

OSTEOPOROSIS + EXERCISE

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WHAT IS OSTEOPOROSIS?

Osteoporosis is a skeletal disease that is characterized by low Bone Mineral Density (BMD) and changes in the microarchitecture of bone that increase susceptibility to fracture.

HOW IS IT MEASURED?

Dual X-ray Absorptiometry (DEXA) scan measures BMD with a T-score (standard deviation to value for healthy man, 30 years old). Normal T-score range is above -1.0. Osteopenia between -2.5 to -1.0. Osteoporosis equal or less than -2.5.

WHAT ARE THE RISKS ASSOCIATED?

Low bone mass and structural deterioration of bone tissue caused by osteoporosis leads to an increased susceptibility to fractures, especially of the hip, spine, and wrist. Hip fracture is the most costly result as it always requires hospitalization with a severely poor recovery rate.

HOW DO WE BUILD BONE?

BONE REMODELING : RESORPTION + FORMATION

Bone is a living tissue, like skin, continually renewing itself in a process called bone reformation or turnover which involves both resorption and formation. Resorption occurs as osteoclasts, or destruction cells, break down bone, releasing minerals like calcium into bloodstream. Formation occurs as osteoblasts, bone building cells, lay down and mature into full bone cells (osteocytes) and mix with minerals (including calcium) along with collagen in a matrix to form new bone.

PEAK BONE MASS

We build more bone (formation) than we destroy (resorption) during childhood and adolescence, building our peak bone mass at this time. In our 30's, bone formation begins to decline (more resorption than formation at the cellular level). An important hormone in regulating resorption is estrogen. For women, during menopause, the reduction in estrogen can cause a rapid drop in BMD. *It is estimated in the United States that 30% of women and 15% of men over 50 have osteoporosis.

BONE TISSUE TYPES : CORTICAL + TRABECULAR

Cortical bone tissue is found in the majority of our skeleton and mostly in the outer shell of the bone. Trabecular bone tissue concentrates at the ends of long bones (like the femur) and in irregularly shaped bones (like vertebrae) and has a higher rate of turnover. As we get older, with bone formation decline, trabecular bones - those with a higher rate of turnover - are more susceptible to loss and weakness (remember above where we mentioned osteoporotic fractures are most common in hip, spine, and wrist?).

STRENGTHENING BONE

Regardless of age and even with osteoporosis, bone is constantly regenerating, even if at a slower rate. Research has shown that bone tissue strengthens in response to pulling and pushing forces from muscle and connective tissue as well as compression from gravity and other forces. We can build bone thru weight bearing exercise, resistance exercise, and impact.

BENEFITS OF EXERCISE FOR OSTEOPOROSIS

PREVENTION

Exercise is the primary nonpharmacological treatment for prevention of osteoporosis (remember above where we mentioned building bone mass in our youth?).

MAINTAINING AND BUILDING BONE STRENGTH

Recent evidence also indicates that weight bearing and resistance exercise can play a role in strengthening bone tissue thru "osteogenic loading." Loading adds stress to the bones that stimulates bone building. The load compresses the bone matrix and triggers the cells to take in more calcium and other minerals, and ultimately increase bone density. Osteogenic loading, however, only occurs in the involved area (for example, bench presses won't improve bone strength in the hip).

While normal daily activities are sufficient to prevent harmful effects of unloading (as results from prolonged bed rest or space travel, for example), significant loading appears to be required to increase bone density. Some research has shown we need over 4x our bodyweight to trigger bone building. When we stand, gravity applies a load to our bones that equals our body weight. Walking briskly increases load, and running or jogging adds even more load, but we need higher-impact activities like jumping or strength training to add four or more times our body weight.

In general, bone loading force increases parallel to exercise intensity (more challenging = more bone strengthening). However, it is important to always begin loading activities at a level that is right for you and progress from there. If you

are walking, work to increase your walking stride. If you are running, consider adding higher-impact activities. Weight or resistance training is beneficial to muscle, and with enough load, it can stimulate bone-building as well.

NOTE: Immobilization and bed rest lead to profound bone loss and poor prognosis of recovery of BMD. Even the frailest should remain as physically active as health permits to preserve musculoskeletal integrity.

PREVENTING FALLS : BALANCE, POSTURE, FLEXIBILITY, STRENGTH

Exercise can also help individuals with osteoporosis as it can be used to improve balance, posture, flexibility and strength, all important in preventing falls.

BALANCE is the ability to maintain a desired position, whether static or dynamic. Balance problems also make older people more likely to fall - one of the most common causes of hip fracture.

Balance exercises should engage the primary balance muscles of the quadriceps, hamstrings, gluteals, and trunk and should incorporate tasks with eyes closed for those with low or moderate risk. Balance training should include a) progressively difficult postures that reduce base of support (two legs to one leg), b) dynamic movements that move center of gravity (walk in line, circle turns), c) stress postural muscles (heel, toe stands), d) reduce sensory input (eyes closed), e) tai chi.

Combining balance, agility, and proprioceptive training 2-3 days a week is shown to reduce and prevent falls. There is also strong evidence that multicomponent physical activity that includes 2 or more of either strength, balance, endurance, or flexibility, can significantly reduce fall-related injuries by 32-40%. Fall prevention programs using multicomponent activity reduced fall bone fractures 40-60% among older adults in community + home settings.

Poor POSTURE leads to a forward shift in center of gravity, affecting balance. Strengthening axial muscles to support posture can help maintain one's center of gravity. Axial muscles include abdominals but almost more importantly require the recruitment of extensor muscles.

FLEXIBILITY can also affect one's range of motion and ability to navigate obstacles and maintain one's balance.

STRENGTH. It should also be noted that insufficient power is associated with greater risk of functional decline and falls. Increase muscle power can prevent falls. Resistance training is MORE important as we get older as muscular strength decreases rapidly with age. Increase muscle power with both single and multiple joint exercises (1-3 sets) using light to moderate loading (30-60%) of your 1 repetition max for 6-10 repetitions with high velocity.

	AEROBIC	RESISTANCE*	FLEXIBILITY
WHAT	Walking, cycling, (weight bearing preferred) Impact loading like jumping, bench stepping if low/mod risk of fracture.	Standard equipment. Compound movements best.	Static stretching all major joints.
INTENSITY	Moderate, 3-4.	High, last 2 are challenging.	Stretch to point of tightness or slight discomfort.
DURATION	20min. Progress to 30. Max 45-60min.	1 set of 8-12. Increase to 2 sets after ~2weeks. No more than 8-10 exercises per session.	Hold static stretch for 10-30sec. 2-4 rep each exercise.
FREQUENCY	4-5days/week	1-2 non-consecutive days. Progress to 2-3 days/week.	5-7days/week.

(FIIT Recommendations for Individuals with Osteoporosis, ACSM Guidelines for Exercise Testing and Prescription, 11th)

WHAT EXERCISES TO AVOID?

There are no current established ACSM guidelines for contraindications regarding exercise and osteoporosis but general recommendation is **moderate intensity weight bearing exercise that do not exacerbate pain.**

AVOID:

- **Explosive movements or high-impact loading should be avoided.**
- **Excessive twisting, bending, compression of spine should be assessed and avoided.**

RESOURCES:

American College of Sports Medicine (ACSM)
Guidelines for Exercise Testing & Prescription
<https://www.acsm.org>

2018 Physical Activity Guidelines Advisory Committee
(PAGAC) Scientific Report
https://health.gov/sites/default/files/2019-09/PAG_Advisory_Committee_Report.pdf

National Osteoporosis Foundation / Bone Health and
Osteoporosis Foundation
<https://www.bonehealthandosteoporosis.org/>

International Society of Clinical Densitometry
<https://iscd.org/>

National Institutes of Health Osteoporosis and Related
Bone Diseases
<https://www.bones.nih.gov/>

World Health Organization
<https://www.who.int/>

MAYO Clinic
<https://www.mayoclinic.org/>

American Bone Health
<https://americanbonehealth.org/>