THE PREVENTION AND TREATMENT OF OSTEOPOROSIS: A REVIEW

By Denise Mann

Based on a position paper of the American Council on Science and Health (ACSH) by Felicia Cosman, MD, Medical Director, Clinical Research Center, Helen Hayes Hospital

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Executive Summary

Osteoporosis is a disease in which bones become fragile and more likely to break. Currently, about 8 million women and 2 million men in the United States have this debilitating disease. The majority of bone mass is achieved during the first two decades of life and on average, it reaches a peak during the early 20s or late teens. While bone mass is determined by a host of environmental and genetic factors, it is maintained by a process called remodeling, which involves the continuous breakdown and reformation of bone. In young adults, the bone created is equal to the bone that is removed, and the frequency with which bone remodeling units are activated is constant. As a result, bone remodeling is balanced. With advancing age, this balance shifts and sets the stage for osteoporosis. Measuring bone mineral density (BMD) is the only way to accurately diagnose osteoporosis and predict risk for future fractures, and today the gold standard is a test called dual X-ray absorptiometry (DXA). The National Osteoporosis Foundation recommends that all women have their BMD measured by age 65 or earlier if other risk factors are present. If your test reveals that you have osteoporosis, it implies that you are at an increased risk of sustaining a fracture. About 1.5 million osteoporosis-related fractures occur each year in the US, costing about $15 million annually. Fractures can cause pain, swelling and difficulty with movement. As such, they often have a pronounced effect on quality of life. Along with surgery to repair existing fractures, certain medications can be prescribed to reduce fracture risk among people at highest risk. Moreover, certain prevention approaches can be helpful in staving off fracture-causing falls. These include a thorough medication review to determine if any medications cause drowsiness or dizziness, eliminating exposed wires and slippery rugs and getting regular eye exams. There are currently no accepted guidelines for monitoring osteoporosis treatment. However, as most treatments produce small or moderate bone mass changes, follow-up DXA can be useful after a sufficient amount of time has passed.

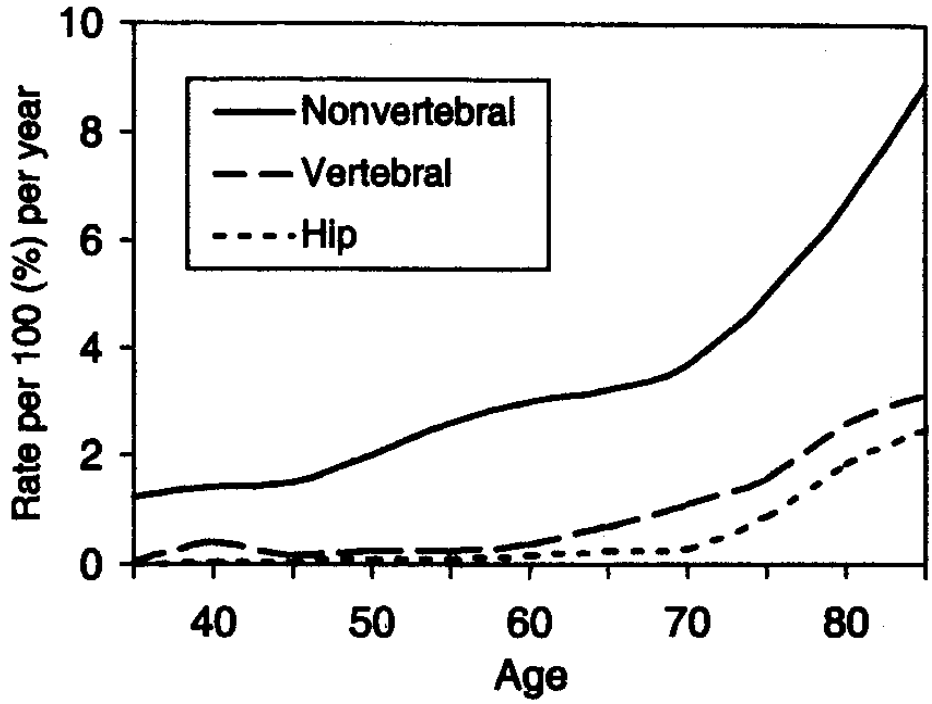
Osteoporosis is preventable to some degree. The first line of prevention includes good nutrition, regular weight-bearing exercise, not smoking and avoiding excessive alcohol consumption.

While osteoporosis cannot be “cured,” certain medications along with simple strategies to prevent falls around the home can reduce fracture risk. It’s extremely important to talk to your doctor about bone health. The good news is that the future is looking bright. Research is currently underway that aims to improve diagnosis and develop newer and even more effective treatments.

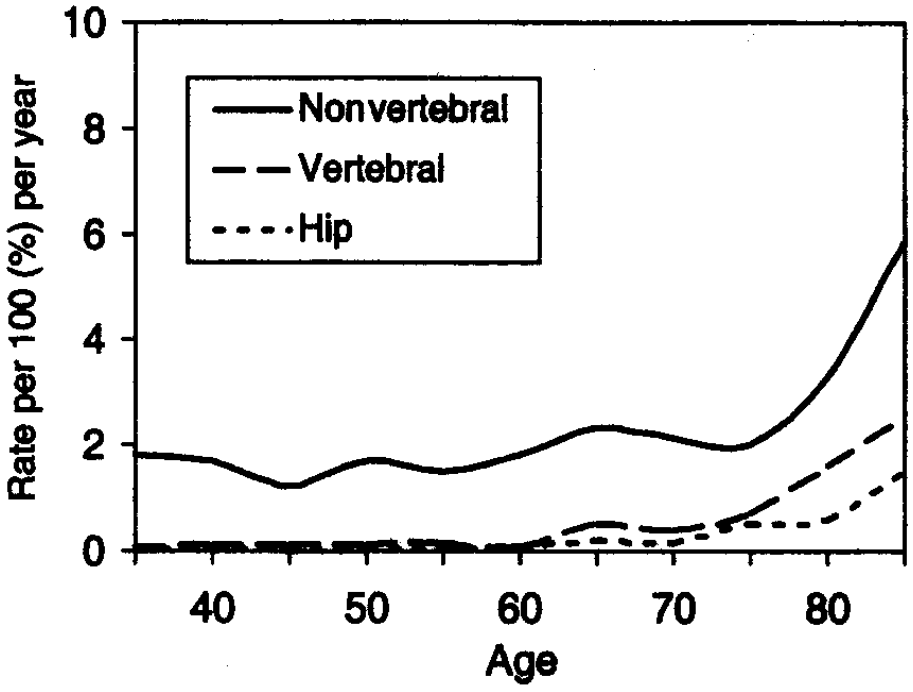
What Is Osteoporosis?

Osteoporosis is defined as a disease in which bones become fragile and more likely to break. It is characterized by low bone mass and structural deterioration of bone tissue that leads to bone fragility and an increased susceptibility to fractures especially of the hip, spine and wrist (although any bone can be affected). About 8 million women and 2 million men in the United States have osteoporosis (1). Osteoporosis tends to develop as we age. Among American women, 13% will have osteoporosis in their 50s, 27% will develop it in their 60s, 47% in their 70s and a whopping 67% develop brittle bones in their 80s (2). Osteoporosis is often symptomless until a fracture occurs -- ringing a loud siren. With severe osteoporosis, bones become so porous that fractures can occur with minor or no trauma. But osteoporosis fractures can, and often do, have dire health consequences including pain, disability, deformity and, at times, premature death from complications.

Increasing incidence of fractures with age in women. (2)



Increasing incidence of fractures with age in men. (2)



All About Bone Mass and Bone Remodeling

To fully comprehend how osteoporosis occurs, it's important to understand bone mass and the processes by which bone continuously rebuilds itself.

What is peak bone mass?

The majority of bone mass is achieved during the first two decades of life. Rapid skeletal growth occurs in utero and infancy, while growing children tend to experience slow and steady increases in bone mass until puberty. During the adolescent growth spurt, young people achieve up to 60% of their total bone mass. By age 18, skeletal growth is nearly complete (save for minor accumulations in bone density that continue to occur until around the age of 30). On average, bone mass or density reaches a peak during the early 20s or late teens.

So, what else plays a role in determining peak bone mass?

Peak bone mass is determined primarily by genetic factors, although environmental and lifestyle factors also play a role. For example, bone mass differs among ethnic groups and between genders. African-American populations have up to 10% greater bone mass than their white counterparts (3-5). Young men have higher bone mass than their female counterparts (6, 7). This sex difference may be a result of how male and female hormones affect a process

called periosteal apposition, which makes bone stiffer. Higher levels of male sex hormones called androgens result in greater periosteal apposition, while the main female sex hormone, estrogen, has been known to inhibit this process. Genes too play a role in the development of osteoporosis. Researchers know that peak bone mass is lower in people with a family history of osteoporosis (8, 9), but exactly which genes play a role is not yet known. Several candidate genes have been suggested.

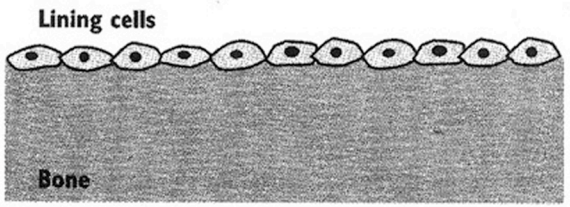
Another factor that affects peak bone mass is menstruation. Several studies have shown that reduced bone mass occurs in women with amenorrhea (the absence of menstrual periods) from various causes including excessive exercise (10-14), anorexia nervosa (15, 16) and hyperprolactemia (a condition in which the body produces overly high levels of the hormone prolactin). The good news is that bone mass in the spine may increase after runners who had ceased menstruating begin to do so again (17, 18). Additionally, a birth control option known as Depo-Provera, an injection which suppresses the body's production of the hormone estrogen, may also have a small negative effect on bone mass (19).

Bone remodeling

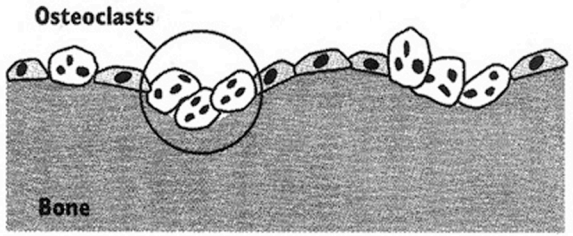
Once bone formation (the acquisition of bone mineral density (BMD)) has stopped, bone mass is maintained by a process called *remodeling*. Remodeling involves the continuous breakdown and re-formation of bone and is controlled by a number of hormones.

The breakdown part is called *resorption* and is performed by cells called *osteoclasts*. These cells continually remove microscopic portions of bone at the edge of the bone surface. Nearby, bone-forming cells called *osteoblasts* begin to fill in the holes left behind.

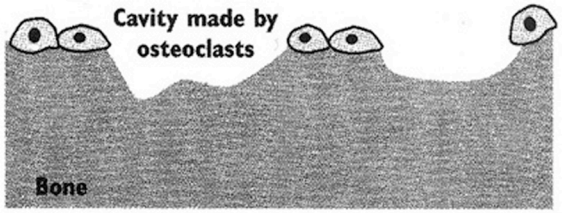
Schematic of steps in normal bone remodeling. (67)



1. Resting Phase
The bone is covered by a protective layer or lining of cells.

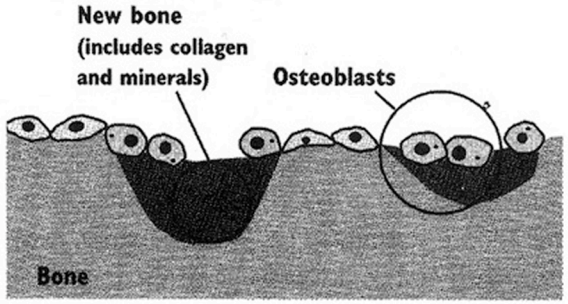


2. Resorption
The osteoclasts invade the bone surface, carve it up, and cut out a cavity by dissolving it.



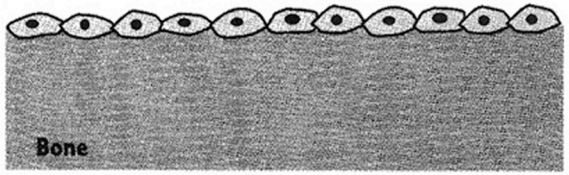
3. Resorption Complete
A complete cavity is created in the surface.

It's like potholes in pavement being formed and repatched.



4. Formation–Repair
Osteoblasts fill in cavity by building new bone.

The potholes (bone cavities excavated by the osteoclasts) are filled in with new bone (by the osteoblasts).



5. Repair Complete
New bone surface has replaced old bone.

It takes about three weeks for the osteoclasts to dig a pothole (pit in bone) and about three months for the osteoblasts to fill in the pothole with new bone.

In young adults, the bone replaced is equal to the bone that is removed. In addition, the frequency with which bone remodeling units are activated is constant. As a result, bone remodeling is balanced. But this changes with advancing age. As we age, the amount of bone tissue is the result of bone mass accumulated during growth and consolidation (also known as peak bone mass) minus the loss of bone tissue that occurs with aging.

During the early menopausal years in women, there is a dramatic reduction in circulating estrogen. As a result, there is an increase in the rate of bone resorption, but not reformation. This creates an imbalance and sets the stage for osteoporosis (20, 21). Although bone loss in women slows after the early postmenopausal years, loss continues through the latter decades of life, and in very old age the rate of loss increases again (22-24).

But this imbalance is not limited solely to women. Age-related bone loss is dependent, in part, on estrogen production in both sexes (25, 26). While estrogen is considered the female sex hormone, men also produce some estrogen. And as they age, men may experience a decrease in their ability to convert male sex hormones called androgens into estrogen (27-29). Recent research suggests that estrogen deficiency and reduced levels of other sex hormones may be a cause of osteoporosis in men.

In addition to hormonal changes, age-related bone loss is also due to reduced ability to utilize calcium (30), decreased vitamin D supply due to lower production and reduced absorption, as well as decreased activation of vitamin D by the kidney (30-32). (For more on calcium and Vitamin D, see subsection A, “Nutrition,” in the chapter on Prevention.) All of these factors contribute to the increase with age in another hormone -- parathyroid hormone (33, 34). When there is too much parathyroid hormone released in the body (hyperparathyroidism), bones release excessive calcium into the blood stream. As a direct result, bones lose their density and hardness.

Diagnosis: Osteoporosis

If osteoporosis is so silent and insidious, how do you know if you have it?

Measuring BMD is the only way to accurately diagnose osteoporosis and predict risk for future fractures. Today, the gold standard is a test called dual X-ray absorptiometry (DXA). In most centers, the lumbar spine (lower back) and the hip are the skeletal sites usually examined by DXA, but specialized DXA X-ray machines are also available that can measure bone in the forearm or the heel.

From DXA, a low-dose X-ray, doctors can determine how strong your bones are and what your risk for fractures is. Hip fracture risk is best predicted by DXA

measurements of the hip. In younger (recently postmenopausal) women, spine measurement may be a more sensitive predictor of bone loss.

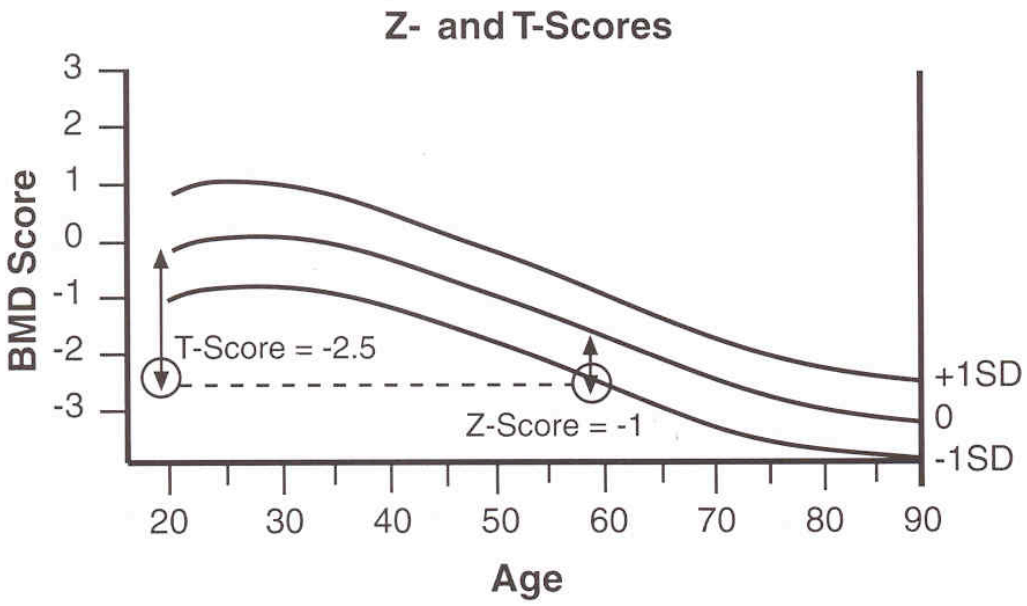
To undergo this non-invasive test, you will be asked to lie down as two X-ray beams are projected onto the bones. The amounts of each X-ray beam blocked by bone and soft tissue are compared to estimate the bone density. It is quick and safe, as it involves very low doses of radiation.

What do your results mean?

There are two scores that are used to evaluate a person's bone density -- a T-score and a Z-score. The results are given as a T-score. A T-score is basically the comparison of your bone mass with that of a healthy young person of the same gender at peak bone mass. The lower or "more negative" the score is, the greater the risk of fracture. T-scores above -1.0 are considered normal. T-scores between -1.0 and -2.5 reveal osteopenia or low bone density, while scores below -2.5 indicate osteoporosis.

By contrast, the Z-score is defined as the comparison of your bone mass with that of the average age- and gender-matched person. In other words, your T-score looks at how your bones compare to someone at peak bone mass, while your Z-score determines how you stand up against people of your own age and sex.

Illustration of a 59 year-old patient with a Z-score of –1 and a T-score of –2.5.



Other methods of bone mass measurement that can be used to measure spine and hip include computer tomography (CT) or CAT scans. Software is currently under development to permit its use.

Who should get tested?

In the US, the average age of natural menopause -- defined as one year without a menstrual period -- is 51. Bone mass measurement should be performed at the time of menopause if other risk factors are present (such as prior history of fracture, family history of fracture, thin build, smoking, the presence of certain underlying diseases or use of medications known to increase risk of osteoporosis). For example, anyone taking long-term steroids or who is being started on steroids that may be continued for more than three months should get tested (35).

All women should have their BMD measured by age 65, according to the National Osteoporosis Foundation (http://www.nof.org/osteoporosis/bonemass.htm) (36).

Currently, there are no screening recommendations for healthy men. However guidelines under development are slated to recommend routine screening in men aged 70 to 75. Younger men with such risk factors as underlying diseases, prior vertebral fractures or fractures at other sites would also be advised to undergo bone density testing.

Additional radiologic procedures

There are other tests that can help your doctor diagnose osteoporosis and related damage. For example, height loss of 1.5 inches, significant kyphosis (curvature of the spine) or back pain (particularly with onset after menopause), call for a test known as lateral spine radiography (a simple X-ray) to look for vertebral compression fractures.

A new test called vertebral morphomertry can also provide a lateral or side view of the spine. If this test suggests evidence of a compression fracture, a standard X-ray can be taken to confirm it. A compression fracture is a break in the vertebrae that causes it to collapse. As a result, compression fractures of the spine can cause loss of height, a curving of the shoulders and back and a thickening waistline. Other tests including CT scans and magnetic resonance imaging (MRI) can also help find fractures and/or distinguish fractures from other bone characteristics.

What happens next?

Once a diagnosis of osteoporosis is made, your doctor will order:

-a complete blood count
-an assessment of blood calcium levels
-a test of kidney and liver function.

For people with a low Z-score, tests may be run to exclude other diseases including:

-hyperthyroidism
-hyperparathyroidism
-vitamin D deficiency

and these extremely rare diseases:

-a form of cancer known as multiple myeloma
-celiac disease (a digestive disorder marked by the inability to digest gluten or wheat proteins in specific cereal grains)
-renal hypercalciuria or the leakage of calcium from the kidney.

Several tests are now available to provide an index of the overall rate of bone remodeling. These tests provide markers related to bone formation or bone resorption. They are relatively new and not that valuable, as the results vary greatly from individual to individual.

The Consequences of Osteoporosis

If your test reveals that you have osteoporosis, it implies that you are at an increased risk of sustaining a fracture. You are not alone. About 1.5 million osteoporosis-related fractures occur each year in the US, costing about $15 million annually (37, 38, 39, 40, 41). Of these, 700,000 are vertebral (42), 300,000 are hip fractures and 300,000 occur in the distal radii (the ends of the arm bones nearest to the wrist) (38, 39). The radius is the forearm bone on the thumb side. Distal radius fractures are generally caused by a fall on an outstretched hand. The fracture is almost always within an inch of the wrist joint, and may extend into the wrist.

While fractures can occasionally occur with little or no trauma, certain factors can increase risk -- namely reduced bone mass, advanced age and falling. Most fractures are related to thinning bones. (Exceptions to this rule include fractures of the skull, fingers and toes.) Trauma can also play a role, especially in younger people. In general, fracture risk increases as bone density decreases. For every 10% decline in bone mass, fracture risk doubles (43).

Specifically, risk of vertebral fracture increases from the 50s on up, while risk of hip fracture tends to increase starting in the 70s and beyond. Moreover, a history of a previous fracture also ups risk of future ones -- regardless of bone density (44). For example, a history of a vertebral or spine fracture increases risk of future spine fracture fivefold, and risk of non-spine fracture -- including hip fracture -- doubles (45, 46).

Fractures can cause pain, swelling and difficulty with movement. As such, they often have a pronounced effect on quality of life. The majority of fractures will require X-ray or other imaging procedures for diagnosis. This may be followed by casting, splints, surgery, hospitalization and/or pain medication. People who sustain fractures may also require physical and/or occupational therapy for extended periods of time. Moreover, some fractures do not heal well and may require several attempts to re-set the bone, resulting in even longer disability.

But it doesn't stop there. Other complications of fractures can include soft tissue injuries such as tendonitis and ligament sprains. Sometimes nerve injury known as reflex sympathetic dystrophy can occur, which causes chronic pain, swelling, numbness and weakness and prevents a full recovery.

Other fracture-promoting factors

Other factors can affect bone mass and increase risk for fractures. For example, excess preformed vitamin A (retinol) may cause bone loss and promote fractures. High intakes have been associated with a two-fold increase in risk of hip fracture in some studies (47-49). Long-associated with good vision, vitamin A has also been found to direct the process of borrowing and redepositing calcium in bone.

Abuse of alcohol increases risk of osteoporosis because it inhibits the function of osteoblasts and reduces bone formation (50), thus increasing risk of hip fracture (51). However, moderate alcohol consumption may increase bone mass and may reduce risk of vertebral fracture.

Smoking affects osteoblast function. Smokers typically have low bone mass (52, 53). They also tend to weigh less and are generally less physically active than their non-smoking counterparts, further increasing their fracture risk.

Many chronic diseases are associated with more rapid bone loss and increased risk of osteoporosis. They include hyperthyroidism; hyperparathyroidism; rheumatoid arthritis (RA); systemic lupus erythematosus; chronic lung disease; gastrointestinal diseases associated with difficulty absorbing nutrients, eating disorders, certain cancers and organ transplantation; and neurological disorders including Parkinson's disease, multiple sclerosis (MS) and spinal cord injury.

The bone loss associated with these diseases can occur for a host of reasons including the medications used to treat them, related nutritional factors and diminished ability to be physically active, as in Parkinson's disease, MS and RA.

Certain medications are known to change bone metabolism and as a result, have a negative effect on the skeleton. For example, corticosteroids often used to treat RA and some types of cancer can inhibit osteoblasts. Other medications that have a negative effect on bone include anti-epileptics, chemotherapy, excessive doses of thyroid hormone and gonadotropin-releasing hormone (GnRH) antagonists, which are hormone drugs used to treat infertility. If you have been on any of these drugs, talk to your doctor about your risk of osteoporosis.

A. Hip Fractures

Just about all of the 300,000 hip fractures (38) that occur in the US each year will require surgery and/or hip replacement to enable a person to walk again. Hip fracture is a serious condition, aside from the problems in pain and walking: up to 20% of people die within the year following their hip fracture. This can result from underlying disease made worse by the hip fracture or, in a small percentage of people, a complication of the fracture or the surgery (54), such as a life-threatening blood clot.

In fact, hip fracture is the No. 1 condition resulting in a stay at a rehabilitation facility or in a nursing home immediately following surgery (55). About half of all those who sustain a hip fracture and do return home will need help to perform their normal daily activities.

B. Vertebral Fractures

Reach around and feel the bumps in the center of your back. Each bump is a bone called a vertebra. There are 33 vertebrae running from your neck to your tailbone that comprise your spine. Vertebral or spine fractures are the second most significant osteoporosis-related fracture. Unlike hip fractures, these tend to be silent at first. But over time they can produce height loss, round shoulder deformity (kyphotic deformity) and, due to the tension they produce in the surrounding soft tissues, chronic pain.

In as many as 30% of people, these fractures produce sharp, excruciating neck and back pain requiring emergency medical attention. Pain from vertebral fractures can become chronic and chronic pain may develop after a previously silent fracture. This may be a direct result of the compression fracture or due to the chronic strain associated with trying to avoid pain in the affected part of the neck or back.

Treatment

This pain may require over-the-counter or prescription pain killers such as non-steroidal anti-inflammatory drugs (NSAIDS), acetaminophen and sometimes prescription painkillers (narcotics). It may respond to back strengthening exercises and frequent periods of rest in the supine position (lying on the back with the face upward) to allow the tense tissue to relax.

Some people with back pain may benefit from short periods of bed rest. While this used to be the standard recommendation, today many doctors feel that too much bed rest can weaken muscles, ultimately promoting bone loss and delaying recovery. Today people are encouraged to start walking earlier.

Sometimes a soft, elastic brace may help increase mobility sooner.

The muscle spasms that sometimes occur with acute compression fractures can sometimes be treated with muscle relaxants and/or by applying moist or dry heat to the area.

Fractured and collapsed vertebrae can shorten and curve the spine. This moves the ribs down toward the pelvis and compresses the chest and stomach. Compression of the lungs can create new respiratory disorders, or worsen already-existing ones, including lung disease and pneumonia (56). Moreover, vertebral fractures may also cause distension of the stomach, constipation and other abdominal symptoms by constricting the abdominal muscles. Many people with vertebral fractures also report depression, anxiety and withdrawal from life (57).

A. Vertebral Fracture Repair

Sometimes these compression fractures are treated by injecting surgical cement called methylmethacrylate into the fracture. These injections can be done directly through a procedure called vertebroplasty or through a balloon known as kyphoplasty. Both procedures are performed by an orthopedic surgeon using image guidance and under general anesthesia.

During the vertebroplasty procedure, a cement mixture is injected into the vertebrae with a metal needle. The cement hardens and lends support and stability to the fractured vertebra. In kyphoplasty, the doctor threads a balloon-tipped catheter into a compressed vertebra and slowly inflates the balloon to reduce the fracture. Then methylmethacrylate cement is injected into the space created by the balloon.

These injections do relieve pain but as of now, there are no long-term studies supporting their benefits. However, a better understanding of the risks, benefits

and indications for vertebroplasty and kyphoplasty should come in the next several years.

In some instances, ultrasound and transcutaneous (through the skin) nerve stimulation may also help lessen pain. Ultrasound involves using sound waves to heat tissues and relieve pain. Transcutaneous nerve stimulation employs an electrical current, which generates heat to relieve stiffness, improve mobility and relieve pain.

B. Medications to Treat Osteoporosis

Along with surgery to repair existing fractures, certain medications can be prescribed to reduce fracture risk among people at highest risk.

If you have osteoporosis by BMD criteria with T-score of –2.5 or below, medications should be started. Women with very low bone mass in the range of 1.5 and –2.5 may be candidates for medication based on the number of other risk factors that they possess and the strength of those factors, including:

-prior history of fracture
-family history of fracture
-low weight
-underlying disease
-medications
-bone turnover rate
-current history of smoking

One of the biggest initiatives in the next several years will be the development of an absolute risk paradigm that can determine who should receive medication for fracture prevention. Such a paradigm would include BMD measurements as well as age, history of prior fracture, weight and family history and other risk factors.

Currently there are several medications approved to reduce fracture risk. The biphosphonates (alendronate and risedronate), calcitonin, estrogens and raloxifene affect the bone remodeling cycle and are classified as anti-resorptive medications.

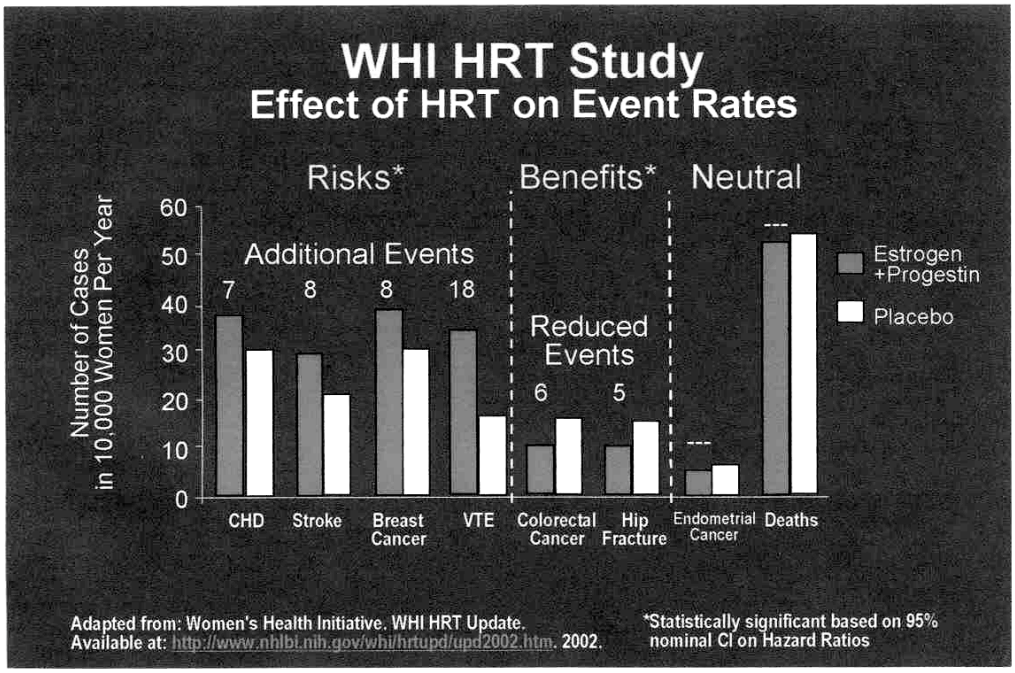
Antiresorptive Medications

Medication	FDA Status
Bisphosphonates	
Alendronate (Fosamax)	Approved for prevention and treatment
Risedronate (Actonel)	Approved for prevention and treatment
Ibandronate (Boniva)	Approved for daily use but monthly use in development
Zoledronic Acid (Zometa)	In phase III trials for osteoporosis
Calcitonins	
Nasal Spray (Miacalcin)	Treatment of osteoporosis
Oral Calcitonin	In phase III trials for osteoporosis
Estrogens/Hormones	
Conjugated Estrogen (Premarin) Conjugated Estrogen MPA (Prempro)	Prevention of osteoporosis if other medications contraindicated or not tolerated
Selective Estrogen Receptor Modulators (SERMS)	
Raloxifene (Evista)	Approved for prevention and treatment
Lasofoxifene	In phase III trials for osteoporosis

Basodoxifene	In phase III trials for osteoporosis
Arzoxifene	In phase III trials for osteoporosis
Anabolic Medications	
Teriparatide (Forteo)	Treatment of osteoporosis
PTH(1-84) (Preos)	In phase III trials for osteoporosis

Estrogen/HRT can reduce bone turnover and preserve or increase bone mass in healthy postmenopausal women and those with osteoporosis (58). Progestin, the other hormone given along with estrogen to protect the uterus in combined HRT, probably does not exert any additional effect on bone when compared with estrogen alone (59, 60). According to a large government-sponsored trial known as the Women's Health Initiative (WHI), hormone therapy can reduce risk of hip fractures and symptomatic fractures of the spine by 34% and all other fractures by 24% (61).

Effect of HRT on Event Rates in the Women's Health Initiative HRT Study. (170)



However HRT is not risk-free. This same study also showed that HRT could slightly increase risk of heart disease, stroke, blood clots and breast cancer (61).

Another arm of this study is still looking at estrogen alone in women who have undergone a hysterectomy. It is unclear whether the risk of estrogen alone is lower than those of combined HRT. Talk with your doctor to see if HRT or estrogen alone is right for you.

Ultra-low-dose estrogens are also being investigated. It may have positive effects on bone turnover and bone mass that makes them comparable to other approved drugs for osteoporosis. But long-term safety data and data on how they affect fractures are not yet available.

Selective estrogen receptor modulators (SERMs)

Selective estrogen receptor modulators (SERMs) are hormone-like drugs that affect multiple tissues. These drugs are able to selectively block estrogen from certain tissues -- namely the breast -- while increasing its availability in other areas such as the bones. In its simplest terms, the goal of these drugs is to maximize the beneficial effect of estrogen on bone and to minimize the deleterious effects of the hormone on the breast and endometrium (lining of the uterus).

Two SERMS, tamoxifen and raloxifene (Evista), are currently used in postmenopausal women. Raloxifene is FDA-approved for the treatment and prevention of osteoporosis, while tamoxifen is used to treat and prevent breast cancer.

While only approved for breast cancer, tamoxifen has also been shown to reduce bone turnover and bone loss in postmenopausal women.

In a large study of more than 7,700 women with osteoporosis, raloxifene reduced occurrence of vertebral fractures by 30 to 50%. However this trial and its one-year extension found no such benefits in any other fracture site (62, 63). Long-term studies that are now underway will look at raloxifene effect on non-spine fractures and on heart disease risk factors such as blood cholesterol levels.

Raloxifene, like its cousin tamoxifen, seems to reduce hormone-sensitive breast cancer (64). It may increase risk of blood clots and make women more prone to hot flashes (65). It is not approved for the prevention and treatment of breast cancer at this time.

Bisphosphonates

This class of drugs affects the bone remodeling cycle and falls under the rubric of anti-resorptive medications. Currently there are two drugs in this class.

Alendronate sodium (Fosamax)

Alendronate is approved for both the prevention and treatment of postmenopausal osteoporosis. It reduces bone loss, increases bone density and reduces the risk of spine, wrist and hip fractures. It is also approved for treatment of steroid-induced osteoporosis in men and women and the treatment of osteoporosis in men. Fosamax can be taken daily or weekly.

Risendronate sodium (Actonel)

Risedronate is approved for the prevention and treatment of postmenopausal osteoporosis. Taken daily, it slows bone loss, increases bone density and reduces the risk of spine and non-spine fractures. Like alendronate, risedronate is approved for use by men and women to prevent and/or treat steroid-induced osteoporosis.
Side effects for alendronate and risedronate are uncommon. They may include:

-abdominal or musculoskeletal pain
-nausea
-heartburn
-irritation of the esophagus.

Both drugs must be taken with water only -- no food. They should be taken on an empty stomach, first thing in the morning, with eight ounces of water (no other liquid!), at least 30 minutes before eating or drinking. You must remain upright during this 30-minute period and until the first meal of the day to avoid a chemical irritation of the esophagus (the tube that connects the mouth with the stomach).

Calcitonin (Miacalcin)

Calcitonin is a naturally occurring hormone produced by the thyroid gland and is involved in calcium regulation and bone metabolism. Exactly what this naturally occurring hormone does in the body is unclear, but it may protect the maternal skeleton during pregnancy.

It is approved for women who are more than five years past menopause and for people with Paget’s disease or hypercalcemia. (Paget's disease is a chronic condition that causes abnormal bone growth. Hypercalcemia refers to excessive blood levels of calcium.) Calcitonin is available as an injection or nasal spray.

Studies show that injectable calcitonin can produce some modest gains in spine BMD, but hip BMD has never been assessed (66). Small studies have shown that the nasal spray provides modest effects on bone turnover and bone density in the spine but no significant effect on the hip (66). Because calcitonin is a protein, it cannot be taken orally as it would be digested before it could work.

Parathyroid hormone (Fortéo)

Teriparatide, a form of parathyroid hormone, is approved for the treatment of osteoporosis in postmenopausal women and men who are at high risk for a fracture. This medication stimulates new bone formation and significantly increases BMD. In postmenopausal women, fracture reduction occurred in the spine, hip, foot, ribs and wrist. In men, fracture reduction was noted in the spine, but there is not enough data to evaluate fracture reduction at other sites. Fortéo is self-administered as a daily injection for up to two years. Side effects can include nausea, leg cramps and dizziness.

Some safety questions have surfaced about giving teriparatide with the biphosphonate drugs. At this time, it is best used alone in newly diagnosed, previously untreated people. After a course of this drug, another drug such as one of the biphosphonates may help maintain the benefits.

In addition to these FDA-approved medications, several new medications are being developed and tested. They include SERMS as well as new anabolic or steroid agents, including strontium renalate and new forms of parathyroid hormone including patches, inhalants and oral forms. Stay tuned.

Bisphosphonates	Alendronate sodium (Fosamax) Risedronate sodium (Actonel)
Selective estrogen receptor modulators (SERMs)	Raloxifene (Evista) Tamoxifen (Nolvadex)
Bone-Forming Medications	Parathyroid hormone (Fortéo)
Hormonal medications	HRT Estrogen Calcitonin (Miacalcin)

C. More than Medications

Along with medications, certain prevention approaches can be helpful in staving off fractures. Most osteoporosis-related fractures happen as a result of falls. In fact, about 30% of the free-living elderly fall at least once a year and that number is even higher among nursing home residents (67). Advanced age and history of prior falls increases risk of falls. Other intrinsic factors that affect fall risk include underlying disorders that impair balance and walking and poor eyesight. External factors that increase fall risk include certain medications such as anti-anxiety drugs, sedatives, alcohol abuse, hypnotics and diuretics, as well as environmental hazards such as exposed wires and slippery rugs.

Simple strategies can help lower risk of falls around the home. They include:

-Eliminating exposed wires, curtain cords, slippery rugs and mobile tables. This will reduce risk of tripping and falling around the house.

-Not walking in stockinged feet on wood or tile floors.

-Making sure there is adequate lighting in and outside the home. Increased visibility may help prevent falls and subsequent fractures.

-Seeing an eye doctor for evaluation and treatment of any vision problems, especially those that involve depth perception (which are specifically associated with increased risk of falls.)

-Wearing protective pads around the outer thigh. These pads protect the hips and have been shown to prevent hip fractures in elderly nursing home residents. In this study, no one who fell sustained a hip fracture if they were wearing a protective pad. Two issues with their use include compliance and comfort. However, newer more comfortable and convenient pads are currently being designed.

-Sporting shoe chains (called Yaktrax) may also help to prevent slipping on icy or snowy paths. These are currently being evaluated to see if they can diminish falling risk.

-Eating a healthy diet replete with bone-strengthening calcium and vitamin D and getting adequate exercise are important parts of staving off the consequences of osteoporosis once you already have the disease, as well as preventing it from developing in the first place. (For more on calcium and Vitamin D, see the Prevention chapter, subsection A: “Nutrition.”)

Medication review

Besides getting regular exercise and eating a healthful diet rich in calcium and vitamin D, it's important to review all other osteoporosis risk factors with a health care provider. The next step is to modify any that are modifiable -- including those that contribute to bone loss and those that contribute to risk of falling.

For instance, any medication that may cause bone loss (including steroids and thyroid hormone replacement) should be reviewed to make sure that if they are truly needed, they are given in the lowest possible dose. This will minimize any bone-depleting effects.

If you smoke, quit. If you drink excessive amounts of alcohol on a regular basis, you should consider seeking evaluation and treatment. Besides having deleterious effects on bone, alcohol abuse increases risks of falls that occur while under the influence. Other factors that may increase risk of falls should be evaluated. They include a review of all medications that can cause low blood pressure upon standing (orthostatic hypotension) and/or sedation including anti-anxiety and hypnotic drugs.

Treatment monitoring

How do you know if treatment is making a difference in what is already a silent disease? Good question.

There are currently no accepted guidelines for monitoring osteoporosis treatment. However as most treatments produce small or moderate bone mass changes, DXA can be useful. Still, precision errors can occur even in the best of circumstances with repeat measurements. As a result, changes should be more than 4% in the spine and 6% in the hip to be considered improvements. Since changes take a while to accrue, BMD testing should not be repeated at intervals of less than two years. Follow-up bone density testing is also useful to follow bone loss in people who are not currently being treated and can help doctors make a decision about when to start treatment. Bone turnover tests can also be used to monitor how well treatment is working.

Prevention

There is no cure, but osteoporosis is preventable to some degree. There are several steps you can take to prevent osteoporosis -- namely, lifestyle factors, including good nutrition and regular exercise.

A. Nutrition

Calcium

Many nutrients play a role in skeletal growth and attaining peak bone mass. In today's world, however, people are mainly concerned with calcium. In fact, how much milk children and adolescents consume is directly related to their bone density as they age (68-71). Studies have shown that higher calcium intakes are associated with lower rates of devastating hip fractures (72). Calcium provides mechanical rigidity to bones and teeth. Calcium balance is determined by intake, absorption and losses of calcium that occur through sweat, breath and urine.

Supplement savvy

Ideally, calcium should come from a healthy diet replete with fruits and vegetables and low in saturated fat and salt. If supplements are taken, however, doses should be less than or equal to 600 mg at a time. The percent that gets absorbed decreases with higher doses of calcium. Look for the words "elemental calcium" on the supplement label as this refers to the amount available for absorption by your body. Calcium carbonate supplements should be taken with food since they need acid to be digested and absorbed. Calcium citrate supplements, however, can be taken at any time with or without food.

Side effects of calcium supplements may include constipation, distention and/or excess gas.

Current Daily Calcium Recommendations (73)

Ages 3 to 8	800 milligrams (mg) of calcium
Ages 9 to 18	1,300 mg
Ages 19 to 50	1,000 mg
Ages 51 to 70	1,200 mg (more for women not taking HRT)

Ages 70 and older	1,200 mg

Milk is not the only dietary source of calcium. Far from it. Many foods are rich in calcium, although it is probably best absorbed from milk and other dairy products.

Food	***Serving size***	***Calcium (mg) per serving***
Sardines in oil	3 oz	370
Milk (whole, 2%, 1%, and skim)	1 cup	290–300
Swiss cheese	1 oz	250–270
Yogurt	1 cup	240–400
Canned salmon (with bones)	3 oz	170–210
Broccoli	1 cup	160–180
Ice cream	1/2 cup	90–100
Cottage cheese	1/2cup	80–100

http://www.nal.usda.gov/fnic/foodcomp (74)

Getting enough calcium can help reduce bone loss and suppress bone turnover (40, 42, 92, 100, 106, 110-113).

Consuming adequate calcium in the diet or from supplements can stop bone loss in postmenopausal women. Calcium alone and with Vitamin D has been shown to reduce the risk of vertebral, hip and other non-spine fractures (75-78)

But some dietary factors including phytate in wheat, oxalates, iron and excess caffeine can reduce calcium absorption by the gastrointestinal tract. Phytates found in wheat bind to minerals like calcium and reduce their absorption. Oxalates also bind to calcium and make it difficult for the body to absorb. Too much sodium also increases the amount of calcium that we excrete (79). In fact for every teaspoon of salt, urinary calcium excretion increases by 23 mg (80). If you are prone to kidney stones, your doctor might order a 24-hour urine calcium determination test before increasing your calcium, because any additional calcium could increase risk of stones in people who are prone to them. To compensate for high levels of urinary calcium, he or she may consider prescribing a thiazide diuretic to increase calcium absorption and reduce level of urine in the calcium.

Vitamin D

Vitamin D is often called “the sunshine vitamin” because it is made by the body after exposure to the sun. It can also be obtained from diet. It aids in calcium absorption and can have direct effects on the skeleton.

Vitamin D deficiency or insufficiency (less than 20 milligrams [mg] of vitamin D per milliliter [ml] of blood) is believed to play a strong role in osteoporosis -- primarily by increasing rates of bone loss. Vitamin D deficiency also contributes to muscle weakness, impaired balance and increased risk of falls (81, 82).

Supplements of Vitamin D ranging from 700 to 800 International Units a day (along with adequate or supplemental calcium) reduce fracture rates by up to 60% in the elderly (83, 84). This much vitamin D can reduce hip fracture by 40% (85). At this point, there are no studies looking at how vitamin D supplementation affects vertebral compression fracture risk.

Vitamin D recommendations (73)

Aged 50–65	400 IU/day
Aged 65 and older	600-800 IU/day

Dietary sources of vitamin D include several types of fish and vegetable oils, as well as fortified dairy and other products.

Food	***International Units (IU) per serving (86)***	
Salmon, cooked	3 ounces	360
Mackerel, cooked	3 ounces	345
Tuna fish, canned in oil	3 ounces	200
Milk (nonfat, reduced fat and whole, vitamin D fortified)	1 cup	98
Fortified soy and other Milk substitutes	1 cup	40-100

http:://www.nal.usda.gov/fnic/foodcomp online (86)

Blood tests to measure vitamin D can be used as an indicator of vitamin D status. Talk to your doctor.

Other nutritional shortfalls can play a role in the development of osteoporosis and its related fractures.

Among elderly people, low protein can have negative effects on bone. In fact, studies have shown that hip fracture patients are frequently malnourished due to inadequate protein. In addition, supplementing protein has been shown to reduce complications following hip fracture (87-90).

Some elderly people may be deficient in phosphate, which can contribute to bone loss (91). Bone mineral density is a measurement of the concentration of minerals including calcium and phosphate.

In the elderly, chronically ill people, or those with intestinal disease, low levels of the mineral magnesium may accelerate bone loss (92, 93). Other vitamins that may be needed for healthy bone mass are vitamin C and vitamin K. Vitamin C, found in citrus fruits, tomatoes, green pepper and potatoes, is needed for collagen production (94). Collagen is a protein that helps gives bones their flexibility and strength. Bones with low levels of collagen composition are brittle and easily broken.

Vitamin K, which is found mainly in green, leafy vegetables, plays an important role in calcium regulation and bone formation (95-101). Aim for one or more servings per day of broccoli, Brussels spouts, dark green lettuce, collard greens, spinach or kale. These should help you meet your daily dose of bone-building K.

Select populations may benefit from supplements of magnesium, phosphorus or other nutrients. Talk to your doctor.

B. Working Your Bones with Exercise

Exercise is also key to building peak bone mass. The reason is simple. Bone is known to adapt to loads that are applied to it. The increased mechanical loads associated with exercise lead to an increase in bone density, especially during childhood (102-106). Just as a muscle gets stronger and bigger the more you use it, bone too becomes stronger and denser when you place demands on it with exercise. When you strike a tennis ball or land on your feet after a jump, chemical messengers tell your arm and leg bones to be ready to handle that weight and impact again. The converse is also true. If your bones are not exercised, they do not receive these strengthening messages. That's why a lack of exercise, particularly as you get older, may contribute to lower bone mass or density.

Two types of exercises are important for building and maintaining bone mass and density: weight-bearing and resistance exercises. Weight-bearing exercises are those in which your bones and muscles work against gravity. They include jogging, walking, stair climbing, dancing and soccer. In a nutshell, it's considered weight-bearing if your feet and legs bear your weight. By contrast, swimming is not weight-bearing.

Resistance exercises use muscular strength to improve muscle mass and strengthen bone. They include weight lifting with free weights and weight machines.

Exercising throughout the lifespan will have positive effects on the skeleton (107-110). But don't despair -- even older postmenopausal women who start weight-bearing exercise or muscle-strengthening exercises can help prevent bone loss.

During the course of one year, older exercisers gain about 1% in bone mineral density compared to non-exercisers (111). If this effect continues with each year, exercise could ultimately have a very substantial effect on bone mineral density. What's more, exercise also has positive effects on neuromuscular function, coordination, balance and strength, and can reduce risk of falling. It also benefits the heart and circulation.

Exercise Rx

Just do it. Engage in some form of exercise at least three times a week (but any exercise is better than none). Walking can be especially helpful. It may be enough, especially among people with major co-existing medical conditions. High impact exercise may be best for people with no other musculoskeletal problems or conditions.

Conclusion

When it comes to osteoporosis, prevention remains the best strategy. Optimal prevention starts with building strong bones, especially before the age of 30, mainly by consuming daily recommended amounts of bone-building calcium and vitamin D, engaging in regular weight-bearing exercise and avoiding smoking and excessive alcohol consumption.While osteoporosis cannot be “cured,” certain medications along with simple strategies to prevent falls around the home can reduce fracture risk. It’s extremely important to talk to your doctor about bone health and, if indicated, get a bone density test. The good news is that the future is looking bright. Research is currently underway that aims to improve diagnosis and develop newer and even more effective treatments.

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