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### Learning Objectives

- Review bone structure and formation
- Discuss bone health risks
- Discuss nutrition and supplementation considerations for bone health
- Identify diseases and medication that may affect BMD
- Discuss exercise effects on bone health



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Let food and movement be your medicine. Unless you need medicine, then use all three. - me



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The acute concerns of bone health change as we age. However, what we do when we are younger can radically change our bone health when we are older.

- 0-30 years
  - "The foundational years"
  - Stress fractures
  - Menstrual dysfunctions
  - Bad vs good habit formation (e.g. nutrition)
- 30-60 years
  - "The wear and tear years"
  - Early degenerative changes
- 60+ years
  - "The maintenance or replacement years"
  - Osteoarthritis
  - Osteoporosis
  - Fall related injuries



6

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## Understanding Bone Formation

- Main hormonal pathways:
  - Calcitonin
  - PTH
  - Estrogen
  - TSH

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10

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## Nutrition: Supplements

- Vitamin D3
  - 400-1000IU daily, for healthy. 800IU is a good recommendation.
  - Sunlight, UVB rays
    - Can't pass through windows or sunscreen
    - Highly variable time depending on geographic location, skin color and Fitzpatrick skin type (I-V)
      - 6min-2hours
    - Probably not recommended by your friendly neighborhood dermatologist
    - May consider supplement during winter months only
  - Foods:
    - Natural: Oily fish. Salmon, mackerel,
    - Supplemented: Milk,
  - Caution: Vit D3 can be a marketing tactic, so make sure patients are looking at how much they are taking if they are taking multiple supplements. Too much VitD can lead to hypercalcinosis.

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11

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## Supplements

- Calcium (Ca)
  - Ca Carbonate highest amount of elemental Ca (40%)
  - Supplement split into BID to aid in absorption and avoid constipation
  - Take with food
  - Anecdotal practice:
    - 2000mg/day (not necessarily the elemental Ca) for fractures

Life Stage Group	Calcium (mg/d)
<b>Infants</b>	
0-6 mo	210 <sup>2</sup>
7-12 mo	270 <sup>2</sup>
<b>Children</b>	
1-3 y	500 <sup>2</sup>
4-8 y	800 <sup>2</sup>
<b>Males</b>	
9-13 y	1,300 <sup>2</sup>
14-18 y	1,300 <sup>2</sup>
19-30 y	1,000 <sup>2</sup>
31-50 y	1,000 <sup>2</sup>
51-70 y	1,200 <sup>2</sup>
> 70 y	1,200 <sup>2</sup>
<b>Females</b>	
9-13 y	1,300 <sup>2</sup>
14-18 y	1,300 <sup>2</sup>
19-30 y	1,000 <sup>2</sup>
31-50 y	1,000 <sup>2</sup>
51-70 y	1,200 <sup>2</sup>
> 70 y	1,200 <sup>2</sup> (5)

Milk (whole, 2%, 1%, skim, chocoate) → ~300mg (+100mg Fortified) → 1 cup (8oz)

Soy milk (fortified) → ~300-450mg (organic Ca content lower) → 1 cup (8oz)

Almond milk (fortified) → ~300-450mg (organic as low as ~100mg) → 1 cup (8oz)

Coconut milk (fortified) → ~450mg (organic as low as ~100mg) → 1 cup (8oz)

Yogurt (plain, low fat) → ~400mg → 1 cup (8oz)

Orange Juice (fortified) → ~350mg → 1 cup (8oz)

Almonds, dry roasted → ~300mg → 1 cup

Cheese, cheddar shredded → ~400 → 1/2 cup

Cheese, mozzarella stick → ~200mg → 1 stick

Cheese, sliced american (fortified) → ~350mg → 1 slice

Other foods: Beans, broccoli, oranges, figs, raisins, breads, tuna, sardines

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12

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## Proper Nutrition

- Energy Excess/Obesity
  - Reverse epidemiology
  - Some people who are "obese" have a higher BMD secondary to increased load on bones thus increasing bone formation
- Healthy Obese vs. Obesity with Co-morbid conditions
  - BMI is not the best assessment of "healthy habits"
    - If building blocks are there, bone density may not suffer
    - Co-morbid conditions detrimental to BMD
      - Sedentary activity level
      - Hyperlipidemia
      - Diabetes
      - Cardiorenal disruptions
      - Some negative androgenic effects of excess white fat



16

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## Nutrition: Things to avoid

- Carbonated beverages
  - No good studies to prove the acid-balance or excess phosphorus intake theories of decreasing BMD is true
  - However, 'colas' often contain other ingredients that may affect BMD negatively (e.g. excess sodium, sugar, HFCS)
- Alcoholism
  - Decreased intake nutrients, intervenes with Vit D3 production, negative effects on hormones, fall risks
- Salt (NaCl)
  - Kidneys use Ca to eliminate excess Cl, may even tap into Ca stores to eliminate



17

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## Medications to Consider:

- Glucocorticoids
  - Increase resorption, decrease remodeling
- PPI's – Maybe not
  - Recent studies show this does not appear to be true <sup>(7)</sup>
- Anti-epileptic drugs
  - Offer supplementation of Vit D3
- Medroxyprogesterone ("Depo" shot) contraceptive
  - Noted in first 2 years of use
  - Takes ~2 years after cessation to reach non-Depo user BMD
  - Monitor Ca and Vit D, routine DEXA not indicated
- Aromatase Inhibitors



18

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### Medications

- OCP's for prevention?
  - Good for contraception
  - Not a preventative medication
  - The menstrual cycle can be a useful indicator of health status
  - Not recommended for women who have irregular cycles due to caloric deficiency (Female Athlete Triad)



19

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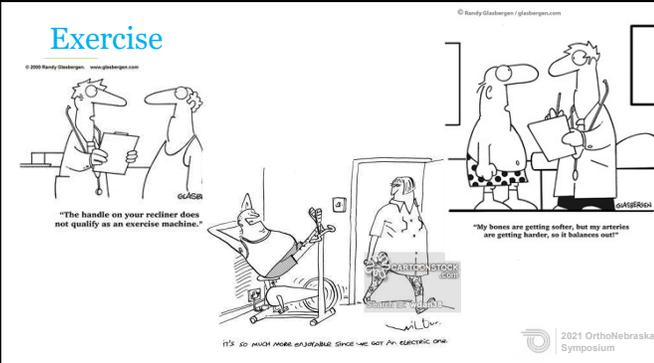
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### Exercise




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### Exercise

- Increased bone remodeling throughout the lifetime
  - 0-30yo: Important to build a strong foundation
  - 30-60yo: Maintain a good structure, make repairs as needed and get ready for retirement
  - +60yo: Continue to make repairs and keep the house clean
- Loading on the bones via the musculotendinous junctions and mechanical loading stimulate bone remodeling that strengthens the bone by increasing bone density <sup>(1)</sup>
- Not found to worsen osteoarthritis in setting of non-injury, in fact can be beneficial to maintain ROM and improve strength



21

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## Exercise

- Long distance runners have lower BMD
- Swimming, cycling, rowing have lower BMD than those who perform regular weight-bearing activities <sup>(8)</sup>
- BMD increases in exercise <sup>(9)</sup>
  - High load, low reps had greatest effect <sup>(9)</sup>
  - Progressive resistance strength training (greater effect on femoral neck BMD)
  - Multicomponent training (greater effect on spine BMD)
  - Most changes from exercise were seen after 6mo-24mo and >3 times a week, for 30-60minutes
- BMD maintenance with exercise
  - Walking seems to help maintain but not increase



22

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## Exercise

- High-Intensity Resistance and Impact Training Improves Bone Mineral Density and Physical Function in Postmenopausal Women With Osteopenia and Osteoporosis: The LIFTMOR Randomized Controlled Trial. <sup>(10)</sup>
  - Watson et al. Journal of Bone and Mineral Research. 2019 Mar;34(3):572.
- Single-blind, randomized controlled trial
  - 101 participants (406 consented to participate), z1-score <-1.0 at hip and/or spine
  - Intervention (49): 8-month, twice weekly, 30-minute, supervised HiRIT program (5s/5r, 80-85%i)
  - Control (52): 8-month, twice weekly, 30-minute, home Li program
- Results
  - HiRIT superior to Control
    - Lumbar spine BMD 2.9+/-2.8% vs -1.2+/-2.8%, p<0.001
    - Femoral neck BMD 0.3+/-2.6% vs -1.9+/-2.8%, p<0.004



23

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## Exercise

- 0-30 years
  - "The foundational years"
  - Bone mass peaks in the second decade of life
    - ~90% obtained: by 18yo in females and 20yo in males
  - Burst exercises of running, jumping, dancing and vigorous activity help to lay down strong frameworks of cortical bone
  - Sports, encouraged play, and weightlifting
  - Avoid sports specialization
    - Adequate rest, decrease injury by allowing healing
      - At least 4 months (non-consecutive) off each year from main sport
    - Multi-dimensional athletes have greater all-over strength



24

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**Exercise**

- 30-60 years
  - "The wear and tear years"
  - Continue weight-bearing activities
  - Start learning or consistently incorporate strength training and core strength
  - Core strength
    - Abdominal muscles
    - Gluteus medius/minimus (hip abductors)
    - Iliopsoas (hip flexors)



25

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**Exercise** Motion is lotion. – Andrew Porter, DO, CAQSM

- 60+ years
  - "The maintenance or replacement years"
  - Consider decreasing frequency and duration of high impact activities such as repetitive jumping, running long distances
  - Fracture reduction
    - JUST MOVE
    - Movement also stimulates gains in strength of the muscles as well as decreases the proprioception losses associated with aging
    - Better balance leads to less falls
    - Physical Therapy to learn home exercises that can be done based on individual limitations
    - Tai Chi, pool exercise
    - Modified yoga, chair yoga
    - Modified weightlifting, e.g. seated and avoid axial compression



26

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**Interesting**

- Bone stimulators:
  - Stimulates osteoblasts, capillary proliferation, etc.
  - Basically, gives exercise to bone without actually moving
  - Often used with delayed union fractures or high-risk fractures
    - eg. navicular, base of the 5<sup>th</sup> metatarsal, anterior tibia
    - Unfortunately, insurance generally requires malunion diagnosis and >3months of closed fracture care. Cash price can be thousands of dollars.
- OR
  - Cat's purr produces: 25-150 Hertz
  - Human bone healing: 50-80Hertz



27

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  - Fall related injuries



28

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The acute concerns of bone health change as we age. However, what we do when we are younger can radically change our bone health when we are older.

- 0-30 years
  - "The foundational years"
  - Stress fractures
    - Improper nutrition
    - Energy deficiency
    - Poor mechanics
  - Menstrual dysfunctions
    - Red-S
  - Bad vs good habit formation (e.g. nutrition)
    - Learning and incorporating proper nutrition
    - Exercise as part of routine
    - Adequate rest to decrease injury



29

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The acute concerns of bone health change as we age. However, what we do when we are younger can radically change our bone health when we are older.

- 30-60 years
  - "The wear and tear years"
  - Early degenerative changes
    - Changes from early life now may become noticeable in daily life
    - Lifestyle changes will have less positive effects but positive lifestyle changes may greatly attenuate negative effects on bone health
    - Wear and tear injuries related to tendon are more common but begin to affect the underlying bone health



30

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The acute concerns of bone health change as we age. However, what we do when we are younger can radically change our bone health when we are older.

- 60+ years
  - “The maintenance or replacement years”
  - Osteoarthritis
    - Pain is largely dependent on severity but more on activity level
    - Management is mostly about improving quality of life with replacements
  - Osteoporosis
    - Still possible to make positive changes to BMD but focus is more on maintaining BMD and decrease rate of loss
  - Fall related injuries
    - Muscle recruitment, core stability, and mobility issues more compounded
    - Hip fracture and mortality<sup>(11)</sup>
      - 33% mortality rate at 12 months
      - Mortality rate increasing and greatly affected by co-morbid diseases

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31

## Helpful Resources

- NIH - Osteoporosis and Related Bone Diseases National Resource Center
  - <https://www.bones.nih.gov/>
- Osteoporosis Canada
  - <https://osteoporosis.ca/>
  - Exercises for Healthy Bones
    - [Too Fit to Fall or Fracture Exercises](#)
    - [How to Safely Do Everyday Activities](#)

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32

## Working references:

1. Hunter DJ, Eckstein F. Exercise and osteoarthritis. *J Anat.* 2009 Feb;214(2):197-207. doi: 10.1111/j.1469-7580.2008.01013.x. PMID: 19207981; PMCID: PMC2693777.
2. Melo-Fonseca F, Miranda G, Domingues HS, Pinto JM, Gaski M, Silva FS. Reengineering Bone-Implant Interfaces for Improved Mechanotransduction and Clinical Outcomes. *Stem Cell Rev Rep.* 2020 Dec;16(6):1121-1138. doi: 10.1007/s12015-020-1002-9. PMID: 32803697.
3. Siddiqui JA, Partridge NC. Physiological Bone Remodeling: Systemic Regulation and Growth Factor Involvement. *Physiology (Bethesda).* 2016 May;31(3):233-45. doi: 10.1152/physiol.00661.2014. PMID: 27063737; PMCID: PMC4974079.
4. National Institutes of Health Magnesium. Magnesium Fact Sheet for Health Professionals. <https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/>. Accessed: 2021 Jun.
5. Institute of Medicine (US) Panel on Dietary Antioxidants and Related Compounds. Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids. Washington (DC): National Academies Press (US); 2000. FOOD AND NUTRITION BOARD, INSTITUTE OF MEDICINE-NATIONAL ACADEMY OF SCIENCES. DIETARY REFERENCE INTAKES: RECOMMENDED INTAKES FOR INDIVIDUALS. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK225472/>
6. König D, Oester S, Schalla S, Zdzienicka D, Gohlhofer A. Specific Collagen Peptides Improve Bone Mineral Density and Bone Markers in Postmenopausal Women-A Randomized Controlled Study. *Nutrients.* 2018 Jan 16;10(1):97. doi: 10.3390/n10010097. PMID: 29337906; PMCID: PMC5795329.
7. Targownik LE, Leslie WD, Davison KS, et al; CaMos Research Group. The relationship between proton pump inhibitor use and longitudinal change in bone mineral density: a population-based from the Canadian Multicentre Osteoporosis Study (CaMos). *Am J Gastroenterol.* 2012;107:1361-1369.
8. Benedetti MG, Furlini G, Zati A, Leticia Mauro G. The Effectiveness of Physical Exercise on Bone Density in Osteoporotic Patients. *Biomed Res Int.* 2018;2018-4840531. Published 2018 Dec 23. doi:10.1155/2018/4840531
9. Nicholson VP, McKean MR, Slater GJ, Kerr A, Burkett BJ. Low-Load Very High-Repetition Resistance Training Attenuates Bone Loss at the Lumbar Spine in Active Postmenopausal Women. *Calcif Tissue Int.* 2015 Jun;98(6):490-9. doi: 10.1007/s00223-015-9975-6. Epub 2015 Mar 14. PMID: 25772606.
10. Watson SL, Weeks BK, West LJ, Harding AT, Horan SA, Beck BR. High-intensity Resistance and Impact Training Improves Bone Mineral Density and Physical Function in Postmenopausal Women With Osteopenia and Osteoporosis: The LIFE-TMOR Randomized Controlled Trial. *J Bone Miner Res.* 2018 Feb;33(2):211-220. doi: 10.1002/jbm.b.3244. Epub 2017 Oct 4. Erratum in: *J Bone Miner Res.* 2019 Mar;34(3):572. PMID: 29979861.
11. Guzun-Bascas O, Perez G, Fernandez E, Crespi Villaverde N, Quinte Donate FJ, Peña M, Alonso-Bias C, Garcia-Indalio A, Mazzucchi R. Mortality after osteoporotic hip fracture: incidence, trends, and associated factors. *J Orthop Surg Res.* 2019 Jul 4;14(1):203. doi: 10.1186/s13018-019-1226-6. PMID: 31272470; PMCID: PMC6610961.

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33

Let food and movement be your medicine. Unless you need medicine, then use all three. – me

QUESTIONS?



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