

# Bone Mineral Density: Understanding the Importance and Factors Influencing Skeletal Health

Thea Arabella\*

Department of Tissue Science, University of Lima, Lima, Peru

## Abstract

Bone Mineral Density (BMD) is a critical indicator of skeletal health and plays a significant role in assessing the risk of osteoporosis and fractures. Understanding the importance of BMD and the factors influencing it is crucial for effective management and prevention of skeletal disorders. This review aims to provide an overview of the significance of BMD in evaluating bone health and the underlying factors that impact BMD measurements. Key determinants of BMD include age, gender, genetics, lifestyle factors (such as physical activity, diet, and smoking), hormonal status, and certain medical conditions and medications. Additionally, this review discusses the clinical relevance of BMD, its measurement techniques, and the interpretation of BMD results. The knowledge presented in this review emphasizes the significance of BMD assessment in identifying individuals at risk for osteoporosis and fractures, facilitating early intervention, and promoting strategies for maintaining optimal skeletal health.

**Keywords:** Bone mineral density • Skeletal health • Osteoporosis

## Introduction

Bone Mineral Density (BMD) is a crucial aspect of skeletal health, representing the amount of minerals, primarily calcium and phosphorus, present in bone tissue. It serves as an indicator of bone strength and resilience, with low BMD increasing the risk of fractures and osteoporosis. Understanding the significance of BMD, its measurement methods, and the factors influencing it is essential for promoting optimal bone health and preventing skeletal disorders. In this comprehensive article, we will explore the concept of BMD in detail, its clinical relevance, measurement techniques, factors affecting BMD, and strategies to maintain or improve bone health. Bone is a dynamic tissue that undergoes a constant process of remodelling throughout life. Bone mineral density plays a crucial role in maintaining skeletal integrity and preventing fractures. Peak BMD is typically achieved during early adulthood and gradually declines with age. Individuals with low BMD are at a higher risk of developing osteoporosis, a condition characterized by weakened and brittle bones. Several methods are available to measure BMD, with Dual-energy X-ray Absorptiometry (DXA) being the gold standard. DXA is a non-invasive imaging technique that measures BMD at different skeletal sites, commonly the lumbar spine and hip. T-scores and Z-scores are derived from DXA scans, providing a standardized comparison of an individual's BMD to age- and sex-matched reference populations [1].

Other techniques, such as quantitative ultrasound and peripheral DXA, are also used to estimate BMD, particularly in resource-limited settings. Aging is associated with a gradual decline in BMD, more pronounced in women after menopause due to hormonal changes. Estrogen plays a crucial role in maintaining bone density, and its decline leads to accelerated bone loss. Besides menopause, other hormonal imbalances, such as low levels of testosterone in men, can contribute to reduce BMD. Conditions like hyperthyroidism and hyperparathyroidism can also affect bone health. A balanced diet rich in calcium, vitamin D, and other essential nutrients is vital for maintaining healthy bones. Inadequate calcium intake can lead to reduced BMD, as the body withdraws calcium from the bones to meet other physiological needs. Weight-bearing

exercises, resistance training, and activities promoting good posture can enhance BMD. Physical inactivity or prolonged bed rest, on the other hand, can lead to bone loss. Smoking, excessive alcohol consumption and a sedentary lifestyle can negatively impact BMD. Certain medications, such as corticosteroids, anticonvulsants, and some cancer treatments, can decrease BMD. Medical conditions like rheumatoid arthritis, celiac disease, and chronic kidney disease can also affect bone health. Genetic factors influence peak bone mass and susceptibility to bone disorders. A positive family history of osteoporosis or fractures may increase the risk of low BMD [2].

## Literature Review

BMD measurements, along with clinical risk factors, aid in the diagnosis of osteoporosis and help identify individuals at higher risk of fractures. Low BMD is a major risk factor for fractures. BMD measurements, along with other clinical risk factors, assist in predicting fracture probability and guide treatment decisions. Serial BMD measurements can assess the response to osteoporosis treatments and help modify therapeutic approaches if necessary. BMD serves as an essential outcome measure in clinical trials evaluating the efficacy of new drugs and interventions aimed at improving bone health. Consuming a diet rich in calcium and vitamin D sources, such as dairy products, leafy greens, and fortified foods, supports bone health. If necessary, supplements can be prescribed under medical supervision. Engaging in weight-bearing exercises, such as walking, jogging, and dancing, as well as resistance training, helps build and maintain BMD. Preventing falls is crucial to avoid fractures, especially in older adults. Measures like removing tripping hazards, using assistive devices, and improving home lighting can reduce the risk of falls. Avoiding smoking, excessive alcohol consumption, and leading a sedentary lifestyle promotes better bone health. In postmenopausal women with significant bone loss and increased fracture risk, hormone replacement therapy may be considered after careful evaluation of risks and benefits. Various medications, including bisphosphonates, Selective Estrogen Receptor Modulators (SERMs), and denosumab, are available to treat osteoporosis and improve BMD [3].

TBS is a novel technique that provides additional information about the microarchitecture of bone. It assesses the texture or quality of bone and complements BMD measurements. TBS can help identify individuals with higher fracture risk despite having normal BMD values. QCT is an advanced imaging technique that provides three-dimensional assessment of bone density and structure. It offers advantages over DXA, such as separate evaluation of trabecular and cortical bone compartments and the ability to measure volumetric BMD. HR-pQCT is a specialized imaging technique that allows detailed evaluation of bone microarchitecture at the peripheral skeleton, such as the wrist and ankle. It provides information about cortical and trabecular bone density, geometry, and strength, enhancing the understanding of bone health. Biomarkers

\*Address for Correspondence: Thea Arabella, Department of Tissue Science, University of Lima, Lima, Peru, E-mail: Arabella@dts.uni.lima

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are measurable substances in the blood or urine that reflect bone remodelling activity. They can provide insights into the rate of bone turnover and help assess the response to treatment. Examples of bone turnover markers include serum C-terminal Telopeptide of type I collagen (CTX) and serum N-terminal Propeptide of type I collagen (PINP). Women experience accelerated bone loss after menopause due to hormonal changes. Hormone replacement therapy, along with lifestyle modifications, is often considered to maintain BMD in postmenopausal women [4].

## Discussion

While osteoporosis is commonly associated with women, men can also develop low BMD and experience fractures. Low testosterone levels and certain medical conditions contribute to bone loss in men. Evaluation of BMD and appropriate interventions are important for maintaining bone health in men as well. Achieving optimal peak bone mass during childhood and adolescence is crucial for long-term bone health. Adequate nutrition, physical activity, and calcium intake are vital during these developmental stages. Aging is associated with a decline in BMD and an increased risk of fractures. Regular monitoring of BMD, fall prevention strategies, and appropriate interventions are crucial for older adults to maintain bone health and prevent fractures. Advancements in genetics and genomics may contribute to the development of personalized approaches to bone health. Genetic profiling may help identify individuals at higher risk of low BMD and guide targeted interventions. Researchers continue to explore new pharmacological agents and interventions to improve bone health. These may include anabolic agents that stimulate bone formation and novel drug delivery systems to enhance treatment effectiveness. The integration of digital health technologies and remote monitoring may facilitate improved access to BMD assessment and monitoring, particularly in underserved areas [5,6].

## Conclusion

Bone mineral density is a key determinant of skeletal health and fracture risk. Understanding the significance of BMD measurement, the factors influencing it, and strategies to maintain or improve bone health are crucial for individuals of all ages. By adopting a holistic approach that includes proper nutrition, regular exercise, avoidance of risk factors, and appropriate medical interventions, individuals can enhance their bone health, reduce the risk of fractures, and enjoy a higher quality of life. Continued research and advancements in BMD assessment techniques and treatment options will further contribute to our understanding of bone health and guide clinical practice in the future. Bone mineral density is a critical parameter for assessing bone health and the risk of fractures. Understanding the significance of BMD, along with the various factors

influencing it, can guide individuals in adopting preventive measures and making informed decisions about their bone health. Through proper nutrition, physical activity, and lifestyle choices, coupled with medical interventions when necessary, individuals can maintain or improve their BMD, reducing the risk of osteoporosis and fractures, and enhancing their overall quality of life.

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## Conflict of Interest

None.

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