Bone Health:
A Summary of the Science



Osteoporosis in America

Osteoporosis ("porous bones") is a silent disease of low bone mass which predisposes to fractures. Today, more than one-half of Americans over age 50 are estimated to have osteoporosis and low bone mass. The number is projected to increase to 64 million people by 2020 and may climb to 71 million by 2030, with the number of fractures to grow proportionately.

Osteoporosis is considered to have its roots in childhood.

If bone growth is sub-optimal during the crucial time before adulthood, the risk of fractures increases in children, especially those involved in physically active sports, and adults in ensuing decades. Fully 90% of adult bone mass is accumulated by age 18, with 40-60% of peak (maximum) bone mass occurring during the teenage years alone. Attaining peak bone mass during childhood and adolescence is associated with reduced risk of osteoporosis later in life.

> Left unchecked, the bone health status of Americans is only going to get worse, due primarily to the aging of the population. In fact, the prevalence of osteoporosis and osteoporotic-related fractures will increase significantly unless the underlying bone health status of Americans is significantly improved.
>
> *— 2004 U.S. Surgeon General's Report on Bone Health and Osteoporosis*

Risk Factors for Osteoporosis

There are a number of factors that influence bone mass and the risk of osteoporosis. Non-modifiable factors that increase risk include genetics, female gender, and white Non-Hispanic and Asian races. Modifiable factors maximizing bone health include weight-bearing physical activity, maintenance of normal body mass, smoking cessation, hormonal balance, certain medical conditions, medications, and adequate nutrition.

milk Means More
United Dairy Industry of Michigan

Calcium and Bone Health

The body's skeleton is a living tissue that changes constantly. Throughout life, bone is continuously broken down and rebuilt in a process known as remodeling. Through childhood and early adulthood, bone formation exceeds bone resorption. During this time period, maximizing bone mass with proper nutrition and weight-bearing exercise helps reduce the risk of osteoporosis and fragility fractures.

Proper nutrition for optimal bone health includes several nutrients. Calcium is the crucial nutrient for bone mineralization. Fully 99% of the body's calcium is stored in bones and the remodeling process is sensitive to calcium intake. Inadequate consumption of calcium interrupts the process leading to weak, porous bones and ultimately osteoporosis. Additionally, vitamin D promotes calcium absorption; protein provides structure and flexibility to bones; and phosphorus helps to build and maintain the mineral complex responsible for bone hardness and rigidity. Other key nutrients important for bone health are magnesium, potassium, zinc, copper, iron, fluoride, and vitamins A, C, and K.

Calcium Recommendations

LIFE STAGE GROUP	CALCIUM	VITAMIN D
	Recommended Dietary Allowance (mg/day)	Recommended Dietary Allowance (IU/day)
Infants 0 to 6 months	*	**
Infants 6 to 12 months	*	**
1 – 3 years old	700	600
4 – 8 years old	1,000	600
9 – 13 years old	1,300	600
14 – 18 years old	1,300	600
19 – 30 years old	1,000	600
31 – 50 years old	1,000	600
51 – 70 year old males	1,000	600
51 – 70 year old females	1,200	600
>70 years old	1,200	800
14 – 18 years old, pregnant/ lactating	1,300	600
19 – 50 years old, pregnant/ lactating	1,000	600

** For infants, Adequate Intake is 200 mg/day for 0 to 6 months of age and 260 mg/day for 6 to 12 months of age.*
*** For infants, Adequate intake is 400 IU/day for 0 to 6 months of age and 400 IU/day for 6 to 12 months of age.*

source: 2011 Institute of Medicine

Bone Health, Calcium and Dairy Foods

Milk is the number one source of calcium and vitamin D in the American diet. Dairy foods provide a unique package of nutrients including not only calcium but also vitamin D (if fortified), phosphorus, and protein that are nutrients important for bone health. The National Osteoporosis Foundation, based on a recent systematic review of the science, reaffirmed the critical role of adequate calcium, vitamin D, and dairy consumption for bone health. Likewise, the 2015 Dietary Guidelines for Americans (DGA) acknowledges dairy's role in improving bone health, especially in children and adolescents. The DGA identified calcium and vitamin D as nutrients of public health concern because of their low intake, which is associated with adverse health conditions.

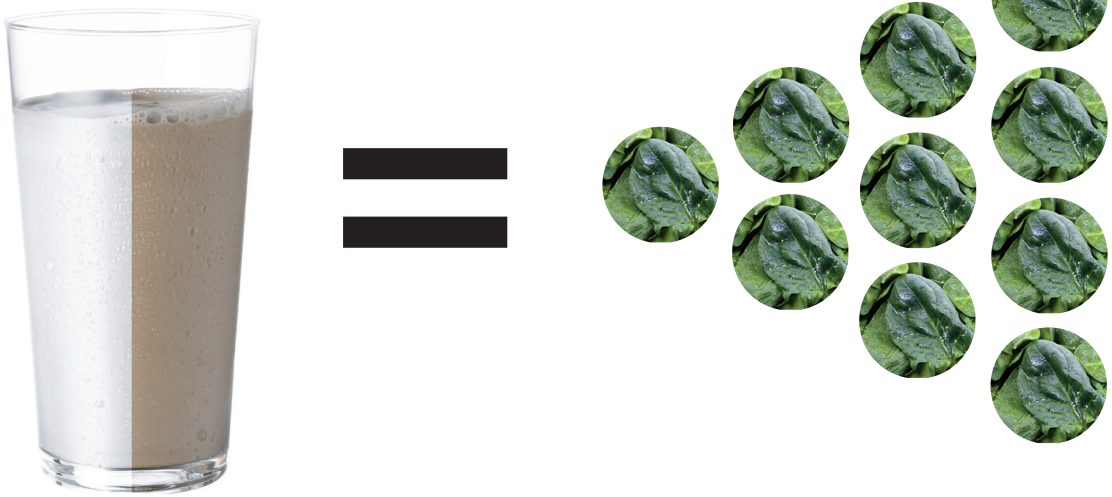
Based on research linking dairy intake to improved bone health, especially in children and adolescents, the 2015 DGA recommends consumption of 2 cup-equivalents per day of low-fat or fat-free dairy for children ages 2 to 3 years, 2 1/2 cup-equivalents for children ages 4 to 8 years, and 3 cup-equivalents for adolescents ages 9 to 18 years and for adults (1 cup equivalent = 8-oz milk, 8-oz yogurt, 1.5-oz natural cheese). Almost 90 percent of the U.S. population fails to consume recommended daily servings of dairy foods Although average dairy intake of very young children aged 1-3 meets recommendations, dairy intake begins to decline in childhood and persists into adulthood.

The 2015 DGA advises Americans of all ages to consume healthy eating patterns including nutrient-dense foods such as dairy foods, rather than supplements, to meet recommendations for essential nutrients and other components that positively impact health.

Dietary Sources of Calcium

As stated, the major source of dietary calcium in the American diet is fluid milk and other dairy foods (yogurt, cheese). Calcium is also present in some dark green vegetables, legumes, and fortified foods including juices and soy products. However, the bioavailability of naturally occurring calcium in plant foods such as spinach, collard greens, sweet potatoes, rhubarb and beans is reduced by the binding with oxalates. Consequently, the amount of plant-based foods needed to provide the same amount of calcium found in an 8-oz serving of milk is substantial.

An 8-ounce serving of milk, flavored or not, provides as much Calcium as 10 cups of raw spinach.



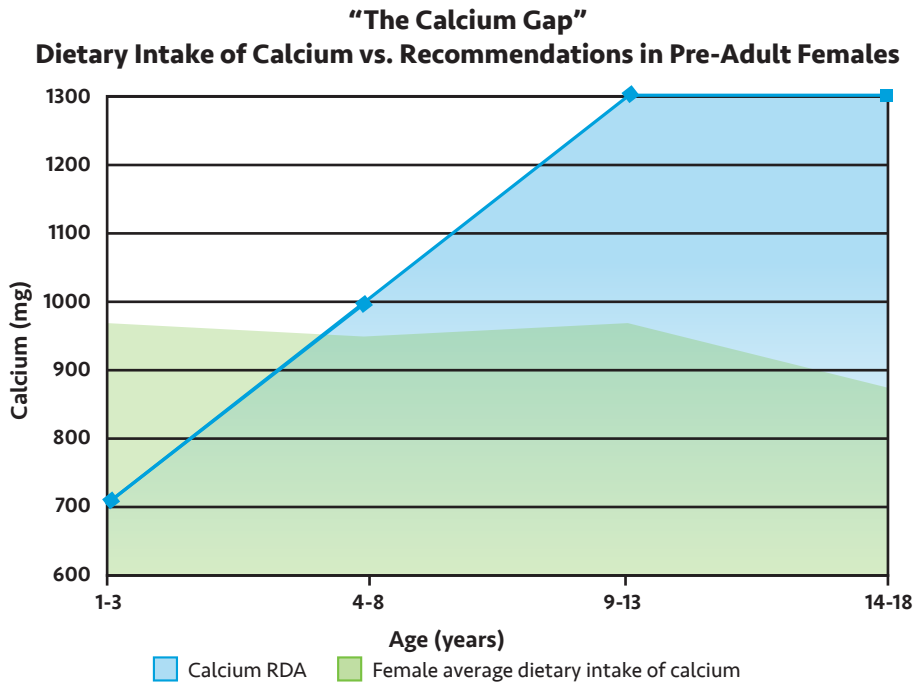
FOOD	Standard Portion Size	Calcium (mg)[a]
DAIRY FOODS		
Low-fat chocolate milk (1%)	1 cup	322
Low-fat milk (1%)	1 cup	305
Reduced fat chocolate milk (2%)	1 cup	272
Reduced fat milk (2%)	1 cup	293
Skim milk (nonfat)	1 cup	299
Whole milk	1 cup	276
Plain yogurt, nonfat	8 ounces	452
Plain yogurt, low-fat	8 ounces	415
Vanilla yogurt, low-fat	8 ounces	388
Fruit yogurt, low-fat	8 ounces	384
Cheddar cheese	1.5 ounces	302
Colby cheese	1.5 ounces	291
Gruyere cheese	1.5 ounces	430
Monterey cheese	1.5 ounces	317
Mozzarella cheese, low moisture part-skim	1.5 ounces	296
Muenster cheese	1.5 ounces	305
Parmesan cheese, hard	1.5 ounces	503
Pasteurized processed American cheese	2 ounces	593
Pasteurized processed American cheese food	2 ounces	387
Provolone cheese	1.5 ounces	321
Ricotta cheese, part skim	½ cup	337
Ricotta cheese, whole milk	½ cup	257
Romano cheese	1.5 ounces	452
Swiss cheese	1.5 ounces	378
NON-DAIRY FOODS		
Broccoli, raw	1 cup	43
Broccoli, cooked	1 cup	62
Collards, cooked	1 cup	268
Mustard spinach (tendergreen), raw	1 cup	315
Sardines, canned in oil, drained	3 ounces	325
Spinach, raw	1 cup	30
Spinach, cooked	1 cup	245
FORTIFIED FOODS		
Almond milk (all flavors)[b]	1 cup	451
Fortified ready-to-eat cereals (various)[b]	¾-1¼ cup	137-1,000
Rice drink[b]	1 cup	283
Orange juice, calcium fortified[b]	1 cup	349
Soymilk (all flavors), enhanced[b]	1 cup	340
Tofu, raw, regular, prepared with calcium sulfate	½ cup	434

[a]Source: U.S Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory. 2016. USDA National Nutrient Database for Standard Reference, Release 28. Available at: http://www.ars.usda.gov/nutrientdata.

[b]Calcium Fortified

The Calcium Gap

Of particular concern is the low intake of calcium-rich foods, especially dairy, by preadolescent and adolescent females. Ninety percent of bone mass accrues by the age of 18 years. In fact, the calcium recommendation of 1,300 mg per day for 9-18 year olds is higher than at any other period in the lifespan. As shown in the Figure below, pre-adult females' consumption of dietary calcium trends downward with age.



Dietary intake based on 2003-2006 NHANES data, Source: Bailey RL, Dodd KW, Goldman JA, et al. Estimation of total usual calcium and vitamin D intakes in the United States. J Nutr. 2010;140(4):817–822

Calcium RDA from 2011 Institute of Medicine Recommendations. Recommended Dietary Allowance (RDA): average daily level of intake sufficient to meet the nutrient requirements of nearly all (97%-98%) healthy people.

The Role of Health Care Professionals

The American Academy of Pediatrics recommends that pediatricians and other health care professionals (HCPs) screen their child and adolescent patients for osteoporosis risk factors during annual exams. To keep nutrition and physical activity in the conversation, HCPs should discuss:

- The type of milk and other dairy foods consumed, and total daily servings of dairy (1 serving = 8-oz milk, 8-oz yogurt, 1.5-oz natural cheese). Does the patient consume non-dairy sources of calcium and/or supplements?
- Barriers to meeting dairy recommendations (e.g., lactose intolerance, weight concerns)
- The importance of milk and other dairy foods in meeting calcium needs and the short-term (e.g., decreased fracture risk when playing sports) and potential long-term (decreased risk of osteoporosis) benefits.
- The type and amount of weight-bearing exercise the patient performs each day.

Resources

Institute of Medicine. 2011. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: The National Academies Press.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2015-2020 Dietary Guidelines for Americans. 8th Edition. December 2015.http://health.gov/dietaryguidelines/2015/guidelines/ (accessed on February 9, 2016).

Bone Health and Osteoporosis: A Report of the Surgeon General. Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General, 2004.http://www.ncbi.nlm.nih.gov/books/NBK45513/ (accessed on January 22, 2016).

Bailey RL, Dodd KW, Goldman JA, et al. Estimation of total usual calcium and vitamin D intakes in the United States. J Nutr. 2010;140(4):817–822

National Osteoporosis Foundation. 54 Million Americans Affected by Osteoporosis and Low Bone Mass. https://www.nof.org/2014/06/02/54-million-americans-affected-by-osteoporosis-and-low-bone-mass/ (accessed on December 15, 2016).

National Institute of Arthritis and Musculoskeletal and Skin Diseases. Handout on Health: Osteoporosis. http://www.niams.nih.gov/Health_Info/Bone/Osteoporosis/osteoporosis_hoh.asp (accessed on February 9, 2016).

National Dairy Council. Science Summary: Peak Bone Mass.https://www.nationaldairycouncil.org/Content/2015/Science-Summary-Dairy-and-Peak-Bone-Mass (accessed on February 5, 2016).

Golden, NH, Abrams, SA, and CON. Optimizing Bone Health in Children and Adolescents. Pediatrics 2014;134:e1229-e1243. http://pediatrics.aappublications.org/content/134/4/e1229 (accessed on December 10, 2015).

Weaver, CM et al. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. Osteoporosis International 2016.http://link.springer.com/article/10.1007%2Fs00198-015-3440-3 (accessed on February 19, 2016).