



## Osteoporosis – causes, epidemiology and symptoms

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### ABSTRACT

Osteoporosis is an extensive disease of the skeletal system, causing a decrease in the mineral density of bones and a disruption of their microarchitecture. Progressing pathological changes lead to increased bone brittleness and the risk of spontaneous fractures. Osteoporosis mainly affects women aged over 60. Statistical data reveal rather alarming tendencies, i.e. one in five elderly persons who has experienced hip fracture will die within 6 months from the incident. In turn, one in three people who have sustained a femoral neck fracture does not return to normal health and requires assistance on a daily basis. The costs of treating osteoporotic fractures are also on the rise. Hence, the disease constitutes a substantial social problem, especially that the number of patients has not been precisely specified, as for some of them clinical diagnosis is only made after a low-energy bone fracture occurs.

**Keywords:** osteoporosis, causes, epidemiology, symptoms

### BONES – ANATOMY AND PHYSIOLOGY

Bones are highly diverse forms of the connective tissue. They consist of organic substances (osteoblasts, osteocytes, osteoclasts, and an intercellular substance containing collagen, elastin, glycoproteins, as well as vessels and nerves which supply the bone), inorganic mineral compounds (70% of the total bone mass), and water [8,13]. The skeleton serves as a support for the muscles, protects internal organs and has a locomotive function. It also contains bone marrow and stores 99% of total body calcium and phosphorus reserves.

Bones are tissues undergoing constant resorption and reformation, which ensures a structural homeostasis of the skeletal system and a proper exchange of its components with body fluids [7]. The bone's organic part comprises osteoblasts (young osteocytes), forming the so-called osteoid. They aid in the correct calcification of the bone, and participate in the differentiation and activation of osteoclasts; after being encased by the bone tissue, they become osteo-

cytes. Osteocytes (mature bone cells), depending on their stimuli, control the mineralisation of the bone tissue and the synthesis of organic substance [8]. If needed, osteocytes can dissolve their nearest bone, releasing calcium and phosphorus to the extracellular fluid and blood [11]. Osteoclasts are bone-resorbing cells which, by creating a highly acidic environment on the bone's surface, use enzymes to dissolve the bone [17]. Phosphorus and calcium, in turn, constitute the main mineral compounds in bones, such as tricalcium phosphates, calcium carbonates and magnesium, and calcium and magnesium fluorides [13].

In the structure of bones, two types of osseous tissue can be distinguished – the cortical (compact) and the trabecular (cancellous) tissues. The cortical bone is built from interconnected plates and small rods, which contain hematopoietic or yellow bone marrow. This tissue can be found primarily at the ends of long bones and inside flat bones. The cortical bone, on the other hand, consists of a dense, cylindrically-shaped tissue (osteons), located concentrically around central canals, or the so-called Haversian systems. These systems contain blood vessels, lymphatic vessels, nerves and the connective tissue, which is present in the shafts of long bones, forms the surface of flat bones, and makes up nearly 90% of the

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skeleton volume [1]. Bone density changes with age – during childhood and adolescence an increase occurs in the bone mass and its volume, which is accompanied by the growth of bone mineral density (BMD) provided in grams of calcium per square centimeter of bone ( $\text{g}/\text{cm}^2$ ). However, after reaching 40 years of age, human body starts to undergo a continuous decrease in bone density [14,17,19].

Both osteogenesis and resorption involve several systemic hormones, including parathormone, triiodothyronine, the growth hormone, glucocorticosteroids, 1.25 dihydroxy-vitamin D, and sex steroids (androgens and estrogens) [1]. Vitamins A and C are required, in turn, for the correct collagen synthesis, while vitamin D increases the absorption of calcium and phosphates in intestines, strengthens the reabsorption of calcium and phosphates in kidneys and raises calcium concentration in the blood serum. It acts synergistically with calcitonin, which intensifies the ossification process by accumulating calcium in the bones in the form of hydroxyapatites [13].

## THE DEFINITION AND CAUSE OF OSTEOPOROSIS

The term „osteoporosis” originates from two words: *osteo*, denoting bone, and *porosis* – bone decay. According to the definition drawn up by the World Health Organisation in Hong Kong in 1993, osteoporosis is “a systemic skeletal disorder, characterised by low bone mineral density (BMD), deterioration of the microarchitecture of bone tissue, and susceptibility to fracture”. In 2001, researchers from the National Osteoporosis Foundation (NOF) and the National Institute of Health (NIH) offered another definition which states that osteoporosis is “a skeletal disorder characterised by compromised bone strength leading to an increased risk of fracture” [4,12,14,18,23]. At the core of this disease there are bone fractures which can be caused even by minor injuries and don’t normally occur in a person with a healthy bone mass.

Literature provides the following nomenclature to describe the level of osteoporosis-related risk: advanced osteoporosis, osteoporosis, osteopenia, and normal bone mass [8,4]. The disease can be broken down with regard to location – generalised and localised osteoporosis – or clinical aspects – primary and secondary osteoporosis. The localised type, occurring always as the secondary variant, includes osteoporosis caused by inflammatory and rheumatic diseases, or immobilisation due to e.g. a plaster cast. Generalised osteoporosis can be divided into primary and secondary types, and primary further into idiopathic (juvenile and adult) and involutive (type I – postmenopausal osteoporosis and type II – senile osteoporosis).

The primary idiopathic type includes osteoporosis, the causes of which cannot be established. The secondary type, in turn, results from other pathological changes, such as hormonal disorders manifested in the course of the

Cushing’s syndrome, hyperthyroidism, hypogonadism, pituitary hypofunction, and diabetes, as well as due to certain medicines (corticosteroids, anticonvulsants, cytostatics and heparin) [3,10,17]. Secondary osteoporosis is diagnosed in congenital diseases, e.g. the Turner’s and Klinefelter’s syndromes, in which the hormone deficiency plays the dominant role. Nutrition disorders, such as nutrient malabsorption and anorexia nervosa, may also lead to secondary osteoporosis [17].

This type of osteoporosis results from the lack of physical activity, and is often induced by pregnancy, during which a low level of vitamin D3 in blood can be observed, in addition to temporary hormonal disorders which prepare the woman’s body for the following weeks of pregnancy and lactation [1]. Menopause, i.e. the last menstruation in a woman’s life, brings about a number of bodily changes. For instance, estrogen production undergoes decrease prior to the menopause and almost completely stops afterwards. In characterising involutive osteoporosis type I (i.e. postmenopausal), one should start from its main causal factor, that is ovarian hypofunction, which intensifies in women after they reach 50 years of age. This initiates numerous processes leading to the reduction of bone mass. In this case, usually observed are vertebral fractures and the peripheral part of the radial bone [2,10,12,13,15,17,18,23].

The cause of osteoporosis type II, also referred to as senile osteoporosis, is a decrease in the number of cells in the bone tissue brought about by its inability to reform, as well as a reduced level of vitamin D3, the lack of which contributes to poorer absorption of calcium in the intestines. This, in turn, lowers calcium concentration in the blood and stimulates the secretion of parathormone, which increases calcium resorption from bones. Thus, fractures of vertebral bodies, the femoral neck, the humerus, and the radius may occur [9,10, 12-14,19].

## EPIDEMIOLOGY

Osteoporosis is the most frequent metabolic disorder of bones. According to the estimates, approximately 100 million people suffer from osteoporosis [10]. Globally 9 million osteoporotic fractures were recorded in 2000, of which nearly 40% occurred in Europe and in developed countries such as Sweden, Denmark, Norway, the United Kingdom and Germany [22]. In the United States, osteoporosis occurs in approximately 25 million people, which accounts for almost 10% of the population, causing 1.3 million fractures per year [10]. It should be borne in mind that approx. 70% of spinal fractures are undiscovered, so statistics may be slightly underestimated. Osteoporotic processes affect both women and men; however, it has been proven that the risk of fractures in women is considerably higher. In women of the Caucasian race aged over 50, this risk reaches 32% for spinal fractures, 16-17.5%

for the proximal part of the femur and 15% for forearm fractures. In comparison, the risk of proximal femur fractures in men of similar age is only 6% [20]. In Poland, the results of the research carried out show that over 25% of women and 13-29% men suffer from this disease [10]. On the other hand, the incidence of femur fractures as well as intertrochanteric and subtrochanteric fractures among Poles aged over 50 is assessed at the level of 165/100 000 residents/year, and in the population of those aged over 85 this amounts to 1138/100 000 women/year and 666/100 000 men/year [22]. Analysis of the literature on the subject with regard to osteoporosis incidence leads to a conclusion that among women primary osteoporosis is found in 70% of cases. Among men secondary osteoporosis prevails (54%), and primary osteoporosis is found in 46% of cases [1,3].

### THE SYMPTOMS OF OSTEOPOROSIS

Before embarking on the characterisation of the clinical symptoms of osteoporosis, it should be mentioned that this disease can remain asymptomatic for years. Initially patients do not experience any health problems. Frequently the initial symptom is chronic pain of the spine and the skeletal system during movement [23]. At first the pain subsides after resting, but as the disease progresses, it becomes permanent, intensifying during movement and restricting patient's mobility within particular sections of the spine. Another symptom, which is also a complication of osteoporosis, is bone fractures [2,12,14,19]. The most frequent osteoporotic fractures include those in the distal part of the radial bone, the proximal end of the humerus, and vertebrae. As a consequence, patients with fractures suffer from pain, immobilisation, a decline in physical fitness, and serious complications may even result in death [5,6]. Acute pain in the dorso-lumbar or lumbar area of the spine while resting, performing daily activities or turning suddenly, may indicate a vertebral fracture [11]. Such fractures lead to a decrease in height; in extreme cases costal margins rest on wings of ilia, which causes high-degree kyphosis referred to as dowager's hump. These symptoms are accompanied by problems with the respiratory system (lowered respiratory capacity, susceptibility to pneumonia), the gastrointestinal tract (hiatal hernia, digestion disorders) and difficulties with defecation, as a result of the change in the body posture [10,16]. As far as osteoporotic fractures of the spine are concerned, three types can be distinguished: biconcave fractures, wedge fractures and compression fractures of vertebral bodies (vertebra plana). These fractures occur seven times more often in women than men [10,21].

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