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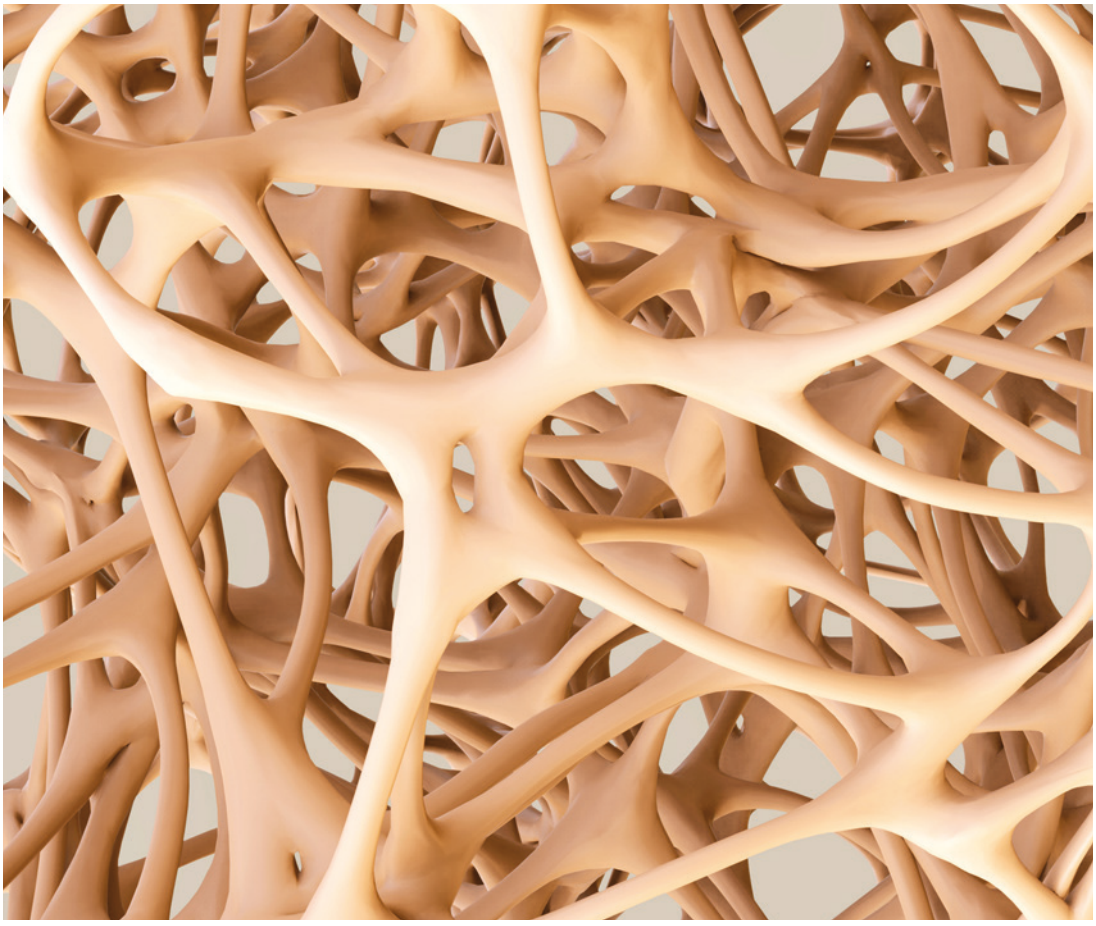
Nutritious by nature

The science behind
the health and nutritional impact
of milk and dairy foods

Bone health

The role of calcium in building and maintaining healthy bones is well established, and dairy foods are recognised as important sources of calcium, supplying up to two thirds of intake in the European diet. However, milk and dairy foods also contain other nutrients needed for bone health including protein, phosphorus and potassium (and vitamin D in the case of fortified dairy). Increasingly, the science indicates that nutrients in the dairy matrix work together to help maintain healthy bones. For example, there is some evidence that milk's calcium may offer longer lasting skeletal benefits than supplements due to its favourable calcium-phosphorus ratio, and that the calcium and protein in dairy have positive interactions on bone health.



Dairy and bone health in children and adolescents

Both observational and intervention studies provide evidence linking dairy consumption with bone health, especially in children and adolescents[1-3]. In children, a meta-analysis of studies investigating the effect of dairy products and dietary calcium (predominantly from dairy) on bone mineral content (BMC) reported that total body and lumbar spine BMC were significantly greater in children with higher intakes[4]. Dairy as part of an overall healthy dietary pattern has also been associated with beneficial effects on bone development[5]. Intervention studies which have specifically used milk or dairy foods are limited compared with those for calcium supplements, but positive effects have been reported; including in French, Finnish and British children[6-8]. For example, significant improvements in bone mineral acquisition compared to control subjects were observed in adolescent British girls who were given 568ml (one pint) of milk a day for 18 months[8]. The corollary is that milk avoidance in children has been associated with increased risk of fracture and poorer bone health[10,11]. In a 2016 position statement on lifestyle choices that promote maximal bone health from childhood through adolescence, the National Osteoporosis Foundation concludes that there is 'good evidence' for a role for dairy consumption (the 'best evidence' is for the positive effects of calcium intake and physical activity)[12]. A number of retrospective studies, although not all, have found that milk consumption in childhood and adolescence is related to better bone health and / or reduced risk of fracture later in life[13]. There are limitations to such studies, however, including accurate recall of childhood milk and dairy intake.

Dairy and bone health in adults

For adults, the majority of observational studies report either a positive association between milk and milk products and BMC or bone mineral density (BMD) or a neutral outcome[1,2]. Again, randomised controlled trials using milk and dairy foods are limited compared with calcium supplementation ones, and longer-term trials and meta-analyses are needed. In such studies the outcome will depend on factors such as the age of the subject, relation to the menopause for women, initial dairy intakes and so on[13]. Intervention studies have, however, reported positive associations between increase in dairy food intake and BMC or BMD, and reductions in bone turnover markers[14,15]. On the whole, there is support for favourable effects of dairy on measures of bone health in adults[3].

Fracture risk

With respect to fracture risk, the effects of dairy are less clear. This may be due to heterogeneity in the study designs, duration, participants' age, and other confounding factors such as vitamin D status and physical activity. A meta-analysis of prospective cohort studies published in 2011, found no overall association between adult milk intake and hip fracture risk in women; insufficient data was available in men[16]. However, the data on women were disproportionately influenced by one study from Sweden; when the authors excluded this study from the analysis there was a marginally significant 5% lower hip fracture risk for each glass of milk consumed per day. A subsequent publication in 2014 utilising data from the same Swedish cohort of 61,000 women but with a longer follow up (around 20 years) found fermented milk products (yogurt and other soured milk products) and cheese consumption were associated with a significant decrease in fracture incidence[17]. However, high intakes of milk (three or more glasses/day; more than 600 ml/day) were associated with increased fracture rate. It is worth noting that when the dietary questionnaires were performed (1987–90 and 1997) milk in Sweden was fortified with high dose of

vitamin A: such levels of vitamin A intake have been linked to an increased risk of fracture. A study of Finnish women has reported that milk avoidance (because of lactose intolerance) was associated with increased fracture risk[18].

No dairy intervention trials on fracture risk are available because of the feasibility of carrying out such a study; however, calcium supplementation trials do exist. A meta-analysis of 17 randomised trials concluded that calcium supplementation (with or without vitamin D) decreases fracture risk by 12% in people aged 50 years and older[19]. The fracture risk reduction was greater (24%) in trials when compliance was high; also in participants older than 70 years and whose daily calcium intake was initially low.

Potential dairy matrix mechanisms

The importance of calcium in bone development and maintenance is well established[1,13]. Milk and milk products make the largest contribution to calcium intake in the European diet. Few other foods naturally contain as much calcium, and dairy sources are some of the most bioavailable[20]. While it is sometimes assumed that supplementation with the same amount of calcium from different sources - e.g. milk, foods fortified with calcium and calcium supplements – have comparable effects on bone health, there is some evidence of a beneficial 'dairy matrix effect'[21]. Dairy foods may have greater benefits than the equivalent calcium in the form of supplements. In adolescent girls, for example, it has been estimated that bone mineral density increases by up to 10% when 700mg extra calcium is provided as dairy foods, compared with an increase of 1% to 5% when the same quantity of calcium is given as a supplement[22]. Similarly, using cheese to increase calcium intake in 10- to 12-year-old Finnish girls resulted in a greater increase in bone mineral density compared to either a calcium supplement or a calcium plus vitamin D supplement[7]. Another randomised controlled trial investigating the effect of dairy products providing 1,200mg calcium a day or an equivalent calcium supplement on markers of bone metabolism and BMD found that after 12 months, the dairy intervention group had greater improvements in pelvis, spine and total BMD than the calcium supplement group[14].

The greater benefits of dairy may be due to the presence of other nutrients in the dairy matrix which are important for bone health such as protein and phosphorus, and their interactions with calcium. Protein is essential for bone development in children and is needed for the maintenance of normal bones in adults since amino acids are required for the synthesis of intracellular and extracellular bone proteins. Older adults consuming a protein-restricted diet are at higher risk for bone loss and fractures, and sufficient protein intake is recommended in guidelines for maintaining skeletal health[23-26]. There has been some controversy around the adverse effects of high protein intakes, but it is now established that although a high-protein diet increases urinary calcium excretion this does not result in a negative skeletal calcium balance, or bone loss[24-28]. Indeed, recent research suggests higher protein intakes are beneficial to bone health, especially when calcium intake is also adequate[29]. For example, in the US Osteoporotic Fractures in Men study, greater intakes of dairy protein were associated with a decreased risk of hip fracture[30]. Similarly, in healthy postmenopausal women, dairy protein intakes were positively associated with measures of bone strength and microstructure[31]. The potential mechanisms for this include protein enhancing calcium balance by stimulating intestinal calcium absorption, both directly and indirectly via an IGF1-vitamin D link. Part of the explanation of the greater effectiveness of dairy calcium versus supplements may also be due to better absorption of calcium because of the presence of lactose and / or casein phosphopeptides in the dairy matrix[7]. Fermented dairy products may additionally enhance calcium absorption through positive alterations in the gut microbiota[32].

In addition to potentially larger effects, it has been suggested that the skeletal benefits of dairy calcium may persist longer than from calcium supplements[25]. In a study of 8-year-old French girls, the benefits of milk-extracted calcium phosphate on bone mass remained 3.5 years post supplementation[4]. This has not been the case after supplementation with calcium salts (such as citrate malate or carbonate). Part of the explanation may lie in the favourable calcium to phosphorus ratio in milk. Phosphorus (as inorganic phosphate) is an important structural component of bone and an adequate intake is necessary for bone growth and development, and the maintenance of normal bones in later life[24]. Although a high intake, if accompanied by low calcium (in a ratio of about 4:1) may be deleterious to bone, the phosphorus to calcium ratio of milk (0.8:1) can enhance calcium balance by stimulating renal tubular reabsorption of calcium and lead to positive effects on bone[33].

Other nutrients in milk and dairy foods are also involved in bone health including magnesium, potassium, vitamin K2 and zinc, as well as vitamin D in fortified dairy[1]. Increasingly, the science indicates that the nutrients in the dairy matrix may work together to help maintain healthy bones. Simply in terms of the quantities of 'bone' nutrients in dairy, however, it has been suggested that it is difficult to devise a diet that is 'bone healthy' without including three servings of dairy a day[1].

Milk nutritious by nature - nutrient richness **- an important part of European dietary guidelines**

Bone health

1. Heaney RP. Dairy and bone health. J Am Coll Nutr. 2009; 28: 82S-90S.

2. Dietary Guidelines Advisory Committee. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. Washington, DC: US Department of Agriculture, Agricultural Research Service; 2010. http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/DGAC/Report/2010DGACReport-camera-ready-Jan11-11.pdf (accessed 11/12/13).

3. Rozenberg S et al. Effects of dairy product consumption on health: benefits and beliefs - a commentary from the Belgian Bone Club and the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases. Calcif Tissue Int. 2016; 98: 1–17.

4. Huncharek M et al. Impact of dairy products and dietary calcium on bone-mineral content in children: results of a meta-analysis. Bone. 2008; 43: 312-321.

5. van den Hooven EH et al. Identification of a dietary pattern prospectively associated with bone mass in Australian young adults. Am J Clin Nutr. 2015; 102: 1035-1043.

6. Bonjour JP et al. Gain in bone mineral mass in prepubertal girls 3½ years after discontinuation of calcium supplementation: a follow-up study. Lancet. 2001; 358: 1208-1212.

7. Cheng S et al. Effects of calcium, dairy product, and vitamin D supplementation on bone mass accrual and body composition in 10–12-y-old girls: a 2-y randomized trial. Am J Clin Nutr. 2005; 82: 1115–1126.

8. Cadogan J et al. Milk intake and bone mineral acquisition in adolescent girls: randomized controlled intervention trial. BMJ. 1997; 315: 1255-1260.

9. Weaver CM. Milk Consumption and Bone Health. JAMA Pediatr. 2014; 168: 12-13.

10. Black RE et al. Children who avoid drinking cow milk have low dietary calcium intakes and poor bone health. Am J Clin Nutr. 2002; 76: 675-680.

11. Goulding A et al. Children who avoid drinking cow's milk are at increased risk for prepubertal bone fractures. J Am Diet Assoc. 2004; 104: 250-253.

12. 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. Osteoporos Int. 2016; 27: 1281-1386.

13. Heaney RP. Calcium, dairy products and osteoporosis. J Am Coll Nutr. 2000; 19: 83S-99S.

14. Manios Y et al. Changes in biochemical indexes of bone metabolism and bone mineral density after a 12-mo dietary intervention program: the Postmenopausal Health Study. Am J Clin Nutr. 2007; 86: 781-789.

15. Moschonis G et al. The effects of a 30-month dietary intervention on bone mineral density: the Postmenopausal Health Study. Br J Nutr. 2010; 104:100-107.

16. Bischoff-Ferrari HA et al. Milk intake and risk of hip fracture in men and women: a meta-analysis of prospective cohort studies. J Bone Miner Res. 2011; 26: 833-839.

17. Michaëlsson K et al. Milk intake and risk of mortality and fractures in women and men: cohort studies. BMJ; 2014 349:g6015

18. Honkanen R et al. Lactose intolerance associated with fractures of weight-bearing bones in Finnish women aged 38-57 years. Bone. 1997; 21: 473-477.

19. Tang BM et al. Use of calcium or calcium in combination with vitamin D supplementation to prevent fractures and bone loss in people aged 50 years and older: a meta-analysis. Lancet. 2007; 370: 657-666.

20. Guéguen L & Pointillart A. The bioavailability of dietary calcium. J Am Coll Nutr. 2000; 19: 119-136.

21. Thorning TK et al. Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. Am J Clin Nutr 2017: 105:1–13.

22. Kerstetter JE. Do dairy products improve bone density in adolescent girls? Nutr Rev. 1995; 53: 328-332.

23. Surdykowski AK et al. Optimizing bone health in older adults: the importance of dietary protein. Aging Health. 2010; 6: 345-357.

24. Bonjour JP. Protein intake and bone health. Int J Vitam Nutr Res. 2011; 81: 134-142.

25. Bonjour JP et al. Dairy in adulthood: from foods to nutrient interactions on bone and skeletal muscle health. J Am Coll Nutr. 2013; 32: 251-263.

26. Rizzoli R et al. The role of dietary protein and vitamin D in maintaining musculoskeletal health in postmenopausal women: A consensus statement from the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO). 2014; Maturitas 17 July 2014:doi: 10.1016/j.maturitas.2014.1007.1005. doi:10.1016/j.maturitas.2014.07.005.

27. Kerstetter, JE et al. Dietary protein and skeletal health: a review of recent human research. Curr Opin Lipidol. 2011; 22:16-20.

28. Fenton TR et al. Causal assessment of dietary acid load and bone disease: a systematic review & meta-analysis applying Hill's epidemiologic criteria for causality. Nutr J. 2011; 10: 41-.64.

29. Mangano KM et al. 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: 69-74.

30. Langsetmo L et al. The association between protein intake by source and osteoporotic fracture in older men: a prospective cohort study. J Bone Miner Res. 2016 Dec 12. doi: 10.1002/jbmr.3058. [Epub ahead of print]

31. Durosier-Izart C et al. Peripheral skeleton bone strength is positively correlated with total and dairy protein intakes in healthy postmenopausal women. Am J Clin Nutr. 2017; doi: 10.3945/ajcn.116.134676

32. McCabe L et al. Prebiotic and probiotic regulation of bone health: role of the intestine and its microbiome. Curr Osteoporos Rep. 2015; 13: 363–371.

33. Bonjour JP. Calcium and phosphate: a duet of ions playing for bone health. J Am Coll Nutr. 2011; 30: 438S-448S.

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September 2017 ref 2383