopenia. International Journal of Molecular Sciences, 23(22), 13823.
51. Smela, B., Toumi, M., Świerk, K., Francois, C., Biernikiewicz, M., Clay, E., & Boyer, L. (2023). Rapid literature review: definition and methodology. Journal of market access & health policy, 11(1), 2241234.
52. Song, Z., Pan, T., Tong, X., Yang, Y., & Zhang, Z. (2023). The effects of nutritional supplementation on older sarcopenic individuals who engage in resistance training: a meta-analysis. Frontiers in Nutrition, 10, 1109789.
53. Srivastava, S., Pandey, V. K., Singh, A., & Dar, A. H. (2024). Exploring the Potential of Treating Sarcopenia through Dietary Interventions. Journal of Food Biochemistry, 2024(1), 3018760.
54. Tezze, C., Sandri, M., & Tessari, P. (2023). Anabolic resistance in the pathogenesis of sarcopenia in the elderly: role of nutrition and exercise in young and old people. Nutrients, 15(18), 4073.
55. Therdyothin, A., Phiphopthatsanee, N., & Isanejad, M. (2023). The effect of omega-3 fatty acids on sarcopenia: mechanism of action and potential efficacy. Marine Drugs, 21(7), 399.
56. Tsai, C. C., Wang, P. C., Hsiung, T., Fan, Y. H., Wu, J. T., Kan, W. C., & Shiao, C. C. (2025). Sarcopenia in Chronic Kidney Disease: A Narrative Review from Pathophysiology to Therapeutic Approaches. Biomedicines, 13(2), 352.
57. Tseng, T. H., Fu, S. H., Sie, N. H., Lu, Y. C., Wang, C. Y., & Wu, C. H. (2025). Epidemiology of sarcopenia: A narrative review. Osteoporosis and Sarcopenia.
58. Tu, S., Hao, X., Xu, S., Jin, X., Liao, W., Xia, H., ... & Sun, G. (2025). Sarcopenia: Current insights into molecular mechanisms, diagnostics, and emerging interventional approaches. International Journal of Molecular Sciences, 26(14), 6740.
59. Umarova, G. A., Batyrova, G. A., Zhubaniyazova, A. S., & Zhubaniyazova, S. (2025). The Relationship Between the Elemental Status of the Elderly and Senile Population and Sarcopenia: A Review. Ekologiya cheloveka (Human Ecology), 32(3), 151-159.
60. van Dronkelaar, C., Fultinga, M., Hummel, M., Kruizenga, H., Weijs, P. J., & Tieland, M. (2023). Minerals and sarcopenia in older adults: an updated systematic review. Journal of the American Medical Directors Association, 24(8), 1163-1172.
61. van Dronkelaar, C., Fultinga, M., Hummel, M., Kruizenga, H., Weijs, P. J., & Tieland, M. (2023). Minerals and sarcopenia in older adults: an updated systematic review. Journal of the American Medical Directors Association, 24(8), 1163-1172.
62. Vanoh, D. (2025). Antioxidant Food for Sarcopenia. In Essentials of Clinical and Public Health Nutrition (pp. 91-113). Cham: Springer Nature Switzerland.
63. Welch, A. A., Scott, J., Cameron, D., & Yates, M. (2025). Are dietary patterns relevant for reducing the risk of fractures and sarcopenia?. Current Osteoporosis Reports, 23(1), 7.

64. Yanai, H. (2015). Nutrition for sarcopenia. Journal of clinical medicine research, 7(12), 926.
65. Yang, Y., Pan, N., Luo, J., Liu, Y., & Ossowski, Z. (2025). Exercise and nutrition for sarcopenia: a systematic review and meta-analysis with subgroup analysis by population characteristics. Nutrients, 17(14), 2342.
66. Yao, X. M., Liu, B. B., Deng, W. Y., & Wang, X. (2022). The awareness and knowledge regarding sarcopenia among healthcare professionals: a scoping review. The Journal of Frailty & Aging, 11(3), 274-280.
67. Yokoyama, Y., Kitamura, A., Seino, S., Kim, H., Obuchi, S., Kawai, H., ... & Shinkai, S. (2021). Association of nutrient-derived dietary patterns with sarcopenia and its components in community-dwelling older Japanese: a cross-sectional study. Nutrition Journal, 20(1), 7.
68. Yoon, Y. E., Ju, S. H., Kim, Y., & Lee, S. J. (2025). Natural Flavonoids for the Prevention of Sarcopenia: Therapeutic Potential and Mechanisms. International journal of molecular sciences, 26(15), 7458.
69. Zhang, F., & Li, W. (2024). Vitamin D and sarcopenia in the senior people: a review of mechanisms and comprehensive prevention and treatment strategies. Therapeutics and Clinical Risk Management, 577-595.
70. Zhang, R., Wang, J., Xi, H., Cheng, Y., & Han, B. (2025). Global research trends in sarcopenia: a bibliometric analysis of exercise and nutrition (2005–2025). Frontiers in Nutrition, 12, 1579572.
71. Zhang, X., Lian, R., Tang, H., Luo, S., Chen, X., Lu, J., & Yang, M. (2025). Diagnostic Prediction Models for Sarcopenia: A Systematic Review and Meta-Analysis. Journal of the American Medical Directors Association, 26(8), 105698.
72. Zhang, Y., Guo, H., Liang, J., Xiao, W., & Li, Y. (2022). Relationship between dietary omega-3 and omega-6 polyunsaturated fatty acids level and sarcopenia. A meta-analysis of observational studies. Frontiers in Nutrition, 8, 738083.
73. Zhang, Z., Chen, X., & Jiang, N. (2024). The triglyceride glucose related index is an indicator of Sarcopenia. Scientific Reports, 14(1), 24126.
74. Zhao, J., Huang, Y., & Yu, X. (2022). Effects of nutritional supplement and resistance training for sarcopenia in patients with inflammatory bowel disease: A randomized controlled trial. Medicine, 101(34), e30386