LINUS PAULING INSTITUTE

BONE HEALTH

Your bones work hard. Give them the support they need to keep you going strong.

The Skeleton's Major Functions

1. Enables us to move
2. Supports and protects the body
3. Contains bone marrow
4. Stores large amounts of calcium and phosphorus

Strong Bones Need

Essential Nutrients
Build and maintain bone tissue

Balanced Lifestyle
Keeps bones strong throughout all life stages

Bone Biology

BONE IS MADE OF

Type 1 Collagen
that constitutes the interior scaffolding of bone

Calcium and Phosphorus Crystals
that add strength to bone

Bone Cells
that are responsible for bone (re)modeling

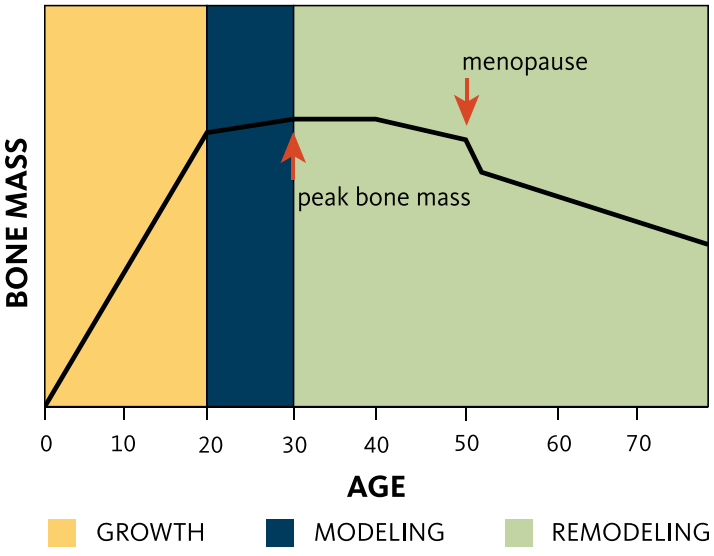
BONE MASS OVER A LIFETIME

Bones grow throughout childhood, adolescence, and well into adulthood. Around age 34, there is an inevitable loss of bone mass with age, accelerated with menopause in women.

Modeling
During childhood and adolescence, bones grow in size and shape.

Remodeling
During adulthood, new bone replaces brittle bone, cracks, and deformities.

GENERAL PATTERN OF BONE DEVELOPMENT OVER TIME

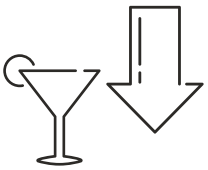


Balanced Lifestyle

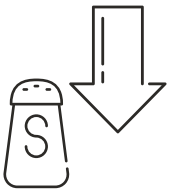
Drinking 2–3 cups of coffee a day is safe for bone health.

*30–60 min of daily moderate-to-high physical activity is recommended to strengthen bones and muscles.

Eating a balanced diet is essential to support bone health.



Light drinking is safe for bone health, but excessive amounts are harmful.



Most people consume too much sodium; reduce your sodium intake to prevent its harmful effect on bone health.

Quitting smoking improves bone health and lowers other health risks.

Avoid soft drinks in place of milk and other calcium-rich foods.

****Any** amount of physical activity is better than none and will bring some benefits to bone health throughout life.*

Essential Nutrients

There are

12

nutrients that support bone health

Calcium*
Vitamin D*
Fluoride
Magnesium
Potassium
Protein
Vitamin A
Vitamin C
Vitamin B_6
Folate
Vitamin B_{12}
Vitamin K

*** Calcium and Vitamin D are of primary importance for bone health*

Recommendation for dietary intake of essential nutrients:

Recommended Dietary Allowance (RDA)

1. Covers the needs of ~98% of the population in a given gender and life-stage group
2. Can be used as a goal for intakes by individuals

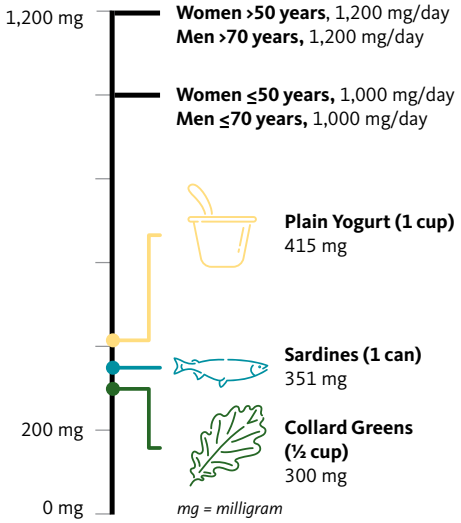
Adequate Intake (AI)

1. Used when an RDA cannot be determined

Essential Nutrients Continued

CALCIUM

Good Sources to help meet the RDA for Calcium



Functions

1. Calcium is a major structural component of bones.

2. Calcium in bone can be released in the blood when the need arises.

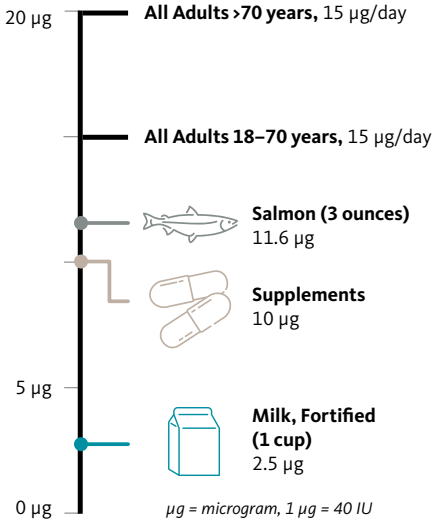
Children with low calcium intakes will not reach their maximum bone density and strength.

Low calcium intakes in adults can accelerate bone loss and increase the risk of osteoporosis and fracture.

Supplemental calcium (and vitamin D) primarily benefit elderly adults in nursing care. Whether calcium intakes beyond the RDA can reduce risk in community-dwelling older adults is debated.

VITAMIN D

Good Sources to help meet the RDA* for Vitamin D



Functions

1. Vitamin D is a fat-soluble vitamin that promotes bone health through regulating calcium and phosphorus balance in the body.

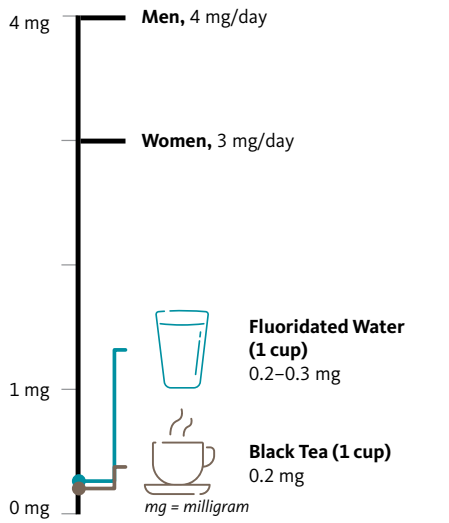
2. Severe deficiency in children and adults results in serious skeletal disorders.

Older people are at high risk of poor vitamin D status due to little sun exposure, a lower capacity for vitamin D synthesis in skin, and reduced dairy intake. Supplementation has been recommended to support bone health and help prevent falls in this population.

***** *The LPI recommends 50 µg (2,000 IU)/day of vitamin D for adults. In a 25-hydroxyvitamin D serum test, you should aim for at least 30 ng/mL (75 nmol/L).*

FLUORIDE

Good Sources to help meet the AI for Fluoride



Function

1. Fluoride increases the structural stability of bones through interacting with calcium phosphate salts.

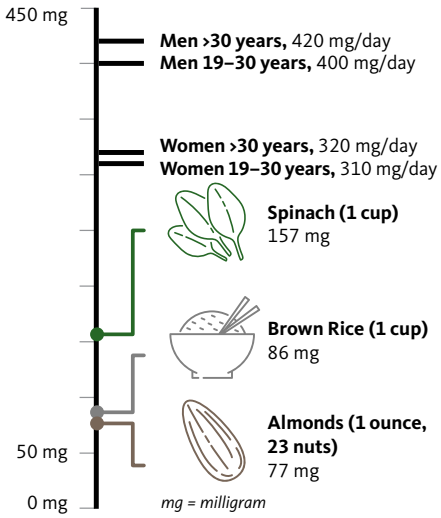
Fluoride exposure through community water fluoridation (<3.4mg/day) has no benefit in the prevention of osteoporosis and fracture.

Fluoride supplementation is not approved for use in the prevention or treatment of osteoporosis.

Essential Nutrients Continued

MAGNESIUM

Good Sources to help meet the RDA for Magnesium



Function

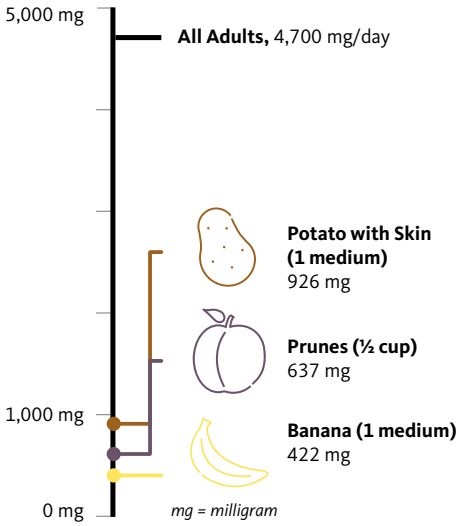
1. About 60% of magnesium is found in bone, which can supply the body when need arises.

Higher magnesium intakes are linked to lower risk of poor vitamin D status.

There is no evidence that magnesium supplementation could help prevent osteoporosis and fracture.

POTASSIUM

Good Sources to help meet the AI for Potassium



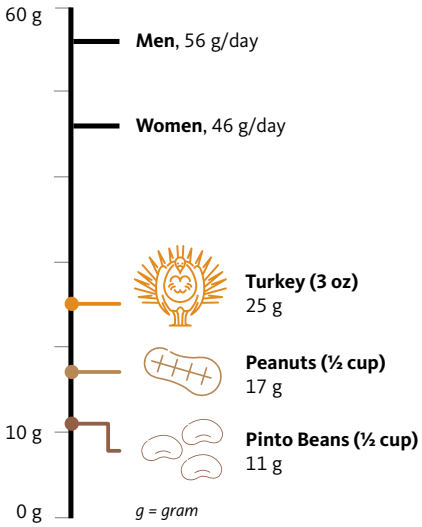
Function

1. Potassium salts may prevent calcium release from bone and loss of calcium in the urine that are caused by the consumption of diets with high sources of acid (fish, meat, cheese) and low in sources of alkali (fruit and vegetables).

Adopting a diet that increases potassium intake and reduces sodium intake (i.e., high in fruit, vegetables, and dairy; low in meat) might help support bone health.

PROTEIN

Good Sources to help meet the RDA for Protein



Function

1. Proteins are essential to build strong bones.

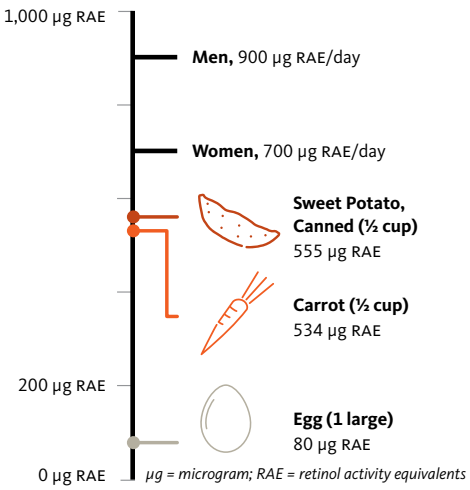
Adequate protein intakes are needed to maintain muscle mass and limit falls and fractures in older adults.

Higher protein intakes are likely to be protective unless calcium intakes are inadequate, in which case higher protein intakes may be harmful.

Essential Nutrients Continued

VITAMIN A

Good Sources to help meet the RDA for Vitamin A



Function

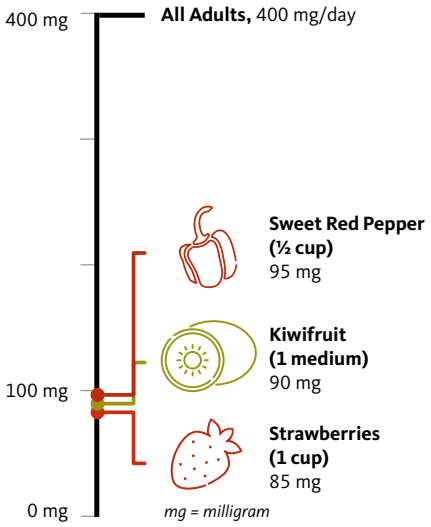
1. Vitamin A (retinol) is a fat-soluble vitamin involved in the growth and differentiation of virtually all cells in the body.

Striving for the RDA for vitamin A is a safe goal for optimizing bone health. Habitual vitamin A intakes greater than the RDA may increase the risk of osteoporosis and fracture.

Vitamin A supplements should be reserved for undernourished populations and those with evidence of vitamin A deficiency.

VITAMIN C

Good Sources to help meet the RDA for Vitamin C



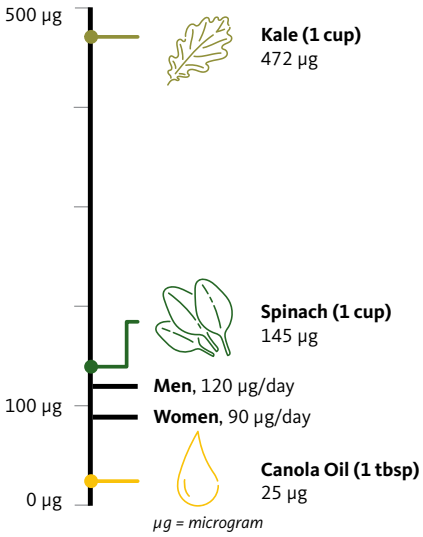
Function

1. Vitamin C is required during the synthesis of collagen, which constitutes 90% of the bone matrix upon which bone minerals are deposited.

The evidence is too limited to suggest a benefit of vitamin C supplements in the prevention of bone loss.

VITAMIN K

Good Sources to help meet the AI for Vitamin K



Function

1. Vitamin K is essential for the activity of several bone proteins involved in bone formation and turnover.

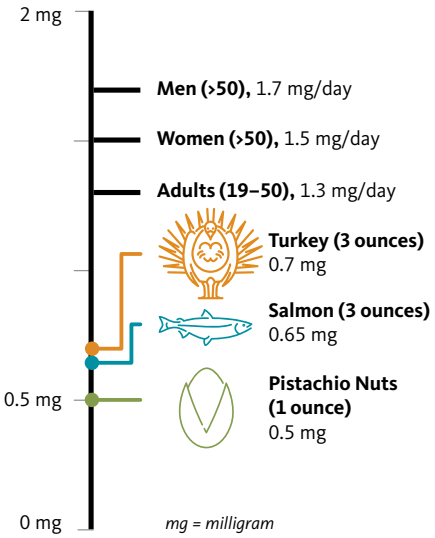
There is little evidence supporting a benefit of vitamin K supplementation in the prevention of osteoporosis.

Taking vitamin K supplements can be dangerous for people at risk of blood clots and those taking blood-thinning medications.

Essential Nutrients Continued

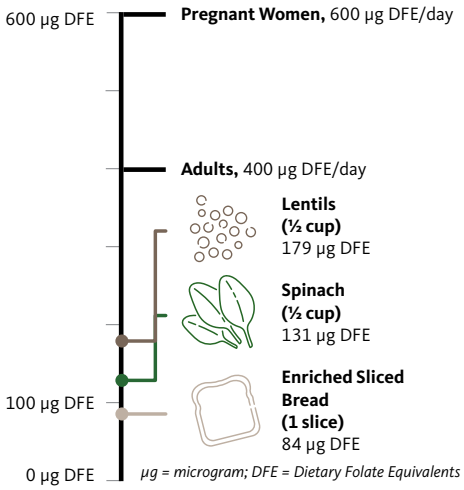
VITAMIN B_6

Good Sources to help meet the RDA for Vitamin B_6



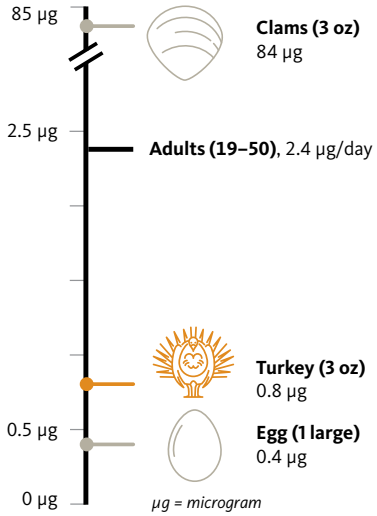
FOLATE

Good Sources to help meet the RDA for Folate



VITAMIN B_{12}

Good Sources to help meet the RDA* for Vitamin B_{12}



Functions of B vitamins

1. Vitamin B_6, folate and vitamin B_{12} work together to lower blood homocysteine concentration.

2. Too much homocysteine in the blood is associated with reduced bone mineral density and osteopenia.

Meeting recommended intake levels for B vitamins with food and/or supplements helps to lower homocysteine concentration in blood.

However, B-vitamin supplementation does not reduce the risk of fracture.

**For adults over 50, the LPI recommends 100–400 µg per day of supplemental vitamin B_{12}.*