The Role of Dairy Foods in Bone Health Across the Lifespan

Overview

Healthy bones are critical for overall health, mobility and quality of life at every age. During childhood and adolescence, achieving optimal peak bone mass is critical for proper skeletal development and long-term fracture prevention. In adulthood, maintaining bone mineralization and minimizing bone resorption helps reduce the risk of age-related bone loss and related complications. Dairy foods at all fat levels, including milk, cheese and yogurt, provide an important, bioavailable source of several key bone-supporting nutrients, along with bioactive compounds that enhance mineral absorption and bone metabolism. The 2025-2030 Dietary Guidelines for Americans (DGA) and several other leading health organizations recommend daily consumption of nutrient-dense dairy foods as part of healthy eating patterns for proper nutrition to support bone health at all life stages. Research continues to support the body of science demonstrating the important contributions that dairy foods, and their unique package of nutrients and bioactives, provide to benefit bone health across all life stages.

Dairy foods provide a unique package of bone-supporting nutrients and bioactive compounds

Consuming a variety of dairy foods (i.e., milk, cheese and yogurt) as part of healthy eating patterns can help ensure Americans meet recommended amounts of bone-supporting nutrients, including high-quality protein, calcium, vitamin D, potassium, magnesium, phosphorus, iodine and zinc. The dairy food group contributes ≥15% of the total nutrient content of more than a dozen nutrients to a healthy eating pattern for most calorie levels.[1] For 8-17% of total calories, three servings of dairy foods can provide an estimated 60-78% of calcium, 55-74% of vitamin D, 15-28% of potassium, 23-41% of protein, 23-39% of vitamin A, 41-61% of vitamin B12, 30-50% of riboflavin (B2), 14-27% of magnesium, 21-39% of zinc, 3-6% of total fat and 8-18% of saturated fat to the diets of Americans 2 years and older.[1]

Beyond their core nutrients, dairy foods contain bioactive compounds that may uniquely benefit bone metabolism. Emerging research indicates that milk proteins and bioactive peptides may enhance mineral absorption and beneficially regulate bone remodeling,[2-6] while prebiotic oligosaccharides if added to dairy foods may contribute to calcium absorption in the gut.[7] Fermented dairy foods (i.e., yogurt, kefir and certain cheeses) may also contain live and active cultures and probiotics, which may support in the inhibition bone resorption and stimulation of bone formation through pathways related to gut microbiota and promoting calcium absorption.[8,9] Studies comparing dairy foods to non-dairy alternatives indicate that significantly reducing or eliminating dairy foods in favor of alternatives may have significant bone health consequences.[8,10-13] A growing body of research emphasizes the importance of a food's matrix – the complex interplay of nutrients, bioactive compounds and the physical structure of a food – which can impact digestion, absorption and overall health.[14-16] Given their unique food matrix, important bone-building nutrient profile and strong scientific support, dairy foods stand out among food groups for their role in bone development, maintenance and retention.

Dairy food consumption is linked with improved bone mineralization in children and adolescents

Achieving peak bone mineral density during childhood and adolescence is crucial for lifelong skeletal health. Research studies assess this by measuring bone mineral content (BMC), which reflects the total amount of mineral in bone, and bone mineral density (BMD), which accounts for bone mass relative to bone size. Recent meta-analyses and systematic reviews, spanning research from 1988 to 2023, indicate that dairy food consumption has a beneficial to neutral impact on bone health in children and adolescents.[17-20] One systematic review found benefits for bone mineralization in 6 of 7 controlled trials of 1,771 male and female children 9–18 years old who consumed 1-3 servings of dairy foods daily for 2–24 months.[17] Two meta-analyses of randomized controlled trials (RCTs) assessing the impact of dairy food consumption on bone markers in male and female children and adolescents (3-18 years old) reported significant increases in BMC and BMD.[18,20] Benefits were more pronounced in younger children (3–6 years old), females, those with low calcium intake and interventions lasting at least six months.[18,20] A separate review of observational studies and RCTs published between 1988 to 2020 noted neutral to beneficial effects of dairy food consumption on BMD, BMC and fracture risk in children and adolescents.[19] The largest and most consistent evidence base were in those 10–18 years old.[19]

Observational studies and RCTs published since 2020 continue to suggest the important role of dairy food consumption in supporting bone health in children and adolescents by improving bone mineralization.[20-25] A cross sectional study of 115 Caucasian males (14-17 years old) of European decent found significant beneficial associations between dairy food consumption and both BMD and BMC.[22] In addition, a cross sectional analysis of 1,061 adolescents who were 13–18 years old from the 2009–2011 Korea National Health and Nutrition Examination Survey (KNHANES) observed that male and female adolescents who consumed milk and engaged in moderate to vigorous physical activity had significantly higher BMD compared to those who did not drink milk and had low activity levels.[23]

Dairy food consumption supports bone health in adults

Among reviews of research published between 1989 and 2021, three systematic reviews, two umbrella reviews and ten meta-analyses suggest that dairy food consumption has a beneficial to neutral[19,26-31,33,35-41] impact on bone health throughout adulthood, while two meta-analyses report adverse associations.[32,34] A meta-analysis of seven observational studies consisting of those two years and older highlighted that a "milk/dairy" dietary pattern, characterized by high milk and dairy food consumption, was associated with a 41% reduced risk of low BMD.[40] Pooled analysis of RCTs involving 1,528 postmenopausal women suggests that milk fortified with calcium and vitamin D, but not supplements alone, significantly increased total and lumbar spine BMD.[31]

Regarding fracture risk, research suggests a neutral relationship between consumption of total dairy foods as well as milk alone.[28,30,32,37,39] However, studies assessing yogurt consumption, although more limited, suggest potential protective effects.[30,35] For example, a meta-analysis of 14 cohort studies found that higher yogurt consumption, but not milk or cheese, was associated with a lower risk of hip fracture in older adults 50–77 years old.[30] Researchers hypothesized that fermented dairy food benefits may stem from probiotics found in some yogurts (e.g., *Limosilactobacillus reuteri*) and fermentation byproducts like short-chain fatty acids, which enhance calcium absorption and stimulate bone-regulating factors and hormones. Two meta-analyses suggested that drinking ~1 additional serving of milk daily was linked to a 7-9% high risk of hip fracture.[32,34] However, among the 14 adult cohort studies analyzed, elevated hip fracture risk with higher milk consumption was reported in only one cohort,[42,43] while neutral or beneficial effects were reported among the other cohorts.

Recent observational studies report beneficial or neutral relationships between dairy food consumption and BMD, fracture risk or osteoporosis risk.[44-68] One prospective cohort study followed 103,003 women 30-55 years old for over 24 years and found that consuming ≥2 servings of dairy foods per day (compared to <1 serving) was associated with a 26% reduction in total fracture risk.[67] Among postmenopausal women, consuming ≥1 serving of dairy foods daily was linked to a 12% lower fracture risk compared to consuming <1 serving of dairy foods daily. Dairy food consumption (≥1 serving of daily vs. <1 serving daily) was also associated with a 17% reduced fracture risk in premenopausal women. Notably, higher calcium intake from non-dairy sources alone did not show a similar protective effect, highlighting the potential unique benefits of dairy's nutrient-rich food matrix.[67]

Recent short-term (acute [≤2 hours] to 12 weeks) RCTs in generally healthy adults found minimal effects on bone biomarkers or BMD.[69-74] In contrast, a two-year cluster RCT in 7,195 residents (mean age: 86 years old) in aged care facilities showed a 33% reduction in overall fractures, 46% fewer hip fractures and improved BMD following increased dairy intake through additional milk, yogurt and cheese.[75] These protective effects emerged after five months, suggesting that extended intervention periods are needed to detect meaningful bone health changes.

Leading health organizations recommend eating dairy foods daily to achieve and maintain optimal bone mass

Consuming nutrient-dense milk and dairy foods for optimal bone mineral density in childhood and adolescence has been recognized by numerous health professional organizations as well as the 2025-2030 DGA. The American Academy of Pediatrics (AAP) clinical report on optimizing bone health recommends that pediatricians "encourage increased dietary intake of calcium- and vitamin D-containing foods and beverages," such as dairy foods.[76] A position statement from the National Osteoporosis Foundation (NOF), which is now the Bone Health and Osteoporosis Foundation, indicates a beneficial role of dairy foods for bone mineral density from childhood through late adolescence.[77] After the authors of the NOF review assessed over 150 studies on lifestyle factors related to peak bone mass in children, adolescents and young adults, they determined that the links between calcium and bone health, and between physical activity, bone mass and density, were supported by the strongest evidence ("grade A"). They also found good evidence ("grade B") supported the links between dairy intake and bone health, vitamin D intake and bone health and physical activity and bone structure.

The 2025-2030 DGA recommends daily consumption of nutrient-dense dairy foods as part of healthy eating patterns for proper nutrition to support bone health at all life stages.[78] Based on the 2025-2030 DGA, recommended dairy food consumption varies by overall calorie needs, ranging from 2 servings per day for young children with lower calorie needs to 2½–3 servings per day for older children, adolescents and adults, with most individuals following eating patterns of 1,600 calories or more advised to consume 3 daily servings of dairy foods. Additionally, full-fat yogurt and cheese are recommended as complementary foods for infants beginning at 6

months of age. The National Institutes of Health (NIH) stresses the importance of calcium for bone development and highlights that consuming adequate amounts of dairy foods per day as recommended by the DGA can help meet calcium requirements.[79] For individuals living with lactose intolerance (LI), lactose-free dairy milk and lower lactose dairy options like yogurt, kefir and cheese are nutrient-dense and accessible choices available in many varieties to meet personal taste and health needs. In fact, the NIH issued a consensus statement in 2010 on LI and health and provided guidance to help people living with LI manage their symptoms; an important finding was that individuals with LI may avoid dairy foods and, as a result, consume less calcium and vitamin D, which can contribute to low bone mineral density and other adverse health outcomes.[80] According to evidence-based recommendations published in 2024, the National Medical Association also recommends incorporating dairy foods into the diets of those with LI to promote bone health across the lifespan.[81] The role of the nutrition and health professional to help educate people living with LI on the number of lactose-free dairy options and other dairy choices with a varying amount of lactose is an important step to removing barriers to dairy consumption and improving bone health.

Conclusion

The health benefits of consuming dairy foods extend well beyond the essential nutrients that dairy foods provide. Dairy foods deliver a unique package of important and bioavailable bone-supporting nutrients and bioactive compounds that promote bone development, maintenance and retention. Research consistently links dairy food consumption with bone health across age groups. In children and adolescents, dairy food consumption is associated with improved bone mineralization, crucial for healthy skeletal development which is associated with reduced risk for osteoporosis later in life. In adults, dairy food consumption has also been linked to bone mineralization and, in some cases, reduced fracture risk, supporting its role in maintaining healthy bones. Consuming dairy foods and the bone-supporting nutrients they provide as part of healthy eating patterns can help support optimal bone health for Americans across the lifespan.

Key Takeaways for Health & Wellness Professionals

- **Dairy foods provide a unique combination of nutrients that support bone health across the lifespan**. Dairy foods can deliver calcium, vitamin D, high-quality protein and other key nutrients, along with bioactive compounds, that work together to support bone development in early life and help protect bone integrity over time.[2-7,19,82-88]
- **Dairy foods may have benefits for bone health beyond their individual nutrients**. The dairy food matrix – the synergistic combination of each food's nutrients, bioactives and physical structure – may help to enhance mineral absorption and bone metabolism in ways that single nutrients alone cannot.[2-7,14-16,19]
- **Consuming dairy foods like milk, yogurt and cheese during childhood and adolescence helps set the stage for long-term skeletal health**. Research suggests dairy milk and dairy food consumption in early life is associated with beneficial to neutral bone health outcomes, suggesting dairy foods contribute to helping children and teens achieve optimal peak bone mass.[17-20]
- **Dairy foods like milk, cheese and yogurt contribute to maintaining bone health in adults, helping to lower osteoporosis risk throughout aging**. Research indicates dairy food consumption is linked with a beneficial or neutral impact on bone health outcomes well beyond childhood, which can help support healthy aging and vitality.[19,26-31,33,35-41,44-68] The International Osteoporosis Foundation recommends dairy milk and dairy foods to help maintain strong, healthy bones.[89]
- **Consuming the recommended daily servings of dairy foods is a practical way to support bone health throughout life**. Leading health organizations, including the Bone Health and Osteoporosis Foundation and the National Institutes of Health, and the Dietary Guidelines for Americans recognize the contributions dairy foods make to helping support bone health from youth to older adulthood.[76-81] Recommended servings vary based on individual calorie needs, with those consuming 1,600 calories or more advised to consume 3 servings of dairy foods per day.[78]
- **Avoiding dairy foods may have unintended consequences for bone health**. Dairy milk, cheese and yogurt offer unique nutrient profiles which may be difficult to replicate with non-dairy alternatives,[19,90-92] and studies suggest that significantly reducing or eliminating dairy foods may negatively impact bone health.[8,10-13,19] There are lactose-free dairy milks, as well as dairy foods like hard cheeses with minimal lactose and yogurt or kefir which can have live and active cultures that help break down lactose making it easier to digest. All of these options still provide nutrients to support bone health, just with zero to lower lactose.[78]

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