

The background features a dark blue gradient with a starry space pattern. Overlaid on this are several technical diagrams, including circular gauges with numerical scales (e.g., 40, 150, 160, 170, 180, 230, 240, 250, 260) and various circular and curved lines, some with arrows, suggesting a scientific or medical context.

OSTEOPOROSIS: THE DISEASE, ITS DIAGNOSIS AND TREATMENT

Sakura Kai, August 17th, 2024

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SOURCE MATERIALS

- “Healthy Bones for Life: Patient’s Guide”
National Osteoporosis Foundation
<https://www.bonehealthandosteoporosis.org/>

KEY POINTS

1. Bones are living tissue and are constantly changing.

From the moment of birth until young adulthood, bones are growing and strengthening. This process is called “modeling”.

2. Bones are made up of three major components that make them both flexible and strong:

- Collagen, a protein that gives bones a flexible framework.
- Calcium-phosphate mineral complexes that make bones hard and strong.
- Living bone cells that remove and replace weakened sections of bone.

3. Children and teenagers form new bone faster than they lose old bone.

In fact, even after they stop growing taller, young people continue to make more bone than they lose. This means their bones get denser until they reach what experts call peak bone mass. This is the point when you have the greatest amount of bone you will ever have. It usually happens between the ages of 18 and 25 years.

4. Old bone cells are replaced on an ongoing basis, a process known as “remodeling”.

After the active skeletal growth phase in youth, and after menopause in women (a bit later in men), the remodeling process becomes unbalanced and we begin to lose more bone than we replace. This results in a net decrease in the total amount of bone. When the amount of bone loss decreases, it is called low bone density (osteopenia) or osteoporosis. Get enough calcium & vitamin D, exercise regularly, and make healthy lifestyle choices.

BONE GROWTH & LOSS

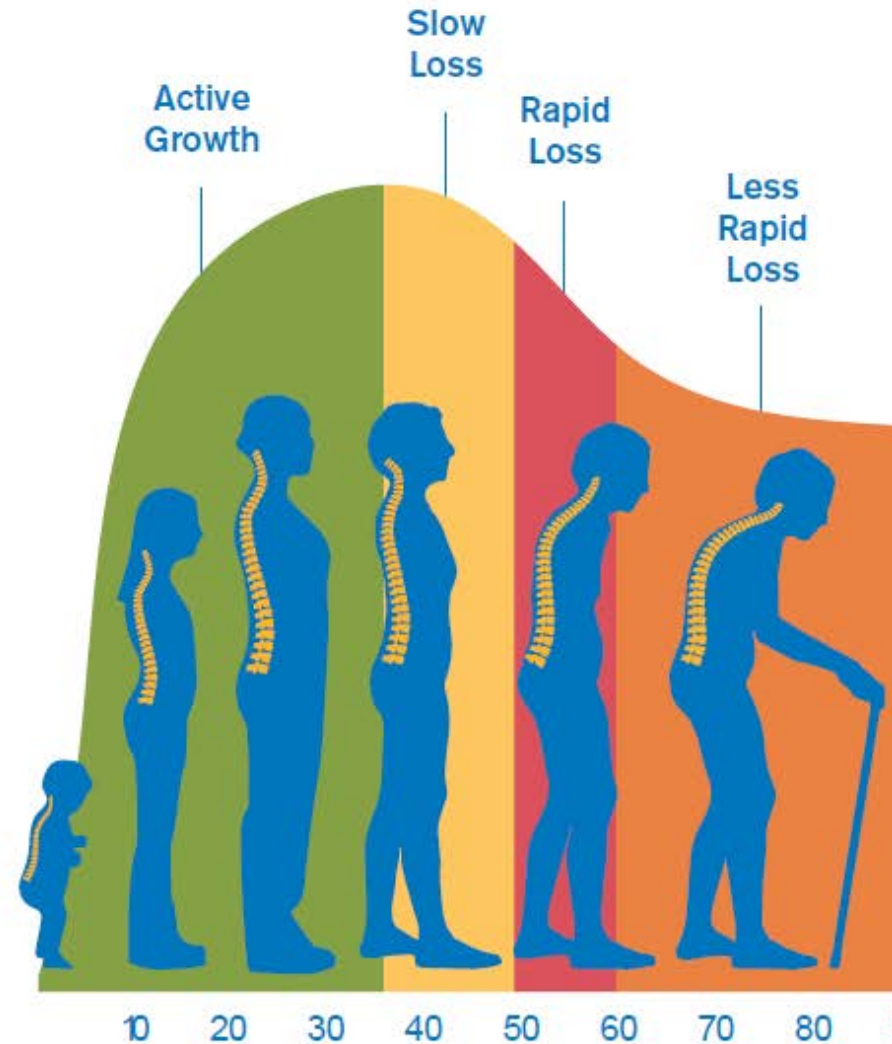


Figure 1

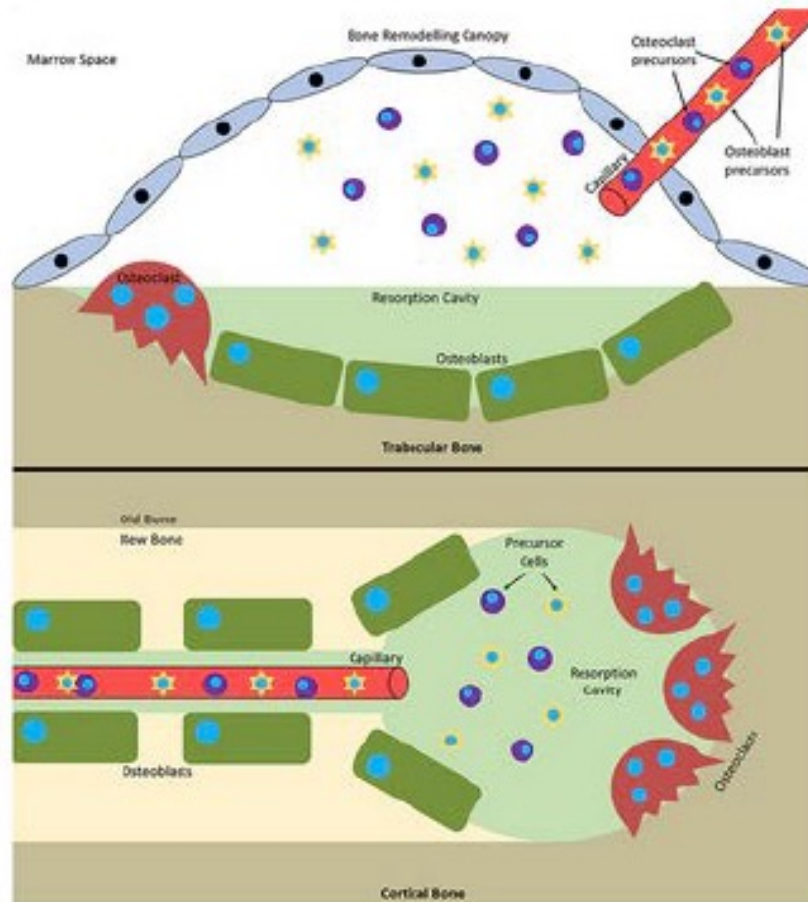


FIGURE 1. Bone multicellular units in (top) trabecular and (bottom) cortical bone. In trabecular bone they initiate underneath bone remodelling canopies formed from bone lining cells and in cortical bone at points within Haversian canals.

In healthy young adults, bone resorption and formation are balanced, and occur with the need for bone tissue repair due to normal usage

***In vitro Models of Bone Remodelling and Associated Disorders R Owen and G Reilly
Front. Bioeng. Biotechnol., 11 October 2018***

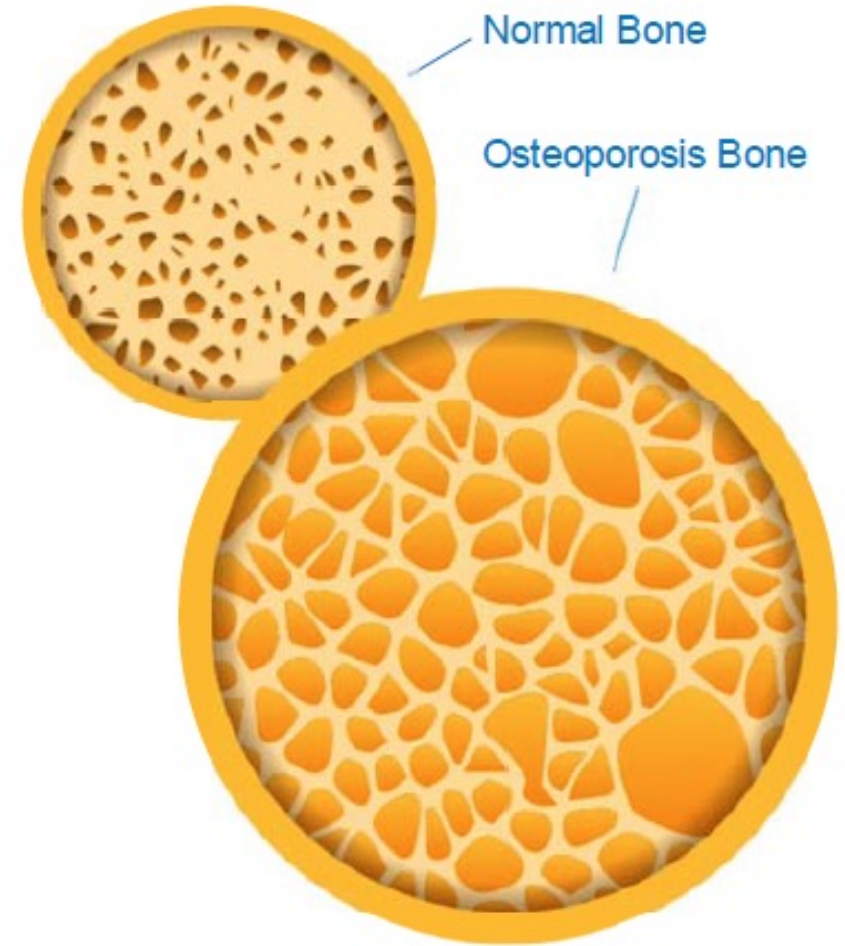
Age-related changes in estrogen levels cause increased activation of osteoclasts compared to osteoblasts and net increase in bone resorption

KEY POINTS

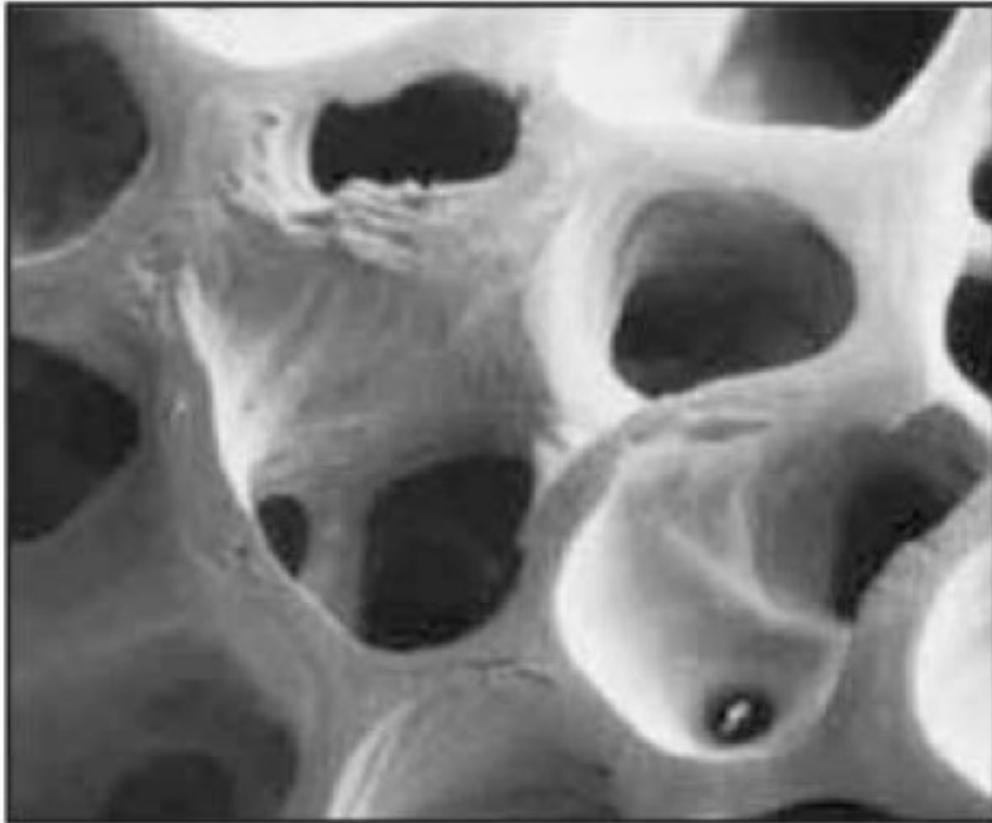
1. Osteoporosis is a condition in which the bones become weak and can break more easily.
2. The term osteoporosis literally means “porous bone.”
3. Bone loss is a natural part of aging, but not everyone will lose enough bone density to develop osteoporosis.

However, the older you are, the greater your chance of having osteoporosis.

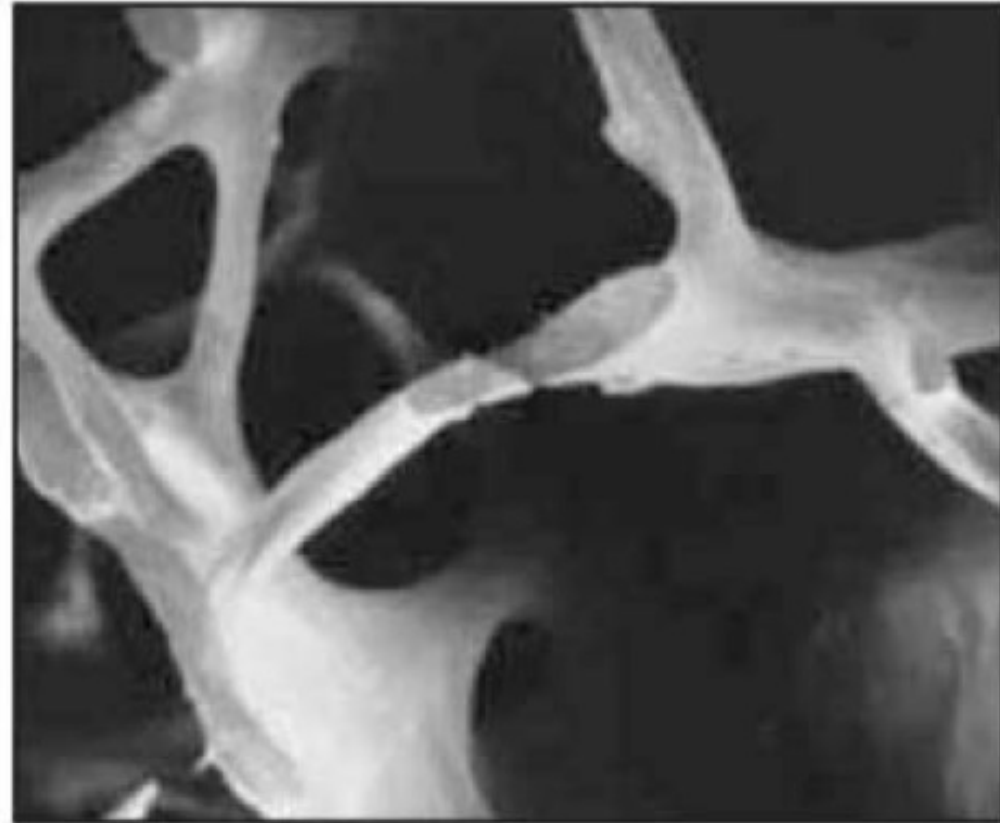
4. About 9 million Americans over the age of 50 years have osteoporosis.
5. One half of women and two in five men will develop osteoporosis during their lifetime.
6. Osteoporosis is the underlying cause of approximately 2 million fractures every year.
7. Back pain, caused by changes in the vertebrae, may be the first sign that something is wrong.



Normal Bone



Osteoporotic Bone



Bone Health and Osteoporosis: A Report of the Surgeon General.
Office of the Surgeon General (US).
Rockville (MD) 2004.

KEY POINTS

1. Begins in childhood via failure to reach peak bone mass.
2. It is not gender specific:
 - A man older than 50 is more likely to break a bone due to osteoporosis than he is to get prostate cancer.
 - A woman's risk of breaking a hip due to osteoporosis is equal to her combined risk of breast, ovarian and uterine cancer.
3. Genetics play a role and so does race and ethnicity.
4. It can be affected by:
 - Poor diet, lack of exercise, smoking and drinking too much.
5. Certain medical conditions can also be a risk factor

RISKS

Risks you cannot change:

- Female gender / past menopause.
- Family member with osteoporosis + and/ or fractures.
- Thin, small or petite body frame.
- Aging, for both genders.
- Other health conditions like rheumatoid arthritis, celiac disease, overactive thyroid gland.
- History of a broken bone (fracture).
- Use of certain medicines like corticosteroids, anticonvulsants or others.
- History of falls over the past year.

Risks you may be able to change:

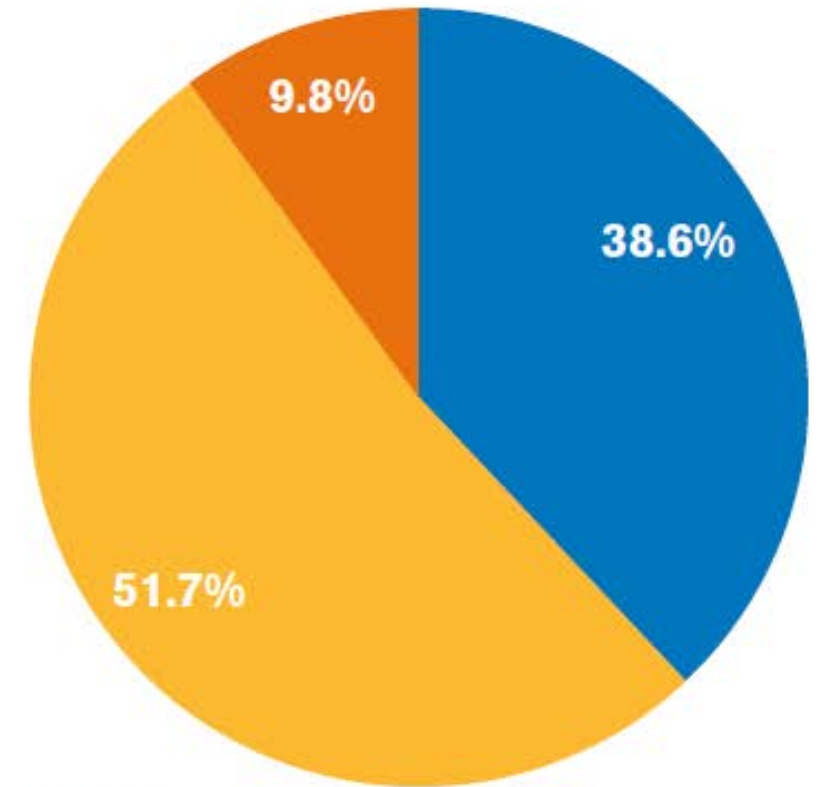
- Woman with estrogen deficiency.
- Too little intake of calcium, vitamin D and other nutrients.
- Too little exercise.
- Smoking or past history of smoking.
- Three or more alcoholic drinks per day.
- Excessive intake of coffee, cola or other caffeinated beverages.

KEY POINTS

1. Low bone mass is when your bone density is lower than normal, but not low enough to be considered osteoporosis.
2. Low bone mass (osteopenia) does not always mean you will get osteoporosis, but it is a risk.
3. Approximately 48 million Americans over the age of 50 years have low bone mass.
4. As we age, we lose more bone than we replace.
5. As with osteoporosis, there are no physical symptoms.

Low bone mass can progress to osteoporosis, but with changes in diet and exercise, you can slow the bone loss.
6. Individuals with low bone mass have a greater chance of developing osteoporosis if they lose bone in the future because they have less bone to lose.
7. People with low bone density are more likely to break a bone compared to people with normal bone density.
8. If you have low bone mass, your doctor will evaluate you to see if you need medication.

LOW BONE MINERAL DENSITY



WHAT WOMEN NEED TO KNOW

1. Low estrogen levels lead to bone loss
 - Estrogen is a hormone that helps protect bone.
2. All women go through menopause and it leads to lower estrogen levels, which cause bone loss.
3. Women's bones are generally thinner than men's & bone density has a rapid decline for a time after menopause.
4. Osteoporosis starts earlier and gets worse faster in women because of midlife hormonal shifts.
5. Women can lose up to 20% of their bone density in the 5-7 years after menopause.
6. 80% of Americans with osteoporosis are women.

WHAT MEN NEED TO KNOW

1. Osteoporosis is associated with some male-only conditions:
 - For example, abnormally low testosterone levels (hypogonadism).
 - Low testosterone levels put men at risk.
2. Men who break a hip or wrist are less likely than women to get treated for osteoporosis.
3. Men may, however, have fewer treatment choices at this time because some drugs have been tested only in women.
4. Starting at about age 65, both sexes lose bone at about the same rate.

BONE MINERAL DENSITY TEST



KEY POINTS

1. What is it?

- Measures the density of minerals, like calcium and other types in your bone.
- Painless.
- May be able to remain fully clothed.
- Takes less than 15 minutes.

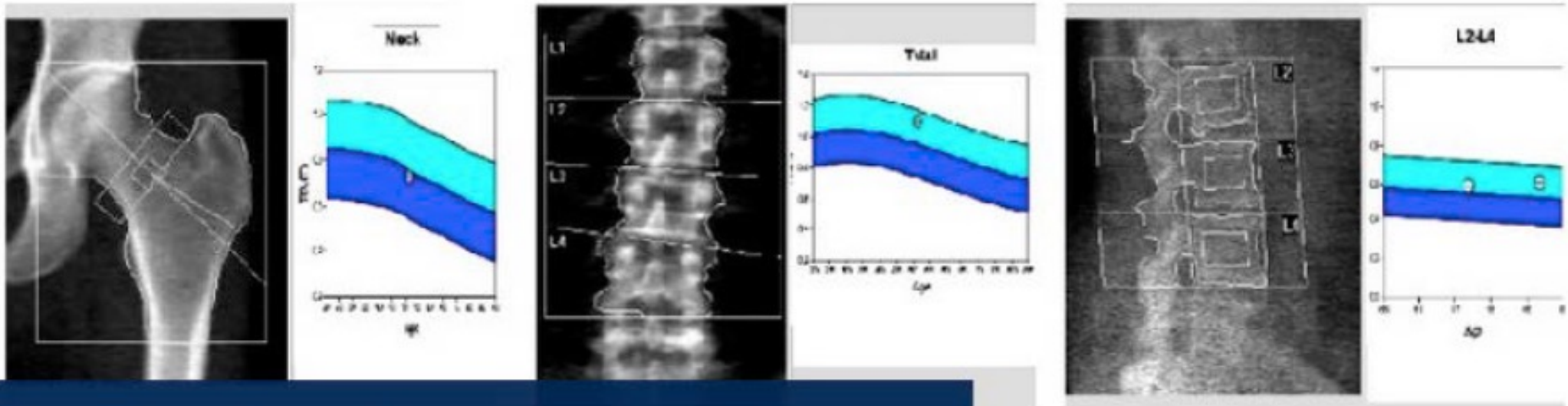
2. How is this important?

- Diagnose bone loss and osteoporosis.
- Shows how well osteoporosis medicine is working.
- Predict risk of future bone fractures.

3. How is this performed?

- Dual-energy x-ray absorptiometry (DXA) scan.
- Peripheral dual-energy x-ray absorptiometry (pDXA).
- Quantitative ultrasound (QUS).
- Quantitative Computed Tomography (QCT)
- pQCT (peripheral QCT) scan.
- Radiographic absorptiometry (RA).
- Single energy x-ray absorptiometry (SXA).

DXA (DEXA) Scan



Dual Energy X-ray Absorptiometry

KEY POINTS

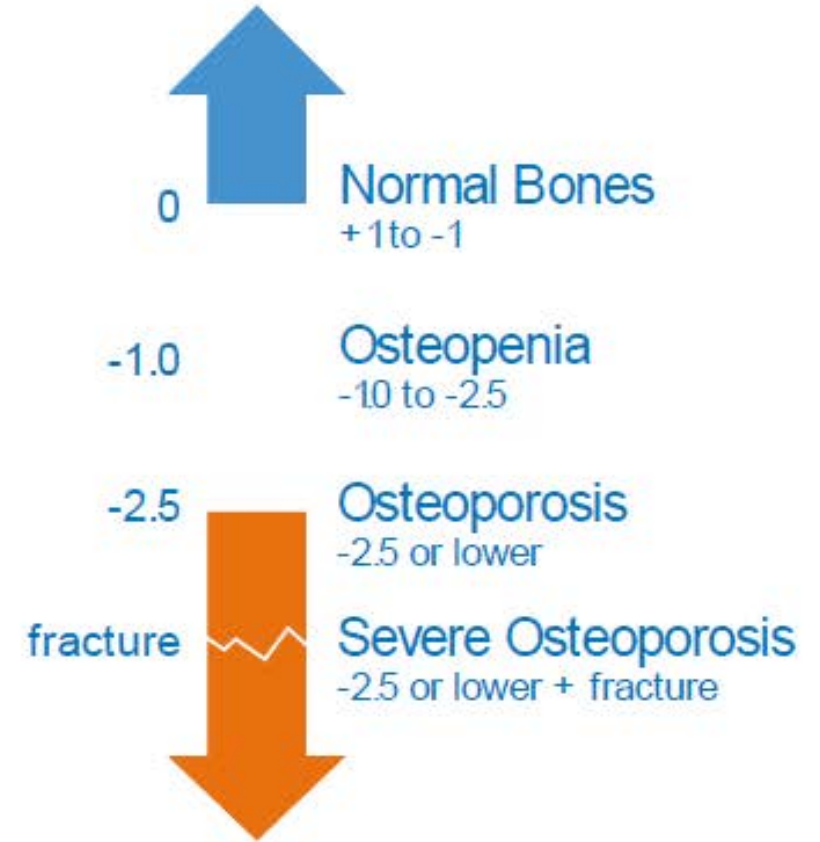
T-score

- Your test result will be compared to the ideal or peak bone mineral density of a healthy 30 year old adult.
- Differences between your BMD and that of a healthy adult are measured in standard deviations (SD).
- The more standard deviations your score is below 0, the lower your BMD and higher your risk of fracture.
- The greater the negative number, the more severe the bone loss.
- Some fractures, especially hip and spine fractures are almost always due to osteoporosis regardless of the T-score.

Z-score

- Used to evaluate BMD in children and adolescents.
- Also used in adults.
- Compares a person's BMD to what is expected in another person of the same age and body size.
- Useful for determining whether an underlying disease or condition is causing bone loss.

T-SCORE = BONE MINERAL DENSITY



FRAX

Please answer the questions below to calculate the ten year probability of fracture with BMD.



Weight Conversion:

pound:

130 pound = 58.97 kg

Height Conversion:

inch:

64 inch = 162.56 cm

Country: **US (Caucasian)** Name / ID:

[About the risk factors](#)

Questionnaire:

1. Age (between 40-90 years) or Date of birth

Age: Date of birth: Y: M: D:

2. Sex Male Female

3. Weight (kg)

4. Height (cm)

5. Previous fracture No Yes

6. Parent fractured hip No Yes

7. Current smoking No Yes

8. Glucocorticoids No Yes

9. Rheumatoid arthritis No Yes

10. Secondary osteoporosis No Yes

11. Alcohol 3 or more units per day No Yes

12. Femoral neck BMD (g/cm²)

Hologic T-score: **-2.2**

BMI 22.3

The ten year probability of fracture (%)

with BMD

Major osteoporotic	17
Hip fracture	3.6

Intervention thresholds
20%
3%

FRAX

- Widely used by osteoporosis specialists, especially as a patient education tool
- Primary care physicians are often familiar with it and use it
- FRAX is often offered with bone density report
- Caveats
 - Not useful for < 40 years
 - Not useful for people who have already been treated for osteoporosis
 - Based on hip BMD may not reflect risk for people with spine osteoporosis

EXERCISE

KEY POINTS

1. Like your muscles, your bones get stronger when you make them work.
2. This means handling impact, weight of your body or more resistance.
3. Exercise will help increase or maintain bone strength & improve ability to do daily activities.
4. Always check with your healthcare provider to find out what exercises are safe for you.

WEIGHT-BEARING EXERCISES

Weight-bearing exercises include activities that make you move against gravity while being upright, such as fast walking.

Higher impact exercises like jogging and running may not be safe if you have osteoporosis or a history of fracture.

Try to do 30 minutes of weight-bearing exercise, moderate pace, most days of the week.

When you do muscle-strengthening exercises, you move your body, a weight, or some other resistance against gravity.

Muscle-strengthening exercises include lifting weights, using elastic exercise bands or using weight machines. They are also called resistance exercises.

Aim to perform 8-12 different muscle-strengthening exercises to cover main body areas.

1-2 sets of 8-10 repetitions to fatigue, for 2-3 days per week.

NEXT STEPS

KEY POINTS

Develop treatment plan including:

- Medication/ Supplements.
- Exercises.
- Healthy Lifestyle.
- Additional testing.
- Keeping clinician informed of changes in routine or/ and general health.

RECOMMENDED TREATMENT

Medications:

- Your healthcare provider will consider other health problems you have when recommending a medicine.

Calcium recommendations:

- ensure you are getting enough.

Vitamin D: helps absorb calcium & make new bone:

- To get enough vitamin D, many people need to take a supplement.

Exercise (role & safe modifications):

Adhere to the U.S. Physical Activity Guidelines for Americans:

- Weight-bearing.
- Balance training.

Nutrition:

- Adhere to the U.S. Dietary Guidelines for Americans.

Lifestyle issues:

- Smoking cessation, limit alcohol.

CALCIUM & VITAMIN D SUPPLEMENTATION

Calcium is an essential nutrient because it provides the building material for building new bone.

Try to get your daily amount of calcium from your diet first and only take supplements to make up the shortfall.

Consider foods that have calcium added. Ex: some brands of cereal & juices.

Try some healthy alternatives:

- Add beans to soups, chili, and pasta dishes.
- Enjoy a smoothie made with yogurt.
- Include leafy vegetables in your meals.

Your body needs vitamin D to absorb calcium.

It is very difficult to get enough of vitamin D from food alone, so many people will need to take a vitamin D supplement (note: most calcium supplements also contain vitamin D) to obtain their recommended amount.

Fatty fish (e.g. salmon, tuna and mackerel) and fish liver oils are the best sources, while beef liver, cheese and egg yolks contribute small amounts. Milk in the U.S. is fortified with 100 IU of vitamin D per 8 ounce serving.

Your body naturally makes vitamin D with prolonged sun exposure.

However, use of sunscreen with an SPF of 15 or greater impairs this action.

Ask your physician to recommend a vitamin D supplement if needed.

CALCIUM & VITAMIN D FOR WOMEN:

- Under age 50 need 1,000 mg of calcium & 400-800 IUs of vitamin D daily.
- Age 50 and older need 1,200 mg of calcium & 800-1,000 IUs of vitamin D daily.

CALCIUM & VITAMIN D FOR MEN:

- Under age 50 need 1,000 mg of calcium & 400-800 IU of vitamin D daily.
- 50-70 need 1,000 mg of calcium & 800-1,000 IU of vitamin D daily.
- 71 and older: need 1,200 mg of calcium & 800-1,000 IU of vitamin D daily.

CREATING THAT HEALTHY LIFESTYLE

DO

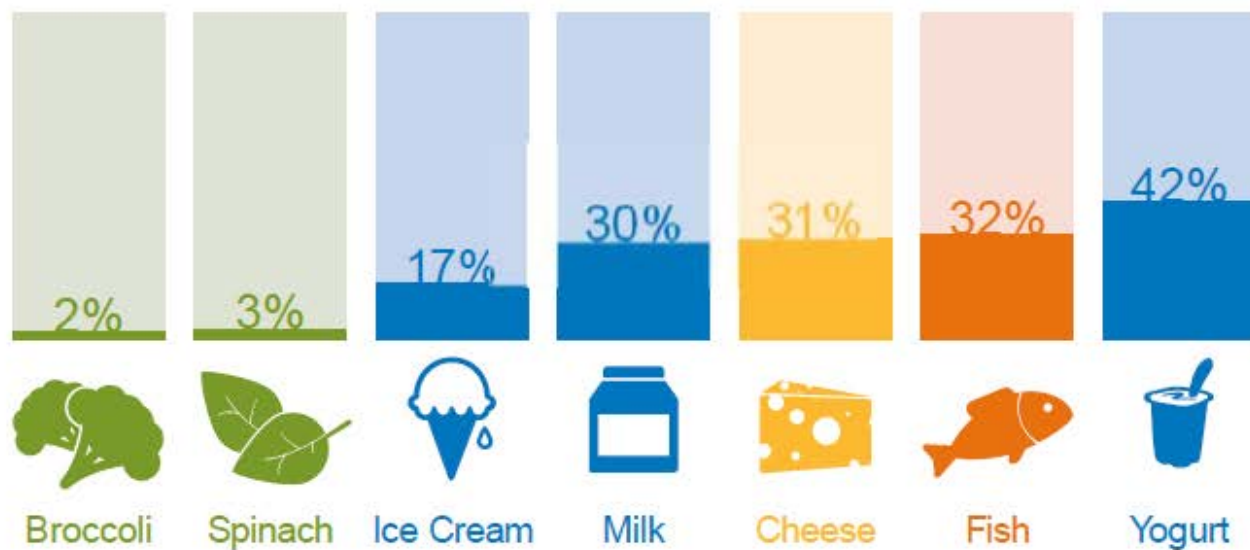
- Eating calcium-rich foods can help your bones no matter what age.
- Consume the equivalent of 3 8-ounce glasses of low-fat or non-fat milk per day to get enough calcium and other nutrients.
- Consume foods rich in vitamin D (e.g. fatty fish) and/ or ask your doctor about taking a vitamin D supplement.
- Leafy green vegetables also provide calcium, magnesium and other essential nutrients that help maintain good bone health.

DO NOT

- Salty foods (canned soups and processed meats) can decrease your bone's calcium reserves.
- Excess caffeine (i.e. more than three cups of coffee a day) can also decrease your bone's calcium reserves.
- Excessive alcohol intake can lead to bone loss.

VITAMIN D RICH FOODS

Percentage of daily value



OSTEOPOROSIS TREATMENT

KEY POINTS

1. While there is no cure, there are steps you can take to slow or stop the progress of osteoporosis or prevent fractures (broken bones).

In some cases, your bones may even improve.

2. If you have osteoporosis or low bone density, you should talk to your healthcare provider about whether you need treatment at this time.

ANABOLIC MEDICINE

Stimulates your body to make new bone more quickly

Increases your bone density

Lowers your risk of breaking bones

Teriparatide (parathyroid hormone or PTH):

- Use in men and women at high risk for fracture.
- Reduces fractures at spine and non-spine sites.
- Give by daily injection for a maximum of 24 months.
- Side effects include leg cramps, nausea, and dizziness.

OSTEOPOROSIS TREATMENT

ANTIRESORPTIVE MEDICINES

Slow the breakdown of bone

Maintain or improve bone density

Lower the risk of breaking bone

Bisphosphonate medicines:

- Reduce bone loss.
- Increase bone density in the hip and spine.
- Reduce the risk of fractures in the spine, hip and other non-spine sites.
- Side effects may include heartburn, nausea, abdominal pain, bone or muscle pain.
- Can be given orally (pill) or intravenously.

Rank ligand (RANKL) inhibitor:

- Slow bone breakdown.
- Increase bone density in the hip and spine.
- Reduce the risk of fractures in the spine, hip and other non-spine sites.
- Given as a subcutaneous injection twice a year.
- Side effects include: Low levels of calcium in the blood, risk of serious skin infections (cellulitis) and skin rash.

Calcitonin:

- Use only when other medicines are not able to be used.
- May reduce the chance of spinal fractures.
- Give by nasal spray or daily injection.
- Side effects include runny nose, bleeding from the nose and allergic reactions.

Estrogen agonist/antagonist medicines (SERMs) (women only):

- Increase bone density in the hip and spine.
- Prevent bone loss.
- Reduce the risk of spinal fracture.
- Side effects may include hot flashes, leg cramps, increased risk of blood clots.

Estrogen therapy, hormone therapy and Tissue-Selective Estrogen Complex (women only):

- Use in early menopause to control menopausal symptoms and hot flashes; will help preserve bone density.
- Primary indication for use is treatment of menopausal symptoms.
- Tissue-Selective Estrogen Complex is a combination of estrogen and bazedoxifene, a SERM, and is used in women who suffer from moderate-to-severe hot flashes (vasomotor symptoms) associated with menopause and to prevent osteoporosis after menopause.
- Side effects include: muscle spasms, nausea, diarrhea, dyspepsia, upper abdominal pain, oropharyngeal pain, dizziness, neck pain, and increased risk of blood clot.

ADHERENCE ISSUES

What happens if I do not treat osteoporosis?

- Your risk of fractures will increase.
- You may have loss of height due to fractures in the vertebrae.
- Spinal fractures may cause a curving deformity of the spine.
- Severe back pain due to vertebral fractures or changes in posture may occur.
- Fractures from osteoporosis may cause temporary or permanent loss of mobility and independence.
- Internal body organs, like the lungs, stomach and intestines may be squeezed for space in the chest and abdomen as the bones in the spine collapse from fractures.

Atypical fractures

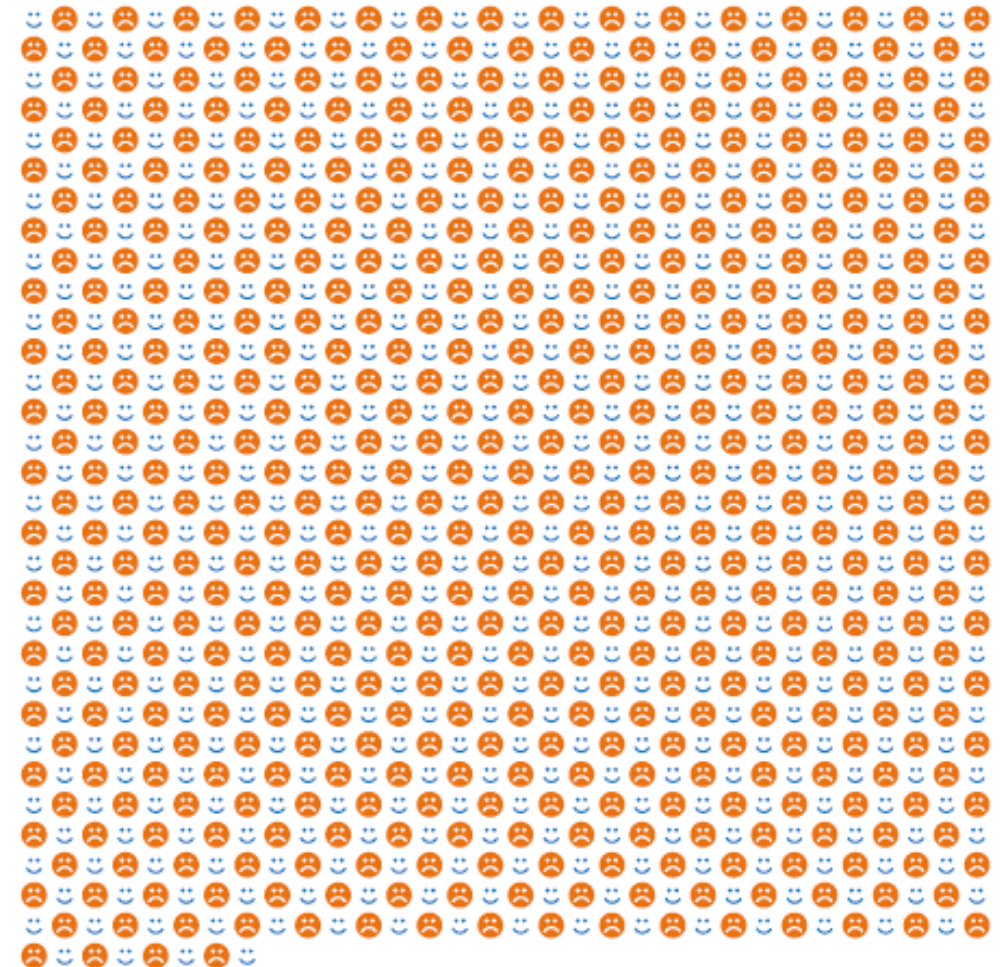
Associated with long-term (5-year) treatment with antiresorptive
Decrease in risk of fracture with treatment is >>> than risk of atypical fractures

Black DM et al N Engl J Med. 2020 Aug 20; 383(8): 743–753.

In a large sub-cohort of treated white women, 149 hip fractures were prevented, compared to 2 atypical fractures.

YOUR RISK OF FRACTURE

Out of 1,000 women, 500 will suffer a fracture without treatment for Osteoporosis.



FRACTURE HAS MANY RISK FACTORS

Bone weakness

- Genetics
- Low peak bone mass due to childhood impairments
- Disease conditions requiring bone-active meds
- Smoking
- Other lifestyle factors

Fall risk

- Muscle weakness
- Poor balance
- Vision impairment
- Poor endurance
- Environmental factors
 - Clutter/Terrain
 - Stairs

SAFETY

1. Fall prevention:

- Wear supportive shoes with rubber soles & low heels.
- Have vision & hearing checked often.
- Use hand rails on stairs & escalators.
- Be careful around pets in the home or when walking outdoors.

2. Fall proof your home:

- Remove clutter, cords & throw rugs.
- Keep halls, stairs, and entryways well lit.
- Use night lights in rooms.
- Use nonskid rubber mats near the sink, bathtub and in shower.

3. Follow guidelines for safe movement; avoid movements that put extra stress on the spinal bones:

- Bending forward from waist: sit-ups, abdominal crunches & toe touches.
- Twisting trunk & bending forward.
- Reaching high or far out in front of you.

4. Ask your health care provider if any medicines you take could cause you to feel dizzy or lose balance.

5. Each year 1/3 of all persons over age 65 will fall and many cause broken bones.

6. Knowing how to move, sit and stand properly can help you stay active while avoiding broken bones.

7. People with osteoporosis or who have an increased risk of breaking a bone should avoid the following positions or movements:

- Having a slumped, head-forward posture.
- Twisting the trunk and bending forward when doing activities such as coughing, sneezing, vacuuming or lifting.
- Anything that requires you to reach high or far in front of you. An example is stretching forward to reach into the trunk of your car to get groceries or other items.