

Prevention and treatment of osteoporosis

Maria Becheva¹, Daniela Taneva¹

¹ Department of Nursing, Faculty of Public Health, Medical University – 15A Vasil Aprilov Blvd., 4002, Plovdiv, Bulgaria

Corresponding author: Maria Becheva (olivier@abv.bg)

Received 26 September 2019 ♦ Accepted 13 December 2019 ♦ Published 2 October 2020

Citation: Becheva M, Taneva D (2020) Prevention and treatment of osteoporosis. Pharmacia 67(4): 181–185. <https://doi.org/10.3897/pharmacia.67.e46865>

Abstract

Osteoporosis is a generalized bone disease characterized by diminished bone strength with an increased risk of fractures. Osteoporosis is a major health concern, both because of the risk of potentially serious fractures and because its prevalence is increasing as the population ages.

The treatment of the disease is complex and includes adherence to a particular diet, medications (hormone replacement therapy, calcium, vitamin D, etc.), kinesitherapy, physiotherapy and orthotics.

To reduce osteoporosis, it is necessary to avoid the risk of fractures, to do regular physical activities, to eat bone-healthy foods, to lead a proper lifestyle with the avoidance of negative habits and to maintain a healthy weight. A person also needs to have knowledge of personal risk factors and to consult a doctor if medical treatment is to be applied. The classic therapeutic approach is with antiresorptive anti-osteoporosis agents. A promising therapeutic trend is the study of compounds with low toxicity and potential properties to influence the pathogenetic mechanisms of disease and oxidative stress, such as phytoestrogens and hormone replacement therapy, at the same time.

The aim of the article is to familiarize the audience with the preventive measures and therapies applied to the treatment of osteoporosis.

Keywords

Osteoporosis, prophylaxis, medication treatment

Introduction

Osteoporosis is described by the World Health Organisation as a progressive systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture (WHO 1994; Kanis et al. 1994).

Osteoporosis is not only somatic but also a psycho-emotional and social disease. To view osteoporosis as a bone disease is one-sided and limited. What must be considered first and foremost, is the carrier of the osteoporotic bone with all his/her individual peculiarities in the nutritional and motor mode, in his/her sexual world and psycho-emotional status. The disease is subject to prevention

and treatment, but because it has no warning symptoms until fractures occur, relatively few people are diagnosed with effective treatment in its early stages (Borisova 1998; Orimo et al. 2012).

The aim of the article is to familiarize the audience with the preventive measures and therapies applied to the treatment of osteoporosis.

Measurement technique

Dual-energy X-ray absorptiometry (DXA) (DXA), which is the reference standard for measuring bone mineral density (BMD) in the lumbar spine and in the proximal

femur, is performed. Bone strength is highly dependent on bone mineral density-BMD. In menopausal women, BMD measurements are interpreted using the T-score, calculated as the difference between the observed BMD and BMD at the same site in young healthy women. The T-score is expressed in standard deviation (SD) units. The World Health Organization defines osteoporosis as a T-score ≤ -2.5 (WHO 1994).

The treatment of the disease is complex and includes adherence to a particular diet, medications (hormone replacement therapy, calcium, vitamin D, etc.), kinesiotherapy, physiotherapy and orthotics.

Osteoporosis prevention

In terms of osteoporosis, the role of the elderly and post-menopausal and its form is most important. Premature menopause (before age 40) and early menopause (between age 40 and 50) are associated with osteoporosis. The earlier menopause occurs, the lower the bone density will be in the next stages of life. Women who underwent surgical removal of the ovaries before the age of 45 are at increased risk of developing osteoporosis.

Prevention begins with proper nutrition and physical activity at an early age, control of risk factors such as smoking (Kanis et al. 2005) and timely management of hormonal balance disorders, menstruation and menopause, followed by the necessary replacement therapy. Undoubtedly, the latter is associated with the best results in increasing bone density and other effects of menopause (Ivanova and Vasileva 2017).

People with osteoporosis can suffer a fracture even after falling slightly during their daily activities.

Measuring BMD helps to assess the risk of fracture. In prospective studies, a reduction in BMD is associated with an increase in the risk of fracture (Marshall 1996). However, measuring BMD may not identify all women at high risk for fractures. In two large cohort studies, less than 50% of breakages occurred in women with T-scores lower than or equal to -2.5 (Schuit et al. 2004; Sornay-Rendu et al. 2005). BMD results are not always sufficient to make treatment decisions. Other risk factors must also be considered, most notably the risk of falling.

According to a database from the NHANES study in the United States, between 20 and 80 years of age, bone mass decreases by 1/3 in women and 1/4 in men, which is why in all ethnic groups at each age 80% of femurs and 75% of vertebral fractures are diagnosed in women, and the incidence increases with age in both sexes. In Europe, the number of post-fracture deaths for 2010 is: 1) women (22,000): 11,000 (femurs), 6,000 (vertebral), 5,000 (other); 2) males (20,000): 9,000 (femurs), 8,000 (vertebral), 3,000 (other). The increase in mortality after femoral and vertebral fractures is due to the low bone mineral density (Ivanova 2015).

To reduce osteoporosis, it is necessary to avoid the risk of fractures, to do regular physical activities, to eat bone-healthy foods, to lead a proper lifestyle with the avoidance

of negative habits and to maintain a healthy weight. A person also needs to have knowledge of personal risk factors and to consult a doctor if medical treatment is to be applied.

Regular physical activity

Often, a combination of exercise is recommended to prevent osteoporosis. All of these are designed to be helpful while reducing the risk of osteoporosis breakage during exercise. Exercise programs must be tailored to the needs and the ability to perform them, so an individual approach is important. During menopause, exercise becomes especially important for maintaining bone mass and muscle strength. The positive effect of physical activity on the bones depends on both the type of exercise and their intensity (NOF 1998). Performing resistance to gravity exercises as well as isometric exercises three to four times a week for 30–40 minutes is of great importance for the prevention of advanced age osteoporosis. Dance, hiking, stair climbing, jogging, rope jumping, intense aerobics, tennis are recommended. Exercise with lifting and loosening, weight lifting (4–5 kg weights), band resistance exercises and in water are applied to strengthen the muscles and bones of the hands and upper spine (Becheva 2019).

In case of proven osteoporosis, the exercise program should be individualized and aimed at posture adjustment, improving balance, gait and coordination. Of particular importance is training of the hip muscles in order to strengthen and prevent the risk of falls.

Osteoporotic individuals should avoid excessive leaning exercises, torso rotation movements, movements involving sharp, extreme amplitudes, or excessive loads (such as jumping), as well as lifting heavy objects, because the movements described may cause vertebrae fractures (Pankova and Tsvetkova 2015).

Healthy eating

Healthy nutrition rich in bone-friendly foods that includes adequate amounts of calcium, vitamin D, protein and other nutrients are an important component of good bone health.

Calcium is the main building block of the skeleton. Bone calcium also plays a role as a reservoir for maintaining the calcium levels in the blood that are important for the functioning of the nerves and muscles. As the body's ability to absorb calcium decreases with advancing age, its intake in the body must increase. The recommended calcium intake for menopausal women and the elderly according to the WHO is 1500 mg daily without hormone replacement therapy (NIH 1994).

Vitamin D is formed in the skin when exposed to the sun and plays a crucial role in bone and muscle health. It helps the body absorb calcium, regulates parathyroid hormone levels, ensures proper bone metabolism and mineralization, and helps improve muscle strength and balance, thus reducing fracture risk (Sanders 2010). People can take the vitamin D they need with about 15

minutes of daily sun exposure, but sunlight is not always a reliable source of vitamin D. The reasons are: seasons and latitude; the use of sunscreen; urban air pollution; the age of the individual and many other factors that influence the absorption of vitamin D. There are also nutritional sources of vitamin D, albeit in limited quantities (Brown 1998). Foods that contain Vitamin D are oily fish, egg yolk, fresh milk, butter and mushrooms. Recommendations for taking Vitamin D are 800 to 1000 IU per day in people over 60 years of age (Papadimitropoulos et al. 2002; Bolland 2011).

The body composition changes in middle age by increasing fat and reducing muscle mass. Low protein intake is associated with loss of bone mineral density in the thigh and spine. Adequate calcium intake is required to achieve the beneficial effect of the protein on bone mineral density (Tsvetkova et al. 2015).

Protein is found in meat, fish, dairy products and eggs. Good vegetarian sources of protein are beans, lentils and legumes, soy products, nuts, quinoa and other whole grains.

The acidic environment has a negative effect on bone protection. Acidosis occurs when people consume foods that produce acid, such as cereals and meat, when the latter are not balanced with enough alkaline fruits and vegetables (Papanov et al. 2015). A diet rich in fruits and vegetables is associated with high bone mineral density and / or low tendency for bone loss. In order to balance the need for protein, acid loading can be reduced by reducing the intake of cereals and increasing the intake of fruits and vegetables (Tsvetkova et al. 2015)

Bad lifestyle habits, such as smoking and alcohol abuse, affect general health and have a negative effect on bone health, increasing the risk of osteoporosis and fractures (Seeman 1996). Nutrition with adequate intake of calories and nutrients is required to maintain bone strength (Petkova et al. 2017).

Drugs that damage bone health. Some medications, such as glucocorticosteroids (prednisone, cortisone), high-dose thyroid hormone treatments, and others, can have side effects that directly damage the bones or increase the risk of fractures in the case of fall or injury.

Medication treatment of osteoporosis

Osteoporotic patients are a specific group that has a number of needs, associated with the disease, medication therapy, and possible severe disabling complications. Pharmaceutical care for them has several main goals:

- monitoring of medication therapy
- training for proper treatment
- tips for a healthy diet through different patterns of structuring nutrition
- tips for appropriate motor activity
- tips for preventing short-term complications that can endanger the patient's life.

The classic therapeutic approach is with antiresorptive anti-osteoporosis agents: bisphosphonates and selective estrogen receptor modulators, but they have many side effects.

A promising therapeutic trend is the study of compounds with low toxicity and potential properties to influence simultaneously the pathogenetic mechanisms of disease and oxidative stress such as phytoestrogens and hormone replacement therapy (Pankova and Tsvetkova 2015).

An important part of the medication control process is the quality control of the active substances. Quality control is a set of analytical procedures for identity, availability of related substances and quantitative content, based on previously validated methodologies. Using the developed new RP-UHPLC-HRMS method (ultra-high performance liquid chromatography coupled with mass spectral detection), (+) ionization results in much higher selectivity and sensitivity in Didostroneerone analysis in Femoston F2 tabl., (TR = 5.48 min) Norethisterone in Tisequens T2 tabl. (tR = 6.07 min), Levonorgestrel in Climonorm CN2 tabl. (tR = 4.83 min), ciproterone acetate in Clement CM2 tabl. (tR = 5.89 min) (Tsvetkova et al. 2016; Tsvetkova et al. 2017).

Bisphosphonates are medicines that occupy a special place in osteoporosis therapeutic regimens, as well as in other diseases affecting bone turnover. They refer to a group of agents with an extreme affinity for bone tissue. They were discovered as a compound in the 19th century but began to be used as inhibitors of bone resorption in humans much later. Bisphosphonates target osteoclasts and their function. Some medicines do this by inhibiting the synthesis of key energy substrates, while others by blocking the activity of the enzyme systems responsible for the production of various proteins. Bisphosphonates are used in osteoporosis (Ivanova and Vasileva 2017), including medication-induced, multiple myeloma, Paget's disease, osteogenesis imperfecta, bone metastases, and more. Their use is associated with a decrease in bone resorption, followed by some suppression and formation; they increase mineralization and bone volume and significantly reduce the risk of fractures. Among the bisphosphonates used for antiosteoporotic purposes are Alendronate, Risendronate, Ibandronate and others. Their use is accompanied by other therapeutic measures, including adequate intake of calcium and vitamin D (Ivanova 2019).

The combination with hormone replacement therapy is assessed individually (Marjoribanks et al. 2012) Dosages for daily and weekly intake are available, as well as preparations administered once a month and once every three months, intravenously. The administration of medicines has short-term effect. As a result, there is a statistically significant decrease in the risk of vertebral fractures in women between 55 and 75 years of age, especially in those who have evidence of previous micro- or clinically manifested vertebral fractures and a low T-score (< 2, 5). Equally encouraging are the results regarding the risk of fracture of the femoral neck. Among women 75–80 years old, statistics are just as good, but after the 80s, the situation aggravates as metabolism changes, bone formation is severely suppressed, and the occurrence of fractures is not depend-

ent on bone density alone. Suppression of bone resorption is achieved relatively quickly, following the treatment regimen. The effect and endurance of treatment discontinuation, of course, depend on its very duration. There are no side effects of bisphosphonates, and those most commonly reported are the ones of the gastrointestinal tract, flu-like symptoms, rashes, electrolyte disturbances, and rhythmic disturbances (Pankova and Tsvetkova 2015).

There are currently no data on long-term administration or long-term effects after bisphosphonate use in connection with the short period of use.

There is doubt about bone turnover in the femoral neck and the occurrence of atypical fractures, but so far this has been rarely observed and the benefit of bisphosphonates far outweighs this risk. Again, there are rare cases not of osteoporosis but of malignancies, chemo or radiation therapy, corticosteroid therapy in connection with various indications, and especially poor hygiene and underlying infections in the oral cavity and tooth (Ivanova and Vasileva 2017).

Conclusion

Efforts in health care should be aimed at reducing the spread of risk factors that cause osteoporosis. Due to the particularly high risk of fractures, patients need to be properly investigated (eg, fracture risk assessment, fall risk assessment, bone density measurement), given lifestyle advice (eg diet, exercise and smoking) and bone protection therapy.

Modern biological therapies are more prevalent in the treatment of osteoporosis. This increases the chance of treating many more post-menopausal patients who are most affected. Biological therapy is sparing and significantly reduces the risk of fractures. It is important that those receiving this treatment do not interrupt their intake of vitamin D, calcium, or stop active movement (Becheva 2019).

References

- Becheva M (2019) A Textbook on Kinesitherapy. Medical University Publishing House. Plovdiv ISBN 978-619-237-037-4, 517 pp.
- Bolland MJ, Grey A, Avenell A, Gamble GD, Reid IR (2011) Calcium supplements with or without vitamin D and risk of cardiovascular events: reanalysis of the Women's Health Initiative limited access dataset and meta-analysis. *BMJ* 2011(342): d2040. <https://doi.org/10.1136/bmj.d2040>
- Borissova A-M (1998) Osteoporosis-Diagnostic, Prevention and Treatment. *Endocrinologia* 3(4): 1-59.
- Brown AJ (1998) Vitamin D Analogues. *American Journal of Kidney Diseases* 32(4): S25-S39. <https://doi.org/10.1053/ajkd.1998.v32.pm9808141>
- Ivanova S (2015) Regulatory aspects of osteoporosis treatment and analytical characteristics of certain steroid-structured medicinal products. PhD Abstract, 19 pp.
- Ivanova St, Vasileva L (2017) Current and emerging strategies in osteoporosis management. *Current Pharmaceutical Design* 23(41): 6279-6287. <https://doi.org/10.2174/1381612823666170714122714>
- Ivanova SA (2019) Osteoporosis and characterization of medicinal products in its therapy. Makros Publishing House ISBN: 978-954-561-469-9, 87 pp.
- Ivanova St, Tsvetkova D, Danchev N (2017) Etiology of osteoporosis and therapeutic strategies. *Sci. Pharmacol.*, 2, 25-32.
- Kanis JA, Johnell O, Oden A, Johansson H, De Laet C, Eisman JA, Fujiwara S, Kroger H, McCloskey EV, Mellstrom D, Melton LJ, Pols H, Reeve J, Silman A, Tenenhouse A (2005) Smoking and fracture risk: a meta-analysis. *Osteoporosis International* 216: 155-162. <https://doi.org/10.1007/s00198-004-1640-3>
- Kanis JA, Melton LJ III, Christiansen C, Johnston CC, Khaltavaev N (1994) The diagnosis of osteoporosis. *Journal of bone and mineral research* 9(8): 1137-1141. <https://doi.org/10.1002/jbmr.5650090802>
- Marjoribanks J, Farquhar C, Roberts H, Lethaby A (2012) Long term hormone therapy for perimenopausal and postmenopausal women. *ochrane Database of Systematic Reviews* (7): CD004143. <https://doi.org/10.1002/14651858.CD004143.pub4>
- Marshall D, Johnell O, Wedel H (1996) Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. *BMJ* 1996(312): 1254-1259. <https://doi.org/10.1136/bmj.312.7041.1254>
- NIH Consensus Conference (1994) Optimal calcium intake. NIH Consensus Development Panel on optimal Calcium Intake. *JAMA* 272: 1942-1948. <https://doi.org/10.1001/jama.272.24.1942>
- NOF (1998) Osteoporosis: Review of the Evidence for Prevention, Diagnosis, and treatment and Cost Effectiveness Analysis. *Osteoporosis international* 8(4): S3-6. <https://doi.org/10.1007/PL00022723>
- Orimo H, Nakamura T, Hosoi T, Iki M, Uenishi K, Endo N, Ohta H, Shiraki M, Sugimoto T, Suzuki T, Soen S, Nishizawa Y, Hagino H, Fukunaga M, Fujiwara S (2012) Japanese 2011 guidelines for prevention and treatment of osteoporosis-executive summary. *Archives of Osteoporosis* 7: 3-20. <https://doi.org/10.1007/s11657-012-0109-9>
- Pankova St, Tsvetkova D (2015) Role of phytoestrogens in prevention of osteoporosis. *International Journal of Current Pharmaceutical Research* 7(2): 1-6.
- Pankova St, Vasileva L, Petkova V (2015) A review of current treatment options for osteoporosis in Bulgaria. *World Journal of Pharmaceutical Sciences* 4(5): 1-12.
- Papadimitropoulos E, Wells G, Shea B, Gillespie W, Weaver B, Zytaruk N, Cranney A, Adachi J, Tugwell P, Josse R, Greenwood C, Guyatt G (2002) Meta-analysis of the efficacy of vitamin D treatment in preventing osteoporosis in postmenopausal women. *Endocrine Reviews* 23(4): 560-569. <https://doi.org/10.1210/er.2001-8002>
- Papanov St, Petkova Ek, Pankova St, Traykova N, Hadjidekov G, Grudeva V (2015) Antioxidant characteristics of different varieties distributed in Bulgaria. *International Journal of Technical Research & Applications* 3(2): 33-36.
- Petkova V, Obreshkova D, Hadzhieva B, Ivanova St (2017) Regulatory aspects of Omega polyunsaturated fatty acids in dietary supplements. *Journal of Pharmaceutical Research International* 18(2): 1-7. <https://doi.org/10.9734/JPRI/2017/35627>
- Sanders KM, Stuart AL, Williamson EJ, Simpson JA, Kotowicz MA, Young D, Nicholson GC (2010) Annual high-dose oral vitamin D and falls and fractures in older women: a randomized controlled trial. *JAMA* 303(18): 1815-1822. <https://doi.org/10.1001/jama.2010.594>
- Schuit SC, van der Klift M, Weel AE, Weel AEAM, de Laet CEDH, Burger H, Seeman E, Hofman A, Uitterlinden AG, van Leeuwen JPTM, Pols HAP (2004) Fracture incidence and association with bone min-

- eral density in elderly men and women: the Rotterdam Study. *Bone* 34(1): 195–202. <https://doi.org/10.1016/j.bone.2003.10.001>
- Seeman E (1996) The Effects of Tobacco and Alcohol Use on Bone. In *Osteoporosis*. Academic Press, San Diego.
- Sornay-Rendu E, Munoz F, Garnero P, Duboeuf F, Delmas PD (2005) Identification of osteopenic women at high risk of fracture: the OFELY study. *Journal of Bone and Mineral Research* 20(10): 1813–1819. <https://doi.org/10.1359/JBMR.050609>
- Tsvetkova D, Klisurov R, Pankova St, Zlatkov A (2015) Investigation of some pharmacological effects of Caffeine and Taurine in food supplements. *International Journal of Nutrition and Food Sciences* 4(1): 18–23. <https://doi.org/10.11648/j.ijnfs.s.2015040101.14>
- Tsvetkova D, Obreshkova D, Ivanova St, Yankov V, Atanasov P, Hadjieva B (2016) Telmisartan quality control by validation of UV-spectrophotometric method. *International Journal of Innovative Research in Medical Science* 1(4): 113–123. <https://doi.org/10.23958/ijirms/vol01-i04/04>
- Tsvetkova D, Obreshkova D, Ivanova S, Hadjieva B (2017) Evaluation of separation of steroids in combined forms by RP HPLC with UV-detection and gas chromatography. *Bulgarian Chemical Communications* 49(2): 377–383.
- World Health Organization (1994) Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: report of a WHO study group. WHO Technical Report Series no. 843WHO, Genève, 29 pp.