

Calcium and Vitamin D Nutrition and Bone Disease in the Elderly: A Clinical Review

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Abstract

Vitamin D and calcium are vital nutrients required for maintaining bone health. Deficiency of either nutrient is prevalent among the elderly population and is a major contributor to osteoporosis, osteomalacia, and increased fracture risk. This review explores the physiological roles of calcium and vitamin D, evaluates evidence from key literature, and highlights current recommendations for their intake in the elderly to prevent bone-related diseases.

I. Introduction

Bone health deteriorates with aging due to hormonal changes, decreased dietary intake, and reduced physical activity. Vitamin D and calcium are central to maintaining skeletal integrity. Deficiencies in these nutrients are highly prevalent in older adults and contribute significantly to fractures and bone diseases. This review synthesizes key findings from existing literature, including studies by Chang et al. (2019), StatPearls (2025), and several clinical meta-analyses, to provide a clear understanding of the current evidence and recommendations.

Aging is associated with profound changes in bone metabolism. One of the most common consequences is osteoporosis, a condition characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility and increased fracture risk.

The elderly population is especially susceptible to this condition due to several interconnected factors such as Decline in calcium absorption, Reduced vitamin D synthesis in the skin with age, Decreased dietary intake of calcium-rich foods, Reduced mobility, limiting sunlight exposure, Co-existing medical conditions and medications that impair bone health.

Calcium and vitamin D are key nutrients involved in the maintenance of skeletal integrity. Adequate intake of both is essential to prevent bone demineralization, reduce the risk of osteoporosis, and minimize fracture risk, particularly in older adults.

Vitamin D is a fat-soluble nutrient essential for calcium homeostasis and bone metabolism. Deficiency of this beneficial substance can lead to nutritional rickets in children and osteomalacia in adults. In the 1930s, North America began fortifying milk with vitamin D to eradicate dietary rickets in children. The recommended daily intake for adults ranges from 400 to 800 international units (IU). However, subclinical vitamin D deficiency remains prevalent worldwide, affecting up to 1 billion people in both developed and developing countries. Subclinical vitamin D deficiency is linked to osteoporosis, increased risk of falls, and fragility fractures. Recent observational studies have shown a potential correlation between vitamin D deficiency and cancer, cardiovascular disease, diabetes, autoimmune diseases, and depression.

The optimal blood concentration of vitamin D remains controversial. According to the 2019 Endocrine Society guidelines, vitamin D sufficiency is defined as having a serum total 25-hydroxyvitamin D level greater than 30 ng/mL (50 nmol/L). Vitamin D insufficiency is defined as having a total 25-hydroxyvitamin D level between 12 and 30 ng/mL (30 to 77 nmol/L), while vitamin D deficiency is defined as having a level below 12 ng/mL (30 nmol/L).

II. Physiology and Function

Calcium forms the structural framework of bones and teeth. Vitamin D enhances intestinal calcium absorption and helps maintain serum calcium levels. Inadequate levels of vitamin D lead to poor calcium absorption, secondary hyperparathyroidism, and subsequent bone resorption.

The elderly are at greater risk due to:

- Reduced skin synthesis of vitamin D
- Limited outdoor activity

Poor dietary intake
Renal insufficiency and decreased hydroxylation of vitamin

III. Prevalence of Deficiency

Vitamin D deficiency affects over 1 billion people worldwide. Chang and Lee (2019) reported a high incidence of rickets among breastfed infants due to the low vitamin D content in breast milk. In older adults, subclinical vitamin D deficiency is common and often undetected until complications such as falls or fractures occur. Calcium intake is also inadequate in many elderly individuals, especially those with dietary restrictions.

IV. Health Implication

4.1 Bone Diseases

Osteomalacia: due to defective bone mineralization from vitamin D deficiency.

Osteoporosis: from long-term calcium and vitamin D deficiency, leading to low bone mineral density and increased fracture risk

Increased falls: Vitamin D supports muscle function; deficiency is linked with sarcopenia and balance impairment.

Calcium and Vitamin D Deficiency

Common in elderly individuals, especially those institutionalized or with limited outdoor exposure leads to:

- Secondary hyperparathyroidism
- Accelerated bone turnover
- Bone loss and osteopenia
- Increased risk of hip and vertebral fractures

Consequences of Deficiency:

- Osteomalacia (softening of bones)
- Osteoporosis
- Proximal muscle weakness
- Postural instability and increased falls
- Vertebral deformities and height loss
- Decreased quality of life and mobility.

4.2 Extra-skeletal Effects

Although still under investigation, vitamin D deficiency may also influence immunity, cardiovascular disease, and diabetes.

V. Recommendations and Guideline

Nutrient	Recommended Intake (≥50 years)	Notes
Calcium	1000–1200 mg/day	Prefer dietary sources over supplements
Vitamin D	800–1000 IU/day	Maintain serum 25(OH)D > 30 ng/mL
	Infants: 400 IU/day (AAP recommendation)	
	Severe deficiency: 50,000 IU/week for 6–8 weeks, followed by maintenance dose	
	Avoid large intermittent doses due to potential risk of falls	

VI. Clinical Evidence

Meta-analyses suggest a modest but consistent reduction in total and hip fracture risk (~8–23%) when calcium and vitamin D are used together. Vitamin D alone is less effective unless dosed adequately (>700 IU/day). High-dose intermittent therapy is associated with adverse outcomes such as increased fall risk.

VII. Monitoring and Management

- Routine testing of serum 25(OH)D is recommended for high-risk individuals
- Bone mineral density (BMD) testing helps identify those needing pharmacological intervention
- Diet and lifestyle modifications remain the first line of defense.

VIII. Lifestyle and Dietary Source

- **Calcium:** dairy products, leafy greens, fortified cereals
- **Vitamin D:** sunlight, fatty fish, fortified milk, supplements
- **Protein:** at least 1.0–1.2 g/kg/day is recommended to support musculoskeletal health

- Encourage weight-bearing exercises and fall prevention strategies.

IX. Conclusion

Calcium and vitamin D are essential components in the prevention and management of bone diseases in elderly populations. Adequate intake, routine monitoring, and lifestyle interventions can significantly reduce the incidence of fractures and improve quality of life. Healthcare providers should ensure that at-risk individuals are adequately screened and treated to prevent long-term complications.

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