

Consumer and Family Sciences



Department of Foods
and Nutrition



Osteoporosis: What You Should Know

April C. Mason, Ph.D.
William D. Evers, Ph.D., RD
Erin E. Hanley, RD

Osteoporosis, meaning porous bone, is a disease that is characterized by a deterioration of bone tissue leading to increased susceptibility to bone fractures, especially in the hip, spine and wrist. (See Figure 1) The disease affects more than 28 million people in the United States alone, 80% of whom are women. The medical costs incurred for treatment, rehabilitation, and care of osteoporosis patients is more than \$14 billion annually. The prevalence of this painful and often crippling disease is unfortunate, because it can be prevented through proper nutrition, activity, and lifestyle. This publication discusses causes of the disease, how it can be prevented, and how it can be treated.

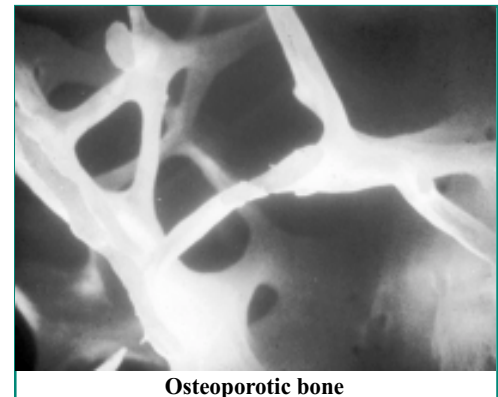


Figure 1: Normal bone vs. osteoporotic bone

Bone Composition

Because osteoporosis is a disease of the bones, it is important to understand bone anatomy and the function of calcium in the body. Bone is a living, growing tissue made up of water, minerals, protein, and fat. Veins and arteries in bone tissue supply it with necessary nutrients.

Bone forms by producing protein (mostly collagen) that hardens when calcium and phosphorus are deposited along with it. Bone mass refers to the amount of bone tissue in the skeleton, while bone density is a measurement of how tightly the tissue is packed with minerals.

The mass, density, and geometric shape of bones are not consistent throughout the human

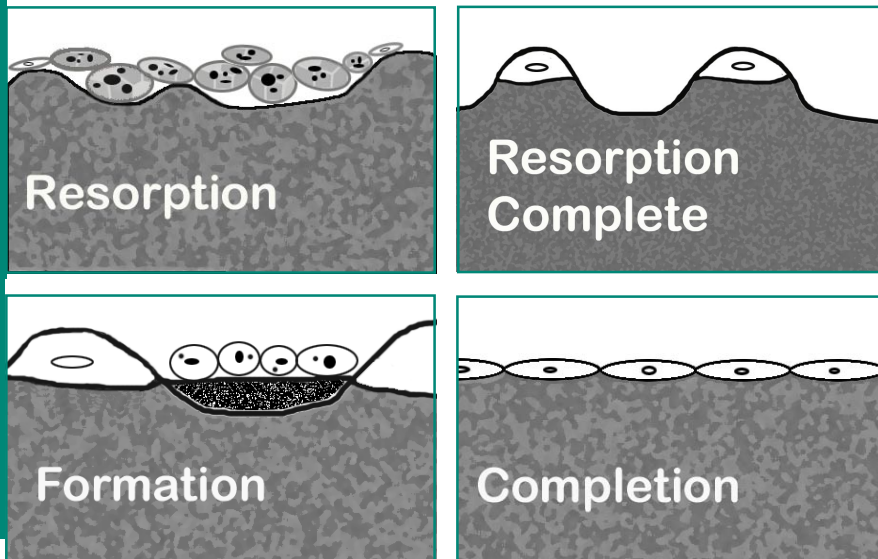


Figure 2. Bone resorption and rebuilding

skeleton. Long compact bones like the arms and legs are more resistant to fracture than more porous bones like the spine, hip, and wrist.

There are two cell types in bone: Osteoblasts are active in bone building, while osteoclasts are active in bone breakdown (resorption). During resorption, the osteoclasts create small cavities on the surface of bone. The osteoblasts then follow with bone building by filling the cavities with new bone. During periods of growth, this is called modeling. When growth is complete, this process is known as remodeling. (See Figure 2) The rate of bone modeling/remodeling is affected by a number of factors, including hormones, calcium, and exercise. If the bone removed is completely replaced, bone strength is maintained. If too much bone is removed or not enough is replaced, the bone loses density and strength, and osteoporosis occurs.

Bone building and bone resorption occur constantly throughout life. From childhood into early adulthood, bone is built faster than it is broken down so that the skeleton grows and bones become denser and stronger.

Humans reach peak bone mass, or maximum bone density and strength of most skeletal sites, between age 20 and 30. Bone loss proceeds at the rate of about 0.5% to 1% per year from the age of approximately 40 years in both genders,

although in women this loss is increased in the first three to five years after menopause. This change places an individual at risk for developing osteoporosis. This is why it is so important for parents to help their children (especially females) make the most of their bone-developing years. Ensuring that children and young adults receive adequate calcium and exercise is the best method to prevent osteoporosis later in life.

Calcium Balance

There are two pools of calcium in the body: 99% is stored in the bone and teeth, and 1% is in the blood and soft tissues. While bone is necessary for structure and protection of our bodies, it also serves as a calcium reserve. The pool of calcium in bone is flexible and changes to some extent throughout life. The calcium in blood and soft tissues, although only 1% of our total calcium, is absolutely essential for life. The concentration of calcium in blood cannot vary much without causing severe illness and even death. Some of the normal functions dependent on calcium are blood clotting, hormone release, antibody formation, muscle contraction, and protein synthesis.

There are three main substances that regulate calcium levels in the blood: vitamin D, parathyroid hormone, and calcitonin.

Vitamin D is a fat-soluble vitamin added to many dairy products. This vitamin is also synthesized in the body when the skin is exposed to sunlight. It promotes the intestinal absorption of calcium, especially when intake is low.

Parathyroid hormone functions to raise calcium blood levels in three ways: it stimulates the kidneys to synthesize the active form of Vitamin D, it increases osteoclast activity to release calcium from the bone, and it increases reabsorption of calcium in the kidney.

Increased blood calcium will shut off parathyroid hormone secretion and trigger release of calcitonin. This hormone has the opposite effect of parathyroid hormone. It inhibits vitamin D and decreases the calcium level in the blood by slowing its resorption from the bone.

It should be noted, however, that after midlife, absorption efficiency declines by about 0.2 percentage points per year, with an additional 2% reduction at menopause.

Osteoporosis is the result of long-term calcium imbalance. Over a period of decades, calcium is removed from bones to maintain blood levels if dietary or absorption levels are not adequate. The process of aging normally causes calcium to be lost from the bone, but osteoporosis is an accelerated loss of bone.

Risk Factors You Can't Change

Gender: Women make up about 80% of those affected by osteoporosis. Women generally have lighter, thinner skeletal frames than men and thus have less bone reserve of calcium. Women also lose bone rapidly in the first three to five years after menopause. Men and women lose calcium from bone at about the same rate after women have finished their initial acceleration following menopause, or after the cessation of hormone replacement therapy.

Age: The longer you live, the greater the chance that you will develop osteoporosis. After age 40, about 0.5 -1.0 % of bone is lost per year.

Ethnicity: Caucasians and Asian-Americans are more likely to develop osteoporosis after age 50. The incidence of the disease in African-Americans and Hispanic-Americans is lower, but still significant.

Genetics: Those who have had a parent with osteoporosis are at a greater risk for developing the disease themselves.

Body Size: The smaller a person is at maturity, the higher the risk of developing osteoporosis. Smaller bones provide smaller reserves of calcium to the body.

Risk Factors You Can Change

Hormone Levels: In women, estrogen protects against bone loss. After menopause, women lose the ability to produce estrogen. This is one of the reasons women may opt for hormone replacement therapy after menopause. Women who enter menopause early, either due to an illness or surgery, are of special concern.

Women of childbearing age who stop or never start menstruating (amenorrhea) are also at high risk of low bone density. Amenorrhea, which can indicate low estrogen levels, may result from excessive dieting, or exercising and/or weight loss. In men, testosterone and estrogen protect against bone loss. Excessive dieting or excessive alcohol consumption can alter testosterone levels in men.

Activity Level: Exercise is essential for building and maintaining bone health. Weight-bearing exercise, like walking, running, and jumping, is a key factor both in building strong bones in the formative years and in keeping bones strong later in life. "Disuse osteoporosis" is the loss of bone mass because the bone does not bear weight. This problem occurs in those bedridden and in astronauts in a weightless environment.

Diet: A diet inadequate in calcium is detrimental to bone health, especially from childhood through the mid-20s. According to the National Institute of Health, only 10% of girls and 25% of boys between ages 9 and 17 obtain an adequate amount of calcium in their diet. Calcium intakes are below the Dietary Reference Intake for most of the population beginning in adolescence.

Smoking: Women who smoke have lower levels of estrogen compared to nonsmokers, and they often go through menopause earlier. Postmenopausal women who smoke may require higher levels of hormone replacement therapy and may experience more side effects. Smoking also may interfere with the absorption of calcium from the diet.

Drinking: Alcohol consumption may cause bone loss. Those who drink heavily are more prone to bone loss and fractures, because of poor nutrition and an increased risk of falls.

Certain Medications: The long-term use of some medications can lead to a loss of bone tissue and an increase in fractures. These medications include glucocorticoids or steroids, some antiseizure medications, gonadotropin-

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releasing hormone (GnRH), aluminum-containing antacids, certain cancer treatments, and thyroid hormone. Talk to your physician if you are concerned that a medication you are taking might contribute to bone loss.

Prevention Is the Key

After peak bone mass is achieved, bone losses can not be recovered. However, further decreases can be slowed through treatment with calcium, vitamin D, and estrogen therapy. Research involving young women indicates that the most important time of prevention is childhood through the mid-20s. Prevention is a lifetime commitment to good nutritional, medical, and physical activity practices.

Diet

Calcium: Your body needs many nutrients to perform its everyday functions, so a complete diet is important to your overall health. While it is important to maintain adequate intakes of bone-related minerals such as magnesium, phosphorus, and calcium to optimize bone health, calcium intake is the most likely to be deficient.

Surveys of dietary intake have shown that the majority of Americans are not consuming enough calcium. Research in the Department of Foods and Nutrition at Purdue University and at other institutions has led to the development of the Dietary Reference Intake Values for Calcium. (See Table 1)

Dairy products such as milk, yogurt, and cheese are excellent sources of calcium. The body easily absorbs the calcium in dairy products. Dairy products are available in low-fat and nonfat varieties that contain the same amount of calcium as the regular varieties.

Some vegetables and beans are good sources of calcium, although they may have other components called oxalates and phytates that interfere with calcium absorption. The range of bioavailable calcium from different vegetables is great, and the calcium concentration is usually less dense in vegetables than it is in dairy products. Other good calcium sources include foods fortified with calcium, such as

some breads, cereals, orange juices, and soy products. Research on the bioavailability of calcium from food, done by Purdue University and other institutions, has led to new recommendations for calcium. (See Table 2)

To determine the amount of calcium in a serving of food, find the percentage of calcium listed on the nutrition facts label, and add a zero to it. This is the amount of calcium in milligrams contained in one serving of this food. For instance, an 8-oz. serving of skim milk has 30% of your Daily Value for calcium. Therefore, there are 300 mg of calcium in the milk.

Calcium supplementation is sometimes necessary if digestive disorders prevent consumption of calcium-rich food. This is a decision for a physician or dietitian to make in consultation with the patient. Self-prescription of supplements is not recommended.

Vitamin D: Your body needs vitamin D to absorb calcium effectively. You must either eat plenty of vitamin D-containing foods or take a supplement. Foods rich in vitamin D are fortified milk and other dairy products, egg yolks, saltwater fish, and liver. The recommended daily vitamin D intake is between 200 and 600 international units (IU), depending on your age. Vitamin D can be toxic at high levels, so do not supplement your diet with more than 600 IU per day unless your doctor prescribes it.

Prevention is a lifetime commitment to good nutritional, medical, and physical activity practices.

Table 1: Dietary Reference Intake Values for Calcium for U.S. and Canada

Life-Stage Group	(mg/day)
0-6 months	210 mg
6-12 months	270 mg
1-3 years	800 mg
4-8	800 mg
9-18	1,300 mg
19-50	1,000 mg
51+	1,200 mg
Pregnant and lactating women	
18 and under	1,300 mg
19-50	1,000 mg

Food and Nutrition Board, Institute of Medicine, National Academy Press, Washington, DC, 1997.

Table 2: Calcium Sources from Highest to Lowest Absorbable Calcium Content

Food	Serving Size	Calcium Content (mg)	Servings needed to equal 8 oz. milk
Milk	8 oz.	300	1
Yogurt	8 oz.	300	1
Cheddar cheese	1.5 oz.	303	1
Pudding made with milk	8 oz.	300	1
Fruit punch with added calcium	8 oz.	300	1
Tofu with calcium	4 oz.	258	1.2
Cottage cheese	4 oz.	75	4
Broccoli	1/2 cup	35	4.5
Spinach	1/2 cup	115	16.3

Weaver, et al., Am J Clin Nutr 1999; 70 (suppl): 543S-8S.

Exercise

Your body needs exercise, no matter what age or stage of life. An exercise program is one of the best methods of slowing the normal bone loss that comes with increasing age. Exercise should be fun and convenient. Walking, for example, requires no special equipment or place, and it is an excellent way of applying stress and pressure to the long bones of the body. Any weight-bearing exercise done with regularity will benefit bone health. Before you begin an exercise program, talk to your physician to decide what may be right for you.

Clinical Signs of Osteoporosis

The decrease in bone density caused by osteoporosis is not normally diagnosed by X-ray analysis or normal medical examination until it is well advanced. Bone fracture is often the first sign that osteoporosis is a problem. The most frequent sites of fracture are the wrist, hip, and spine. (See Figure 3) The spinal fractures can be the most painful and debilitating.

The reliability of clinical tests for abnormal bone metabolism varies. Blood and urine can be

analyzed for abnormal calcium levels or the products of bone loss. However, osteoporotic women have tested normal in some studies.

Tests that actually measure bone density are called bone mineral density (BMD) tests, commonly referred to as bone scans. There are several different types of BMD tests. The most widely used are:

- Dual energy X-ray absorptiometry (DXA, pronounced “dexa”)
- Peripheral dual energy X-ray absorptiometry (PDXA, pronounced “p dexa”)
- Ultrasound
- Quantitative computed tomography (QCT)

A BMD test is a painless, noninvasive and safe method of detecting osteoporosis before a fracture ever occurs. Even after a fracture or the diagnosis of osteoporosis, the tests can be helpful in monitoring the

effectiveness of treatment. If you are concerned about bone loss, a physician can help you decide which BMD test is best in your situation.

Treatment Options

Hormone Replacement Therapy (HRT): After menopause, women have a much higher risk of developing osteoporosis, because they lose the ability to produce estrogen. Studies show that

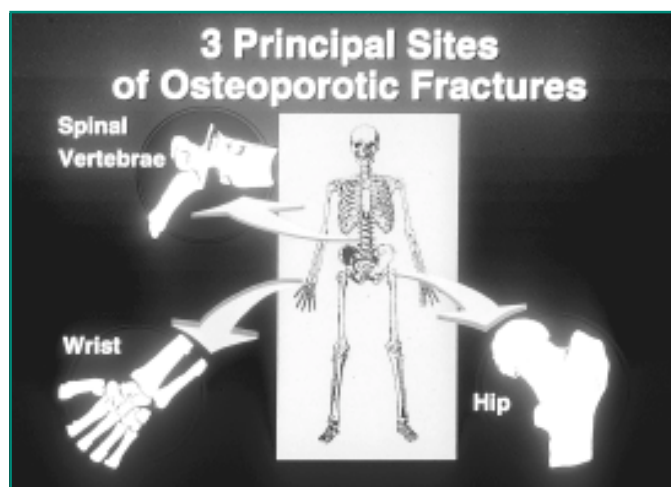


Figure 3: Most common sites of osteoporotic fractures

An exercise program is one of the best methods of slowing the normal bone loss that comes with increasing age.

women lose bone density at a higher than normal rate in the first three to five years after menopause. Estrogen replacement therapy (ERT) has been shown to reduce bone loss and the risk of fractures, and to increase bone density, in postmenopausal women. However, estrogen taken alone can increase a woman's risk of developing breast and endometrial (uterine lining) cancer. For this reason, the hormone progesterone is usually prescribed along with estrogen to lower the risk of cancer. HRT is recommended especially for women whose ovaries were removed before age 50, or for women who have multiple osteoporosis risk factors

such as family history of osteoporosis and below-normal bone mass for their age.

If you think HRT may be right for you, your physician can assess your full family and medical history and discuss the benefits and risks of HRT before prescribing it.

Medication: Some nonhormone medications help reduce bone loss and increase bone density. Those currently approved to prevent and treat osteoporosis are alendronate (brand name Fosamax), raloxifene (brand name Evista), and risedronate (brand name Actonel). The nonsex hormone calcitonin that helps in

calcium regulation is also approved for treatment alone. These medications can be used in combination with or as an alternative to HRT, depending on your individual needs. Women at risk for cancer along with osteoporosis may opt for a nonhormone medication. Like all drugs, they each have possible risks and side effects associated with their use. Check with your physician if you would like to know more about what medications may be helpful for you.

For Further Information

National Institutes of Health Osteoporosis and Related Bone Diseases National Resource Center

1232 22nd Street, NW
Washington DC 20037-1292
(800) 624-BONE
<http://www.osteoporosis.org/osteoporosis.html>

National Osteoporosis Foundation

1150 17th Street, NW
Suite 500
Washington, DC 20036-4603
<http://www.nof.org>

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Connie M. Weaver, Ph.D.

April C. Mason, Ph.D.

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Rebecca J. Bryant, Ph.D.

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