

# Bone Health – Invest in You

Indiana Academy of Nutrition & Dietetics - 2024  
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## A Patient Friendly Formula for Improving Bone Health

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- Board Certification: ABFM & ABLM
- CAQ: Sports Medicine
- Medical Director, MHP Lifestyle Medicine & Bone Health Service
- Conflicts of Interest: None

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### Bone Health Learning Objectives

- Identify the scope of the aging population
- Illustrate healthy bone & describe the remodeling process
- Differentiate Osteopenia vs. Osteoporosis
- Describe the fracture rates associated with osteoporosis
- List the Risk Factors for Osteoporosis
- Identify Lifestyle measures which reduce Osteoporotic Fractures

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### The Population Problem

- The "Silver Tsunami"  
~11,000 Americans turn 65 years old EVERY DAY
- Medical costs expected to outpace payments into Medicare
- Cost of fracture care will increase - unless we reduce fracture volumes




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- An estimated 1.5 million fragility fractures per year
- Fracture rate ~ 25/1000 in people > 65 years old
  - Hip & spine fractures account for 40% of all fractures in the Medicare population
- Osteoporotic fracture costs in 2018 - \$57B
  - By 2040, estimated to be \$95B
- Mortality increases drastically with hip fracture
  - If >64 yo, 30% mortality risk at 1 year
  - 37.5% mortality risk at age >75

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### Falls & Fractures

- Falls occur in up to 30% **women** aged >65 yo and ~40% after age 75
- If **osteopenic**, fracture risk nearly doubles
- After age 45, **men** increase their fracture rate 700% within 5 years, **women** 800%



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### The Bone Density Problem

- Low bone density in 40% of 65 yo, and 70% of 80 yo
- Osteoporosis found in 9% of 65 yo, 40% by age 80
- The risk of fracturing a hip increases with every year beyond 65
- After a hip fracture at age 65, risk of death is 1 in 8 within one year
  - By age 80, risk of death rises to more than 1 in 3

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### Osteopenia vs Osteoporosis

- DEXA – Dual Energy Xray Absorptiometry
- Very low dose radiation
- Spine & hip femoral neck readings
- BMD: Calc bone mineral density
- T-score: BMD c/w mean 20-29 yo BMD
- Z-score: BMD c/w age matched same-gender individuals




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### Osteopenia vs Osteoporosis

DEXA Scan

- Normal BMD = > -1.0 SD
- **Osteopenia = -1.0 to -2.49 SD**
- **Osteoporosis = < -2.5 SD**



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### What Happens with Bones over Time

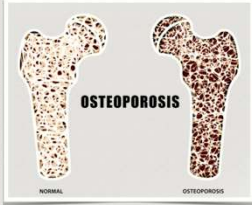
Normal Bone   Osteopenic Bone   Osteoporotic Bone



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### Osteoporosis & Fracture Risk

- Osteoporosis
  - 13% in women 50-64 (3% in men)
  - 27% in women > 65 (6% in men)
- Osteoporosis rates worsened from 2007 to 2017, for women but not for men



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### What can we do?


- Accept that we have an expensive, humanitarian problem facing us
- Address the problem in healthy patients
- Shift our paradigm
  - Show patients they have agency
  - Teach to empower
  - Goal-set with the patient
  - Accountability without judgement



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### Healthy Bone: How does it work?

- Remodeling begins in infancy, continues until death
- We remodel according to:
  - Stresses on the bone
  - Materials supplied
  - Healthy hormone function



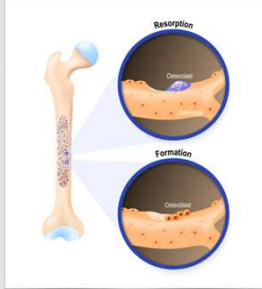
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### The Remodeling Model



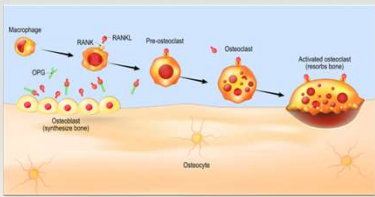
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### Remodeling



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### Remodeling



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### Cell Types in Bone

- **Osteoblasts** - migrate from the marrow; net positive effect on BMD
- **Osteocytes** - Evolve from osteoblasts; maintain bone
- **Osteoclasts** - Immune cells; net negative effect on BMD
  - Release calcium into circulation

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## Cell Types in Bone - Patient Explanations -

- **Builders** - "Osteoblasts" migrate from the marrow, line the bone
- **Maintainers** - "Osteocytes" - Evolve from Builders; maintain bone matrix
- **Dissolvers** - "Osteoclasts" - Immune cells attach to the bone, dissolve it when the Maintainers die
  - Dissolve bone matrix & osteocytes which no are longer functioning
  - Release calcium into circulation

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## The Process of Remodeling

- Mature bone cells live ~ 10 - 30 years, maintaining healthy bone.
  - When they stop functioning, Osteoclasts are activated by Osteoblasts to remove dysfunctional Osteocytes
- Osteoclasts remove dead bone cells & injured bone matrix
- Osteoblasts migrate from bone marrow, migrate to newly created bone crypts & secrete new bone matrix.
- Osteoblasts reconstruct the bone, become encased & differentiate into mature osteocytes
- Bone is renovated constantly throughout life

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## Mechanical Stresses & Remodeling



- **Mechanical loads**
- **Compressive forces**
- **Tensile/shearing forces**
- **Muscle strain** contributes to bone remodeling
- **Nonweightbearing** shifts the equation toward net (-) bone

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## Stresses Determine Remodeling



- **Mechanical loads** - net (+) bone
- **Compressive forces**
- **Tensile/shearing forces**
- **Muscle strain** contributes to bone remodeling
- **Nonweightbearing** shifts the equation toward net (-) bone

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## Remodeling Rate



- Adolescence, teens and twenties
- **Mid to late thirties**
- **Post-Fifties**

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- **Remodeling Rate:**
  - Increases rapidly in adolescence, teens and twenties.
  - Rate of increase slows in early adulthood
  - Rate equalizes by mid-late thirties
- Bone density remains stable b/w breakdown & renovation until fifties
- After 50-55 y.o., most enter a net-negative bone state
- This leaves gaps in the bone, leading to osteopenia & then osteoporosis

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**GHM1** Osteoblasts -> Builders

Osteocytes -> Mature Bone Cells

Osteoclasts -> Dissolvers

Gregory Howard, MD, 4/8/2023

### Risk Factors for Osteoporosis

- Age > 65 for women
- >70 for men
- Prior fracture
- Low body weight
- FMHx
- RA/Autoimmune history
- Smoking/Alcohol use
- Deficiencies
- Calcium
- Vitamin D
- Exercise
- Muscle loss/Fragility/Falls

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### Addressing the Risk Factors for Osteoporotic Fractures

- Menopausal status – at what age?
- Prior adult age fracture?
- Hispanic > White > Asian > Black
- Sedentary lifestyle?
- Medications?
- Smoking/Alcohol use?
- Deficiencies?
- Calcium
- Vitamin D
- Exercise
- Fragility/Falls

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### Reducing the Risk of Osteoporotic Fractures

- Age
- Menopausal status
- Family history
- Hispanic > White > Asian > Black
- RA/autoimmune status
- Medications
- Stop Smoking/Alcohol
- Get sufficient:
  - Calcium - dietary preferred
  - Vitamin D - natural vs Supplement?
- Exercise
- Fall reduction, pre-habilitation

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### Building Bone through Lifestyle

What we must Do

- Deliver Raw Materials
- Put those raw materials to work
- Remodel bone, every night after stressing the bone every day



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## Calcium Recommendations

- Calcium - dietary sources preferred
- Under 50 - 1,000mg/day
- 51-70 - Women 1,200/d, Men 1,000/d
- Over 70 - 1,200 mg/d



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## Calcium Recommendations

- Dairy is the most common source in the West
- **Milk:** 300mg/8 oz.
  - **Yogurt (AC):** 150-220mg/4 oz.
  - **Cheese:** 200-300mg/oz. (Goat 84mg/0z.)
  - **Cottage Cheese:** 200mg/8 oz.
  - **Kefir:** 300mg/8 oz.



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## Calcium Recommendations

### Non-Dairy Sources

- **Almond Milk:** 450mg/8 oz.
- **Oat milk:** 350mg/8 oz.
- **Soy Milk:** 300-450mg/8 oz.  
Tofu: 250mg/90 g block  
Edamame: 100mg/cup
- **Beans- Kidney:** 75mg/0.5 cup  
**Black:** 75mg/0.5 cup  
**Chickpeas:** 55mg/ 0.5 cup  
**Lentils:** 20mg/0.5 cup



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## Calcium Recommendations

### Non-Dairy Sources

- **Spinach (raw):** 120mg/ 4 cups
- **Spinach (cooked):** 120mg/ 0.5 cup
- **Broccoli (raw):** 40mg/ cup
- **Broccoli (steamed):** 60mg/ cup
- **Asparagus:** 34mg/ 10 spears
- **Brussel Sprouts:** 75 mg/ 10 sprouts
- **Egg:** 28mg
- **Ensure Orig. Shake:** 330mg/8 oz.



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## Vitamin D Recommendations

- Vitamin D - natural vs supplement?
- **Sunlight:** 15-20 min (Caucasian)
  - POC may require up to 2 hours
- **Vit D3: 600 - 800 IU/d** (15-20 mcg)
- In Vit D deficiency, the dose can be higher: D3 ~ 4,000-5,000 IU/d



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## Vitamin D Recommendations


### Non-Dairy Sources

- **Salmon:** 600IU/4 oz.
- **Halibut:** 263 IU/ 4 oz.
- **Tuna:** 180IU/ 4 oz.
- **Sardines:** 108IU / 4 oz.
- **Shrimp:** 5 IU / 4 oz.
- **Ensure Shake:** 320IU/bottle
- **Mushrooms (sun exposed):** 400IU/ 3.5 oz



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### Exercise Recommendations



- Weightbearing Exercise is essential
- Recommendation: 30-60 min weightbearing endurance type activity at least 3-5 days/week
- This must be tailored to the individual

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### Exercise Recommendations



- BMD increases w/ higher ground reaction forces
- Bounding exercises are better at increasing BMD than low/non-impact exercises
- Walking alone can help maintain BMD, but might not increase it
- Strength training can increase BMD
- Combination exercising works the best


*Biomed Res Int. 2018; 2018:4840531*

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### Pulling it All Together

◦ **B = C + D + E**

In other words:  
Bone = Calcium + Vitamin D + Exercise




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### Pulling it All Together

◦ **B = C + D + E**

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◦ **A B C D E's**



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### Bibliography

- Social Security Annual Report: <https://www.ssa.gov/oact/TRSUM/>
- Osteoporosis International. 2020; 31: p 1299-1304
- JB JS Open Access. 2019 Mar 27; 4(1): e0045
- Age & Aging. July 2019; 48 (4): p 559-563
- Journal of Orthopaedic Trauma. June 2018; 32(6):p 278-282
- Bone. Feb 2013; 52 (2):541 – 547
- Biomed Res Int. 2018; 2018:4840531
- National Osteoporosis Foundation Report, Osteoporotic Fractures; [https://assets.milliman.com/ektron/Medicare\\_cost\\_of\\_osteoporotic\\_fractures.pdf](https://assets.milliman.com/ektron/Medicare_cost_of_osteoporotic_fractures.pdf)

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### Bibliography

- Incidence and Economic Burden of Intertrochanteric Fracture. [JB JS Open Access](#). 2019 Mar 27; 4(1): e0045
- Treatment rates and healthcare costs of patients with fragility fracture by site of care: a real-world data analysis. [Arch Osteoporos](#). 2023; 18(1): 42.
- US Dept of Agriculture: Food Search <https://fdc.nal.usda.gov/fdc-app.html#/>

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### Disclosure Statement

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- Retained as a medical expert in a State of Indiana medical malpractice case as a Review Board Member & civil lawsuit case.
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