The Role of Diet in Preventing and Managing Osteoporosis and Sarcopenia

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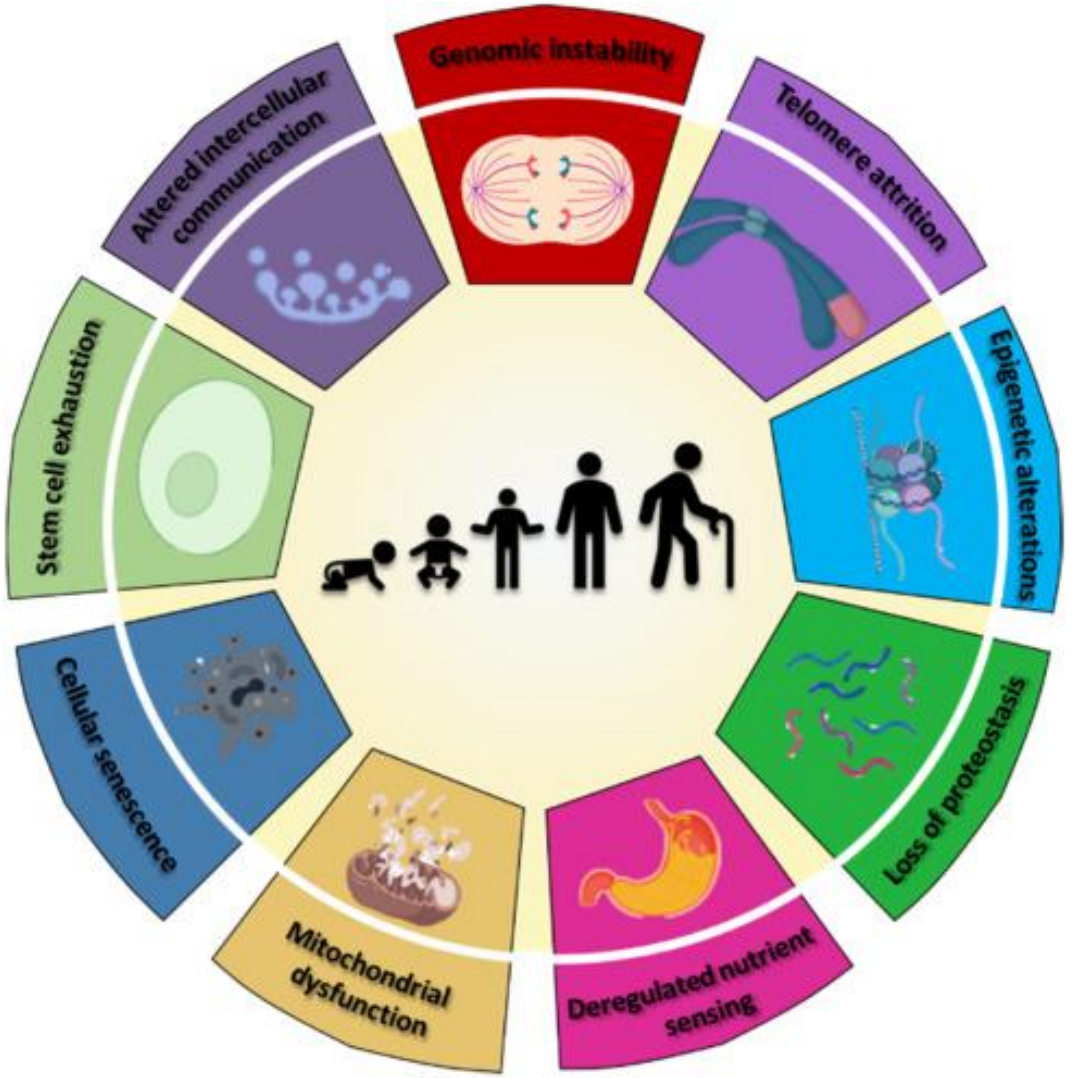
Contents

Introduction

- Aging is a progressive functional decline or deterioration of physiological functions

- Aging is two independent and connected processes:
  - **Primary aging:** Gradual process of body deterioration that takes place throughout life. Is partly based on genetic programs (pre-programed).
  - **Secondary aging:** Results from external factors such as disease, lack of physical activity, unhealthy activities (e.g., excessive smoking and drinking), poor nutrition, and exposure to hazardous materials.

Hallmarks of aging



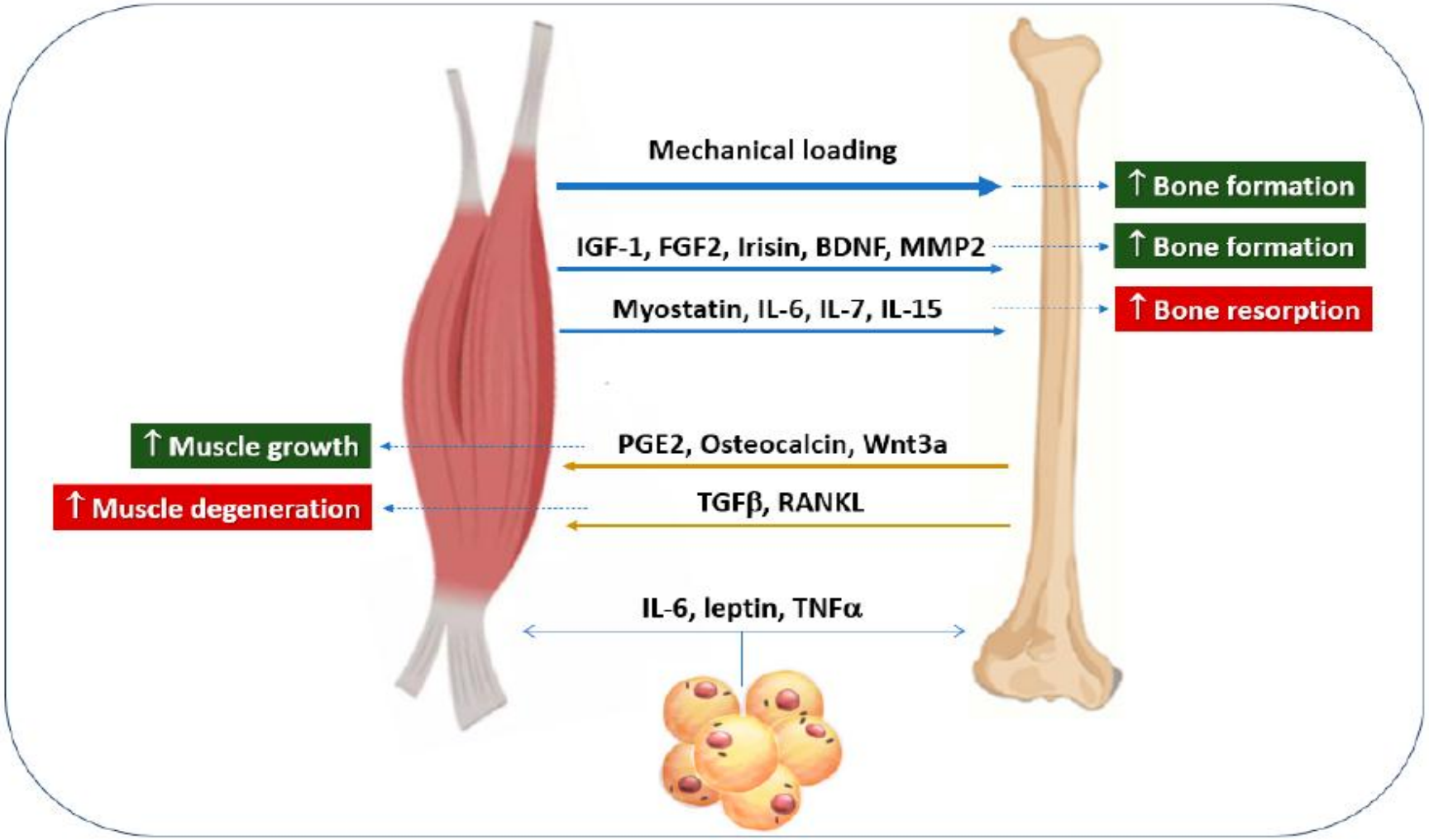
Chapter 3 - Brief about hallmarks of aging. In: Singh SK, Lin C-L, Mishra SK, editors. Anti-Aging Drug Discovery on the Basis of Hallmarks of Aging: Academic Press; 2022. p. 41-60.

Introduction

- Aging in the musculoskeletal system: Sarcopenia and osteoporosis
- Osteopenia/osteoporosis, sarcopenia and overweight/obesity are distinct but interconnected
- The combination of these conditions:
  - ✓ **Osteosarcopenia:** Osteopenia/osteoporosis and sarcopenia
  - ✓ **Sarcopenic obesity:** Sarcopenia and obesity
  - ✓ **Osteosarcopenic Obesity:** Combination of the 3 condition

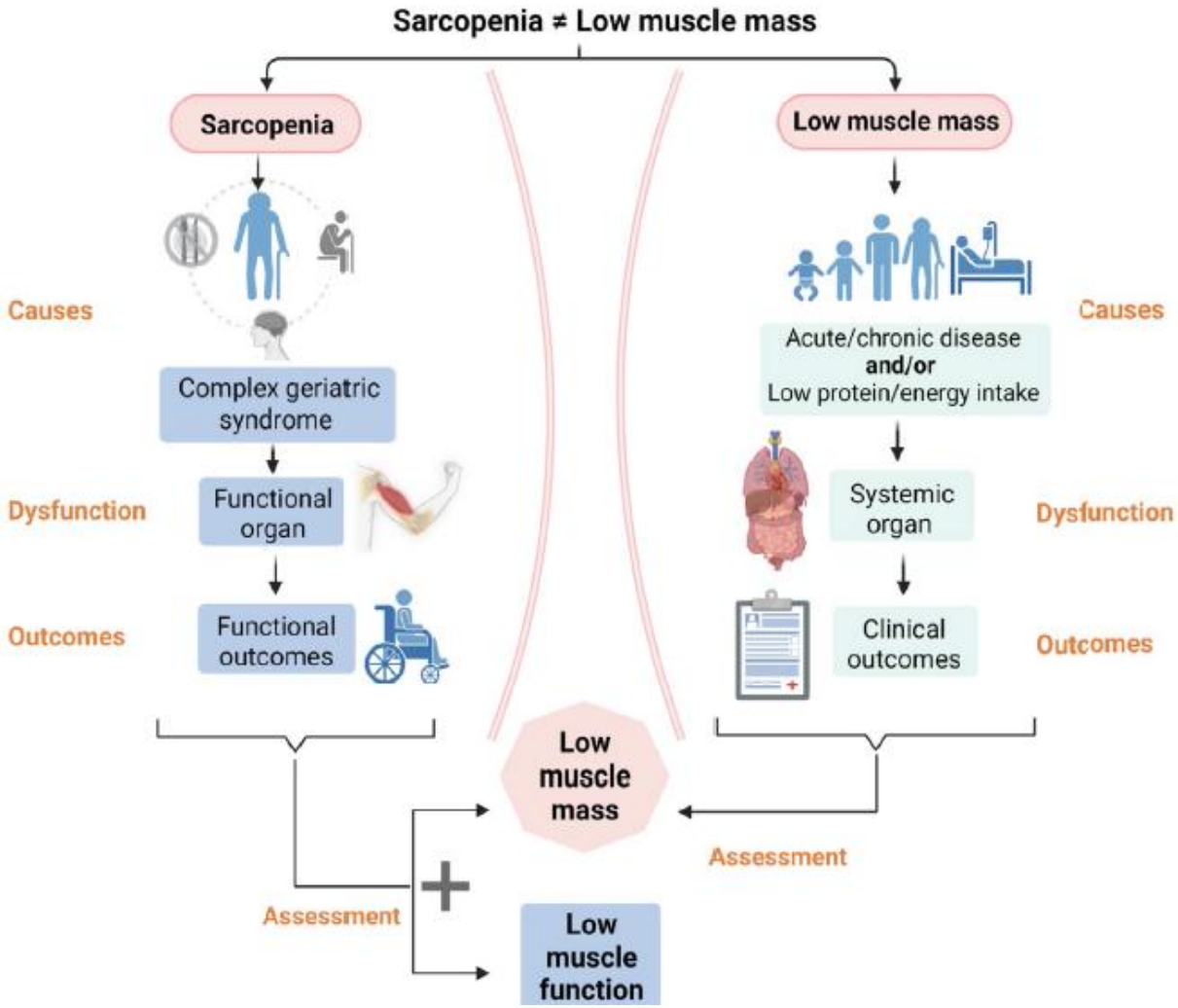
Endocrines 2025, 6, 10
Journal of Cachexia, Sarcopenia and Muscle 2020; 11: 609–618

Cross-talk among muscle, bone, and adipose tissue



Endocrines 2025, 6, 10.
Gerontology. 2025 Jun 19:1-13.

Sarcopenia and low muscle mass

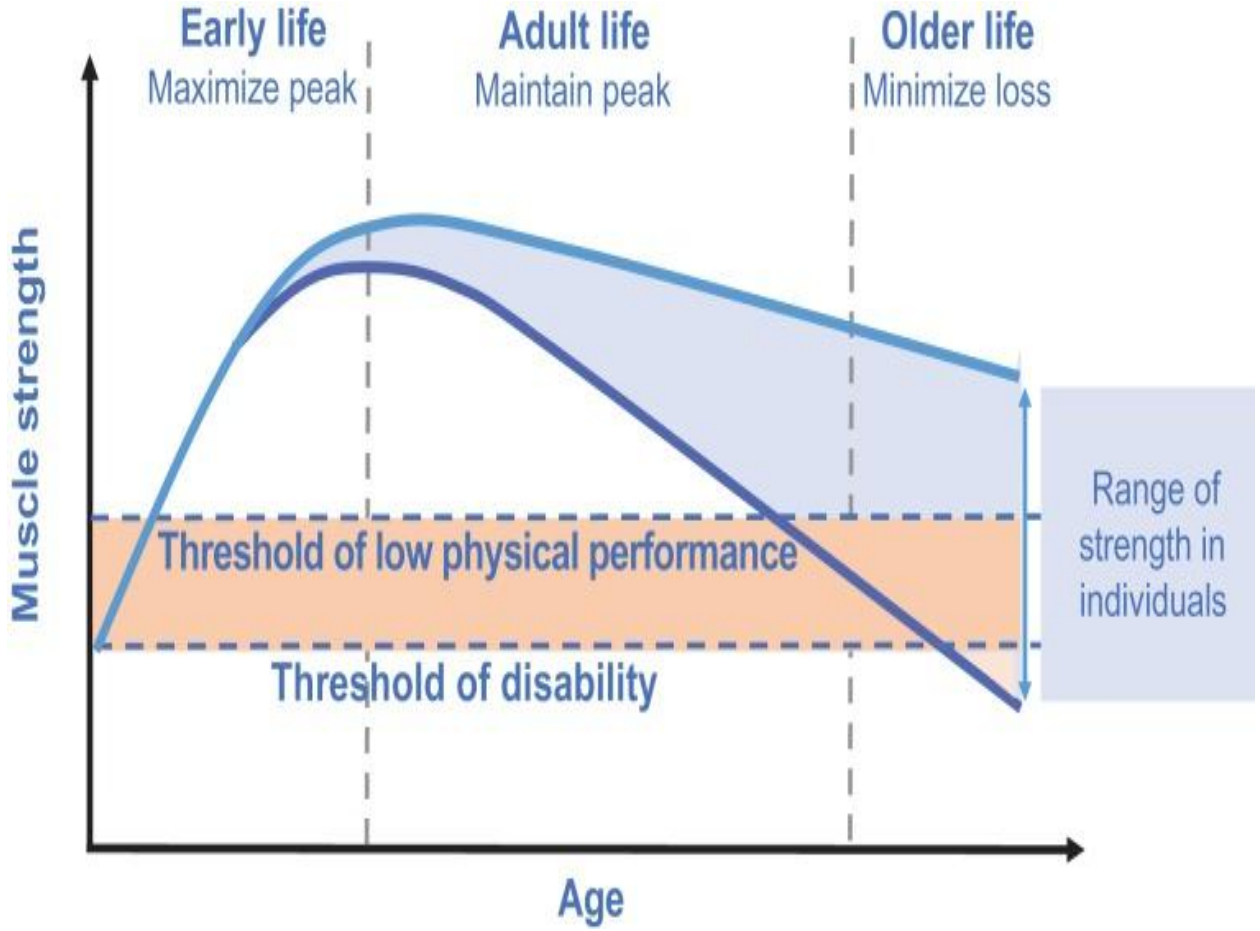


European Geriatric Medicine.2023, 14:225–228

The Lifelong Trajectory of Bone and Muscle

Bone mass and skeletal muscle mass and function in later life:

- Maximal levels reached in early adulthood
- Their later rates of decline



Anorexia of aging

- Decreasing appetite with increasing age (anorexia of aging)
- Even among healthy older adults, age-related falls in intake may be sizable (16-20%↓)
- Anorexia of aging is due to changes in:
  - ✓ Smell and taste perception
  - ✓ Hormonal balance between hunger and satiety signals
  - ✓ Ventricular distention capacity
- The overlap between malnutrition and sarcopenia is significant.
- Adequate intake of energy and protein is fundamental for bone and muscle health.

Nutritional Approaches to Treat Sarcopenia (Chapter 23). Sarcopenia. 2021 [Book], p. 335.

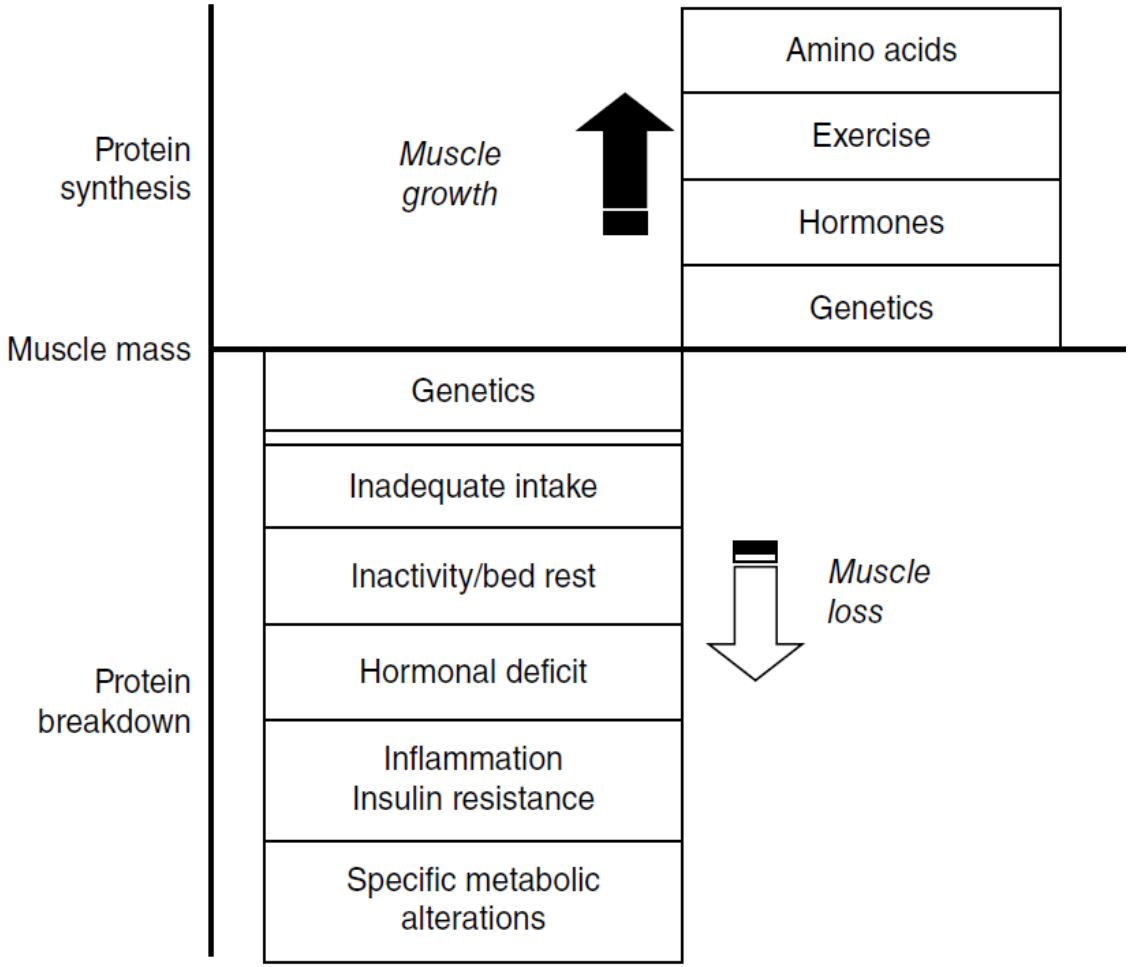
Protein

- Dual Benefits:

  - Muscle: Preservation of muscle mass.

  - Bone & Systemically: Mitigates inflammation and supports bone remodeling.

Regulation of muscle mass



Nutrition, Protein Turnover and Muscle Mass. Sarcopenia. 2021 [Book], p. 46.

Protein

- Protein is an anabolic stimulus for muscle protein synthesis after feeding
- Aging attribute to:
  - The ability to process protein efficiently diminishes
  - The homeostasis of skeletal muscle is disturbed (resulting in overall loss)
  - Anabolic resistance (resistance to external stimuli) is occurred.
- The quantity, quality, and distribution of protein intake are important.

Am J Clin Nutr. 2023;118(5):852-864.
Current Osteoporosis Reports. 2024; 22:515–522.
Nutrients 2022, 14, 52.
Gerontology. 2025 Jun 19:1-13.

Protein quantity

- A long-standing and controversial question in nutrition is how much daily protein is required to maintain bone and muscle homeostasis.
- **General Adults:** 0.8 g/kg/day
- **Older adults in healthy condition**: 1.0–1.2 g protein/kg/day
- **Older adults in chronic or acute illness**: 1.2–1.5 g protein/kg /day weight (Up to 2.0 g/kg/day).
- The aforementioned protein recommendation is safe for elderly with healthy kidney function or mild dysfunction
- In severe CKD are usually recommended a lower amount of 0.6–0.8 protein/kg /day

Nutrients 2021, 13, 4499.

Protein quality

- The quality of a protein (bioavailability and composition of essential amino acids) impacts its anabolic potential.
- The quality of dietary proteins may be less important when protein intake is sufficient.
- Animal-based protein have higher anabolic potential than plant-based protein.
- Plant-based diets can readily meet essential amino acid requirements, though this often requires consuming larger meal volumes.
- Plant based diets also provide a mix of other potentially bone and muscle protective nutrients.

Protein quality

Innovative strategies:

- Leucine fortification of meals
- Supplementation with high-quality protein

These approaches are particularly relevant for older adults experiencing appetite loss, dietary restrictions, or obesity-associated inflammation.

Glutamine and Leucine-enriched supplements have shown promise in **reducing muscle catabolism** during periods of **inactivity** or **stress**, such as **hospitalization**.

Gerontology. 2025:1-13.
Nutrients 2021, 13, 4499

Different commercially available protein sources

Protein Source	EAAs Profile	Leucine Content	Digestion Rate	Bioavailability
Whey	Complete	High	Fast	High
Casein	Complete	High	Slow	High
Milk	Complete	High	Slow	High
Isolated soy	Complete	Medium	Fast	Medium
Collagen	Incomplete	Low	Fast	Medium
Mycoprotein	Complete	High	Fast	High
Isolated wheat protein	Complete	Medium	Fast	High

Nutrients 2022, 14, 52.

Distribution of protein intake

- An even distribution of proteins across meals maximizes the anabolic response and supports bone remodeling.
- Post-exercise protein ingestion enhances protein synthesis and muscle recovery while promoting calcium absorption and bone repair.
- Current recommendations encourage the consumption of ~25 to 30 g of protein with at least 2.5–3 g of leucine per meal to overcome **anabolic resistance** in older adults, **optimize protein synthesis**, and **promote bone health**.
- Leucine is found abundantly in animal-based proteins such as meat and dairy, but plant- based sources like soy might also provide substantial amounts.

Nutrients 2025, 17, 2842.
Gerontology. 2025 Jun 19:1-13.
Journal of Cachexia, Sarcopenia and Muscle 2020; 11: 609–618.

Leucine in foods

Where to Find Leucine in Food and How to Feed Elderly With Sarcopenia in Order to Counteract Loss of Muscle Mass: Practical Advice

Mariangela Rondanelli[1,2], Mara Nichetti[3], Gabriella Peroni[3], Milena Anna Faliva[3], Maurizio Naso[3], Clara Gasparri[3], Simone Perna[4], Letizia Oberto[3], Enrica Di Paolo[5], Antonella Riva[6], Giovanna Petrangolini[6], Giulia Guerreschi[3] and Alice Tartara[3]*

Front Nutr. 2021;7:622391.

Leucine and protein in food

Food	Leucine (g/100g)	Total protein (g/100 g)
Meat and fish		
Bovin, Calf	1.029	20.7
Chicken Breast	1.955	23.3
Lamb	1.532	20
Turkey breast	2.002	24
Anchovey	1.331	16.8
Cod	1.484	14
Salmon	1.496	18.4
Tuna fish	1.871	21.5
Dairy		
Feta cheese	1.531	15.6
Greek Yogurt	0.505	6.4
Mozzarella cheese	1.400	18.7
Parmesan	2.880	33.5

Front Nutr. 2021;7:622391.

Leucine and protein in food

Food	Leucine (g/100g)	Total protein (g/100 g)
Legumes		
Beans	0.488	6.4
Chick peas	0.549	7
Lentils	0.527	6.9
Cereals		
Bread	0.691	9
Corn	1.168	9.2
Rice	0.590	6.7
Semolina pasta	1.033	13.5
Nuts		
Cashew nuts	1.280	15
Hazelnut	0.930	13.8
Pistachios	1.442	20.6
Almonds	1.450	22

Front Nutr. 2021;7:622391.

Leucine and protein in food

Food	Leucine (g/100g)	Total protein (g/100 g)
Other		
Avocado	0.315	4.4
Spinaches	0.323	3.4
Zucchini	0.130	1.3
Green cabbage	0.113	2.1
Chicken egg	1.041	12.4
Chicken egg white	0.862	10.7

Front Nutr. 2021;7:622391.

Vitamin D

- Increasing protein intake is more effective when vitamin D levels are in an optimal range.
- Vitamin D plays a pivotal role in bone health, muscle strength, and function.
- Vitamin D deficiency has been associated with **reduced muscle strength** and **function**, leading to an increased risk of **falls, fractures, and functional impairments**.
- Vitamin D supplementation, especially in those with hypovitaminosis D, can significantly improve muscle strength and lower the incidence of falls in older adults.

Gerontology. 2025 Jun 19:1-13.

Vitamin D

- Foods like fatty fish (salmon, mackerel), fortified dairy products, and egg yolks are rich in vitamin D
- Given the prevalence of vitamin D deficiency among the elderly, due to reduced skin synthesis and limited sun exposure, supplementation is required.
- General recommendation for older adults is around 800–1,000 IU per day, either through diet, supplements, or sun exposure.

Gerontology. 2025 Jun 19:1-13.

Calcium

- ✓ Calcium is an important ion that plays a pivotal role in maintaining bone health, and sustaining its adequate intake is essential in preventing **osteoporosis** and reducing the risk of **fractures**.
- ✓ Calcium works synergistically with vitamin D to support bone mineralization and maintain structural integrity.
- ✓ The recommended daily intake for calcium in adults over 50 is around 1000-1,200 mg per day.
- ✓ The effect of daily calcium intake on sarcopenia is overall unclear and needs to be studied more in the future.

Gerontology. 2025 Jun 19:1-13.

Calcium Content of Common Foods

MILK & MILK DRINKS

Food (1 cup)	Calcium (mg)
Milk, semi-skimmed	294
Milk, skimmed	299
Milk, whole	289
Milkshake	441
Sheep Milk	466
Soy Drink (non-enriched)	32
Soy Drink (calcium-enriched*)	294
Rice Drink (non-enriched)	27
Oat Milk (non-enriched)	20
Almond Milk (non-enriched)	110

YOGHURT

Food (1 cup)	Calcium (mg)
Yoghurt, flavoured	322
Yoghurt, with fruit pieces	276
Yoghurt, natural	338

CHEESE

Food	Serving	Calcium (mg)
Hard Cheese (e.g. Cheddar, Parmesan, Emmental, Gruyère)	1 oz	224
Fresh Cheese (e.g. Cottage Cheese, Riccotta, Mascarpone)	1 cup	156
Soft Cheese (e.g. Brie, Camembert)	1 oz	112
Feta	1 oz	126
Mozzarella	1 oz	113
Cream Cheese	1 tbsp	15

https://www.osteoporosis.foundation/patients/prevention/calcium

Calcium Content of Common Foods

NUTS & SEEDS

Food	Serving	Calcium (mg)
Almonds	1 oz	70
Walnuts	1 oz	26
Hazelnuts	1 oz	52
Brazil Nuts	1 oz	26
Sesame Seeds (hulled)	1 tbsp	11
Tahini Paste	1 tbsp	21

BEANS & LENTILS

Food	Serving	Calcium (mg)
Lentils	1/2 cup raw	48
Chick Peas	1/2 cup raw	124
White Beans	1/2 cup raw	167
Red Beans	1/2 cup raw	107
Green/French Beans	1 cup	7

https://www.osteoporosis.foundation/patients/prevention/calcium

Calcium Content of Common Foods

FRUITS

Food	Serving	Calcium (mg)
Orange	1 fruit (2 5/8" dia)	52
Apple	1 medium (3" dia)	9
Banana	1 medium (7" to 7 7/8" long)	9
Apricot	1 fruit	5
Currant (dried gooseberry)	1 cup	86
Figs, dried	1 cup	238
Raisins (dried grapes)	1 oz (60 raisins)	22

VEGETABLES

Food	Serving	Calcium (mg)
Lettuce	1 cup	14
Kale, Collard Greens	1 cup (raw)	13
Bok Choy/Pak Choi	1 cup (raw)	28
Gombo/Okra	1 cup (raw)	64
Cress	1 cup (raw)	78
Rhubarb	1 cup (raw, sliced)	105
Carrots	1 cup (raw sliced)	37
Tomatoes	1 cup (raw chopped)	17
Broccoli	1 cup (raw chopped)	85

https://www.osteoporosis.foundation/patients/prevention/calcium

Magnesium

- ✓ Cofactor of enzymes related to bone and muscle health
- ✓ Supports bone mineralization
- ✓ Modulates inflammatory markers
- ✓ Critical for muscle function and recovery

- ✓ Suboptimal magnesium levels are associated with increased **fat mass**, **muscle weakness**, and **low bone density**.
- ✓ Dietary sources including nuts, seeds, whole grains, and leafy green vegetables.

Nutrients. 2025 31;17:2842.

Other minerals

- ✓ **Iron**

  - Essential for **oxygen transport** and **energy production** in muscle tissue

- ✓ **Zinc**

  - Component of **bone matrix proteins** and supports **muscle repair and regeneration**

- ❖ Dietary sources includes lean meats, seafood, legumes, and fortified cereals.

- ✓ **Potassium**

  - Maintenance of acid–base balance (critical for **bone mineralization**, and supports **muscle contraction** and **nerve function**).

  - Anti-inflammatory properties

- ❖ Potassium-rich foods include bananas, potatoes, citrus fruits, and beans.

Nutrients. 2025 31;17:2842.

Other vitamins

Vitamin K

- Essential for activating **osteocalcin**
- **Modulating mitochondrial** function and **energy metabolism**

Vitamin C and E

- **Antioxidant**
- Vitamin C is particularly important for **collagen** synthesis
- Vitamin E enhances **mitochondrial efficiency** and **reduces lipid peroxidation** in muscle cells, **improving recovery and strength**

Vitamins B

- B6, B9, B12
- Regulate **homocysteine** levels
- Adequate intake is critical for reducing **systemic inflammation** and supporting **protein metabolism**

Nutrients. 2025 31;17:2842.

Dietary patterns and musculoskeletal health

A growing number of observational studies have considered the role of the whole diet in the etiology of sarcopenia and osteoporosis:

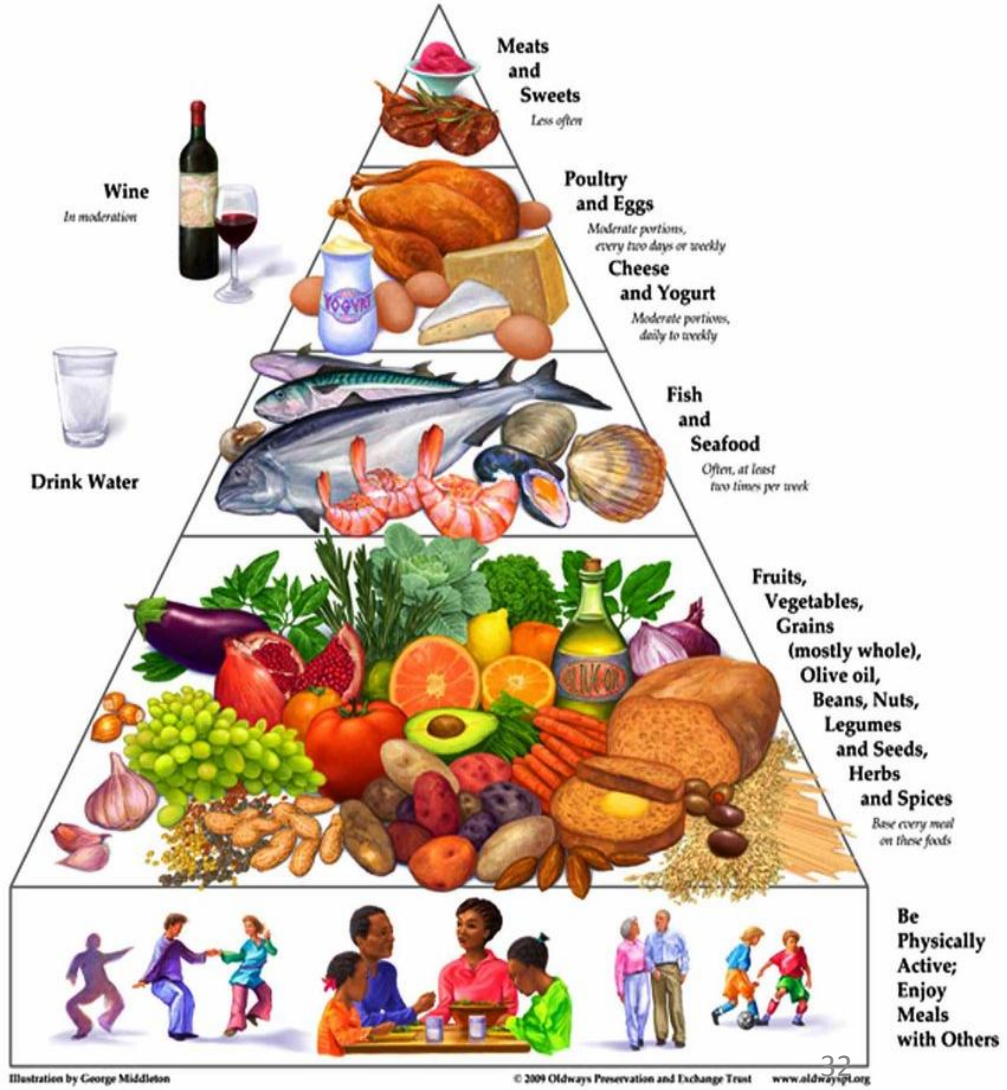
- The Mediterranean diet
- Mediterranean-Dietary Approaches to Stop Hypertension Intervention for Neurodegenerative Delay (MIND)
- The Alternative Healthy Eating Index-2010
- Nordic diet
- Pro-inflammatory diet

Osteoporos Int. 2021 Nov;32(11):2193-2203.
J Nutr. 2016 Jul;146(7):1341-7.
Am J Clin Nutr. 2022 Mar 4;115(3):625-632.

Mediterranean diet (MedDiet)

MedDiet represents a model of a healthy diet.

- ✓ High in virgin olive oil, fruits, vegetables, legumes, whole grains, nuts, fish.
- ✓ Moderate in dairy, poultry, wine.
- ✓ Low in red meat, sweets, and processed foods.
- ✓ Rich in anti-inflammatory and antioxidant components: polyphenols, MUFAs, PUFAs, and fiber.



Mediterranean diet and bone health

- MedDiet adherence is linked to higher bone mineral density (lumber spine, femoral neck, and hip).
- Higher MedDiet adherence associated with up to 21% (95% CI: 13-28%) lower hip fracture risk.
- Associations between the MedDiet and total fracture risk has been contradictory.

Nutrients 2023, 15, 3224.
Eur. J. Nutr. 2018, 57, 2147–2160.

Mediterranean diet and sarcopenia

- Most studies investigated individual components of sarcopenia (**muscle mass, strength, or physical function**) rather than the full syndrome.
- Adherence to the MedDiet was generally associated with positive effects on **muscle mass**.
- The evidence for a link between the MedDiet and **muscle strength** (e.g., handgrip strength) is **unclear** and **inconsistent**.

Nutrients 2023, 15, 3224.
Nutrients 2023, 15, 1104.

Mediterranean diet and physical performance

Most studies reported a beneficial effect of the MedDiet on physical performance.

Examples of Improved Function:

- Faster walking speed
- Better scores on the Short Physical Performance Battery (SPPB)
- Slower decline in mobility over time.

Nutrients 2023, 15, 1104.

Direct Evidence for MedDiet & sarcopenia

- Limited number of studies that directly assessed sarcopenia: no evidence of a positive effect of the MedDiet on the **incidence** or **prevalence** of the condition itself.

- **This does not mean the MedDiet is not beneficial, but that more research using standardized sarcopenia diagnoses is needed.**

Beneficial mechanism of MedDiet on musculoskeletal health

- Anti-Inflammatory & Antioxidant Properties: Rich in foods (fruits, vegetables, olive oil, nuts) that combat chronic inflammation and oxidative stress
- Beneficial Fats: n-3 fatty acids from fish may improve muscle metabolism.
- Nutrient Synergy: The combined effect of multiple beneficial nutrients working together is likely more powerful than any single nutrient alone.
- Gut Health

Nutrients 2023, 15, 3224.
Nutrients 2023, 15, 1104.

Gut microbiota

- Approximately **60%** of the variation in gut microbiota is linked to diet.
- MedDiet modulates gut microbiota, increasing beneficial bacteria (e.g., Bifidobacterium).
- These bacteria produce short-chain fatty acids like butyrate, which:

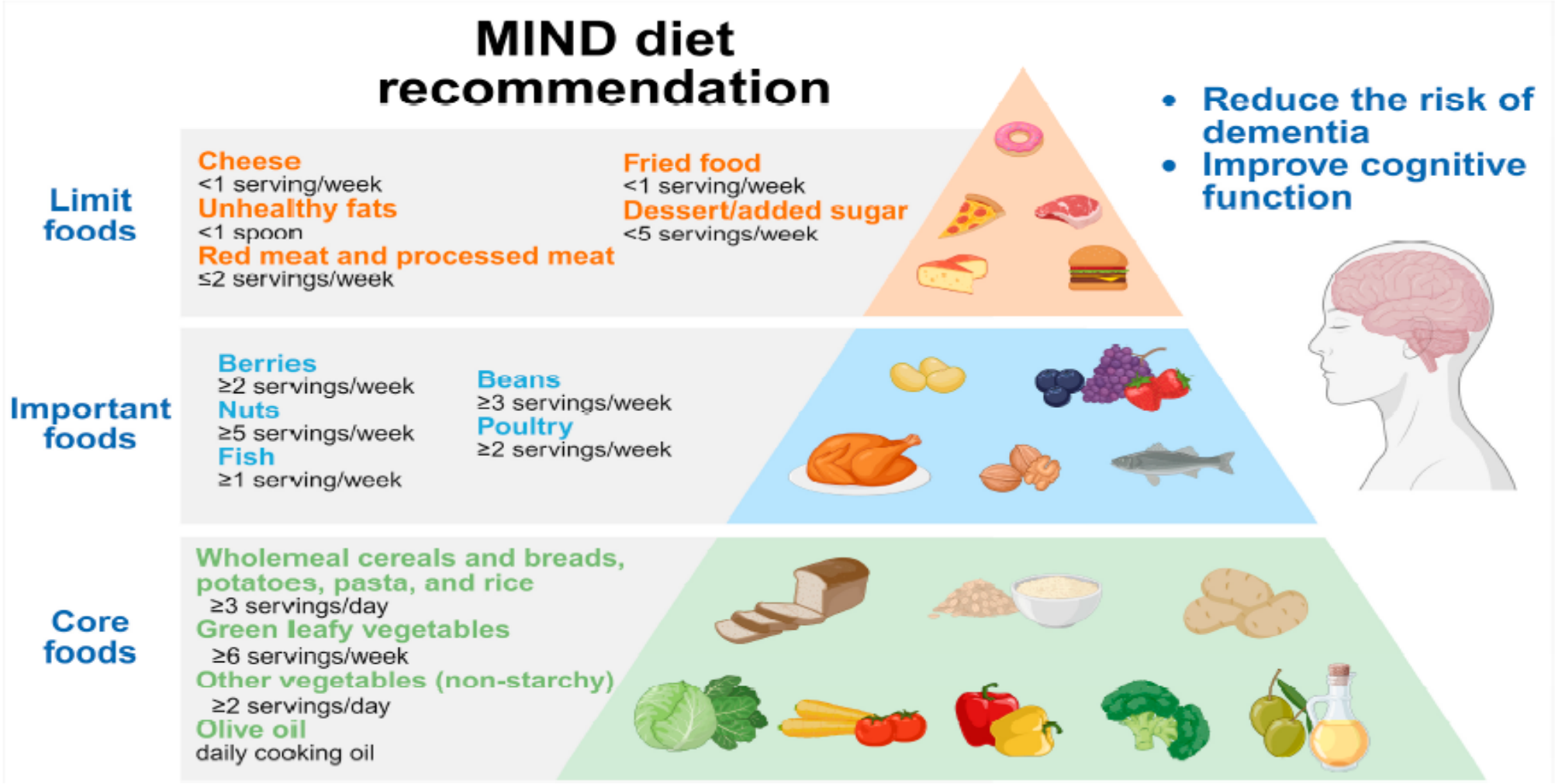
  - Enhance **bone formation** and **vitamin D bioavailability**.

  - Reduce **inflammation** and support **muscle mass**.

- **Gut-muscle** and **gut-bone axes** are emerging as key mediators.

Nutrients 2023, 15, 3224.

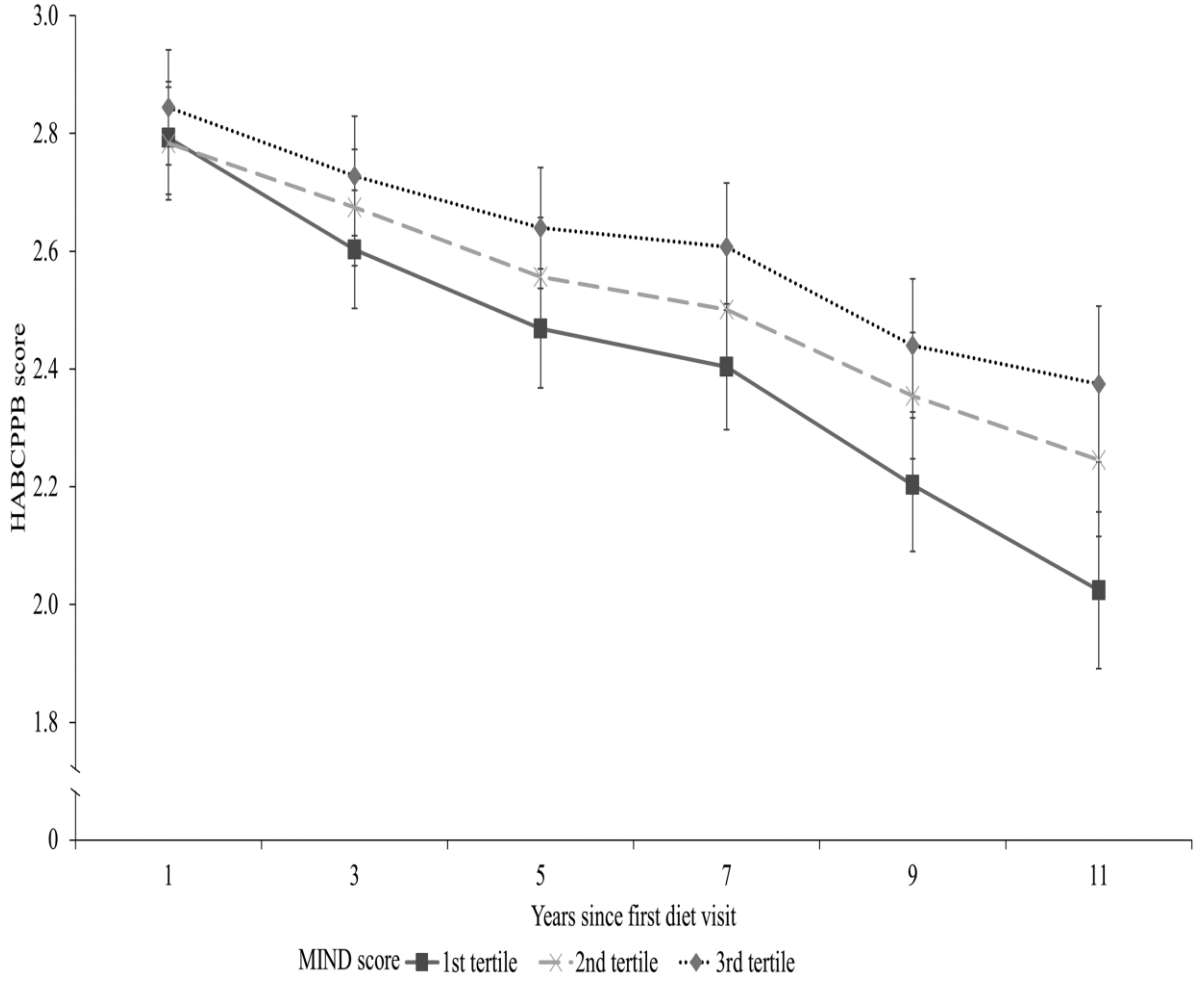
Mediterranean-Dietary Approaches to Stop Hypertension Intervention for Neurodegenerative Delay (MIND)



Nutrients 2025, 17, 1686.

MIND and sarcopenia

- The Baltimore Longitudinal Study of Aging
- Investigate the association between **MIND** and **physical function** and **grip strength** in older men and women
- *n* = 1358, mean ± SD age: 68 ± 14 y at first diet visit
- Median 6 y of follow-up
- 1-point increment in MIND was associated with 19% (95% CI = 7-29%) lower odds of physical function impairment
- Men and women in the highest compared with the lowest tertiles of MIND score had 1.86-kg (95% CI: 0.33, 3.40 kg) and 1.24-kg (95% CI: 0.04, 2.45 kg) greater grip strength, respectively.



Am J Clin Nutr. 2022 Mar 4;115(3):625-632.

Vegan diet and osteoporosis

Results from two meta-analyses of observational studies indicate that:

- Vegetarians and vegans had **lower BMD** at the **femoral neck** and **lumbar spine**
- Increased risk of **osteoporosis**, particularly at the lumbar spine, among individuals following a **vegan diet** or following **a plant-based diet for ≥10 y**
- Vegans also had higher **fracture** rates.
- The heterogeneity observed across studies highlights the need for well-designed prospective studies in future.

Clin Nutr. 2025;50:253-262.
Nutr Rev. 2019;77:1–18.

Dairy and musculoskeletal health

- Dairy—especially milk—was linked to **higher bone mineral density**.
- Total dairy and milk showed inconsistent associations with **fractures**, cheese and yogurt showed more consistent protective effects.
- Prospective studies support **favorable** or **neutral** associations of fermented dairy products with musculoskeletal health.
- The evidence does **not** support that fermented products have significant *unique* benefits beyond what is seen with all dairy.
- Few interventional studies suggest overall **favourable** effects of **fermented dairy** products (yogurt or cheese) on **musculoskeletal health**.

Nutrients 2025, 17, 2723.
Front Nutr. 2025 Sep 30;12:1660505.
Calcif Tissue Int. 2024;115(5):480-497.

Fruit and vegetables and musculoskeletal health

- Fruit and vegetable intake is associated with greater BMD.
- Fewer than 5 servings per day of fruits and vegetables is associated with higher hip fracture risk (A dose–response observational study)
- Fruits and vegetables are the foods linked most consistently to beneficial effects on muscle function across studies of middle-aged adults.

Am J Clin Nutr. 2023;118(5):852-864.
Curr Osteoporos Rep. 2024;22(6):515-522.

Other food patterns/components

- Western or Pro-inflammatory dietary patterns
- Ultra-processed foods
- Sugar-sweetened beverages
- High sodium intake

Limitations of evidence from diets

- **No or limited Clinical Trials:** The absence of RCTs means we cannot establish cause and effect.
- **Inconsistent Measurements:** Studies used different methods to assess diet, muscle mass, strength, and function.
- **Dietary Changes Over Time:** Most studies assessed diet only at one point, but eating habits can change.

Clinical Practice Guidelines

- Although nutrition is considered an important influence on musculoskeletal health there are many gaps in current evidence that limit the translation of findings to population dietary recommendations.

- Dietary recommendations relating to **sarcopenia** are commonly based on **consensus**, with little clinical trial evidence to inform preventive strategies.

Nutritional recommendation for osteoporosis

- Maintenance of an **adequate protein** intake is important for the preservation of musculoskeletal function in postmenopausal women and men over 50 years of age.
- The use of **protein supplements** in patients with **hip fracture**.
- **Lifestyle modifications** to achieve an adequate intake of **calcium** and **vitamin D**
- **Vitamin D**
  - ✓ The desirable blood levels: 30-50 ng/mL
  - ✓ A minimum dose of 400 IU is recommended in case of requiring supplementation
  - ✓ In patients with greater risk of deficiency, such as the elderly and the chronically ill, doses between 800 and 2000 IU are recommended

Osteoporos Sarcopenia. 2019;5:69-77.

Nutritional recommendation for osteoporosis

- **Calcium**
  - ✓ The recommended calcium intake is **1000-1200** mg daily
  - ✓ Preferably through nutritional intake
  - ✓ If the diet does not contain enough, supplementation is required without exceeding **1200 mg** daily
  - ✓ To favor its absorption, it is not recommended to exceed 500-600 mg per dose

Osteoporos Sarcopenia. 2019 Sep;5(3):69-77.

Nutritional recommendation for osteoporosis

- Supplementation with **vitamin K**, **magnesium**, **copper**, **zinc**, **phosphorus**, **iron**, or **essential fatty acids** is not recommended for the prevention or treatment of osteoporosis.
- Reducing the intake of caffeine (no more than 4 cups of coffee per day)
- Limit the consumption of alcohol (no more than 2 units per day)

Osteoporos Sarcopenia. 2019; 5:69-77.

Guidelines/groups for Sarcopenia

Acronym	
EWGSOP1	European Working Group on Sarcopenia in Older People
EWGSOP2	Revised version of the EWGSOP
AWGS	Asian Working Group on Sarcopenia
IWGS	International Working Group on Sarcopenia
FNIH	Foundation of the National Institute of Health-Sarcopenia Project
SDOC	Sarcopenia Definition and Outcomes Consortium
ICSFR	International Conference on Sarcopenia and Frailty Research

International Conference on Sarcopenia and Frailty Research

J Nutr Health Aging. 2018;22(10):1148-1161

INTERNATIONAL CLINICAL PRACTICE GUIDELINES FOR SARCOPENIA (ICFSR): SCREENING, DIAGNOSIS AND MANAGEMENT

E. DENT[1,2], J.E. MORLEY[3], A.J. CRUZ-JENTOFT[4], H. ARAI[5], S.B. KRITCHEVSKY[6], J. GURALNIK[7], J.M. BAUER[8], M. PAHOR[9], B.C. CLARK[10], M. CESARI[11,12], J. RUIZ[13], C.C. SIEBER[14], M. AUBERTIN-LEHEUDRE[15], D.L. WATERS[16], R. VISVANATHAN[17], F. LANDI[18], D.T. VILLAREAL[19], R. FIELDING[20], C.W. WON[21], O. THEOU[17,22], F.C. MARTIN[23], B. DONG[24], J. WOO[25], L. FLICKER[26], L. FERRUCCI[27], R.A. MERCHANT[28], L. CAO[29], T. CEDERHOLM[30], S.M.L. RIBEIRO[31], L. RODRÍGUEZ-MAÑAS[32], S.D. ANKER[33,34], J. LUNDY[35], L.M. GUTIÉRREZ ROBLEDO[36], I. BAUTMANS[37,38,39], I. APRAHAMIAN[40], J.M.G.A. SCHOLS[41], M. IZQUIERDO[42], B. VELLAS[43]

ICFSR

	Guideline
1.Screening	1A. Older adults aged 65 years and older should be screened for sarcopenia annually, or after the occurrence of major health events
	1B. Screening for sarcopenia can be performed using gait speed, or with the SARC-F questionnaire
	1C. Individuals screened as positive for sarcopenia should be referred for further assessment to confirm the presence of the disease
2. Diagnosis	2A. It is recommended that health practitioners use an objective measurement tool for the diagnosis of Sarcopenia, utilising any of the published consensus definitions
	2B. DXA should be used to determine low lean mass when diagnosing sarcopenia
	2C. Walking speed or grip strength should be used to determine low levels of muscle strength and physical performance respectively when diagnosing sarcopenia
3. Physical Activity	3A. In patients with sarcopenia, prescription of resistance-based training may be effective to improve lean mass, strength and physical function
4. Protein	4A. We recommend clinicians consider protein supplementation/a protein-rich diet for older adults with sarcopenia
	4B. Clinicians may also consider discussing with patients the importance of adequate calorie and protein intake
	4C. Nutritional (protein) intervention should be combined with a physical activity intervention
5. Vitamin D	5A. Insufficient evidence exists to determine whether a Vitamin D supplementation regime by itself is effective in older adults with sarcopenia

J Nutr Health Aging. 2018;22(10):1148-1161.

Conclusions

- Diet directly influences osteoporosis, sarcopenia, and obesity through multiple mechanisms: providing anabolic stimuli, reducing inflammation, and supporting gut microbiota.
- Adequate protein intake, with attention to quality (rich in Leucine) and even distribution across meals, is crucial to overcome anabolic resistance and support both muscle and bone.
- Protein's effectiveness is enhanced by sufficient Vitamin D (800-1000 IU/day) and Calcium (1000-1200 mg/day)

Conclusions

- The MedDiet shows benefits for BMD, fracture risk, and physical performance
- Pro-inflammatory diets (e.g., high in processed foods) are detrimental, while diets rich in dairy and fruits and vegetables are associated with better outcomes.
- **Adopting a high-quality diet should be encouraged to preserve musculoskeletal health.**

A guide for healthy eating