

OSTEOPOROSIS PREVENTION IN LIGHT OF MODERN NUTRITION

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ABSTRACT

Nutrition plays a central role in bone metabolism as well as in the prevention and treatment of osteoporosis. Essential nutrients such as calcium, vitamin D, protein, and trace elements contribute to bone health, while a balanced diet reduces the risk of degenerative diseases. Calcium and vitamin D are crucial for bone density and formation, and proteins, particularly plant-based ones, also promote bone health. At the same time, "calcium thieves" such as phosphate and oxalic acid should be avoided, as they inhibit calcium absorption. Physical activity supports bone metabolism and minimizes fracture risk. Supplementation with calcium, vitamin D, and other nutrients shows promising but heterogeneous results regarding fracture prevention. A personalized nutrition therapy tailored to individual needs remains essential for maintaining bone health, especially for vegans and people with food intolerances. Future research must further refine specific recommendations for nutrient intake to optimize the preventive benefits of nutrition in osteoporosis.

Introduction

Nutrition plays a significant role in bone health in relation to osteoporosis, particularly through the intake of protein, calcium, vitamin D, and other micronutrients. Numerous studies investigate the effects of dairy products, fruits, and vegetables on bone structure and emphasize the importance of a balanced diet in achieving optimal bone density during youth. Additionally, research explores how targeted nutritional strategies in later life can help reduce the risk of osteoporosis and its complications. The focus is on the prevention of degenerative bone diseases, supported by conscious nutrient choices and the reduction of "calcium thieves" in the diet.

Method

Scientific literature and online research.

Results

Dietary behavior plays a crucial role in bone metabolism, with protein, calcium, vitamin D, various trace elements, and dietary fibers being particularly important. Numerous studies have analyzed the effects of consuming dairy products, fruits, and vegetables on bone health. A central research focus is to understand how adequate nutrition during youth can contribute to achieving optimal bone density. Additionally, researchers are investigating how targeted nutrition in later life can reduce the risk of developing osteoporosis and its potential complications (Rizzoli, 2023).

The human skeletal system undergoes lifelong remodeling processes. Bone formation occurs until about the age of 30, followed by a phase of bone resorption, which can be counteracted by proper nutrition. A bone-friendly diet is crucial for the prevention of osteoarthritis, arthritis, and osteoporosis, and should be actively communicated by orthopedists and rheumatologists. A diet that supports bone health provides essential nutrients to the skeleton and can prevent or slow down degenerative processes in bones and joints. Calcium is the central building block for bone

formation and plays a key role in metabolism. The body excretes at least 300 mg of calcium daily, requiring an intake of 900 to 1,000 mg per day to maintain balance. For osteoporosis patients, a calcium-rich diet is particularly important, with recommendations of 1,000 to 1,500 mg daily. Good sources of calcium include dairy products and certain vegetables like broccoli and kale. Studies have shown that increased calcium intake in children contributes to a healthy bone structure but is not associated with a reduced number of fractures in old age (Krapf, 2024). Nutrition in childhood lays a foundation for bone health, but calcium intake later in life is more significant for osteoporosis prevention (Rizzoli, 2023; Winzenberg et al., 2006).

Excessive intake of "calcium thieves" should be avoided, as they inhibit calcium absorption or promote its excretion. Phosphate has an ambivalent role: it stabilizes bones but can hinder calcium absorption when consumed in excess. Foods like meat and cola are rich in phosphate, while vegetables and dairy products are more beneficial. The role of dairy products will be discussed further, as it is complex. Oxalic acid-containing foods like spinach and rhubarb should also be consumed in moderation, as they inhibit calcium absorption. Additionally, high salt intake and certain medications promote calcium excretion. Alcohol and caffeine can also negatively affect calcium absorption and increase fracture risk (Krapf, 2023).

Adequate vitamin D intake is essential for optimal calcium utilization. UV radiation promotes the body's own vitamin D synthesis, while a vitamin-rich diet is important during winter months. Vitamin D supports calcium absorption and increases bone density. The importance of protein for bone health is often underestimated. Higher protein intake correlates with higher bone density, with plant-based protein being more advantageous than animal-based. A balanced acid-base ratio is crucial for bone health. A diet rich in fruits and vegetables can help neutralize acids and promote bone health. Omega-3 fatty acids, especially from cold-water fish (herring, matjes, trout), have anti-inflammatory properties and can reduce the need for pain medication in people with osteoporosis. Plant-based enzymes like bromelain and papain also have anti-inflammatory effects and can be helpful in acute conditions. Adequate intake of folic acid and vitamin B12 is also important, as high homocysteine levels can increase fracture risk. Vitamin K promotes calcium incorporation into bones, while vitamin C supports calcium absorption. Magnesium and zinc are also essential for bone health (Krapf, 2023).

In summary, a balanced diet rich in calcium, vitamins, and healthy fats is essential for maintaining bone health and preventing degenerative diseases (Krapf, 2023). A growing number of people are adopting a meat-free diet and food products without animal ingredients, as this form of nutrition is considered particularly health-promoting. This is also associated with changes in protein and bone metabolism among these individuals. Due to the variety of dietary forms and often the associated lifestyle changes, making statements about bone-related risks is problematic. Meat-free foods are often fortified with certain nutrients and minerals. An antioxidant effect of a vegetarian diet is likely and beneficial for metabolism. Fracture studies, at least in one large study, show an increased number of fractures with a vegan diet. Risks arise from lower body weight and reduced calcium and protein intake. Strength training and supplementation of protein and calcium are recommended for people following a vegan diet. A conclusive assessment of these dietary and lifestyle forms regarding the risk of developing osteoporosis is currently problematic and should be approached with caution (Kasch et al., 2022).

The investigation into the significance of supplements and deficiency prevention in osteoporosis nutrition has increasingly become a focal point of interest. However, the science surrounding this topic is predominantly based on observational studies, while the precise study of causal relationships and dose-response effects remains a challenge. In particular, data on the value of protein supplementation, as well as targeted intake of folic acid, vitamins B6 and B12, potassium, and green tea for bone health, are heterogeneous. While the data on protein supplementation generally suggest positive effects, the optimal amount, protein composition, and sources, as well as potential side effects, remain subjects of debate. The role of folic acid, vitamins B6 and B12 is complex, especially in the context of homocysteine metabolism, warranting a cautious approach to recommendations. Research on the influence of potassium on bone metabolism is promising, but dosages and forms vary significantly across studies. Similarly, studies on green tea show some positive effects on bone metabolism, but the precise mechanisms and optimal amounts remain unclear. Overall, when used with care, the available evidence suggests no immediate risks associated with the mentioned supplements. However, the concrete benefits that would justify specific recommendations are insufficiently supported by data, and further research is needed to establish precise and standardized guidelines for their use in promoting bone health (Genest et al., 2024).

The role of milk, dairy products, and cheese in osteoporosis nutrition and prevention is controversial. While dairy products are often recommended as important sources of calcium, there are also concerns about their potential negative effects on bone health. Individuals with food intolerances tend to avoid dairy products, and many modern diets, such as veganism or paleo, exclude them entirely. The goal of dietary therapy for osteoporosis is to ensure adequate calcium and nutrient intake. Numerous scientific studies have examined the effects of milk and dairy products on bone health and overall well-being. In the context of disease detection, dietary history should include consumption of dairy products and adherence to specific diets. If nutrient deficiencies are detected, a detailed dietary history by professionals is required. To ensure recommended nutrient intake, it is important to work with patients to develop a practical and individualized dietary plan that also takes into account intolerances, allergies, and personal preferences (Haidenberger, 2021).

According to Haidenberger (2021), a daily calcium intake of over 525 mg is recommended, which can be difficult to achieve on a vegan diet without the targeted selection of calcium-rich mineral waters or fortified alternatives. No negative effects on bone health have been demonstrated with normal consumption of dairy products. However, a dairy-free diet carries a risk of calcium deficiency, so the overall composition of the diet should be considered. Specific dietary counseling can help identify deficiencies, promote adherence to dietary recommendations, and facilitate practical implementation in daily life. With the rise of vegan diets among young people and the increase in food intolerances, adequate calcium and nutrient intake is becoming increasingly important for the primary prevention of osteoporosis (Haidenberger, 2021).

Calcium is undoubtedly essential for bone health, but for years there has been a controversial debate about the optimal intake level. Calcium supplementation is viewed critically due to potential cardiovascular risks, and the consumption of milk is also questioned by some researchers. A Swedish cohort study by K. Michaelsson (2014) shows a dose-dependent increase in fractures and higher mortality associated with cow's milk consumption, with lactose, which is converted to

D-galactose in the body, being identified as a potential risk factor. Nevertheless, no negative effects have been demonstrated for the recommended amounts of 150–200 g of milk per day. Thus, the daily recommendation of 200 g of milk and 50–60 g of cheese remains to meet the calcium requirement of 800–1000 mg per day. Milk also provides high-quality proteins, and an appropriate protein intake of 1.2 to 1.5 g/kg body weight is crucial for bone health and muscle mass, with increased production of IGF-1 having a significant osteoanabolic impact (Osteoporose Selbsthilfegruppen Dachverband e.V., 2023).

As part of basic therapy for osteoporosis, it is recommended to ensure adequate calcium and vitamin D intake, as well as regular physical activity, as these factors are crucial for maintaining bone health and reducing fracture risk. Basic therapy is a fundamental pillar in the treatment of osteoporosis and plays a vital role in primary prevention, even before a decline in bone mineral density or the occurrence of fractures is detectable. Recommendations for calcium and vitamin D intake, which can be achieved either through diet or supplementation depending on individual circumstances, remain unchanged. Vitamin K is only recommended to compensate for a proven deficiency, as evidence for broader application, particularly concerning general fracture prevention, is considered inconsistent. Furthermore, physical activity has demonstrable positive effects on fracture risk and bone density and thus remains a central recommendation. Ideally, this should be done through an individualized and supervised training program (Maus et al., 2023).

The prevention of osteoporosis, therefore, requires a comprehensive prevention program that includes a balanced diet, sufficient intake of calcium and vitamin D, as well as regular physical activity to promote bone health throughout all stages of life and significantly reduce the risk of fractures. The fight against osteoporosis can begin at any age. Bone health is already promoted in childhood by building maximum bone density, which forms the foundation for healthy bones in old age. It is crucial that patients are continuously motivated to support their bone health throughout life. A diet rich in protein and calcium, along with additional vitamin D intake, is essential but does not serve as medicinal therapy for osteoporosis. Certain dietary factors can deplete minerals from the bones and thus lead to osteoporosis unnoticed (Bartl & Bartl, 2021). A healthy diet is only effective if these inhibitory substances are simultaneously considered to ensure that the minerals consumed actually reach the bones. Osteoporosis patients should not only focus on calcium and vitamin D intake but also consider the effects of other foods. Current research on diet and osteoporosis suggests that a balanced intake of calcium and high-quality protein, combined with avoiding foods that inhibit calcium absorption, is crucial to support bone health and reduce the risk of fractures in osteoporosis patients (Osteoporose Selbsthilfegruppen Dachverband e.V., 2023).

A sufficiently high calcium intake, as an important building block of bone tissue, is also necessary to achieve peak bone mass during growth and to treat osteoporosis. This is especially true during medicinal osteoporosis therapy. A significant portion of the European population suffers from vitamin D deficiency. In addition, vitamin D not only affects calcium homeostasis and bone mineralization but also muscles and the risk of falls. The simultaneous supplementation of calcium and vitamin D shows evidence that it could significantly reduce fracture risk. Furthermore, there is widespread vitamin K deficiency, which plays an important role in bone mineralization and preventing ectopic calcifications. The effects of vitamin K supplementation on fracture risk are currently controversial. Proteins are an essential component of muscles and the skeletal system.

Increased protein intake can raise IGF-I secretion, which may have beneficial effects on bone metabolism, although the results regarding fracture risk reduction in the literature are inconsistent. Recent studies have not confirmed the previously postulated negative impact of animal protein on bone homeostasis (Schultz et al., 2022).

An adapted lifestyle, healthy diet, and regular physical activity are of great importance for both genders and at any age. Physical activity reduces the risk of osteoporosis and fractures by optimizing peak bone mass during youth, reducing bone loss in old age, and minimizing the risk of falls. It is crucial to carefully evaluate all medications and existing diseases for their potential negative effects on bone health. This review helps to identify possible risk factors and take appropriate measures to minimize damage to bone structure. A positive attitude towards life, joy, and confidence also contribute to bone health. Finally, fall prevention and hip protectors can significantly reduce the risk of hip fractures in old age (Bartl & Bartl, 2021).

The medicinal therapy of osteoporosis includes a variety of strategies that use both antiresorptive and osteoanabolic drugs to increase bone mineral density, reduce fracture risk, and minimize long-term side effects. The choice of therapy should be tailored to the severity of the disease and the specific needs of the patients. The essential components of osteoporosis therapy include nutrition, physical training, fall prevention, pain therapy, calcium and vitamin D intake, anti-osteoporotic medications, continuous monitoring of progress, rehabilitation, and self-help. Newer therapies like romosozumab break the “coupling” of bone cells and exhibit both antiresorptive and osteoanabolic effects. Nitrogen-containing bisphosphonates (BP) remain the gold standard in medicinal treatment, with intravenous administration preferred over the oral form. Long-term side effects of antiresorptive drugs, such as osteonecrosis of the jaw (ONJ) or atypical femur fractures (AFF), are only observed in individual cases. The treatment duration should be at least 3–5 years, covering the period of increased fracture risk. Resuming therapy after 5 years depends on the current severity of osteoporosis and clinical circumstances; a therapy break (“drug holiday”) should be considered after 5 years (Bartl, 2023).

Conclusion

The central importance of diet for bone metabolism and osteoporosis prevention is indisputable. Essential nutrients such as calcium, vitamin D, and proteins are crucial for bone health, while a balanced diet can significantly reduce the risk of degenerative diseases. However, further research is needed to develop more precise dietary recommendations for osteoporosis prevention. Particularly important is a personalized nutritional strategy tailored to individual needs, such as for vegans or people with food intolerances. Future studies should develop differentiated recommendations for targeted nutrient intake to maximize the preventive benefits of diet.

Outlook

In the future, it will be crucial to further explore and clarify the role of nutrition in the context of bone health and osteoporosis prevention. Special attention should be given to developing personalized dietary recommendations that consider the needs of different population groups and individual dietary habits, such as vegan diets or food intolerances. Moreover, there is a need for more clinical studies to standardize the heterogeneous results on the supplementation of calcium, vitamin D, and other nutrients and formulate clear guidelines for fracture prevention. Innovative research approaches examining the relationship between diet, genetics, and bone health could lead

to personalized prevention strategies. Additionally, the impact of nutrition in combination with physical activity and other lifestyle factors should be further investigated to ensure a holistic approach to osteoporosis prevention.

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