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Osteoporosis - A Childhood Illness?

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Abstract

Osteoporosis is a multifactor illness of the bone mass, the risk of which can be decreased by adequate nutrition and lifestyle. The prevention must start in childhood, because in this period, the bone mass formation is very intense, and reaching the peak bone mass is a necessary basis for the ideal bone density at older age. Most recommendations are related to all age groups. In different life periods, the reasons for osteoporosis are different. The ideal intake of calcium and the vitamins D and K is an important factor in primary and secondary prevention. Various studies associate low levels of vitamin D in the blood with increased mortality and many illnesses. The goal is reaching the values of >50 nmol/l (>20 ng/ml) of 25-OH-D_3 concentration in the blood serum. When there is a risk of falls and fractures, the goal is >75 nmol/l (>30 ng/ml). The supplementation in patients with osteoporosis and elderly people does not require measuring blood level, because a low concentration of 25-OH-D_3 in these people is common. A monthly supplementation of 600 μg of vitamin D_3 (20 μg/per day) led to the best results in fall and fracture prevention. Many nutrition substances can increase or decrease calcium absorption and urinary excretion. The intestines and kidneys are able to absorb it up to a certain level and regulate calcium metabolism by the needs of the organism. Other food nutrients – vitamins B_6, $B_{12,}$ folic acid, vitamin C, proteins, fats, phytates, oxalates, common salt and others – play an important role in the prevention of osteoporosis. The risk factors include body weight, eating disorders, alternative forms of nutrition, alcohol, smoking and a lack of movement. The right nutrition is recommended to include the regular intake of adequate milk and dairy products, prebiotics, fatty fish, some vegetables, mineral water, and the restriction of salt intake, oxalates, phytates, alcoholic beverages as well as nicotine abstinence. Regular movement plays an important role, not only in the prevention of osteoporosis, but in fall and fracture prevention as well.

Keywords: Osteoporosis; Metabolism; Risk factors; Nutrition; Prevention

Introduction

According to the WHO, osteoporosis belongs to the world's ten most frequent illnesses. Its incidence and prevalence is associated with the growing life expectancy. It is stated that every third woman over 50 years and every seventh man over 50 years suffers from osteoporosis. The probability that a woman will suffer from an osteoporotic fracture once in her lifetime is approximately 40% and the probability in men is 15%. The growing life expectancy contributes to the increasing incidence and prevalence of this illness. Osteoporosis mostly develops over years and emerges at older age when bones are easily fractured. Osteoporosis does not occur only at older age. However, it is one of the illnesses that may be prevented by the intake of adequate nutrients and appropriate body movement, or it may be postponed to older age. Osteoporosis comes from the Greek: osteo = bone and poro = opening, hole. An effective prevention is crucial for averting chronic pain, restricted mobility and fractures. It is also necessary for economical reasons: the costs of the treatment of osteoporosis are as high as the costs for the myocardial infarction and stroke treatment [1].

The Definition and the Factors Influencing the Extent of Peak Bone Mass

Osteoporosis is an illness of the skeleton, which is characterized by a low bone density, deterioration of the microstructure spongiosis and lower stability of the bone tissue. The result is higher bone refractiveness and a higher fracture risk. Bones are a living matter and a metabolically very active tissue. They are an important supply of minerals (calcium, phosphor, magnesium) and the space for the bone marrow. They have an important mechanical function (body support, enabling movement, organ protection) [2]. Bones are an active organ in metabolic processes. Every 5 years, the bone mass renews itself. The co-ordination between bone mass and muscles is very important in the renewal because the muscle traction crucially influences the bone mass formation and maintenance. Along with the period of infancy, puberty is the period of the most intense bone

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growth: 90% of the peak bone mass is formed in adolescence [3]. In the first 5-6 years, approximately 100 mg of calcium per day is retained for bone formation, whereas in puberty, it is 400 mg and more. The peak bone mass is reached around the age of 30. The intestinal calcium absorption decreases with age: in the period of infancy it reaches 75%, and in adults the percentage is between 20-30% [3,4]. For these reasons, childhood and adolescence are important periods for the optimal bone tissue development and the prevention of osteoporosis at older age. After the age of 30, the bone formation is complete and the natural decrease of the bone tissue follows. The degradation of the bone mass is stronger, especially during the climax because of the lower production of estrogens. At the beginning, the trabecular mass is reduced and the bone mass is degraded by the compact bones. The physiological degradation causes the skeleton to lose approximately 1% of its mass per year. The process of the bone mass decrease can be insignificantly influenced by increased calcium intake. With the increasing age, bones become porous, thus the stability and firmness are gradually at a lower level and even a small strain on the skeleton may cause fractures. The most affected areas are hips, forearms, thighbones and the vertebra, especially in the chest and the lumbosacral area. The typical symptom is the "geriatric hump", which is formed by the deformation of a few porous vertebra. It is the reason for body shortening and, along the spine wrinkles reminiscent of a fir tree are formed (the fir tree phenomenon) [1]. A severe pain from the spine to the legs may reduce mobility during walking or standing. The extent of the peak bone mass is influenced by a number of factors. They are heredity, gender, age, family and personal anamnesis, nutrition, being underweight, anorexia, endocrine factors, mechanical impacts and other risk factors. Nutrition is one of the factors that influence bone density. For example, genetic factors are the reason why osteoporosis is very rare in many population groups despite a low calcium intake. The content of minerals in the bones of Afro-American women is up to 10% higher than in European women. Besides that, Africans retain a higher percentage of calcium from food. This is an important factor in why Africans have considerably less osteoporosis and a lower incidence of fractures. In the Central European population, there are people with a high or low risk of osteoporosis as well. It is associated with the gene that increases bone density by a sextuple. Based on the studies of twins and families and their members, it is possible to assume that a genetic code significantly defines bone density in 40% to 60% of cases and, with it, the risk of osteoporosis [5]. The extent of the peak bone mass and the calcium metabolism in the bone mass is influenced by active lifestyle as well. Mechanical forces have a crucial influence. Body weight is not important, but the traction of the muscular heads is. In the post-climax period, active women have higher intestinal calcium absorption and a higher calcitriol level in the blood in comparison to inactive women. Some of the good activities are strength workouts, regular walking, dancing and gymnastics, which also contribute to the improvement of movement co-ordination and injury prevention, particularly falls [3,4,6].

Risk Factors

The risk of osteoporosis is influenced by a number of factors. Besides the common factors (as stated below), it is necessary to be aware of the factors of various illnesses. People with mellitus type I diabetes and people with a restricted renal function or the parathyroid gland hyperfunction face a greater risk. Anaemia (caused by the deficit of vitamin B_{12}), conditions after an organ transplant, celiac diseases or chronic inflammatory intestinal illnesses (*Colitis ulcerosa*, Morbus Crohn) may lead to osteoporosis as well [7].

Common risks of osteoporosis:

- female gender;
- age;
- positive family anamnesis;
- underweight, anorexia;
- personal anamnesis;
- low level of sexual hormones;
- low level of estrogens, climax;
- low level of testosterone in men;
- inadequate nutrition;
- lack of movement;
- smoking;
- alcohol abuse;
- medicines;
- Secondary causes.

Lactose intolerance can be one of the risk factors if there is an insufficient intake of milk and dairy products. Acidophil milk and such dairy products are not the cause of clinical symptoms because the lactose level is low and the bacteria produced by fermentation (*Lactobacillus acidofillus*, bifidobacteria) produce the deficit enzyme - lactase. Semi-hard, hard and processed cheeses do not contain lactose [8,9]. Some medicines, e.g. long-term high dosage of cortisone or anti-epileptics, increase the risk of osteoporosis. Some medicines used for the treatment of type II diabetes and medicines for stomach hyperacidity and anti-depressants (e.g. SSRI – Selective Serotonin Wiederaufnahme Inhibitor) increase the risk as well [1]. Body weight is an important factor as well, because there is a positive correlation between bone density and BMI. People with a BMI under 23 have a lower level of bone tissue density than people with a BMI of 27 to 28. Overweight or obese women better absorb calcium after climax than women with a normal weight and they also lose less bone mass. An effective prevention in older women is to be slightly overweight (BMI up to 27-28) - if there are no risk factors of KVO (hypertension, dyslipidemia, type II diabetes and others). Nevertheless, it has been shown that a BMI over 40 increases the risk of osteoporosis [10]. Being underweight (BMI under 20) is a great risk factor because it correlates with a low level of bone density. In particular, very thin older people and young people with eating disorders are at a higher risk of osteoporosis, because they have an insufficient intake of proteins and energy that leads to the degradation of muscles and bone tissue. For this reason, it is recommended that the unclear causes of being underweight and protein deficit are explained for maintaining or increasing the muscle mass [7]. Starvation increases the degradation of bone tissue. The reason is a lack of calcium and its increased urinary excretion. Starvation causes a metabolic acidosis, which decreases the resorption of calcium in the tubules. By supplementing with 5g of calcium lactate (equal to 1040mg of calcium) during starvation, the lack of calcium can be balanced [7]. Anorexia increases the level of urinary excretion up to three times. Even the supplementation of 1500mg of calcium cannot balance the necessary daily intake. The lack of estrogens causes amenorrhoea. Hormonal changes are not the only reason for a great decrease in bone mass. There is a lack of a number of nutrients that participate in the metabolism of the bone mass, e.g.

proteins, calcium, vitamin D, vitamins of the B group and others. A successful treatment of anorexia leads to the quick normalization of biomarkers of the metabolism. However, the mineralization of bones takes a few years before it is comparable to healthy people [7]. The positive influence of vegetarian food on bone density has not been proven. The reason is probably a relatively high content of amino acids with SH group, which are included in cereals, rice, oats, nuts and seeds. Another reason is fibre, phytates and oxalates vegetarian food, which influence the resorption of calcium and its urinary excreting [5].

The Influence of Nutrients and other Food Content

Calcium: Calcium is the basic part of bone tissue, where there is 99% of body calcium content. The bone is a great calcium supply. If the intake of calcium is low or there is an absorption disorder, there is a stimulation of the parathyroid glands and an increased secretion of the parathyroid hormone, which increases bone remodelling and releases calcium from bones, which leads to increased refractiveness [2]. Of all the nutrients, calcium is the best documented substance in the bone tissue metabolism. Sufficient intake of calcium and its use by the organism are important in the primary and secondary osteoporosis prevention. A number of factors influence calcium absorption as well as its urinary excreting [3,4,11]. Calcium from food is absorbed in the small intestine by a calcium binding protein. Such a process depends on vitamin D. During infancy, 60% of calcium is absorbed from mother's milk [12] and adults absorb 20% up to 40% from assorted diet. The lower the calcium intake, the higher the absorption percentage, and vice versa [13,14]. Factors that influence calcium absorption are its chemical form, contents of other substances in food, physiological factors, the quantity of calcium in food and its daily intake [3]. Vitamin D is one of the substances that influence calcium absorption. It increases the intestinal absorption of calcium and can compensate for its lower intake. Lactose increases the intestinal absorption of calcium [3,11]. The effects have been unclear so far and there are discussions on its influence on pH in the small intestine. Glucose and fructose also increase calcium absorption. Sweet beverages frequently consumed at the expense of milk cannot be an alternative for such an important source of calcium. Prebiotics, lactulose and oligofructosis increase its absorption by one sixth up to one third. The effect is explained by the bifidobacteria growth support, which decrease pH in the intestine and increase calcium solubility [3]. Fats and fatty acids in the intestine bind with calcium and make calcareous soaps; complexes which are not absorbed [11]. No study has proven the influence of a high fat intake on the risk of osteoporosis. Unsaturated fatty acids of type ω-3 have a protective effect on bone mineralization: their existence in the blood serum positively correlates with the density in the vertebra and the whole skeleton. Besides that, up to the age between 22 and 24, the increase of bone mineralization correlates with the DHA (Docosahexaenoic Acid) in the blood serum. A higher intake of ω-6 PUFA probably decreases the pelvis bone mineralization [15]. A lack of protein in food is one of the osteoporosis risk factors. It decreases calcium absorption and increases bone demineralization at a higher age, especially the vertebra and the femur neck. Amino acids within the SH group, mainly contained in proteins of animal origin, decrease the urine pH and calcium resorption in kidney tubules. However, such negative effect has no significant influence on the risk of osteoporosis. There were no differences in the incidence of fractures between vegetarians and others as well. Phospholipids, which are the product of the digestion process during casein split, increase calcium solubility and may increase calcium resorption, especially when there is a lack of vitamin D [3,4,15]. The recommended daily calcium intake from 10 to 12 years is 1 100mg. From 13 to 18 years it is 1 200mg. In people over 18 years it is 1 000mg. Pregnant and breastfeeding women should not increase the recommended intake [16]. The main source of calcium is milk and dairy products: 2 dl of milk, 180g of yoghurt and 60g of semi-hard cheese cover two- thirds of the recommended daily calcium intake. Other sources are some vegetables (broccoli or leek), wholegrain cereals, pulses, mineral waters with at least 150mg Ca/l, water and some types of nuts (hazelnuts or Brazil nuts). The ideal calcium intake is in food, rather than supplementation. Such have been the recommendations of the highest authorities of the societies for the treatment of osteoporosis since 2009 [7]. The Institute of Medicine established the highest tolerable daily calcium intake to 2500mg in 1997. A higher intake increases the risk of calcification of soft connective tissues. The connection between the calcium intake from food and the possible side effects (e.g. cardiovascular problems, kidney stones or frequently mentioned gastrointestinal problems) has not been proven. The reason is probably slow and even calcium absorption in the small intestine [14].

Proteins: A frequent lack of proteins in people of a higher wage increases the risk of hip joint head fracture and worsens its prognosis. The reason is the decrease of bone mass and the main protein reservoir in the organism, as well as the insufficient protection of the joint area. While the lack of protein in children and adolescents negatively influences the peak bone mass, too high an intake increases the urinary excretion of calcium and contributes to osteoporosis. Studies of healthy people confirmed such a hypercalciuretic effect and showed that mainly amino acids within the SH group (methionine or cystine), which can be found especially in animal origin proteins, decrease the urine pH and calcium resorption in kidney tubules [5,15]. Measuring bone mass of different parts of the skeleton negatively correlated with animal origin proteins and positively with plant protein intake. The same fact was found regarding thighbone neck fracture frequency [5]. This is the reason why it is efficient to restrict animal origin protein intake and increase plant protein intake. The studies of healthy people showed that mainly acid-forming food decreases urine pH in comparison to basic food. Such a load increases calcium excretion by 74% without the increase of intestinal calcium absorption.

Vitamin A: Vitamin A decreases bone density and increases the risk of hip joint fractures. The assessment of Women's Health Study in 30,000 post-climatic women showed that the risk in women who used the vitamin as a supplement was slightly increased. The newest NHANES I follow-up study shows that a low as well as high vitamin A intake is associated with a higher risk of hip joint fractures [15,17]. Some other vitamins also directly or indirectly contribute to bone mineralization (vitamins B_6, B_{12} or C).

Vitamin D: Vitamin D is necessary for calcium and phosphate homeostasis and bone metabolism. Lately, there has been more awareness of the extraskeletal positive effects of vitamin D [2]. Vitamin D has special features in comparison to other vitamins because it can be found in food, but it is formed in the skin as well. To reach the optimal 25-hydroxyvitamin-D-concentration saturation of at least 50 nmol/l in blood serum during endogenic formation, intake of this vitamin by food is not sufficient. The gap must be covered by endogenic formation and/or vitamin D_3 supplementation [16]. Vitamin D from food is absorbed with fats and it is transported in the lymphatic system by chylomicrons. The level of absorption is

approximately 80% [18]. The sun causes the formation of the vitamin D_3 (wave extent is 280 to 320 nm) from 7-dehydrocholesterol [19]. Vitamin D from food or synthesized from the skin is transported to the liver through the blood. There, the prohormone 25-OH-D_3 is formed by hydroxylation 25-hydroxycholecalciferol, known as calcidiol. In the kidneys, it is again hydroxylated to 1.25-OH_2-D_3, 1.25-dihydroxycholecalciferol, known as calcitriol. This metabolite is the active product of vitamin D in the targeted organ [5,20]. Vitamin D_3 is especially important in childhood during the skeleton development. It is one of the most important regulators of calcium metabolism with a number of effects on the skeleton [21].

Vitamin D:

- increases calcium absorption from the intestines to blood flow;
- decreases urinary excretion of calcium;
- increases the formation, maturation and activity of bone cells;
- activates osteoclasts and keeps the level of extracellular calcium at normal levels;
- increases bone mineralization;
- Together with calcium, decreases the risk of fractures [11].

Other advantages of an adequate vitamin D supply are under discussion [11], such as:

- muscle mass increase;
- fall risk decrease;
- improvement of movement co-ordination;
- systolic and diastolic blood pressure decrease and improvement of cardiac insufficiency;
- decrease of the risk of breast and large intestine cancer [16,22,23];
- influence on the skin: growth deceleration and the support of keratocyte maturation;
- influence on the metabolism of fats and carbohydrates;
- antithrombotic effect;
- Anti-inflammatory effect, especially in immunological and allergy illnesses and in HIV patients.

The recommended daily intake for adolescents and adults with a missing endogenic formation is 20 µg [16]. The main sources are fatty fish (herring or mackerel), liver, egg yolk, margarine with vitamin D and some varieties of mushrooms [24].

Vitamin K: Vitamin K is also important for normal bone formation. Its intake decreases the risk of fractures [11]. It is necessary for the formation of osteocalcine and other proteins which are specific for bone mineralization [3,15]. Animal experimenting, and the fact that the skeleton formation in the uterus can be damaged if vitamin K antagonists are taken in, shows that vitamin K is necessary for the formation of bone proteins because proteins are crucial for calcium apatite storage. After menopause, vitamin K increases calcium resorption in the kidneys and decreases the risk of fractures [5]. The optimal vitamin K dosage is the basis for the sufficient synthesis of osteocalcine - extracellular bone matrix protein - which is formed by osteoblasts. This protein makes up 20% of total bone protein. Although the osteocalcine function has not been unravelled yet, it is known that its concentration rises with the increasing osteoblasts activity. The DACH's recommended daily vitamin K intake in adolescent and adult men under 50 is 70 µg, and in women it is 60 µg. The recommended daily intake in men over 50 is 80 µg, and in women it is 65 µg [15]. A high content of vitamin K can be found in green vegetables, milk and dairy products, meat, eggs, cereals, fruit and other kinds of vegetables [24,25].

Other Vitamins and Minerals

Vitamin C is necessary for the maturation and "cross-linking" of collagenous molecules; it stimulates osteoblasts and supports intestinal calcium absorption [11]. The recommended daily intake in adolescents and adults is 100 mg [16]. Vitamins B_6, B_{12} and folic acid are necessary for bone density. They influence homocysteine degradation, which is an important osteoporosis risk factor. The deficit of vitamin B_{12} correlates with low bone formation marker values, low specific alkalic phosphatase and low osteocalcine value. Patients with vitamin B_{12} deficit have lower bone density and a higher risk of fractures [11]. Other important substances are magnesium, boron, silicon, zinc and copper. Magnesium is important for the metabolism of vitamin D and parathormone regulation and it activates the bone alkalic phosphatase. Studies of older age patients have shown that a higher magnesium intake positively correlates with a higher bone density. Magnesium supplementation is recommended to people with a deficit of this mineral. The recommended daily intake in adolescents and adults is 400 mg, in girls it is 350 mg, in adult men the recommended intake decreases from 400 mg to 350 mg, and in women from 350 to 300 mg [16]. Good magnesium sources are wholegrain cereals, milk and dairy products, liver, poultry, potatoes, fish, many kinds of vegetable, oranges and bananas [16].

Phosphates: A high phosphate intake decreases calcium absorption and usage [3,4,11]. Considering our eating habits, the daily phosphate intake has no important influence on bone density. Referential values for nutrient intake of the German, Austrian and Swiss nutrition company DACH [17] recommend for adults a daily phosphate intake of 700 mg. Considering the bone mass growth and tissue formation in puberty and adolescence, the recommended daily intake increases to 1 250 mg. As mentioned, a higher phosphate intake does not increase the process of the bone mass resorption. For this reason, the calcium and phosphate food intake does not have to be abided [5].

Common salt: Common salt increases urinary calcium loss by 4-5% per 500 mg of sodium in food. However, the osteoclasts activity is not influenced by a higher salt intake. After menopause, women react to common salt more strongly than younger women, so they must be careful not to increase salt intake and to increase calcium intake. A high salt intake increases the risk of hypertension. Patients with hypertension excrete more calcium and they are at a higher risk of osteoporosis. Newer studies show that reducing the common salt intake decreases the risk of osteoporosis [11]. Study results conclude that an average daily salt intake of up to 9 g does not increase the risk in healthy people [5]. The recommended daily salt intake is 5 g [16].

Wholegrain products, oxalates: Foods that decrease the intestinal calcium absorption are wholegrain products, mainly bran, containing phytates [26]. Their influence on bone density has not

been shown, probably because they increase calcium resorption in kidneys. Wholegrain nutrients contain substances that have a positive effect on bones, such as lignans and phytoestrogens, contained mainly in soya [3,4]. Higher phytoestrogen dosage can have a similarly positive influence to ovarian estrogens because they bind to estrogenic receptors [3]. By consuming foods with a high level of oxalates (spinach, asparagus), a non-dissolvable calcium oxalate is formed. It is not absorbed, so the calcium usage from these foods is decreased [26].

Other Factors

There are other factors that influence calcium resorption by 10-60 %. It is valid for the concentration of the 25-hydroxy-vitamin-D, parathormone, the intestinal transit period, the contents of fats in foods, etc. [5]. In prospective epidemiological studies, older men and women showed a positive correlation between an increased fruit and vegetable consumption and a higher intake of potassium and magnesium and bone density. A high intake of these minerals slowed down the decrease of bone density in the hip joint. This positive effect is explained by a decrease of the renal calcium excretion during a high potassium intake and the alkalization of urine due to fruits and vegetables [5]. Animal experimenting and studies of healthy individuals show that prebiotics, such as lactulose, oligofructose or transgalacto-oligocarbohydrates, significantly increase calcium resorption. Because there is not an increased urinary calcium excretion, retention is increased. It is assumed that an increased bacterial synthesis of short chain fatty acids improves calcium absorption [5].

Alcohol: Study conclusions on the influence of alcohol on the level of minerals in the skeleton are not unanimous. The probable reason is the influence of the quantity of alcohol intake. The intake in men up to 20g/per day (2 dl of wine or 5 dl of beer) and 10g/per day in women (1 dl of wine or 3 dl of beer) increases the level of bone minerals. On the other hand, a long-term high alcohol intake leads to a significant decrease of bone mass [5,11]. A long term alcohol intake probably negatively influence bone metabolism:

- high alcohol intake influences the osteoblasts activity;
- covering the necessary essential nutrients is decreased in alcoholics;
- along with liver damage due to alcohol, there are vitamin D metabolism disorders;
- Alcoholics have a higher parathormone concentration in the blood serum.

Coffee: Studies on the relationship of caffeine intake, calcium balance and bone density have reached different conclusions. Some studies found that coffee consumers have a decreased calcium excretion and decreased bone density [11]. This was mainly related to women with a low calcium intake and regular coffee intake. Younger people compensate the urinary calcium excretion by increased calcium absorption, while such compensation decreases with age [5,27,28]. 2 cups of coffee per day (200 mg of caffeine) have no negative effects on the organism.

Prevention and Nutrition Therapy

Calcium: The need for calcium for a healthy bone tissue has been well documented. An intake of under 800 mg/per day increases the risk of hip joint fractures [29]. A number of authors conclude that 800 mg of calcium per day is the lowest intake for the optimal bone formation. The recommended daily intake for adults is 1,000 mg/per day [16]. The recommendations do not take height into consideration. Shorter people need less calcium. A high intake of over 1,500 mg does not improve its effect. With an existing osteoporosis, sufficient calcium intake must be long term. Usually, supplementation is necessary. A varied and balanced diet ensures the required quantity of calcium (1,000 mg) only if milk and dairy products are regularly consumed. On average, a vegan diet contains 500 mg of calcium and increases the risk of osteoporosis. It is necessary to be aware of the calcium levels from foods of plant origin, which is much lower compared to milk and dairy products. A vegan must be careful with the selection of foods that are rich in calcium and proteins. An ovo-lacto-vegetable diet is not associated with the risk of osteoporosis [30]. Supplementation is recommended with an existing osteoporosis or fractures if the daily calcium intake of 900–1 000 mg is not ensured. The quantity of the supplemented calcium must respond to its deficit. The chemical composition of the supplement is not clinically relevant. It is not recommended to use the supplement on an empty stomach and the adult dosage should not be higher than 500 mg. The result is an improvement, as well as a slower intestinal absorption [30]. Calcium supplementation alone is not an osteoporosis therapy. The supplementation combined with vitamin D decreases fracture incidence. Supplements can even increase the risk in older patients because they decrease phosphate absorption and, with their deficit, the fracture incidence can increase [31]. Calcium from food does not increase the risk of cardiovascular diseases. It is related to calcium supplementation as well: 4 randomized controlled, 26 cohort studies or monitoring studies found no significant differences between calcium supplementation (with vitamin D or without) and placebo regarding cardiovascular diseases or mortality. The results of these studies lead to the conclusion that the maximum 2.0-2.5 g calcium intake does not increase cardiovascular risk in healthy people. The application (food or supplement) has as little influence as the combination with vitamin D [32].

Vitamin D: The optimal saturation by vitamin D is necessary for the bone tissue. Solar radiation is insufficient in our country, so the level 25-OH-D is low, and at old age is associated with osteoporosis and an increased incidence of bone fracture. The optimal level in blood can be reached by daily exposure of the face, arms and legs to the sun for 10-20 minutes. UV radiation is the most important source of vitamin D, but it is not reliable. In winter, the UV radiation is insufficient, which leads to a decreased production of vitamin D. In old age, the production in the skin is decreased and seniors avoid being exposed to the sun. For this reason, most of the Middle-European population have an increased deficit of vitamin D. The production of the vitamin in the skin is also decreased by sun creams or unsuitable clothes. Other factors also influence its production: geographical latitude, daytime, altitude, cloudy weather, cloud types, ozone, air pollution, altitude and the reflection of sunrays [33]. A number of studies show that low levels of vitamin D in the blood are associated with an increased mortality and various illnesses. The goal is to reach a >50 nmol/l (>20 ng/ml) concentration value of 25-OH-D_3 in blood serum. When there is a risk of falls and fractures, the value should be >75 nmol/l (>30 ng/ml). The concentration of 21–30 ng/l signals a deficit, 10–20 ng/l a considerable deficit and <10 ng/l a great deficit [14,30]. During supplementation in patients with osteoporosis and elderly people, measuring the level in the blood is not required because a low concentration of 25-OH-D_3 is common. Only with the vitamin D intake of 100 μg per day can there be side

effects (some authors claim 150 µg per day) [30]. Vitamin D is stored in the organism so the supplementation can be concentrated on one dose in longer time intervals. Regarding fall and fracture prevention, the best results were shown by a monthly supplementation of 600 µg of vitamin D_3 (20 µg per day). A higher dosage has no positive advantages. It can even lead to a higher fall risk [34]. Osteoporosis prevention – practical recommendations:

- consume 3 portions of milk and dairy products with low level of fat per day;
- give preference to vegetables rich in calcium (broccoli, cabbage);
- drink mineral waters with a high calcium content;
- be careful with alcohol intake;
- consume fatty fish (mackerel, herring) at least once per week;
- instead of salt, use parsley, chives and chervil;
- eat fruit and vegetables five times per day;
- restrict the consumption of foods which contain oxalates (rhubarb, spinach, cocoa);
- pay attention to a sufficient vitamin D (fish, liver, milk), vitamin K (green vegetables, liver, fish) and vitamin C intake;
- restrict salt consumption;
- pay attention to a regular movement;
- Do not smoke.

Conclusion

Osteoporosis is a systematic skeleton disease, which is characterized by increased bone refractiveness. The causes are a decreased bone density and disorders in the bone tissue micro-architecture. Those affected are mostly men and women at a higher age, but also young people who are underweight or people with eating disorders. The growing life expectancy increases the prevalence of this disease.

A varied and full diet, regular movement and stays in the countryside are crucial for prevention. The goal is to reach the peak bone mass at a young age and to slow its decrease at old age. Mainly, keeping the level of bone mass and the optimal calcium and vitamin D intake are important. It is good not only for prevention but osteoporosis treatment as well.

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