

## Osteoporosis

### Introduction

Keeping your bones healthy is a lifelong process that depends on a number of factors, including body weight, exercise, illnesses, age, and diet. Out of all of these factors, diet is the one that is most easily controlled. Children are taught from a young age to drink milk so that they can build strong bones. However, the consequences of a poor diet may not be seen until much later in life when options for improving bone health are limited. Chronically inadequate calcium intake can lead to osteoporosis in old age. Without complications, osteoporosis is a silent disease. A person may be unaware of any problems until something as simple as tripping over a rug shatters a hip. The consequences of fractures can be debilitating. About 24 percent of patients who fracture a hip die within one year of the injury (1). About 53% are discharged from the hospital into a skilled nursing facility (1). If we lived long enough, eventually everyone would get osteoporosis. However, there are ways to prevent or delay osteoporosis that, if started early, could allow most people to never have a concern about bone health.

### Disease Description

Osteoporosis is a disease of very low bone mass density (BMD) that occurs mostly in the elderly. It is diagnosed when BMD is 2.5 standard deviations or more below the average BMD of healthy bone (2). In the US, osteoporosis is quite common. About 54 million Americans have osteoporosis, a majority being women (3). About half of women and one-fourth of men over 50 years old may have osteoporosis (3). The biggest health risk of having osteoporosis is high susceptibility to low trauma fractures, such as breaking

the hip after tripping over a rug. These fractures commonly occur in the vertebrae, hip, and forearm. In 2005, more than 2 million fractures occurred due to osteoporosis (4). In that same year, 793.5 out of 100,000 women and 369 out of 100,000 men age 65 and older experienced a hip fracture (1).

### Etiology

Osteoporosis has both primary and secondary causes. Primary osteoporosis is related to hormonal changes and age. Beginning around menopause, women experience decreased estrogen production and losses of trabecular bone (4). Though not as common, hypogonadism in men and the resulting decrease in androgens can also cause osteoporosis (4). As humans age, the process of bone remodeling becomes increasingly unbalanced, with bone resorption happening much more quickly than bone formation (4). This results in an increasing net loss of bone density. Thus, age and gender are major risk factors for primary osteoporosis.

Secondary osteoporosis occurs when other diseases, medications, lifestyle factors, or environmental factors cause a decrease in bone density. Calcium is an important component of bone matrix. Diets that are chronically deficient in calcium or vitamin D (which increases calcium absorption), decrease the body's ability to store calcium in the bone and result in decreased BMD. For this reason, adequate dietary calcium and vitamin D intake is the major focus of osteoporosis prevention.

Certain medications can reduce BMD. For example, the prolonged use of glucocorticoids can cause glucocorticoid-induced osteoporosis. Glucocorticoids decrease bone formation by impairing the function of osteoblasts, decreasing the number of osteoblasts, and impairing collagen synthesis (5). Smoking and excessive alcohol consumption are also risk factor for osteoporosis. Smoking decreases the absorption of

calcium in the small intestine and decreases BMD (6). Some evidence suggests that alcohol consumption actually increases bone density (7). However, excessive alcohol intake (more than one drink for women, more than two drinks for men) increases the risk of falling and is therefore considered a risk factor for decreased bone health (8). Other risk factors for osteoporosis include low body weight, white or Asian ethnicity, and low exercise (4).

### Pathophysiology

Bone matrix is primarily made of collagen and hydroxyapatite crystals, which contain calcium (4). Most of the body's calcium is stored this way in the bones. When insufficient calcium is provided from the diet, the body removes the calcium from the bones and uses it in the body (4). Bones are dynamic organs. Bone matrix is continually being broken down (called bone resorption) by osteoclasts, and built back up (called bone formation) by osteoblasts (4). Bone density is a result of the balance of these two processes. Throughout childhood and into early adulthood, the balance favors bone formation, thereby allowing bones to grow (called bone modeling) and then become more dense (called bone consolidation) (4). Around age 30, humans achieve peak bone mass (4). As people continue to age, the balance between osteoclast and osteoblast activity increasingly favors osteoclasts (4). With these processes out of balance, BMD gradually declines (4). For women, this decline happens most rapidly right after menopause as estrogen production decreases (4). As BMD decreases, bones have an increased risk of fracturing and collapsing. Osteoporotic compression fractures in the spine can cause kyphosis (9). If bone mass loss is severe enough, fracture can occur from low trauma falls or doing everyday activities. Osteoporotic fractures can be debilitating. Over half of patients who break their hip subsequently need skilled nursing care (1).

## Methods of Medical Diagnosis

The “golden standard” tool for diagnosing osteoporosis is a dual-energy x-ray absorptiometry (DXA) scan, which measures body composition. For osteoporosis, DXA scans measure bone density in the hip and vertebrae. Osteoporosis is diagnosed when bone-mass density is below 2.5 standard deviations under the mean density of healthy bone within the same gender (10). While the DXA scan is the gold standard for diagnosing osteoporosis, other methods can be used for screening. These methods include CAT scans, MRI, x-rays, and ultrasounds (4). A limitation of these methods that measure BMD is that they are unable to assess the risk of fracture.

To assess fracture risk, the World Health Organization developed the Fracture Risk Assessment Tool (11), which takes into account a person’s clinical risk factors and BMD and calculates the probability that an individual will have an osteoporotic fracture within the next 10 years (11). FRAX is an online tool and therefore easy and cost free to use.

## Current Medical Therapies

There are a few different routes for medically treating osteoporosis, including medication, exercise, and supplementation. There are five major classes of osteoporosis medications: estrogen replacement therapy, selective estrogen receptor modulators (SERMs), bisphosphonates, calcitonin, and parathyroid hormone therapy. Estrogen replacement therapy (ERT) is used primarily in women soon after menopause. After menopause, decreased levels of estrogen cause increased bone loss. Estrogen blocks the release of cytokines that promote osteoclast activity, thereby increasing bone density. However, some evidence suggests that estrogen replacement therapy may increase the risk of breast cancer, myocardial infarction, stroke, pulmonary emboli, and deep vein

thrombosis (8).

The next class of medication is bisphosphonates. Bisphosphonates block osteoclastic bone resorption and are used to prevent future fractures. Different bisphosphonates reduce the incidence of fractures between 36 and 71 percent (8). Side effects of glucocorticoids include dysphagia, gastritis, esophagitis, and some instances of jaw necrosis with long term use (8).

Selective estrogen receptor modulators (SERMs) are the third class of medication. SERMs act as estrogen receptor agonists on bones, and as estrogen antagonists at the breast (8). While estrogen replacement therapy increases the risk of breast cancer, SERMs do not because they do not stimulate the breast (8). SERMs decrease the risk of a vertebral fracture by 50% in individuals who have not had a fracture, and by 30% in individuals who have had a previous fracture (8). Side effects of SERMs may include hot flashes and deep vein thrombosis (8).

The fourth class of osteoporosis medications is calcitonin. Calcitonin blocks parathyroid stimulation of osteoclasts and can decrease the risk of vertebral fractures by 30% (8). However, calcitonin is only recommended for use in women who are at least five years postmenopausal and when alternative medications are not appropriate (8). Side effects of calcitonin include epistaxis, rhinitis, allergic reactions, and a small increase in the risk of cancer (8).

The last class of osteoporosis medication is parathyroid hormone therapy. In this therapy, teriparatide, a recombinant form of parathyroid hormone, increases the number and function of osteoblasts (8,4). Teriparatide is often used before bisphosphate treatment to increase BMD before blocking resorption (4). Parathyroid hormone therapy reduces the risk of fractures by 23-34% (8). Side effects may include

leg cramps, nausea, and dizziness (8).

Osteoporosis is a silent disease because it is often asymptomatic until an individual fractures a bone. One of the most common fracture sites is the hip. When individuals with osteoporosis fracture their hip, they often require hip surgery to be able to walk again. When an individual fractures the head or neck of the femur, the first option for hip surgery is hip repair surgery. In this surgery, the bones are first put back into their proper alignment, then screws, nails, pins, and rods are used to pin the bone in place (12). This technique is often the first option suggested because it makes use of the individual's own bone. However, hip repair has a much higher chance of having complications and requiring reoperations than a total hip replacement (13).

In a total hip replacement surgery, an individual receives an entirely new hip joint. The neck and head of the femur are removed and replaced by a metal piece that acts as the new ball (14). The inside of the acetabulum is first smoothed out, and then a new socket is placed into the acetabulum (14). There are two ways in which these new parts can be attached to the bone. When the new joints are cemented in, a glue or cement is used. When the new joint is uncemented, the surface of the joint that attaches to the bone is porous, allowing new bone to eventually grow into the pores (14). The uncemented method is not recommended for patients with osteoporosis because their bone health is too poor to grow to form a firm attachment (14).

#### Alternative Therapy

For a person with osteoporosis, minor falls can cause major damage. One method that might be helpful in preventing hip fractures from falls is the use of hip protectors. Hip protectors are specially designed undergarments that have built-in padding and/or plastic shields that dissipate the force of impact on the hips when a person falls.

According to a Cochrane review of the effectiveness of hip protectors, hip protectors probably reduce the risk of hip fractures from falling (15). However, hip protectors are not commonly used, even when provided (15). Low acceptance is a major barrier to the use of hip protectors for fracture prevention.

### Nutrition Assessment

A nutritional assessment for osteoporosis includes taking into account anthropometric measurements; biochemical markers; clinical signs, symptoms, and medical diagnosis; dietary habits; and a family history of osteoporosis. Important anthropometric measurements include current height and weight, along with historical losses in height and weight (8). Losses in height may be indicative of spinal osteoporotic compression fractures. Age and gender must also be ascertained since the risk of low BMD increases for females and as people age.

Biochemical markers that are important for osteoporosis are ones that indicate either bone formation or bone resorption (4). Plasma bone-specific alkaline phosphatase, osteocalcin, and amino terminal propeptide of type I procollagen, are markers of bone formation (8). Plasma crosslinked collagen telopeptides, urinary N-telopeptides, and plasma tartrate-resistant acid phosphatase, are markers of bone resorption (4). These biochemical markers may be used to assess the patient's bone turnover rate and may help predict the risk of fracture (8).

For the clinical assessment, look for spinal curvatures (e.g. kyphosis, lordosis). Also note any bone fractures, DXA scans, FRAX assessments, and medications. Certain medications may cause increased bone loss, such as glucocorticoids (4).

Appropriate tools for a dietary assessment include a 24 hour recall and a food frequency questionnaire. Note the calcium and vitamin D content of the patient's diet. It

is also important to record alcohol consumption and history of smoking, as these are two risk factors for osteoporosis and bone fractures (4).

### Medical Nutritional Therapy

Calcium and vitamin D intake are the two main focuses of medical nutritional therapy for bone health. The main nutritional diagnosis of a patient with osteoporosis is inadequate calcium intake (16). An appropriate PES statement could look like the following: Inadequate calcium intake related to inadequate nutrition knowledge as evidenced by reported food intake and osteoporotic fracture. Adequate dietary intake of calcium and vitamin D throughout life allows calcium stores to build up in the bone rather than being removed from the bone for use in the body (4). Women 51 years and older and men 71 years and older should consume 1200 mg/day of calcium and 800-1000 IU/day of vitamin D (8). Men ages 50 to 70 should consume 1000 mg/day of calcium and 800-1000 IU/day of vitamin D (8). When these levels are not met from dietary intake, calcium and vitamin D should be supplemented (8).

### Long Term Prognosis

Osteoporosis medication can help prevent future fractures. However, in patients with osteoporotic fractures, disability and mortality rates increase (1). Approximately 17% of women and 31% of men die within one year of fracturing a hip (17). Osteoporotic fractures can drastically affect quality of life. Over half of patients who break their hip subsequently need skilled nursing care (1).

### Summary

Osteoporotic fractures can be debilitating and deadly. However, Osteoporosis can be prevented or treated effectively if efforts begin early. The best thing each person can do to safeguard his bone health is to consume adequate amounts of calcium and vitamin



D throughout life. Even when a person already has low bone mass, medications and lifestyle changes can help prevent fractures.

## References

1. Brauer C, Coca-Perrillon M, Cutler DM, Rosen AB. Incidence and mortality of hip fractures in the United States. *JAMA*. 2009;302:1573-1579.
2. WHO scientific group on the assessment of osteoporosis at primary health care level. Available at <http://www.who.int/chp/topics/Osteoporosis.pdf>. Accessed March 17, 2015.
3. National Osteoporosis Foundation. What is osteoporosis? Available at <http://nof.org/articles/7>. Accessed March 17, 2015.
4. Chapman-Novakofski K. Nutrition and bone health. In Mahan LK, Escott-Stump S, Raymond JL, ed. *Krause's Food and the Nutrition Care Process*. 13<sup>th</sup> ed. St. Louis, MO: Elsevier; 2012:531-546.
5. Canalis E, Mazziotti G, Giustina A, Bilezikian JP. Glucocorticoid-induced osteoporosis: pathophysiology and therapy. *Osteoporosis Int*. 2007;18:1319-1328.
6. Krall EA, Dawson-Hughes B. Smoking increases bone loss and decreases intestinal calcium absorption. *J Bone Miner Res*. 1999;14:215-220.
7. Sommer I, Erkkila AT, Jarvinen R, et al. Alcohol consumption and bone mineral density in elderly women. *Public Health Nutr*. 2013;16:704-712.
8. National Osteoporosis Foundation. Clinician's guide to prevention and treatment of osteoporosis. Available at <http://nof.org/files/nof/public/content/file/2791/upload/919.pdf>. Accessed March 16, 2015.
9. MedlinePlus. Kyphosis. Available at <http://www.nlm.nih.gov/medlineplus/ency/article/001240.htm>. Accessed March 17, 2015.
10. The International Society for Clinical Densitometry. 2007 official positions and pediatric official positions. Available at <http://www.iscd.org/wp-content/uploads/2012/10/ISCD2007OfficialPositions-Combined-AdultandPediatric.pdf>. Access March 15, 2015.
11. Kanis J. Welcome to FRAX. Available at <http://www.shef.ac.uk/FRAX/>. Accessed on March 17, 2015.
12. Osteoporosis fracture repair. Available at <http://www.webmd.com/osteoporosis/hip-fracture-repair-hip-pinning>. Accessed March 17 2015.
13. Chammout G. Total hip replacement versus open reduction and internal fixation of displaced femoral neck fractures: A randomized long-term follow-up study. *J Bone Joint Surg*. 2012;94:1921-1928.
14. Foran JRH. Total hip replacement. Available at <http://orthoinfo.aaos.org/topic.cfm?topic=A00377>. Accessed March 17, 2015.
15. Santesso N, Carrasco Labra A, Brignardello Petersen R. Hip protectors for preventing hip fractures in older people. *Cochrane Database Syst Rev*. 2014;3:CDO01255.
16. Academy of Nutrition and Dietetics. Inadequate mineral intake (specify). Available at <http://ncpt.webauthor.com/pubs/idnt-en/codeNI-5-10-1>. Accessed March 15, 2015.

17. Forsén L, Sogaard AJ, Meyer HE, et al. Survival after hip fracture: short and long term excess mortality according to age and gender. *Osteoporos Int.* 1999;10(1):73-78.