

1. Calcium and Vitamin D Nutrition in the Elderly

Calcium & Vitamin D Nutrition in the Elderly

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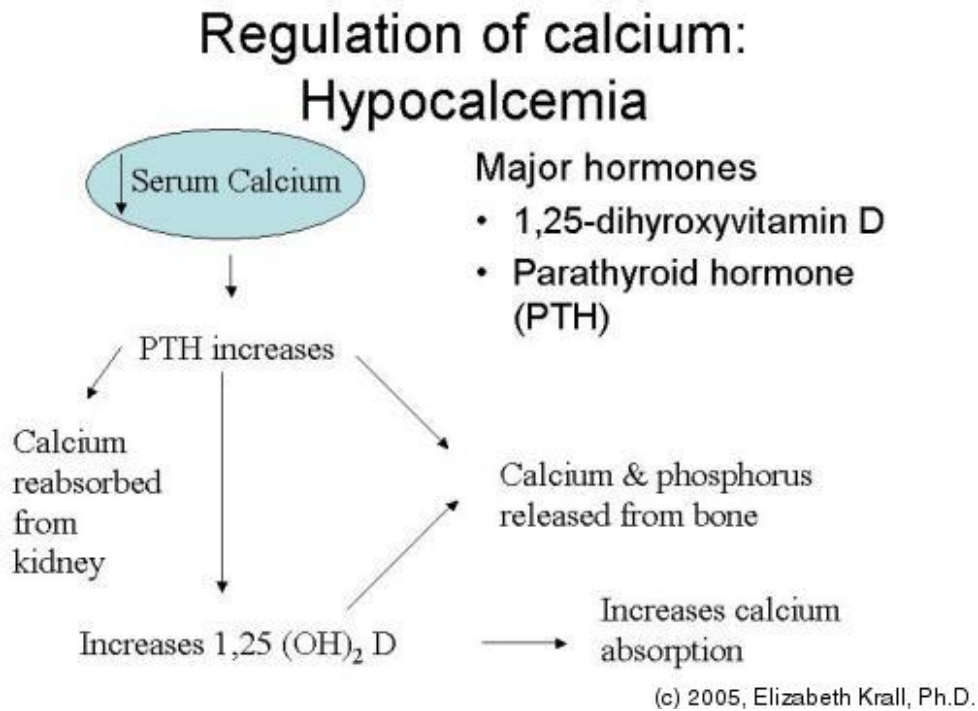
2. Functions of Calcium

Functions of Calcium

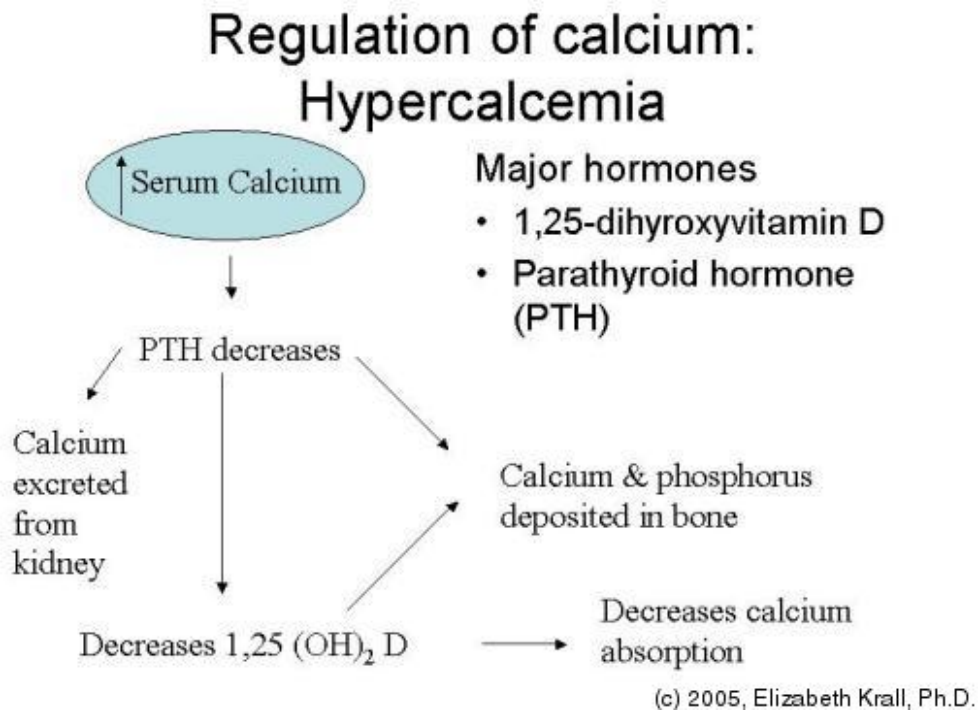
- Mineralization of bones and teeth
hydroxyapatite = $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$
~98% of total calcium in body in bones and teeth
- Blood coagulation, muscle contraction, transmission of nerve impulses
- Catalyst for enzymes, e.g., lipase
- Tooth development in utero and infancy

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3. Regulation of calcium: Hypocalcemia



4. Regulation of calcium: Hypercalcemia

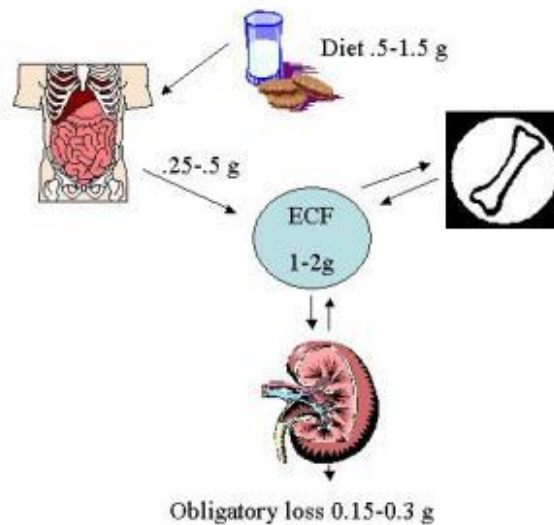


5.

Calcium Homeostasis

Calcium Homeostasis

- Daily obligatory loss should be replaced by diet
- If not, reservoir of calcium in bones is depleted



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6.

Calcium absorption

Calcium absorption

- On average, net calcium absorption = 0 if dietary calcium intake < 200 mg /day
- Estimated minimum calcium intake = 400 mg (200 to get net absorption > 0 + 200 to cover obligatory losses)
- 1,25-dihydroxyvitamin D (calcitriol) enhances calcium absorption

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7. Some factors influencing calcium absorption

Some factors influencing calcium absorption

- Increased absorption
 - Increased renal or extrarenal 1,25-hydroxyvitamin D production
 - Growth
 - Pregnancy and lactation
 - Diseases such as primary hyperparathyroidism

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8. Some factors influencing calcium absorption

Some factors influencing calcium absorption

- Decreased absorption
 - Decreased renal or extrarenal 1,25-hydroxyvitamin D production
 - Vitamin D deficiency, rickets
 - Chronic renal insufficiency
 - Hypoparathyroidism
 - Aging
 - Glucocorticoids
 - Malabsorption diseases
 - Other components of diet - fiber, phytic acid (cereal husks), oxalic acid (rhubarb, spinach, chard)

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9. Consequences of calcium insufficiency

Consequences of calcium insufficiency

- Children –
 - Delayed tooth eruption
 - hypomineralization of developing tooth
- Adults –
 - Long-term insufficiency - osteoporosis

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10. Calcium intake and periodontal disease

Calcium intake and periodontal disease

- Nishida et al (J Periodontol, 2000) - low dietary calcium intake associated with higher prevalence of clinical attachment loss (mean AL \geq 1.5 mm) in NHANES III.
- Compared to \geq 800 mg calcium /day:
 - 500-799 mg calcium /day: 1.3 times higher risk
 - <500 mg calcium /day: 1.3 to 1.6 times higher risk

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11.

Vitamin D

Vitamin D

- Fat soluble vitamin – stored in body tissues
- FUNCTIONS
 - Acts as hormone to regulate calcium balance
 - May have role in inflammatory response

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12.

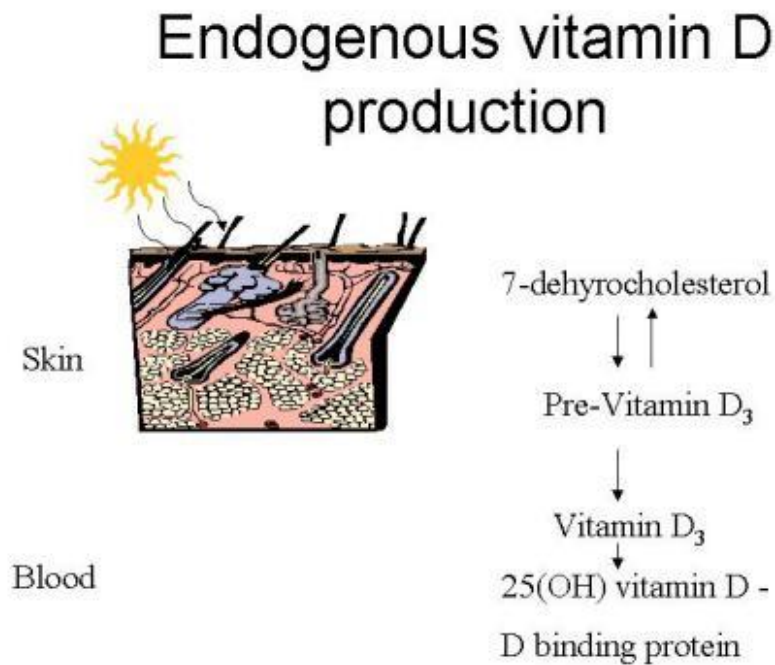
Vitamin D

Vitamin D

- Sources:
 - Diet
 - Ergocalciferol (plant sources)
 - Cholecalciferol (animal sources)
 - Endogenous production from 7-dehydrocholesterol when exposed to ultraviolet radiation

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13. Endogenous vitamin D production



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14. Forms of vitamin D in serum

Forms of Vitamin D in serum

- 25-hydroxy vitamin D [25(OH)D]
 - Major form in blood
 - Used to determine vitamin D status. Usual range is > 10 ng/ml
- 1,25-dihydroxy vitamin D [1,25(OH)₂D]
 - Biologically active form
 - Conversion occurs mainly in kidney

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15. Factors affecting Vitamin D status

Factors affecting Vitamin D status

- Season
- Age
 - Endogenous production decreases
 - Exposure to sunlight decreases in some segments of population (homebound, institutionalized)
- Use of sunscreen blocks endogenous production
- Diseases that affect stomach, intestinal tract, kidney (site of conversion to active form), liver
- Medications

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16. Vitamin D production in skin by season

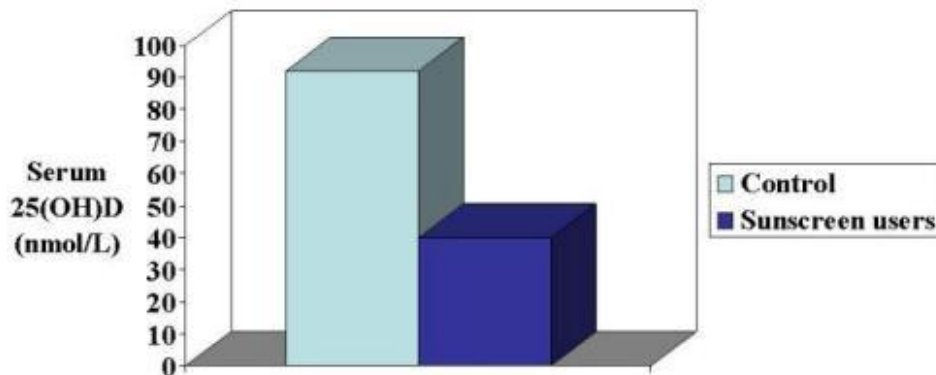
Vitamin D production in skin by season

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17. Calcium and Vitamin D in the Elderly: Slide 17

Sunscreen and Vitamin D production in skin



Normal range is 20 to 150 nmol/L.

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18. Calcium and Vitamin D in the Elderly: Slide 18

- Most healthy individuals can make enough vitamin D from casual exposure to sunlight
 - E.g., 10 to 60 minutes of exposure to hands, face and forearms per week, *without sunscreen*

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19. Diseases related to vitamin D deficiency

Diseases related to vitamin D deficiency

- Children –
 - Rickets
- Adults
 - Osteomalacia
- Many cases of vitamin D deficiency are result of
 - diseases that cause fat malabsorption
 - medications that interfere with vitamin D/fat absorption
 - or limiting exposure to sunlight (without adequate diet intake)

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20. Calcium and Vitamin D in the Elderly: Slide 20

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**Awareness about vitamin D
Nutrition And fortification of milk
has largely eliminated rickets**

**However, in a recent article
(Bishop, 2003 *Lancet*, 362:1389)
it has been shown that rickets
is on the rise**

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21. Calcium and Vitamin D in the Elderly: Slide 21

Cancer and exposure to sunlight

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- ♣ **There is an inverse relationship between prostate cancer mortality and exposure to sunlight**
- ♣ **Similar trend exists for breast, colon, colo-rectal cancer**

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22. Osteoporosis

Osteoporosis

- Reduction in bone density such that bones fracture easily even with low trauma
- More than 1.5 million fractures each year
- Among the elderly, 80-90% of all fractures are due to osteoporosis
- 80% of patients with osteoporosis are female, 20% male

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23.

Normal bone

Normal bone

- Pores are small, regular in shape & distribution
- Trabeculae separating pores are thick and continuous
- Good support, resistant to breaking

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24.

Bone Remodeling

Bone Remodeling

Bone remodeling unit

- Activation of osteoclasts
 - Resorption of minerals and matrix
 - Reversal
 - Migration and differentiation of preosteoblast
 - Matrix formation
 - Mineralization
- } Resorption
- } Formation

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25.

Uncoupling

Uncoupling

Resorption > Formation

- Increases with age
- Other factors, e.g., hypogonadism, calcium insufficiency
- Can result in osteoporosis

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26.

Osteoporotic bone

Osteoporotic bone

- Pores are large, irregular in shape
- Trabeculae are thin, fractured in some areas
- Poor support, easy to fracture

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27.

Vertebral fractures

Vertebral fractures

- More than 700,000 vertebral fractures each year in US
- Loss of height and curvature of the spine are consequences of osteoporosis
- Often unrecognized or misdiagnosed

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28.

Hip fractures

Hip fractures

- **300,000 hip fractures each year in US**
- About one-quarter of hip fracture patients who were ambulatory before the fracture require long-term care afterward
- About one-quarter of hip fracture patients over age 50 die within 1 year

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29.

Costs of osteoporosis

Costs of osteoporosis

- Hospital and nursing home costs are more than \$15 billion per year (and rising)
- Loss of mobility and independence

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30.

Causes of low bone density

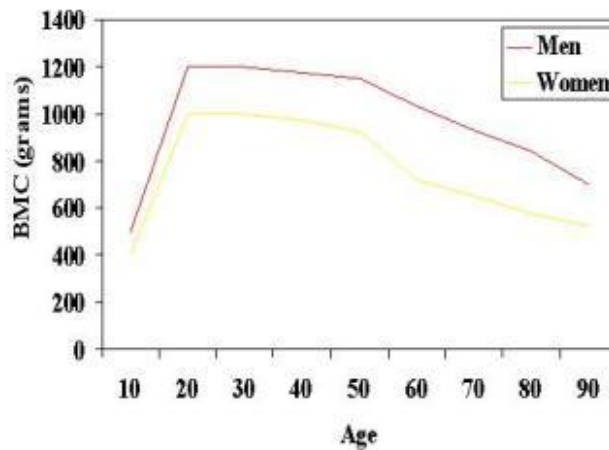
Causes of low bone density

- Failure to build up peak bone mass in young adulthood
- Excessive rate of bone loss in older adulthood

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31. Bone mineral content changes with age

Bone mineral content changes with age



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32. Risk factors for osteoporosis

Risk factors for osteoporosis

- Being female
- In women, being postmenopausal
- In men, low testosterone levels
- Advanced age
- Caucasian or Asian ethnicity
- Family history of osteoporosis
- Thinness and/or small frame

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33. Risk factors for osteoporosis

Risk factors for osteoporosis

- Cigarette smoking
- Low level of physical exercise
- Excessive use of alcohol
- Use of certain medications such as corticosteroids or anticonvulsants

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34. Dietary risk factors for osteoporosis

Dietary risk factors for osteoporosis

- Low calcium intake, especially long term
- Low vitamin D intake, especially if limited exposure to sun
- Low protein
- Excessive alcohol
- Excess sodium
- Excess caffeine, if calcium intake is low
- Excess vitamin A?
- Low folate, vitamin B₁₂, vitamin K?

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35. Calcium and D nutrition and bone

Calcium & D nutrition and bone

- Children and adolescents
 - If calcium intake is low, increasing it can increase bone mass during growth
- Elderly
 - If calcium and vitamin D intakes are low, increasing them can slow down (but probably not stop) bone loss
 - Calcium and vitamin D supplementation to intakes near or above recommended amounts can reduce risk of osteoporotic fracture

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36. Dietary Recommendations

Dietary Recommendations

- Calcium – aim to (1) increase peak bone mass, and (2) reduce the rates of bone loss and fracture
- Vitamin D – aim to eliminate seasonal variation in blood levels of vitamin D and other hormones involved in calcium regulation

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37. Adequate Intakes

Adequate Intakes

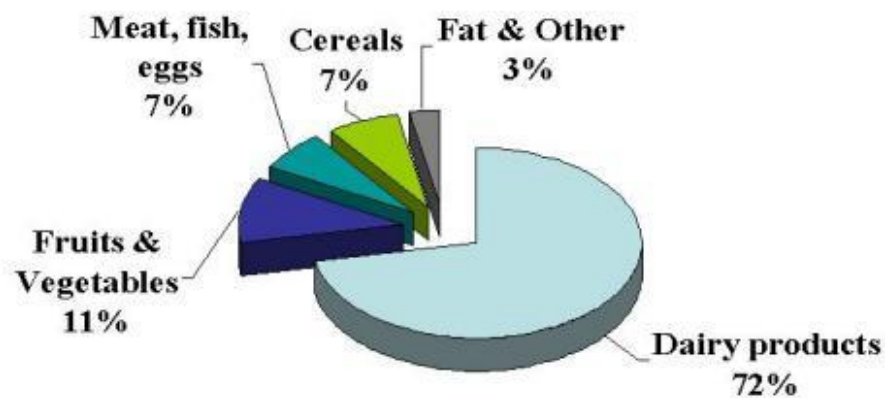
Age	Calcium/mg/day	Vitamin D (IU/day)
Birth-6 months	210	200
6 months-1 year	270	200
1-3 years	500	200
4-8 years	800	200
9-18 years	1300	200
19-50 years	1000	200
51-70 years	1200	400
71+ years	1200	600

From Food and Nutrition Board, National Academy of Sciences, Washington DC, 1997

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38. Dietary sources of Calcium

Dietary sources of Calcium



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39. Nutrient content of foods

Nutrient content of foods

Food item	Serving	Calcium (mg)	Vitamin D (IU)
Milk or yogurt	1 cup	280	100
Pizza	2 slices	300	Minimal
Cheese	1 ounce	200-300	Minimal
Greens (e.g. collard, kale)	¾ cup	230	0
Canned salmon	3 oz	150-300	500
Egg yolk	1	Minimal	30
Chocolate	1 ounce	Minimal	30
Calcium-fortified fruit juices	1 cup	~300	0
Fortified breakfast cereal	¾ - 1 cup	Varies	varies

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40. Calcium and Vitamin D in the Elderly: Slide 40

- Age 21-50, to meet calcium recommendations with food, need to eat:
 - 3.5 cups of milk, (300 calories skim; 525 calories whole)
 - or 7 slices pizza, (1000 calories)
 - or 3.5 cups of cooked greens (100 calories)
- Age 51+, calcium recommendation increases by 20%, vitamin D by 100%
 - Many elderly need fewer calories, less fat, cut down on food intake

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41. Supplemental sources

Supplemental sources

- Calcium
 - Vitamin and mineral supplements
 - Fortified juices
 - Upper limit of intake is 2500 mg/day
- Vitamin D
 - Vitamin and mineral supplements
 - Upper limit is 2000 IU/day. Excess can be harmful

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42. Recommendations to Decrease Osteoporosis Risk

Recommendations to Decrease Osteoporosis Risk

- Don't smoke
- Maintain healthy weight
- If drink alcohol, do so in moderation
- Get some sun

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43. Calcium and Vitamin D in the Elderly: Slide 43

Keep physically active

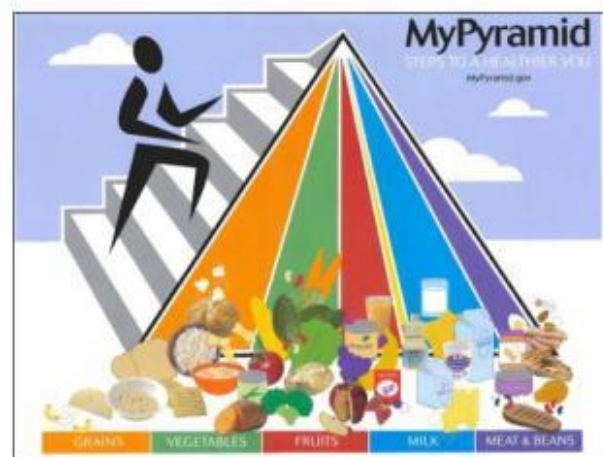
- Modest improvements in BMD
- Improve muscle strength and coordination



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44. Eat a balanced diet

Eat a balanced diet



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