Bone Health

Vitamins and Minerals to Support Your Skeletal System

Why is Bone Health Important?

The health and growth of the skeletal system during each life stage — from childhood and adolescence through adulthood — is integral to one's overall health and growth. In fact, measurements of bone mineral content (BMC) can serve as a substitution to track aging in general over the course of a person's life.[1] Your skeleton serves two important functions: 1. To support and protect your body to allow you to move around and 2. As a reserve supply for calcium and phosphorous when your body needs these minerals. Bone tissue is continually being remodeled to carry out its functions.

Bones grow and develop during childhood and adolescence and continue into early adulthood (Figure 1). There are three phases of bone development over a lifetime: growth, modeling, and remodeling.

1. **Bone growth:** from birth to around age 2, bones grow rapidly in size and continue to grow in spurts during childhood and adolescence, eventually ending in early adulthood, around age 25.

2. **Bone modeling:** in early adulthood bones continue to change in size and thickness, accruing mass when stressed (as in weight-bearing exercise).

3. **Bone remodeling:** Bone remodeling occurs throughout adulthood and serves to adjust bone architecture to meet the changing needs while helping to repair microdamages in bone matrix and preventing accumulation of old bone.

The greatest change in BMC, or peak bone mass gain (PBMG) occurs during puberty, which starts earlier in females compared to males. The period prior to peak bone mass, from childhood to early adulthood, is critical as high peak bone mass reduces the risk of osteoporosis and fracture later in life. Peak bone mass is achieved by the mid-20s, and at around age 34, there begins an inevitable decline of bone mass that continues with age. Men achieve higher peak bone mass and experience a later, more gradual decline in BMC loss compared to women (Figure 2). Menopause in women further accelerates loss of bone mass, as estrogen is necessary to maintain BMC by helping to retain calcium in the bones.

What is Osteoporosis?

Osteoporosis is a skeletal disorder characterized by loss of bone mass and strength — leading to an increased risk of fracture. Common sites of osteoporotic fracture are the hip, femoral neck, and vertebrae of spinal column. Among these, the hip is the most serious, as nearly one-third of those who sustain osteoporotic hip fractures enter nursing homes within a year following the fracture, and one in four die within one year of suffering an osteoporotic hip fracture.[2]

FIGURE 1: BONE MASS OVER A LIFETIME

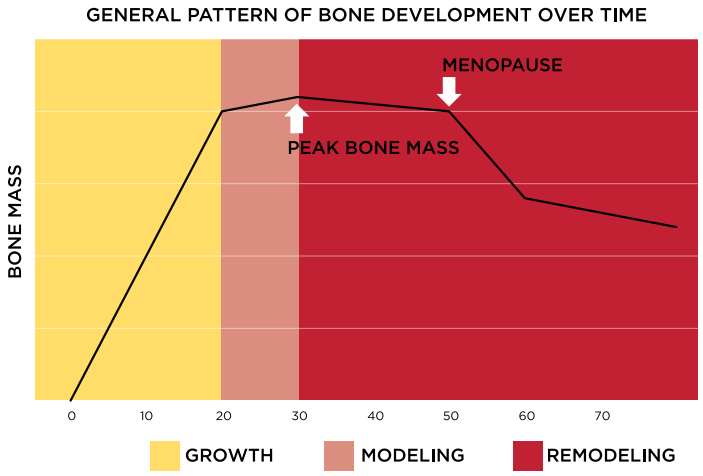
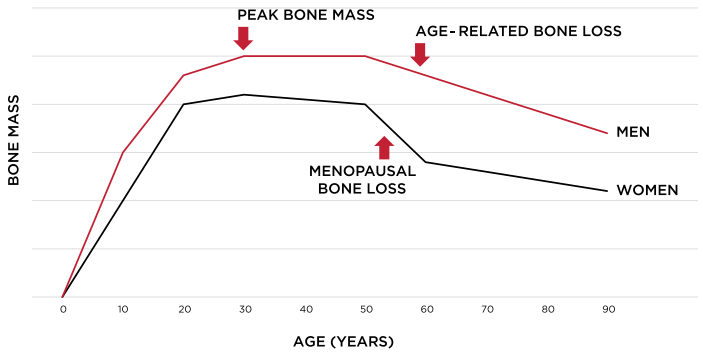


FIGURE 2: PEAK BONE MASS AND AGE-RELATED BONE LOSS IN MEN AND WOMEN



What are the Key Vitamins and Minerals to Support Bone Health?

Achieving peak bone mass is greatly impacted by an individual's general health, level of physical activity, and quality of diet during the crucial growth and modeling phases starting in childhood through early adulthood. Physical activity (such as weight-bearing exercise) applies force onto the skeleton and is necessary to shape and maintain normal bone mass. The quality of the daily diet, especially consuming adequate amounts of key vitamins and minerals, is also needed to achieve peak bone mass and support the skeletal system throughout life.

TABLE 1: KEY VITAMINS AND MINERALS FOR BONE HEALTH AND FUNCTION[3-5]

Recommended Dietary Allowance (RDA)		Calcium	Vitamin D	Magnesium	Vitamin K*
Children 4-8 y		1,000 mg	15 mcg (600 IU)	130 mg	55 mcg
Children 9-13 y		1,300 mg	15 mcg (600 IU)	240 mg	60 mcg
Adolescents 14-18 y	**Males** **Females**	1,300 mg 1,300 mg	15 mcg (600 IU) 15 mcg (600 IU)	410 mg 360 mg	75 mcg 75 mcg
Adults 19-50 y	**Males** **Females**	1,000 mg 1,000 mg	15 mcg (600 IU) 15 mcg (600 IU)	400-420 mg 310-320 mg	120 mcg 90 mcg
Adults 51-70 y	**Males** **Females**	1,000 mg 1,200 mg	15 mcg (600 IU) 15 mcg (600 IU)	420 mg 320 mg	120 mcg 90 mcg
Adults 71+ y	**Males** **Females**	1,000 mg 1,200 mg	20 mcg (800 IU) 20 mcg (800 IU)	420 mg 320 mg	120 mcg 90 mcg
Pregnancy	**14-18 y** **19-50 y**	1,300 mg 1,000 mg	15 mcg (600 IU) 15 mcg (600 IU)	400 mg 350 mg	75 mcg 90 mcg
Lactation	**14-18 y** **19-50 y**	1,300 mg 1,000 mg	15 mcg (600 IU) 15 mcg (600 IU)	360 mg 320 mg	75 mcg 90 mcg
Food Sources		Yogurt, 8 oz = 415 mg Sardines, 1 can = 351 mg Milk, 8 oz = 300 mg	Salmon, canned, 3 oz = 11.6 mcg (465 IU) Milk, 8 oz = 2.7 mcg (108 IU) Orange juice, 8 oz = 1.0 mcg (100 IU)	Brown rice, 1 cup = 86 mg Cashews, 1 oz = 83 mg Spinach, cooked ½ cup = 78 mg	Kale, 1 cup = 472 mcg Parsley, ¼ cup = 246 mcg Spinach, 1 cup = 145 mcg

**Adequate Intake (AI)*

Calcium

As an essential nutrient and the most abundant mineral in the body, calcium is mostly stored within the bones and teeth, while a small amount circulates in the blood. Calcium is necessary for bone structure and maintenance throughout life. Inadequate calcium intake may lead to lower levels of bone mineral density gains during adolescence and early adulthood.[6] A recent study using National Health and Nutrition Examination Survey (NHANES) data found that BMC and PBMG among individuals ages 8 to 29 with adequate calcium intake was significantly greater than those who reported inadequate calcium intake.[7] This suggests that calcium intake, through the diet and/or supplements, may play an important role in supporting bone development gains during the growth spurt stage in adolescence, with lasting effects into the adult years. In this group of individuals ages 8-29 years, almost 58% of males and females reported inadequate calcium intake.[7]

Later in life, particularly after menopause in women, low dietary calcium intake can accelerate bone loss and increase the risk of osteoporosis and fracture. Recent analysis of NHANES data suggests that over 72% of females and 51% of males over the age of 50, have inadequate dietary calcium intake. Only 30% of this group reported supplementing with calcium and vitamin D.[8] The US National Osteoporosis Foundation and other professional organizations recommend supplemental calcium (1,000-1,200 mg/day) and vitamin D (800-1,000 IU/day) as a public health intervention to reduce the burden of fractures in all middle-aged adults.[9]

Qualified Health Claim for Calcium and Vitamin D: Adequate calcium and vitamin D as part of a healthful diet, along with physical activity, may reduce the risk of osteoporosis later in life.

Vitamin D

As an essential fat-soluble vitamin, vitamin D serves an important role of controlling blood concentrations of calcium through the parathyroid hormone (PTH). In the kidneys, PTH converts the storage form of vitamin D into its active form – 1α, 25-dihydroxyvitamin D_3, which then circulates in the blood and stimulates absorption of calcium in the small intestine and allows retention of filtered calcium by the kidneys. Active vitamin D_3 and PTH also release minerals like calcium from the bone when needed, which restores normal blood concentrations but removes these needed minerals from the skeleton.

While vitamin D can be absorbed in the skin from UV rays from the sun, various factors affect absorption — including time of day, length of time in the sun, season, age, sunscreen use, and the amount of melanin, or brown pigment, that your skin produces. Darker skin has a higher melanin content compared to fair skin and can impact absorption. Vitamin D is also found in relatively few foods but is fortified in some foods like milk and juice. As much as 95% of US adults do not consume enough vitamin D from their food alone.[10] Older adults and those with a vitamin D insufficiency or deficiency should add a vitamin D supplement to their daily routine. The American Geriatric Society recommends 1,000 IU vitamin D supplementation along with calcium for older adults over 65 years old.[11]

Magnesium

Magnesium plays important structural and functional roles in the body, and is found largely in our skeleton, with about 50-60% of total body magnesium located in the bones. Regarding bone health, magnesium plays a role in PTH secretion and the release of the active form of vitamin D in the kidneys. A cross-sectional analysis of NHANES data found lower risks of vitamin D insufficiency or deficiency in those with higher magnesium intakes.[12] Research suggests that magnesium deficiency could impair bone mineralization and may be a risk factor for osteoporosis. Despite the importance of magnesium, US adults are not meeting the dietary recommendations for this essential mineral, with about 54% of Americans having usual intakes below the recommended levels.[13]

Vitamin K

There are two forms of naturally occurring vitamin K: vitamin K_1 (phylloquinone) and vitamin K_2 (menaquinones). Green leafy vegetables are good sources of vitamin K_1 while fermented foods such as cheese and natto (fermented soybeans) are good sources of vitamin K_2. Vitamin K works as an important cofactor for reactions that modify proteins present in bone tissue, such as osteocalcin, that helps with calcium binding. Made by osteoblasts (bone-forming cells), osteocalcin is needed in bone mineralization as it is required for the growth and development of the calcium-containing bone matrix.[14] Research suggests that vitamin K_2 supplementation may support bone mineralization when taken with calcium, with many of the studies conducted in menopausal and postmenopausal women.[15,16]

How Does Physical Activity Contribute to Bone Health?

Physical activity supports skeletal health through each life stage. Physical activity early in life contributes to higher peak bone mass.[17] Throughout adulthood, maintaining an active lifestyle in the presence of adequate calcium and vitamin D may have a modest effect on slowing the rate of bone loss later in life.[18] Current National Osteoporosis Foundation guidelines recommend regular muscle-strengthening (weight training and other resistance exercises such as yoga and pilates) and weight-bearing exercise (like walking, jogging, stair climbing) to all postmenopausal women and men ages 50 and older.[19] These exercises may improve strength, posture, balance and coordination, thus contributing to reduced risk of falls.[19]

Should I Add a Dietary Supplement to My Daily Routine?

It's important for patients to communicate with their healthcare professionals about any changes to their daily regimen including dietary supplements. Work together to understand personal nutrition needs as well as current dietary patterns to identify nutrient gaps. For those who are still unable to meet their nutrient needs from diet alone, it's important to discuss the need to fill any potential nutrient gaps with dietary supplements, as a safe and effective way to ensure adequate intake of all essential nutrients.

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***Based on 2019 U.S. News & World Report - Pharmacy Times Survey*

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