



Dairy foods supply key nutrients that can support bone health in children and adolescents

Overview

Daily consumption of low-fat or fat-free dairy foods such as milk, cheese and yogurt are part of the Dietary Guidelines for Americans (DGA) and American Academy of Pediatrics (AAP) recommendations for children and adolescents. Milk contains calcium and vitamin D, essential nutrients for bone growth and development. These essential nutrients, and others found in dairy foods, can be important factors in helping to achieve peak bone mass, which is associated with reduced risk for osteoporosis later in life. Research supports the 2015 DGA recommendations to consume three servings of low-fat or fat-free dairy foods for children and adolescents 9 years and older as part of healthy eating patterns, accompanied by adequate physical activity, to support bone health.

Healthy eating patterns including dairy support bone health in children and adolescents

Many nutrients work together to support growth and maintenance of bone, including calcium, vitamin D, and phosphorus (1-5). Consuming adequate amounts of calcium and vitamin D is especially important during childhood and adolescence to help support bone health (2, 4, 5). Milk is the main food source of calcium, vitamin D, phosphorus and protein in the diets of children (6), reinforcing the role of dairy foods as an integral part of healthy eating patterns for growing children and adolescents (4, 5, 7, 8). Research supports developing peak bone mass by young adulthood, via good nutrition (including calcium and vitamin D) and physical activity, as one strategy to optimize bone health and help reduce the risk of bone diseases later in life (4, 5).

Good nutrition plays a key role in bone health for children and adolescents

Bone is a living and dynamic tissue that requires a variety of essential nutrients for growth and maintenance (5). During childhood, bones are growing in length, breadth and mass (9). With the onset of the adolescent growth spurt, bone mineral accretion is rapid (5), and by the age of 18 years, at least 90% of bone mass has accrued (10). Bone is composed mainly of a calcium-phosphate mineral complex and connective tissue, which is made of the protein collagen (1, 5).

The 2015 DGA states that research has linked dairy intake to improved bone health, especially in children and adolescents (7).

Much nutrition research on bone health has focused on the role of calcium and vitamin D in bone growth and maintenance (2, 4, 11-17). Because calcium is a primary component of the skeleton, bone growth during childhood determines much of the daily calcium requirement (2). Vitamin D helps the body maintain adequate calcium levels by modifying calcium absorption, which is especially important during times of low calcium intakes (2). Phosphorus helps build and maintain the calcium-phosphate bone matrix (3), and protein provides structure and flexibility to bones (1, 5). While there has been speculation that animal protein interferes with the body's ability to retain calcium, newer research has found that higher protein consumption is not harmful to bone in healthy individuals, and the beneficial effects of protein for bone health may be apparent only when adequate calcium is also consumed (17-19).

Authoritative reports recommend dairy foods and dairy nutrients for bone health

The Institute of Medicine (IOM) published the 2011 expert report *Dietary Reference Intakes for Calcium and Vitamin D*, based on the substantial body of evidence linking adequate calcium intake and vitamin D status to higher bone mass, mineral density and content (2). The report recommends 700-1,300 mg calcium per day and 600 IU vitamin D per day for children ages 1-18 years, and recommends obtaining these nutrients from dietary sources (2). The 2015 DGA states that dairy consumption is linked to improved bone health, especially in children and adolescents (7). The DGA recommends three daily servings of low-fat or fat-free dairy foods for children and adolescents 9-18 years, 2½ servings for children 4-8 years and two for children 2-3 years (7). The AAP, in its 2014 clinical report on optimizing bone health, recommends pediatricians “Encourage increased dietary intake of calcium- and vitamin D-containing foods and beverages” and “Children 4 through 8 years of age require 2-3 servings of dairy products or equivalent per day. Adolescents require 4 servings per day” (4).

The National Osteoporosis Foundation states that following the Dietary Guidelines and Physical Activity Guidelines for Americans is “an important and positive step toward ensuring healthy bone growth and/or maintenance throughout the lifecycle” (5).

National Osteoporosis Foundation statement focuses on peak bone mass

Osteoporosis and low bone mass affect about 54 million Americans, particularly women over 50 years of age (20). Osteoporosis refers to low bone mass leading to structural fragility, which can lead to an increased risk of fracture; fracture can be associated with increased mortality (15, 21). Maximizing peak bone mass by young adulthood is one strategy recommended to help reduce the risk of bone diseases like osteoporosis (4).

In 2016, the National Osteoporosis Foundation (NOF) published a position statement and systematic review on peak bone mass development (5). The statement confirms the importance of achieving peak bone mass to reduce the risk of osteoporosis later in life. The authors reviewed more than 150 studies on various lifestyle factors related to peak bone mass in children, adolescents and young adults published between 2000 and 2014. The best evidence, grade A, was found for calcium and physical activity (effect on bone mass and density), and good evidence, grade B, was found for dairy, vitamin D and physical activity (effect on bone structural outcomes). The NOF states that following recommendations in the DGA (7) and the Physical Activity Guidelines (PAG) for Americans (22) is “an important and positive step toward ensuring healthy bone growth and/or maintenance throughout the lifecycle” (5).

Most Americans are not meeting current DGA dairy food recommendations

Children 1-3 years old meet recommended dairy intakes, however, by the time they reach school age, consumption falls short of recommendations (7). Americans 2 years and older consume about 2 servings per day of dairy foods, on average (23). The 2015 DGA identified calcium and vitamin D as nutrients of public health concern due to underconsumption by Americans, including school-aged children and adolescents (7). While most Americans 2 years and older consume adequate phosphorus, just over half of adolescent girls 14-18 years of age were not meeting the Estimated Average Requirement in 2005-2006 (24). Adding just one daily serving of dairy foods to current consumption can help many Americans meet dairy recommendations and contribute to closing nutrient gaps (25).

Conclusion

The 2015 DGA states that research has linked dairy intake to improved bone health, especially in children and adolescents (7), and recommends three daily servings of low-fat or fat-free dairy foods for children and adolescents 9-18 years, 2½ for children 4-8 years and two for children 2-3 years. Calcium, vitamin D and phosphorus have been recognized as the most critical nutrients for bone health (26), and milk is the No. 1 food source of calcium, vitamin D, phosphorus, protein and other nutrients in the diets of children (6). Lifestyle choices can influence 20-40% of adult peak bone mass, and following the DGA and PAG can support bone health during all stages of life (5).

References

1. Heaney RP. Dairy and bone health. *J Am Coll Nutr* 2009;28:82S-90S.
2. Institute of Medicine. 2011. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: The National Academies Press.
3. Bonjour JP. Calcium and phosphate: a duet of ions playing for bone health. *J Am Coll Nutr* 2011;30:438S-48S.
4. Golden, NH, Abrams, SA, and CON. Optimizing Bone Health in Children and Adolescents. *Pediatrics* 2014;134:e1229-e1243.
5. Weaver CM, Gordon CM, Janz KF, Kalkwarf HJ, Lappe JM, Lewis R, Karm MO, Wallace TC, Zemel BS. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporosis Int*. Published online February 8, 2016.
6. Keast DR, Fulgoni VL, Nicklas TA, O'Neil CE. Food sources of energy and nutrients among children in the United States: National Health and Nutrition Examination Survey 2003-2006. *Nutrients* 2013;5:283-301.
7. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015-2020 Dietary Guidelines for Americans. 8th Edition, December 2015. Available at <http://health.gov/dietaryguidelines/2015/guidelines/>.
8. Dror KD, Allen LH. Dairy product intake in children and adolescents in developed countries: trends, nutritional contribution, and a review of association with health outcomes. *Nutr Rev* 2014;72:68-81.
9. Heaney RP, Abrams S, Dawson-Hughes B, Looker A, Marcus R, Matkovic V, Weaver C. Peak bone mass. *Osteoporosis Int* 2000;11:985-1009.
10. Bacharach LK. Acquisition of optimal bone mass in childhood and adolescence. *Trends Endocrinol Metab* 2001; 12:22-28.
11. Heaney RP, Gallagher JC, Johnston CC, Neer R, Parfitt AM, BChir MB, Whedon GD. Calcium nutrition and bone health in the elderly. *Am J Clin Nutr* 1982;36:986-1013.
12. NIH Consensus Statement. 1994. *Optimal calcium intake*. Internet: <https://consensus.nih.gov/1994/1994optimalcalcium097html.htm> (accessed on November 13, 2015).
13. Institute of Medicine. 1997. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: The National Academies Press.
14. Abrams SA. Calcium turnover and nutrition through the life cycle. *Proc Nutr Soc* 2001;60:283-289.
15. *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. Internet: <http://www.ncbi.nlm.nih.gov/books/NBK45513/> (accessed on October 16, 2015).
16. Heaney RP. Bone health. *Am J Clin Nutr* 2007;85:300S-303S.
17. Bonjour JP. Nutritional disturbance in acid-base balance and osteoporosis: a hypothesis that disregards the essential homeostatic role of the kidney. *Br J Nutr* 2013;110:1168-1177.
18. Kerstetter JE, Kenny AM, Insogna KL. Dietary protein and skeletal health: a review of recent human research. *Curr Opin Lipidol* 2011;22:16-20.
19. Mangano KM, Shivani Sahni S, Kerstetter JE. Dietary protein is beneficial to bone health under conditions of adequate calcium intake: an update on clinical research. *Curr Opin Clin Nutr Metab Care*. 2014 17(1): 69-74.
20. Wright NC, Looker AC, Saag KG, Curtis JR, Delzell ES, Ranfall S, Dawson-Hughes B. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. *J Bone Miner Res*. 2014;29(11): 2520-2526.
21. Osteoporosis Prevention, Diagnosis, and Therapy. NIH Consensus Statement Online 2000 March 27-29; [accessed February 24, 2016]; 17(1): 1-36.
22. USDHHS. Physical Activity Guidelines for Americans. USDHHS, Washington DC; 2008.
23. *What We Eat in America*, NHANES 2011-2012. http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/FPED/tables_1-4_FPED_1112.pdf.
24. Moshfegh A, Goldman J, Ahuja J, Rhodes D, LaComb R. 2009. *What We Eat in America*, NHANES 2005-2006: Usual Nutrient Intakes from Food and Water Compared to 1997 Dietary Reference Intakes for Vitamin D, Calcium, Phosphorus, and Magnesium. U.S. Department of Agriculture, Agricultural Research Service. Internet: <http://www.ars.usda.gov/Services/docs.htm?docid=22659> (accessed on August 24, 2015).
25. Fulgoni VL, Keast DR, Auestad N, et al. Nutrients from dairy foods are difficult to replace in diets of Americans: food pattern modeling and an analysis of the National Health and Nutrition Examination Survey 2003-2006. *Nutr Res* 2011;31:759-765.
26. U.S. Department of Agriculture and U.S. Department of Health and Human Services. *The Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2015*. Internet: <http://www.health.gov/dietaryguidelines/2015-scientific-report/> (accessed on November 17, 2015).