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OSTEOPOROSIS 360

EMPOWERING TO COMBAT OSTEOPOROSIS

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DR. SUSHRUT BABHULKAR, PRESIDENT OSI TALKS ON THE NEED TO COME UNDER ONE ROOF CALLED THE OSI. THE NEED AND THE LARGER IMPACT OF THIS DISEASE CALLED OSTEOPOROSIS. SCAN THE QR CODE TO KNOW MORE.

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BEST PRACTICES IN OSTEOPOROSIS CARE AND FRAGILITY FRACTURE PREVENTION: A COMPREHENSIVE REVIEW

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Introduction

Osteoporosis and fragility fractures have emerged as significant global health concerns in recent years. India, with its large aging population, has the world's highest prevalence of osteopenia.[1] Out of the country's 1.3 billion people, approximately 230 million are aged 50 or older. Studies indicate that osteoporosis affects 8.5%–24.6% of Indian men over 50 and 8%–62% of women across different age groups.[2] Among India's 61 million osteoporosis patients, women account for 80%. Notably, osteoporosis tends to develop 10–20 years earlier in Indians compared to Western populations. Current estimates indicate that over 250,000 Indians experience hip fractures yearly, while more than 4.5 million women above 60 have spinal fractures.[2] It is crucial to address the underlying causes of poor bone health and overcome the challenges in managing osteoporosis.[1]

Definition and classification of osteoporosis

Conceptual definition (WHO)

Osteoporosis is a systemic skeletal disorder marked by low bone mass and deterioration of bone microarchitecture, leading to increased bone fragility and fracture risk.[3]

Diagnostic criteria (BMD-based)

Osteoporosis is diagnosed when the T-score (measured by dual-energy X-ray absorptiometry, dual-energy X-ray absorptiometry (DXA) at the femoral neck is ≤ -2.5 below the average bone mineral density (BMD) of a young, healthy adult reference population. This applies to postmenopausal women and men aged 50+.[4]

Fragility Fractures

Fragility fractures occur due to low-impact forces that would not typically cause a fracture in healthy bone.[4] Studies estimate that 50% of women and 20% of men will experience at least one such fracture in their lifetime.[5] The most common sites include the hip, spine, wrist, and humerus. A major risk factor is a prior fragility fracture, which significantly increases the likelihood of subsequent breaks. Additionally, certain medical conditions—such as diabetes, rheumatoid arthritis, chronic kidney disease, and endocrine disorders—can weaken bones. Long-term use of glucocorticoids also contributes to bone loss and fracture risk.[6]

Risk factors for osteoporosis in postmenopausal

Non-modifiable risk factors

- **Early menopause:** Indian women experience menopause early (average age 46 years), increasing osteoporosis risk.[2]
- **Genetic and ethnic factors:** Indian women generally have 5%–15% lower bone mineral density (BMD) than non-asian women, partly due to genetic variations in vitamin D receptor genes.[2]
- **Body frame and nutrition:** Smaller body frames, low calcium intake, and limited sunlight exposure (leading to vitamin d deficiency) are common in indian women.
- **Age and gender:** Osteoporosis prevalence rises significantly with age, affecting women more than men.

High risk of recurrent fractures

- The International Osteoporosis Foundation (IOF) reports that 50% of osteoporotic fracture patients will suffer another fracture.[7]
- Prior fractures, rheumatoid arthritis ($p<0.05$), and secondary osteoporosis ($p<0.05$) further increase recurrence risk.[8]

> "There is a need for early screening and preventive strategies in high-risk populations."

Modifiable risk factors

Nutritional factors in osteoporosis prevention and management

Nutrition plays a crucial modifiable role in bone health and osteoporosis prevention.[9] Key nutrients influencing bone metabolism include calcium, vitamin D, magnesium, zinc, and copper.

Calcium and vitamin D deficiency in India

- Typically Indian diets often to meet to the ICMR-recommended calcium intake for adults.[10]
- Vegetarian diets, low dairy consumption, and unequal food distribution (favoring men) exacerbate calcium deficiency, particularly in women.[2]
- High phytate-to-calcium ratios in Indian diets further impair calcium absorption ($p<0.0001$).[10,11]
- Low 25(OH)D levels worsen bone mineral homeostasis, increasing osteoporosis risk.

Magnesium's role in bone health

- Essential for osteoblast function and osteocalcin synthesis.[12]

Importance of zinc

- Zinc supports collagen synthesis and bone mineralization; deficiency correlates with lower BMD and higher fracture rates.[9]
- Studies confirm lower serum zinc and dietary intake in osteoporotic patients. Zinc supplementation improves femoral neck and lumbar spine BMD ($p<0.0001$).[13]

BMI, BMD, and T score

Body weight and bone health[2]

- Women weighing under 60 kg face significantly higher osteoporosis risk. Both lean mass and fat mass influence BMD.

Understanding T-scores[2]

- A T-score compares an individual's BMD to the average BMD of healthy young adults (aged 20–29).
- In India, the NHANES III Caucasian female database serves as the reference standard for T-score calculations.

BMI guidelines for fracture prevention

- The SIGN guidelines recommend maintaining a BMI of 20-25 kg/m² to reduce fracture risk.
- Adults over 50 with BMI <20 kg/m² should undergo fracture-risk assessment, especially if additional risk factors are present.[4]

Elevated homocysteine levels

Elevated homocysteine levels serve as a biomarker for osteoporosis risk related to micronutrient deficiencies. Research indicates that homocysteine, along with key vitamins involved in its metabolism (folic acid, vitamin B_6, and vitamin B_{12}), significantly influences bone metabolism, bone quality, and

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fracture susceptibility, particularly in older adults.[14] Elevated homocysteine levels increase the risk of fracture. A Mendelian randomization study found a causal association between genetically predicted serum homocysteine levels and reduced heel bone mineral density (H-BMD), with an odds ratio of 0.96 (p=0.011). Researchers reported a potential link between elevated homocysteine and site-specific bone loss.[15]

Other lifestyle factors

Other factors such as a sedentary lifestyle, decreased exposure to sunlight, and low physical activity, are detrimental to bone health.[2]

Quantifying the risk of fracture

Patients presenting with fragility fractures should be evaluated for potential underlying osteoporosis. In postmenopausal women, a height reduction exceeding 4 cm may indicate the presence of undiagnosed vertebral fractures.[2] The Indian Menopause Society recommends a case-finding approach for postmenopausal osteoporosis in India, combining clinical risk factor assessment with selective DXA testing, given the lack of validated population screening tools. For asymptomatic women, opportunistic screening is advised starting at age 40. Practical risk assessment tools like:[16]

- The Osteoporosis Self-Assessment Tool (OSTA), specifically validated for Asian populations
- The Simple Calculated Risk Estimation Score (SCORE)

FRAX

The Fracture Risk Assessment Tool (FRAX®) is a validated, web-based algorithm that calculates an individual's 10-year probability of sustaining major osteoporotic fractures (vertebral, hip, shoulder, or wrist).[2] It is usually used to identify patients in the osteopenia group most likely to benefit from treatment.[16]

DXA and BMD measurements

Dual-energy X-ray absorptiometry, or DXA, is commonly used to measure BMD to identify individuals at risk of developing future fractures so that preventative strategies can be employed. Indications for BMD testing include:[17]

- All women 65 years of age or older
- All postmenopausal women
  - » With a history of fracture without major trauma and osteopenia identified radiographically
  - » Use of systemic glucocorticoid therapy (≥3 months)
- Other perimenopausal or postmenopausal women with risk factors for osteoporosis if willing to consider pharmacologic interventions
  - » Low body weight (<127 lb or body mass index <20 kg/m^2)
  - » Early menopause
- Secondary osteoporosis

Quantitative ultrasound

Quantitative ultrasound (QUS) is not suitable for diagnosing osteoporosis because it measures different bone parameters than DXA. However, calcaneal QUS serves as a practical tool for early detection and pre-screening, helping to identify high-risk individuals. By distinguishing patients at very low risk, it can reduce unnecessary DXA referrals.[18]

Biochemical investigations and bone turnover markers

- Prior to starting pharmacologic treatment for osteoporosis, it is recommended to obtain baseline laboratory tests including serum calcium, phosphorus, total alkaline phosphatase, creatinine, 25-hydroxyvitamin D, and intact parathyroid hormone (iPTH) levels.[2]
- Bone turnover markers (BTMs) serve as valuable tools for initial assessment and for monitoring treatment adherence and effectiveness. These markers help differentiate between rapid and slow bone loss during menopausal transition, supporting clinical decision-making in osteoporosis management.[16]

Management: Targeting treatment based on fracture risk, vertebral and hip fractures

The initiation of anti-osteoporotic therapy should be guided by clinical risk assessment tools and diagnostic imaging results. Table 1 outlines the principal indications for osteoporosis treatment.[2]

Table 1. Indications for initiating anti-osteoporotic therapy

Vertebral or non-vertebral fractures:

- Presence of any vertebral fracture (either clinically symptomatic or detected through imaging)
- History of non-vertebral fragility fractures (hip, wrist, or humerus)
- DXA-Confirmed Osteoporosis:
- For patients aged >50 years with femoral neck, total hip, or lumbar spine T-score ≤-2.5 on DXA scan

Osteopenia with elevated fracture risk:

- Patients with osteopenia (T-score between -1.0 and -2.5 at femoral neck or lumbar spine) and presence of clinical risk factors or FRAX-calculated 10-year risk:
- Hip fracture ≥3.5% OR
- Major osteoporotic fracture ≥10.5%
- Special consideration for diabetes:
- Treatment threshold should be adjusted to femoral neck, total hip, or lumbar spine T-score ≤ -2.0 on DXA scan

Management of osteoporosis in postmenopausal women

The primary goal in managing postmenopausal osteoporosis is fragility fracture prevention through combined pharmacological and non-pharmacological approaches.[5] Key recommendations from the Endocrine Society 2020 guidelines include:[19]

- Prioritize treatment for postmenopausal women with high fracture risk (especially those with recent fragility fractures).
- Lifestyle and nutritional measure for bone health in all post-menopausal women, especially calcium and vitamin D supplements.
- Fracture risk assessment: Calculate 10-year probability using country-validated risk tools (e.g., regionally adapted FRAX)

Vitamin D, Calcium, magnesium, vitamin K, and other minerals in bone health

Calcium

The American Association of Clinical Endocrinologists (AACE) recommends a total daily calcium intake of 1,200 mg (combining dietary sources and supplements if needed) for adults aged ≥50 years as part of comprehensive bone health maintenance. Adequate calcium consumption remains essential for skeletal integrity across all life stages.[17] Major professional societies (AACE, NOF, NAM [formerly IOM], and the Endocrine Society) uniformly recommend a total daily calcium intake of 1,200 mg from combined dietary and supplemental sources for women aged ≥51 year.[17]

Vitamin D

Vitamin D plays a major role in calcium absorption and bone health and may be important in muscle performance, balance, and risk of falling. vitamin D status has been shown to increase response to bisphosphonate therapy, increase BMD, and prevent fractures.[17]

In this double-blind, RCT, monthly high-dose vitamin D3 supplementation (60,000 IU) was administered to adults for up to 5 years. While the study found no significant reduction in fracture risk overall, the hazard ratio (HR) for total fractures showed a declining trend with longer follow-up. Specifically, the HRs were 0.96 (95% CI 0.85–1.08) for non-vertebral fractures, 1.00 (0.85–1.18) for major osteoporotic fractures, and 1.11 (0.86–1.45) for hip fractures. These results suggest that long-term vitamin D supplementation may potentially reduce total fractures over time, though further research is needed to confirm this effect.[20]

In a meta-analysis of four RCT (n=1136 patients) evaluated the efficacy of vitamin D supplementation in knee osteoarthritis progression. Pooled results demonstrated that vitamin D significantly improved WOMAC pain (WMD: -1.24, 95% CI: -2.41 to -0.07) and function scores (WMD: -3.56, 95% CI: -6.12 to -1.00). Subgroup analysis revealed that daily doses exceeding 2000 IU provided the most robust pain and functional benefits. Safety profiles were comparable to placebo, with no increased adverse events (RR: 1.05, 95% CI: 0.91–1.21).[21]

Magnesium and vitamin K

A systematic review and meta-analysis in older adults that elevated magnesium intake reported that it significantly improved BMD at the hip and femoral neck. The analysis revealed a statistically significant positive association between magnesium consumption and hip BMD (pooled $\beta = 0.03$, 95% CI 0.01-0.06, $p < 0.05$).[22]

The Indian Menopause Society's Guideline on Postmenopausal Osteoporosis recommends a daily Vitamin K2–7 intake of 180–350 μg, to be combined with adequate calcium, magnesium, vitamin D, and a balanced diet for postmenopausal women.[16] Individual clinicians can decide on supplementing Vitamin A, Vitamin B12, and phytoestrogens for postmenopausal women.[16]

Importance of physical activity and exercise

Lack of physical activity is associated with reduced bone mass whereas exercise involving bone loading promotes an increase in bone mass.[4]

- Adequate physical activity is required to maintain bone health; brisk walking 4-5 times a week for 30 min, appropriate resistance, weight-bearing aerobics, and core-stabilizing exercisers.[22]
- In early postmenopausal women, strength training leads to small yet significant changes in BMD.[16]

Prevention of falls

To prevent falls, patients should consistently wear low-heeled, rubber-soled shoes for stability, avoid slippery surfaces, use stair handrails, maintain proper lighting throughout living spaces, secure loose rugs, and install bathroom grab bars.[2]

Conclusion

Osteoporosis and fragility fractures present a major healthcare challenge worldwide and in India. The diagnosis and treatment of osteoporosis in India face distinct difficulties owing to the sizable aging population and widespread osteopenia. Importantly, osteoporosis develops at a younger age in Indians, highlighting the necessity for earlier detection efforts.

Optimal care should emphasize fracture risk evaluation and prevention using combined drug and lifestyle approaches. Dietary improvements - particularly calcium, vitamin D, magnesium and zinc supplementation - can complement treatment, especially for men and postmenopausal women with reduced bone density and elevated fracture probability.

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EXPERT OPINION

Modern strategies for osteoporotic fracture fixation and recovery

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Introduction

Fracture healing demands immobilization, achieved either conservatively (casts/orthoses) or surgically (implants like plates, screws, or nails). Osteoporotic fractures, however, present unique challenges:[1]

Complex fracture patterns: Low bone density and brittleness lead to comminuted fractures, necessitating advanced surgical skills and robust implants for stable fixation.

Elderly vulnerability: Older patients often struggle with limited mobility, impaired balance, and comorbidities, increasing fall risks and complicating postoperative weight-bearing restrictions. Fixation must tolerate immediate full loading.

Biological limitations: Osteoporotic bone's porous structure and thin cortex reduce implant anchorage, raising risks of loosening, cut-out, and peri-implant fractures.

Comorbidity burden: Age-related organ decline demands minimally invasive, rapid surgeries to avoid complications, requiring implants that enable early mobilization.

This review explores contemporary fixation strategies for osteoporosis-related fractures—particularly with regard to various techniques.

Principles of fracture fixation[2]

Key determinants of successful surgical management for osteoporotic fractures

Optimal outcomes in osteoporotic fracture repair depend on four critical considerations:

- Patient Factors - Physiological status, functional capacity, comorbidities, and medications significantly impact healing potential and implant selection.
- Fracture Characteristics - Metaphyseal comminution, unstable patterns, and compromised epiphyseal segments present particular fixation challenges.
- Soft Tissue Preservation - Maintaining viable surrounding tissue is essential for creating a conducive healing microenvironment.
- Biomechanical Principles - Osteoporotic bone's diminished screw purchase and increased risk of early fixation failure demand specialized implant strategies.
- The interplay of these factors dictates surgical approach selection and ultimately determines treatment success. Particular attention must be paid to the compromised holding strength of osteoporotic bone and its propensity for fixation failure under physiological loads.

Considerations for fixation techniques[2-5]

Key considerations for plate fixation in osteoporotic bone

- In osteoporotic bone, fixation failure typically occurs due to bone compromise rather than implant failure, highlighting the importance of bone quality in surgical outcomes.
- The aging process and osteoporosis significantly reduce screw anchorage, with cadaveric studies showing a 50% decrease in holding power for every 1 mm reduction in cortical thickness.
- Traditional plating systems rely on bone-plate friction for stability, creating concentrated stress points that predispose to screw pull-out under cyclic loading conditions.
- Modern locking plate technology achieves stability through screw-plate interface fixation, demonstrating:
  - » Reduced micromotion at the screw-bone junction
  - » Decreased risk of cut-out during repetitive loading
  - » Superior performance in low-density bone

While locking plates provide excellent stability, surgeons must balance:

- » The risk of excessive stiffness leading to non-union
- » The need for strategic gap management in comminuted fractures
- » The benefits of longer plate constructs with distributed screw placement

Recent innovations address the stiffness challenge through:

Far cortical locking:

- » Utilizes reduced-diameter screws for flexible fixation
- » Potential trade-off in fatigue resistance

Near cortical slots:

- » Requires proximal cortex over-drilling
- » Maintains standard locking screw diameter

These advanced techniques show promising biomechanical results but require further clinical validation to establish their role in routine practice.

Intramedullary nailing[2-4]

Intramedullary nails excel in load sharing between implant and bone, offering superior bending resistance. This mechanical advantage enables earlier weight-bearing in osteoporotic fractures while minimizing soft tissue disruption. The fixation's most vulnerable area occurs at metaphyseal interlocking sites, where expanded medullary dimensions and compromised bone quality significantly diminish screw-nail stability.

Originally optimized for diaphyseal fractures, traditional nails demonstrated limitations in osteoporotic metaphyseal regions, frequently resulting in fixation failure and rotational malalignment when dealing with small articular fragments.

Contemporary systems incorporate multiplanar interlocking options and helical blade technologies, enhancing stability through expanded load distribution and decreased construct stress, thereby improving overall fixation rigidity. Fixed-angle locking mechanisms substantially improve fixation integrity by minimizing screw movement within the nail during functional loading.

Augmentation techniques[2-4]

- Polymethylmethacrylate (PMMA), originally developed for dental and ophthalmic applications, has become a standard bone cement in orthopedics for fracture fixation and prosthetic stabilization.
- Clinical evidence supports PMMA's effectiveness in augmenting fractures of the hip, proximal humerus, and proximal tibia, where it substantially decreases failure rates in unstable hip fractures.
- The proximal humerus presents unique fixation challenges due to its frequently compromised bone density, prompting the use of calcium phosphate cements to improve implant stability in this region.
- Modern orthopedic devices including cannulated screw systems and angle-stable plating now allow direct PMMA application during surgery, enhancing fixation in osteoporotic bone.
- While conventional treatment of osteoporotic tibial plateau fractures involves bone grafting for subchondral defects, this approach sometimes provides inadequate structural support during the healing phase.
- Recent innovations in bone substitute materials demonstrate superior performance in maintaining fracture reduction in low-density bone, with positive results in both laboratory and clinical evaluations.

Allograft augmentation[3]

- Modern locked plating systems have largely superseded cortical strut allografts as the preferred treatment for periprosthetic femoral fractures in osteoporotic patients.
- There is growing clinical adoption of fresh frozen allografts for managing fractures of the proximal humerus and humeral shaft.
- Fibular strut augmentation demonstrates comparable efficacy across age groups in proximal humerus fractures by maintaining medial support and minimizing varus deformity.
- While some surgeons employ humeral shortening techniques, fibular strut augmentation continues to provide reliable stabilization in proximal humerus fractures.
- Fibular strut application is expanding to humeral shaft fracture fixation, especially in complex revision and nonunion cases, despite limited large-scale clinical data supporting this approach.

Primary arthroplasty[3,4]

- Elderly patients with intra-articular fractures face considerable treatment difficulties because of compromised subchondral bone structure and damaged joint surfaces, which hinder proper alignment and stabilization.
- Initial joint replacement has become standard treatment for specific fracture types prone to bone death, including femoral neck and proximal humerus fractures, facilitating quicker rehabilitation and load-bearing.
- When performing hip replacement for fresh acetabular fractures, surgeons typically employ a posterior surgical method with posterior column stabilization, adding an anterior approach when needed; while function and satisfaction rates are positive, implant durability remains shorter than with non-surgical approaches.
- Surgeons are more frequently choosing direct total knee replacement for severe tibial plateau fractures in older patients, permitting immediate weight-bearing through specialized knee implants.
- For older individuals with existing rotator cuff damage, inverted partial shoulder replacement can produce satisfactory functional recovery.

Post-operative management of patients

Good daily life management is beneficial in the prevention and treatment of osteoporosis

The following recommendations represent an evidence-based summary of daily life management strategies for postoperative patients with osteoporotic fractures, aimed at enhancing recovery and promoting overall bone health.[5]

- Diet: Eat >12 different foods daily and >25 weekly, and. Drink 1500–1700 ml of water daily.
- Sugar/Salt: Limit sugar to <25 g/day. Reduce smoked/cured meats and keep sodium ≤6 g/day (adults) or ≤5 g/day (elderly).
- Calcium: Consume ≥1000 mg/day if over 50 or postmenopausal; ≥1200 mg/day if over 70, with a max of 2000 mg/day.
- Vitamin D: Supplement with 800–1200 IU/day, max 4000 IU/day.
- Lifestyle: Stop smoking, limit alcohol, coffee, and carbonated drinks. Avoid high alcohol consumption (>50 g/day). Get sunlight exposure twice a week (15–30 minutes each time). Maintain a healthy weight and monitor height.
- Monitoring: Check serum and urinary calcium levels regularly; perform spinal imaging if height decreases by >2 cm.

Nutritional deficiency can contribute to decreased bone mineral density, development of osteoporosis, and heightened fracture susceptibility. To address these potential shortfalls, dietary supplementation with key micronutrients - particularly calcium, vitamin D, magnesium, and zinc - often becomes essential.[6]

Fall prevention to avoid subsequent fractures

Effective fall prevention is critical for patients recovering from osteoporotic fractures, as it significantly lowers the risk of recurrent injuries. A comprehensive, evidence-based approach should include:[5]

Routine fall risk assessments

- All patients aged 50+ should undergo regular evaluations of gait, balance, medication use, and home hazards to identify potential risks.

Long-term monitoring & follow-up

- Patients with prior fractures should receive at least 2 years of tailored follow-up care, including periodic reassessments of fall risk and bone health.

Conclusion

Surgical approaches and implants should be tailored to individual patient characteristics, including physiological status, baseline functional capacity, concurrent medical conditions, and medications that may impact bone repair. Postoperative care must incorporate systematic monitoring and adherence-enhancing interventions to maximize rehabilitation outcomes and minimize future fracture risk in osteoporotic patients.

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OSTEO CROSSTALK

Osteopenia/osteoporosis and sarcopenia: An emerging global health burden

Introduction

Osteosarcopenia, the concurrent deterioration of bone and muscle tissue, represents a significant age-related condition with strong interconnections between its components.[1] A study of 590 Finnish postmenopausal women revealed those with sarcopenia had a 12.9-fold increased risk of osteoporosis compared to those without muscle loss.[2] Similar findings emerged from the Sarcophage Cohort, where sarcopenic individuals showed a five-fold greater osteoporosis risk (95% CI 1.16–19.41).[3] Recent investigations using updated diagnostic criteria (n=3,334 older adults) found that probable and confirmed sarcopenia cases exhibited significantly lower bone mineral density and poorer bone architecture across multiple skeletal sites. This robust evidence supports the concept of osteosarcopenia as a distinct clinical entity characterized by the synergistic decline of musculoskeletal integrity.[4]

Prevalence of osteosarcopenia

Age-related increase

- Men: 14.3% (60-64y) → 59.4% (≥75y)
- Women: 20.3% (60-64y) → 48.3% (≥75y)

Gender disparity

- Women affected more (25.5-82.6%) than men (16.4-32.0%)

High-risk groups

- Minimal-trauma fractures: ~46%
- Post-hip fractures: 17.1-96.3%

Clinical significance

- Hallmark of aging & multimorbidity

Mechanisms linking osteopenia and osteoporosis to sarcopenia

The association between osteopenia and osteoporosis with sarcopenia, can be explained through several mechanisms.

First, the "mechanostat theory" suggests that mechanical stimulation from muscles influences bone formation and remodeling. According to this theory, muscles are a key anabolic regulator of bone tissue. However, the exact mechanisms remain unclear, and further research is needed.[5]

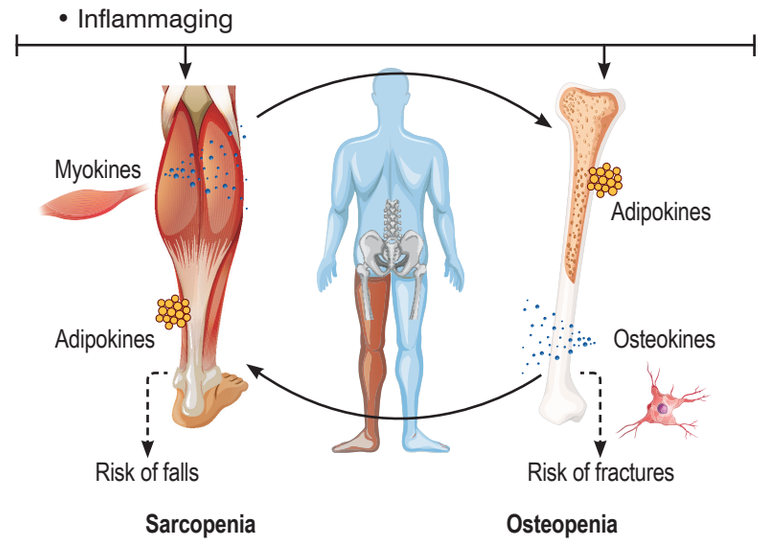
Second, muscle-derived factors play a crucial role in bone metabolism. Muscles secrete insulin-like growth factor-1 (IGF-1) and fibroblast growth factor-2 (FGF-2), which promote bone formation. Conversely, myostatin and pro-inflammatory cytokines contribute to bone resorption. An imbalance between these factors may disrupt bone-muscle homeostasis, leading to deterioration in both tissues.

Third, vitamin D is essential for both bone and muscle metabolism. It binds to muscle cells, enhancing protein synthesis and facilitating calcium transport across cell membranes, thereby supporting musculoskeletal health.[5]

Pathology of osteosarcopenia

The pathophysiological mechanisms underlying osteosarcopenia are still being elucidated, but current evidence suggests that multiple catabolic factors associated with immunosenescence contribute bidirectionally to both bone and muscle deterioration. Emerging research indicates that age-related immune system dysfunction creates a pro-inflammatory milieu that simultaneously drives osteoporotic changes in bone and sarcopenic changes in muscle tissue, Figure 1.[6]

Figure. 1 Risk factors, muscle–bone crosstalk (myokines, osteokines, adipokines), and the pathophysiology of osteosarcopenia[6]



Osteoporosis/osteosarcopenia screening and assessment

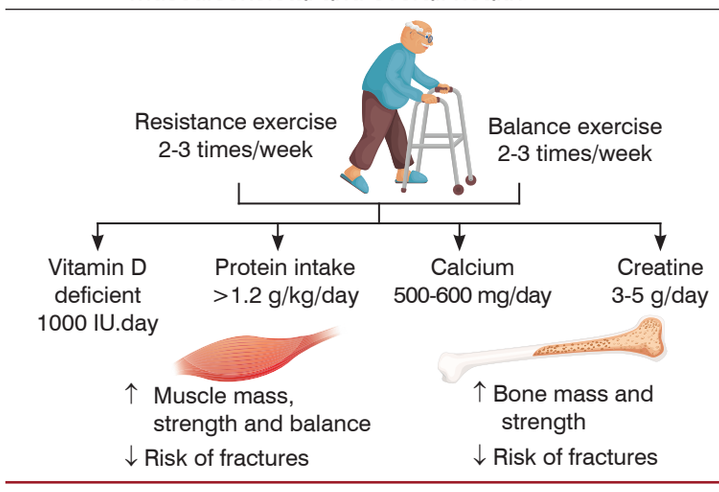
Current guidelines strongly advocate for proactive screening of both osteoporosis/osteopenia and sarcopenia in older adults. Given their frequent co-occurrence, the diagnosis of either condition should automatically trigger evaluation for osteosarcopenia.[7] A thorough diagnostic workup for osteosarcopenia should include:[6]

- Detailed history-taking: Medical, social, falls, fracture, etc
- Risk factor analysis: Contributors to musculoskeletal decline
- Physical examination: Assess muscle strength, function, and bone health indicators
- Targeted investigations: Utilizing diagnostic tools

Treatment approach: Physical training combined with proper nutrition

Progressive resistance exercise effectively promotes bone formation (osteoblastogenesis) and muscle protein synthesis, enhancing bone density, muscle mass, strength, and mobility in older adults with osteoporosis or sarcopenia. Beyond musculoskeletal benefits, resistance training also improves cardiovascular and cognitive function.[8] Researchers recommend exercise modality to prevent and manage osteosarcopenia and other age-related chronic conditions. Additionally, balance exercises and adequate nutrition are essential to optimize outcomes and reduce fall risk in this population (Figure 2).

Figure. 2 Integrated benefits of resistance training for musculoskeletal and overall health



Calcium's role in bone and muscle health

Calcium is the primary mineral in bone, while evidence on calcium's direct impact on fracture prevention remains inconclusive, current guidelines recommend a daily intake of 1000–1300 mg. If dietary sources are insufficient, supplementation may be necessary to meet these requirements.[9]

Role of vitamin D

Aging decreases the capacity of human skin to produce vitamin D. Vitamin D deficiency often occurs and it is associated with sarcopenia, bone loss, and disability. A nutritional intervention of vitamin D and amino acid supplementation could be a strategy to support muscle protein availability and synthesis in sarcopenia condition.[10] The European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO) recommends postmenopausal women maintain musculoskeletal health through: 800 IU daily vitamin D (serum >50 nmol/L), 1000 mg calcium, adequate high-quality protein (especially post-exercise), combined with 3–5 weekly exercise sessions. This combined nutritional-exercise approach helps prevent age-related bone and muscle deterioration.[11]

Role of soy isoflavones

In a 6-month randomized trial, researchers assessed the bone-sparing effects of higher-dose soy isoflavones (84 mg/day and 126 mg/day) in 90 early postmenopausal women (aged 45–60) with climacteric symptoms. Results showed a significant dose-dependent attenuation of bone loss at both the lumbar spine (p=0.042) and femoral neck (p=0.016), with greater BMD preservation at higher doses. The protective effect appeared mediated through reduced bone resorption (p=0.014), though no significant changes in bone formation markers (osteocalcin, BAP) were observed. The findings suggest that higher isoflavone doses may help preserve BMD in symptomatic, non-obese postmenopausal women, likely by suppressing bone turnover, particularly resorption.[12]

Summary

The concurrent sarcopenia and osteoporosis—has emerged as a critical focus in aging research. A combination of sedentary lifestyles, obesity, and poor nutrition interacts with genetic, mechanical, and hormonal factors to accelerate musculoskeletal deterioration. Current evidence supports combined resistance and balance training, along with targeted nutritional supplementation (vitamin D, calcium, etc) for deficient individuals, as an effective strategy to mitigate osteosarcopenia. Advancing research in this field is essential to develop translational diagnostic and treatment approaches, helping to address the rising global burden of osteosarcopenia in aging populations.

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