

Osteoporosis: A Review of the Factors Affecting Osteoporosis and its Management

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ABSTRACT

Osteoporosis is the most common skeletal disease in humans in which bone density and quality are reduced, leading to osteoporotic fractures. Most osteoporotic fractures occur in areas such as the spine, hip, and wrist. Factors involved in the development and exacerbation of osteoporosis include non-modifiable factors such as age, gender, race, and genetics, and modifiable factors such as body mass, smoking, sedentary lifestyle, and diet. In this review article, we have evaluated osteoporosis, the related factors, and the management of this disease. During this study, after electronic search and review of titles and abstracts, articles with appropriate consistency and content were included in the study. The findings showed that although a decrease in bone density and strength with age is inevitable, by taking measures such as the use of pharmacological and non-pharmacological strategies, increasing physical activity, and adding nutrition containing vitamin D in the diet of people, the occurrence of this complication can be prevented.

Keywords: Osteoporosis, Osteoporotic fractures, modifiable and non-modifiable factors, treatment of osteoporosis.

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INTRODUCTION

The most common skeletal disease in humans is osteoporosis, in which bone strength and density decrease and the risk of bone fracture increases. Decreased bone density intensifies with age, which varies between sexes and races. The most important non-modifiable factors in the development of osteoporosis include age, menopause, and female gender. Also, factors involved in increasing the risk of bone fractures include vitamin D deficiency and sedentary lifestyle, premature menopause, autoimmune diseases, the use of certain drugs, and neurological disorders [1]. After the first fracture, the risk of subsequent fractures greatly increases, which is associated with decreased quality of life [2]. White women are more likely to develop osteoporosis, whereas 46% of white women over the age of 50 have this condition, and two-thirds of them are asymptomatic. Exercise, prevention of falls, and consumption of appropriate and recommended amounts of calcium and vitamin D are important and essential factors in the prevention of bone fractures and osteoporosis [3].

With age, the possibility of fractures (especially in the hip area) increases in people, which strongly affects the quality of life [4, 5]. Investigating the factors involved in osteoporosis is an important issue [6] and can be effective in the awareness of individuals and society. Considering the importance of osteoporosis and recognizing the factors affecting health, the present study examines osteoporosis, the affecting factors, and its management.

MATERIALS AND METHODS

The review study was conducted in December 2020 and to obtain articles on osteoporosis, databases of Nature, PubMed, Medline, NCBI, PsycINFO, and other reputable sources in the world were used. In order to collect

information in the field of osteoporosis in terms of content, keywords such as osteoporosis, osteoporotic fractures, modifiable and non-modifiable factors, treatment of osteoporosis, etc. were searched in the desired databases. Articles that were consistent with the present research in terms of subject and content were used in this article. By reviewing the articles, information on the patterns and quality of treatments of osteoporosis, classification of types of osteoporosis, factors involved in the development of this disorder, osteoporotic fractures, prevention and management and treatment of osteoporosis, non-pharmacological treatment and management, the effect of exercise and physical activity in patients with osteoporosis, the effect of vitamin D in patients with osteoporosis, and drug therapies and hormone therapy, were extracted from the studies.

Osteoporosis

Cells called osteoblasts, which are the result of differentiation of bone marrow mesenchymal cells, are responsible for bone structure. The activity of these cells, along with osteoclasts (responsible for the decomposition of bone matrix), causes the bone to regenerate continuously. Osteoporosis is the most common skeletal disease in humans in which bone density and quality are reduced, leading to osteoporotic fractures. Most osteoporotic fractures occur in areas such as the spine, hip, and wrist [4], of which hip fractures are more usual and this type of fracture may be associated with mortality and decreased levels of physical function. On the other hand, fractures of the spine cause disability and increase mortality and morbidity among individuals. In general, osteoporosis and its complications can affect the quality and lifestyle of patients and cause problems such as depression, anxiety, and low self-esteem [5].

Classification of types of osteoporosis and the factors involved in their development.

Osteoporosis is divided into primary and secondary types:

Primary type: It is a process caused by aging and lack of gonadocorticoids. Bone density decreases with age, a trend that is more pronounced in postmenopausal women. Factors involved in accelerating this type of osteoporosis include body mass index (BMI), smoking and alcohol consumption, and sedentary lifestyle [6, 7].

Secondary type: Factors involved in the development of this type of osteoporosis include endocrine and metabolic disorders (such as hypogonadism, acromegaly, and anorexia nervosa), nutritional problems (such as calcium and vitamin D deficiency, malabsorption), some medications (such as poisoning with vitamin D, glucocorticoids and heparin), and some diseases (such as Marfan syndrome, some cancers, and thalassemia major) [8].

Factors affecting osteoporosis and osteoporotic fractures.

Factors affecting osteoporosis include clinical factors (such as age and gender), medical factors (such as gastrointestinal disorders, hematological and hypogonadal disorders, and the use of certain medications), behavioral factors (such as smoking and sedentary lifestyle), nutritional factors (calcium and vitamin D deficiency), and genetic factors.

Age: In general, with age, bone density decreases, and the rate of osteoporosis increases.

Gender: The prevalence of osteoporosis is higher in women than men.

Diseases and Medications: Underlying conditions such as malabsorption syndrome, inflammatory diseases, and thalassemia, as well as the use of certain medications such as glucocorticoids and heparin, can affect bone quality and strength and cause or exacerbate osteoporosis.

Smoking: Smoking and caffeine consumption increase the risk of hip fractures by reducing the efficiency of intestinal calcium absorption.

Vitamin D: Vitamin D deficiency affects osteoporosis and increases the risk of bone fractures by affecting BMD and reducing calcium absorption.

Genetics: The prevalence of osteoporosis varies between different races and ethnicities, whereas it is more frequent among white and Asian women than others. Small body size and family history are other cases involved in osteoporosis [9, 10].

These factors are referred to as modifiable risk factors (environmental factors) and non-modifiable risk factors (genetic factors) that individually or in combination reduce bone density and result in osteoporosis [11].

Diagnosis of osteoporosis

In patients with osteoporosis, it is highly important to evaluate and determine bone density, the risk of fracture and choose the appropriate treatment. One of the methods to diagnose osteoporosis is to conduct a bone mineral density test, which measures the amount of bone mineral density. According to the world health organization (WHO), osteoporosis is determined based on the test scores of this test (BMD). During this test, the amount of minerals in the bones of the individual is compared with the results of the amount of these substances in a young and healthy person of the same sex. The standard deviation (SD) in the bone density of the subject is different from that of a healthy person and the result is a T-score. A score less than 2.5 is considered osteoporosis; in general, any SD less than normal increases the risk of bone fractures by 2 to 3 times. Bone density can also be measured with Dual-energy X-ray absorptiometry (DXA). To test bone density, a very low

dose of ionizing radiation is used to produce images of the spine, hip, waist, and lower back. This method is a simple, fast, and non-invasive method and due to having the highest accuracy, it has a gold standard in the diagnosis of osteoporosis [11-13].

Prevention, management, and treatment of osteoporosis

Although a decrease in bone density and strength with age is inevitable, measures can be taken to prevent this complication. Childhood is a sensitive and effective period in the field of prevention of this disease. Receiving adequate levels of vitamin D and calcium and regular physical activity is an effective step in increasing a person's bone density, which reduces the risk of osteoporosis and related fractures in the future [14].

Non-pharmacological management and treatments

The rate of bone fractures in older people with osteoporosis is higher than in others, therefore reducing this risk is important, which is possible with non-pharmacological therapies. Since aging causes poor vision and muscle weakness in people, the risk of falls and bone fractures increases in the elderly; in order to prevent this risk, it is necessary to take some measures such as the provision of a safe environment for the elderly (even if possible, an environment without stairs), cessation of the consumption some medications, treatment of their vision problems, light and proper exercise, and consumption of vitamin D. Also, the use of assistive devices such as walkers, crutches, bedsides, and shower chairs reduce the risk of falls and fractures in the elderly [15].

The effect of exercise and physical activity in patients with osteoporosis

Exercise is one of the main strategies to prevent and reduce the risk of osteoporosis. Exercise stimulates bone formation, increases bone density, muscle mass, and BMD in patients with osteoporosis [16]. Moderate to vigorous physical activity three to four times a week is associated with a significant reduction in the risk of bone fractures and an increase in bone strength and stamina in both sexes [17]. The most effective types of exercise in increasing femoral BMD are weight-bearing exercises such as water exercise and hydrotherapy, and to increase BMD of the spine, physical activity, and combined exercises are highly effective. These types of exercises are very effective in preventing and treating osteoporosis in postmenopausal women, reducing bone loss and increasing bone density in these people [18]. Physical activities for patients with osteoporosis should include weight-bearing exercises (such as walking and jogging), balance exercises (such as tai chi), and strength exercises to strengthen bone density and reduce osteoporotic fractures. In addition, walking does not singly affect spinal BMD, but can have long-term positive effects on femoral BMD during menopause [19, 20].

The effect of vitamin D in patients with osteoporosis

In addition to affecting cell differentiation and proliferation and strengthening the immune system, by increasing the intestinal absorption of calcium and releasing phosphate and calcium from the bones, vitamin D helps the maintenance of the optimal concentration of these two elements in the body [21]. Vitamin D plays an important role in bone metabolism and its consumption is associated with increasing life expectancy and preventing several acute and chronic diseases. Although this vitamin cannot help regenerating lost bone matrices and minerals, which is caused by osteoclasts, receiving adequate amounts of vitamin D can increase an individual's BMD and reduce the risk of diseases such as

diabetes type 2 and cardiovascular diseases [22]. Studies show that the consumption of vitamin D alone is not effective in preventing bone fractures in the elderly [23], but the use of this vitamin with calcium has a positive effect on BMD and reduces the risk of falls and bone fractures [21]. Although vitamin D and calcium intake can prevent hip fractures or other types of fracture, consideration should be given to the use of these supplements in patients with heart, kidney, and gastrointestinal diseases, because supplements such as calcitriol (the active form of vitamin D) are associated with an increased risk of hypercalcemia [24].

Pharmacological treatments

In acute and advanced cases of osteoporosis, drug therapies are used to manage and treat this complication. Bisphosphonates are the most commonly used medications in the treatment of osteoporosis, which significantly reduce fractures due to osteoporosis. Bisphosphonates contain a carbon-phosphate-carbon structure and attach to the surface of the bones to protect them against chemical hydrolysis. Mechanisms of action of these compounds include inhibition of osteoclast precursor, osteoclast apoptosis, and inhibition of the mevalonate pathway. The most common drugs in this category are: Alendronate (Fosamax), Risedronate (Atelvia, Actonel), Ibandronate (Boniva), and Zoledronic Acid (Zometa, Reclast), among which zoledronic acid is used intravenously to reduce fractures of the hip, spine, and non-vertebral fractures and the other three medications are used orally to reduce fractures of the hip and spine [25, 26].

Other medications used for the treatment of osteoporosis include SERMs. These compounds are selective modulators of estrogen receptors and act as estrogen antagonists or agonists, depending on the target tissue. SERMs reduce the risk of spinal fractures but have no effect on other fractures. The most important drugs in this category are raloxifene and bazedoxifene [27].

Another drug used for the treatment of osteoporosis is denosumab, a monoclonal antibody that binds to RANK-L (activator receptor of nuclear factor kappa B) and inhibits its binding to its receptor. This increases BMD and calcium concentration, thereby increasing bone strength and reducing bone damage. This medication is used intravenously to reduce the risk of hip, spinal and non-vertebral fractures [28].

Another drug used in the treatment of osteoporosis is teriparatide, which is an effective anabolic substance and a recombinant protein of parathyroid hormone that is used intravenously and increases bone density and reduces the risk of osteoporotic fractures by regulating calcium and phosphorus metabolism. This medication is used in the initial treatment of osteoporosis in postmenopausal women in which other treatments have not been successful [13].

Hormone therapy

One of the methods used for the treatment of osteoporosis and resulting fractures in postmenopausal women is hormone therapy or hormone replacement therapy (HRT). Estrogen plays an important role in bone metabolism; bone metabolism decreases with age, especially in menopausal women, which leads to a decrease in BMD and an increase in fractures due to osteoporosis. Hormone therapy increases bone density and strength by increasing BMD and reduces the risk of fractures. This method is not usually used as the first line of treatment for osteoporosis [29].

DISCUSSION AND CONCLUSION

Osteoporosis is a systemic skeletal disease that is associated with decreased bone density and strength, as well as an increased risk of bone fractures, which imposes high economic and social costs on individuals and countries each year. This condition is called silent disease since it occurs in the bones without any signs or symptoms. Most fractures due to this complication usually occur in areas such as the hip (hip joint) and spine [30]. Factors involved in the development and exacerbation of osteoporosis include non-modifiable factors such as age, gender, race, and genetics, and modifiable factors such as body mass, smoking, sedentary lifestyle, and diet [31]. Non-pharmacological and pharmacological treatments are used to control and treat osteoporosis and reduce the risk of fractures. One of the most important methods of prevention and non-pharmacological management is physical activity and adequate intake of calcium and vitamin D. Certainly, improvement of vitamin D levels by consuming foods rich in vitamin D and exposure to sunlight helps reduce osteoporosis by increasing bone density. Exercise and physical activity in childhood and adolescence stimulate bone formation and increase bone density and strength, and in the elderly protect bone mass, thereby reducing the risk of fractures of bones and vertebrae. In various studies, the positive effects of different sports in the prevention and treatment of osteoporosis have been proven [32-35]. Vitamin D and calcium intake also improve osteoporosis and reduce the risk of fractures by increasing BMD and bone strength [36-39]. In more advanced cases of osteoporosis, treatments include hormone therapy and administration of various drugs, especially bisphosphonates, which reduce the risk of hip and spinal fractures by increasing bone density and strength [40-42].

It is suggested that in the future, clinical studies be conducted on the important factors affecting osteoporosis and that the best treatment methods be further examined.

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