

# THE COURSE OF OSTEOPOROSIS IN OVERWEIGHT MEN WITH TYPE 2 DIABETES AND ITS PREVENTION

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**Annotation:** This article analyzes the progression of osteoporosis in overweight men with type 2 diabetes mellitus and evaluates preventive strategies. It examines metabolic, hormonal, and lifestyle factors influencing bone density reduction. The study highlights the importance of early diagnosis, lifestyle modification, and clinical interventions to reduce fracture risk and improve patient outcomes.

**Keywords:** Type 2 diabetes, osteoporosis, overweight, bone density, prevention

Osteoporosis is a systemic skeletal disorder characterized by decreased bone mass and deterioration of bone microarchitecture, leading to increased fragility and fracture risk. In recent years, growing attention has been given to the relationship between osteoporosis and metabolic disorders, particularly type 2 diabetes mellitus (T2DM). Overweight men with T2DM represent a specific risk group in which multiple metabolic and hormonal factors interact, accelerating bone loss and increasing susceptibility to fractures. Type 2 diabetes is a chronic metabolic disease characterized by insulin resistance and relative insulin deficiency. Although patients with T2DM often present with normal or even increased bone mineral density in some cases, their fracture risk remains paradoxically high. This phenomenon is explained by impaired bone quality, altered collagen structure, and accumulation of advanced glycation end-products (AGEs), which negatively affect bone strength. Overweight and obesity further complicate this condition. Excess adipose tissue influences bone metabolism through the secretion of adipokines and inflammatory cytokines. Chronic low-grade inflammation contributes to increased bone resorption and decreased bone formation. Additionally, reduced physical activity in overweight individuals leads to mechanical unloading of the skeleton, further promoting bone loss. In men, osteoporosis is often underdiagnosed

compared to women, despite its significant clinical consequences. Male patients with T2DM are at higher risk due to combined effects of hyperglycemia, insulin resistance, and hormonal imbalances, including reduced testosterone levels. These factors collectively impair osteoblast function and promote osteoclast activity, resulting in progressive bone deterioration. The clinical importance of studying osteoporosis in this population lies in its asymptomatic nature during early stages. Many patients remain undiagnosed until a low-energy fracture occurs, commonly affecting the hip, spine, or wrist. Such fractures significantly reduce quality of life, increase disability, and impose a heavy burden on healthcare systems. Therefore, understanding the mechanisms of osteoporosis progression in overweight men with type 2 diabetes is essential for developing effective preventive strategies. Early identification of risk factors, regular screening of bone mineral density, and implementation of lifestyle modifications are key components of disease management.

The development of osteoporosis in overweight men with type 2 diabetes is a multifactorial process involving metabolic, hormonal, and lifestyle-related mechanisms. One of the primary pathological mechanisms is chronic hyperglycemia, which leads to the formation of advanced glycation end-products (AGEs). These compounds accumulate in bone collagen, reducing bone elasticity and increasing brittleness. Insulin plays an important anabolic role in bone metabolism by stimulating osteoblast activity. In type 2 diabetes, insulin resistance reduces this effect, leading to decreased bone formation. At the same time, increased osteoclast activity enhances bone resorption, creating an imbalance in bone remodeling. Vitamin D deficiency is another significant factor contributing to osteoporosis in diabetic patients. Overweight individuals often have reduced bioavailability of vitamin D due to its sequestration in adipose tissue. This deficiency impairs calcium absorption and negatively affects bone mineralization. Hormonal changes also play a crucial role. In men, decreased testosterone levels are commonly observed in type 2 diabetes and obesity. Testosterone is essential for maintaining bone mass, and its deficiency leads to accelerated bone loss.

Additionally, increased levels of inflammatory cytokines such as TNF- $\alpha$  and IL-6 promote osteoclast activation. Lifestyle factors further contribute to disease progression. Physical inactivity, poor dietary habits, smoking, and excessive alcohol consumption significantly increase osteoporosis risk. Sedentary behavior reduces mechanical stress on bones, which is essential for maintaining bone strength. Genetic predisposition may also influence susceptibility to osteoporosis in diabetic patients. Certain genetic variations affect bone density, insulin sensitivity, and inflammatory response, making some individuals more vulnerable than others. In clinical practice, the coexistence of obesity and type 2 diabetes creates a complex metabolic environment that accelerates skeletal deterioration. Therefore, early identification of these risk factors is essential for timely intervention and prevention of complications.

Osteoporosis in overweight men with type 2 diabetes is often clinically silent in its early stages. Patients usually do not experience symptoms until significant bone loss has occurred or a fracture develops. This asymptomatic nature makes early diagnosis challenging and emphasizes the importance of screening in high-risk groups. The most common clinical manifestation is fragility fractures, which occur after minimal trauma. Typical sites include the vertebral bodies, hip, and distal radius. Vertebral fractures may present with chronic back pain, reduced height, and spinal deformities such as kyphosis. In diabetic patients, the risk of falls is also increased due to peripheral neuropathy, visual impairment, and hypoglycemic episodes, further contributing to fracture risk. Bone mineral density (BMD) assessment using dual-energy X-ray absorptiometry (DEXA) is the gold standard for diagnosing osteoporosis. However, in type 2 diabetes patients, BMD may not fully reflect fracture risk due to altered bone quality. Therefore, additional diagnostic tools are required. Laboratory investigations include serum calcium, phosphate, vitamin D levels, and bone turnover markers such as osteocalcin and C-terminal telopeptide (CTX). These markers provide information about bone formation and resorption activity. Advanced imaging techniques, such as quantitative computed tomography (QCT), can also be used to assess bone

structure more precisely. In some cases, vertebral fracture assessment (VFA) is performed to detect asymptomatic spinal fractures. Risk assessment tools such as FRAX (Fracture Risk Assessment Tool) are widely used to estimate the 10-year probability of fractures. However, in diabetic patients, FRAX may underestimate risk, indicating the need for adjusted clinical evaluation.

Prevention of osteoporosis in overweight men with type 2 diabetes requires a comprehensive and multidisciplinary approach. The main goal is to reduce fracture risk, improve bone strength, and control metabolic disorders. Lifestyle modification is the cornerstone of prevention. Regular weight-bearing and resistance exercises help stimulate bone formation and maintain bone density. Physical activity also improves insulin sensitivity and aids in weight control. Dietary intervention is equally important. A balanced diet rich in calcium, vitamin D, protein, and essential micronutrients supports bone health. Limiting excessive sugar intake and processed foods helps control blood glucose levels and reduces metabolic stress. Vitamin D supplementation is often necessary, especially in individuals with confirmed deficiency. Adequate sun exposure and nutritional support contribute to improved calcium absorption and bone mineralization. Pharmacological treatment may be required in high-risk patients. Bisphosphonates are commonly used to reduce bone resorption and prevent fractures. In selected cases, other agents such as selective estrogen receptor modulators or anabolic therapies may be considered. Optimal control of type 2 diabetes is essential in preventing osteoporosis progression. Maintaining stable blood glucose levels reduces the formation of advanced glycation end-products and protects bone quality. Weight management is another critical factor. Gradual weight reduction in overweight individuals helps reduce inflammatory activity and improve overall metabolic health. Patient education plays a key role in prevention. Patients should be informed about risk factors, importance of adherence to treatment, and strategies to prevent falls and fractures.

### **Conclusion**

Osteoporosis in overweight men with type 2 diabetes mellitus represents a significant but often underrecognized clinical problem. The coexistence of metabolic dysfunction, hormonal imbalance, and lifestyle-related factors creates a high-risk environment for progressive bone loss and increased fracture risk. The findings of this review highlight that osteoporosis in this population is not solely dependent on bone mineral density but also on bone quality, which is significantly affected by chronic hyperglycemia and metabolic disturbances. Early stages of the disease are typically asymptomatic, making screening and preventive strategies essential components of clinical management. A multidisciplinary approach is required to effectively address this condition. This includes strict glycemic control, lifestyle modification, adequate nutritional support, and pharmacological intervention when necessary. Regular physical activity and weight management play a crucial role in maintaining bone health and reducing complications. Early diagnosis through appropriate screening tools, including bone density measurement and biochemical markers, allows timely intervention and reduces the risk of fractures. Healthcare professionals should pay special attention to high-risk groups, particularly overweight men with type 2 diabetes. In conclusion, prevention remains the most effective strategy in managing osteoporosis in this population. Integrated clinical care, patient education, and regular monitoring can significantly improve outcomes and enhance quality of life.

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