Should dairy be recommended as part of a healthy vegetarian diet? Point 1–3

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ABSTRACT

A benefit-risk evaluation of the evidence for including dairy foods in the diet is presented. For many persons dairy products provide a substantial portion of essential nutrients, but especially calcium, potassium, and magnesium. Dietary supplement and fortified foods can be alternative sources of these nutrients, although other components of dairy foods such as amino acid composition and conjugated linoleic acid may be instrumental in the benefits associated with dairy product consumption for bone health and reduced risk of stroke, metabolic syndrome, and some cancers. Newer evidence shows that protein-induced calciuria does not have a detrimental effect on net calcium retention, and the concentrations of hormones in milk are not outside of the range of endogenous concentrations. Increased dietary protein, including from milk, can elevate serum concentrations of insulin-like growth factor I, which has an unknown relation to cancer. The concern over consumption of milk leading to increased risk of prostate cancer through reduction of serum 1,25-dihydroxyvitamin D, a potent anti-prostate cancer hormone, has been resolved with new evidence that local production of this hormone is independent of diet. Overall, evidence suggests that being a lactovegetarian has greater health benefits and reduced health risks than being a vegan. Am J Clin Nutr 2009;89(suppl):1634S–7S.

INTRODUCTION

A decision to consume dairy products, as with any food group, can be guided by a benefit-risk analysis. This review considers the merits and concerns of dairy products as foods based on peer-reviewed literature and does not address preferences, beliefs, or other issues such as production practices. The evidence that led to the recommendation of 3 cups (720 mL) of milk and milk products daily by the 2005 Dietary Guidelines for Americans Committee is reviewed. The most touted risks of consuming dairy foods include protein-induced calciuria, the presence of hormones and steroids, increased risk of prostate cancer, and the presence of lactose and saturated fats. Dairy foods void of lactose and fat are widely available; therefore, these issues are not discussed.

BENEFITS

Rich package of nutrients

Milk and milk products are recommended to be consumed daily at amounts of 3 cups milk or the equivalent for most energy needs by the 2005 Dietary Guidelines for Americans (1). The percentage of the requirements set by the Dietary Reference Intakes of the Institute of Medicine provided by 3 cups low-fat milk for women aged 31–50 y is given in Table 1. In the food patterns, milk and milk products contribute >10% of the requirements of many nutrients, including riboflavin, vitamin B-12, vitamin A, thiamin, calcium, phosphorus, magnesium, zinc, potassium, protein, and carbohydrates (1). The nutrients most at risk if milk products are excluded are calcium, potassium, and magnesium. For a woman aged 19–50 y, calcium and magnesium recommendations are met with the food guide pattern in MyPyramid. However, without milk products, only 44% of calcium and 57% of magnesium recommendations are met. For potassium, the proportion of the recommended intakes with milk products is 73% compared with 57% without milk products. MyPyramid is based on minimal changes to the typical American diet in an attempt to achieve nutrient recommendations without exceeding energy needs. An analysis of the National Health and Examination Survey 2001–2002 showed that it is impossible to meet calcium recommendations for adolescents while meeting other nutrient recommendations with a dairy-free diet within the current US dietary pattern (2). Although a number of calcium-fortified foods are available and many with good calcium bioavailability (3), they are not selected in sufficient quantities to correct the calcium shortfall created by excluding dairy products. The calcium-fortified food that most closely matches the nutrient profile of milk is calcium-fortified soymilk (Table 1); this product is now allowed in the special supplemental nutrition program for Women, Infants, and Children (WIC). Calcium bioavailability can be as good as milk depending on how it is manufactured (4). Substitution of 3 cups milk with calcium-fortified soymilk in the food patterns would constitute a substantial deviation from the typical American diet and has not been evaluated for overall health to provide comparable evidence to milk as discussed below. Can fruit and vegetables be increased instead of milk to provide potassium and calcium? One-half cup orange vegetables or fruit only provides 213 mg potassium compared...
Dairy products provide the best package for addressing nutrients limited in the diets of many Americans. Dairy products provide an important source of nutrients for high-risk groups, including low-income Americans. The major programs supported by the federal government, such as the National School Lunch Program, the Child and Adult Care Feeding Program, the Summer Feeding Program, the Food Stamp Program, and WIC benefit from the nutrient profile of dairy foods. Approximately 12% of expenditures under the Food Stamp Program were for dairy foods in 2005 (6).

Of the shortfall nutrients most affected by excluding dairy products from the diet, calcium and potassium deserve additional comment for possible consequences to health. Potassium requirements increased considerably with the 2004 revision of the Dietary Reference Intakes (7). The basis for the increased requirements was the blood pressure-lowering effects detected in >20 trials. Calcium intakes of most populations fall short of the requirements of their respective countries, and this is especially problematic during rapid bone growth (8). Calcium intake explained 12.3% of the variance in calcium retention, almost as much as the effect of race (13.7%) in a metabolic study of black and white adolescent girls (9). Quantifying the effect of a single nutrient on an outcome cannot be determined from observational studies in which so many confounders affecting calcium retention are at play. In the controlled feeding study of Braun et al (9) all other nutrients were constant, and the crossover design accounted for physical activity and season and the contribution of individual variation. In observational studies, race effects are fairly easy to quantify because there is limited confusion for classification, but dietary nutrient estimation is poorly estimated and can vary considerably over time.

Calcium should be consumed in adequate quantities to meet demands for growth and obligatory losses. Approximately 1300 mg Ca/d is needed for a female adolescent to meet the demand for skeletal growth; for losses in urine, sweat, and endogenous secretion; and to adjust for average calcium absorption efficiency (7). The ability to adapt to low calcium intakes is incomplete. In girls, urinary calcium excretion was 66 ± 10 mg/d on a low calcium intake (386 ± 14 mg/d), half of that on the recommended calcium intake (1222 ± 42 mg/d) (10). Nevertheless, calcium absorption increased from 249 ± 29 to 587 ± 35 mg/d, and calcium retention increased from 131 ± 14 to 349 ± 32 mg/d when calcium intake was raised to near recommended amounts. Thus, chronic dietary calcium deficiency eventually depletes bone.

### Dairy and bone health

Dairy products have been positively associated with bone health, largely but not exclusively, because of their calcium content. Calcium comprises one-third of bone mineral content (BMC). Low calcium intake leads to increased bone remodeling and increased risk of hip fracture. At the time the 2005 Dietary Guidelines for Americans Committee reviewed the evidence for a relation between intake of milk products and BMC or bone mineral density, all 7 of the randomized, controlled trials and 25 of the 32 observational studies showed a positive relation in ≥1 skeletal sites (1). A particularly persuasive study reported that low milk consumption during childhood, determined retrospectively, was associated with a doubling of hip fracture in a representative US sample of postmenopausal women (11).

Among the observational studies, less confounding occurs in those that compare milk avoiders with milk consumers within the same population. Such studies are available in both children and adults. In New Zealand children, the fracture risk of milk avoiders was 34.8% compared with 13.0% for matched birth cohorts (12). In ~300 white, Hispanic, and Asian sixth grade girls from 2 states, perceived milk intolerance was inversely related to BMC of several bone sites ($P = 0.009$ for the lumbar spine and trends for total hip, femoral neck, and total body) (13). In that study, measured lactose malabsorption was unrelated to bone because those who did not know they were malabsorbers were not avoiding dairy product consumption. In Finnish adults, fracture incidence from 1980 to 1989 in 11,619 women was found to be associated with lactose intolerance. The risk of lower body fractures excluding ankle was 2 times greater for women claiming lactose intolerance than for women without lactose intolerance (odds ratio: 2.15; 95% CI: 1.53, 3.04) (14).

Another type of useful observational study is one within similar cultures, but dairy husbandry is practiced in one location and not in neighboring locations. Such studies have shown bone benefits to the dairy-consuming regions in Yugoslavia (15) and China (16). Vegetarians who include milk in their diet should not have compromised bone health. However, vegans who exclude dairy products in their diets have higher fracture risk according to data from the European Prospective Investigation into Cancer and Nutrition study (17).

### TABLE 1

<table>
<thead>
<tr>
<th>Nutrients provided by 3 cups low-fat (1%) milk compared with 3 cups calcium-fortified soy milk for women aged 31–50 y¹</th>
<th>Cow milk</th>
<th>Calcium-fortified soy milk</th>
<th>Difference between soy milk and cow milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg)</td>
<td>871 ± 87²</td>
<td>1104 ± 110</td>
<td>233</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>695 ± 99</td>
<td>675 ± 96</td>
<td>−20</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>24.7 ± 54</td>
<td>22.1 ± 48</td>
<td>−2.65</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>1098 ± 23</td>
<td>675 ± 14</td>
<td>−423</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>81 ± 25</td>
<td>117 ± 37</td>
<td>36</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>1.35 ± 123</td>
<td>1.58 ± 144</td>
<td>0.23</td>
</tr>
<tr>
<td>Vitamin D (IU)</td>
<td>380 ± 95</td>
<td>360 ± 90</td>
<td>−20</td>
</tr>
</tbody>
</table>


² Mean ± SD (all such values).
Dairy and other health benefits

Health benefits of dairy consumption beyond bone health considered by the 2005 Dietary Guidelines for Americans Committee included hypertension, insulin resistance syndrome (IRS), and stroke. Important evidence that supported including 3 cups milk or milk products daily came from the Cardia Study, a 10-y longitudinal study of 3,157 black and white adults aged 18–30 y from 4 US cities (18). Each daily serving of dairy products lowered the risk of developing IRS, characterized by obesity, hyperinsulinemia, insulin resistance, and hypertension, by 21%. Best results were achieved with ≥3 servings dairy consumed daily. A prospective study of stroke on 2,403 men aged 20–24 y showed a hazard ratio of 0.64 (95% CI: 0.39, 1.06) with ≥2 cups milk consumed daily and 0.37 (95% CI: 0.15, 0.90) if subjects had a prior vascular event (19).

RISKS

Protein-induced calciuria

Much malignment of milk products as a source of calcium has been directed at the 8 g protein/cup that milk adds to the Western diet, which is already excessive in protein. The concern is linked to protein-induced calciuria that has been associated with bone loss (20). Many studies have confirmed the calciuria effect, but several laboratories have shown that overall calcium retention is unaffected by protein amount or type (21–23). The rich content of aromatic amino acids in milk may make this protein source especially important for enhancing calcium absorption (24). The benefits or risk of dietary protein probably depends on the dietary calcium-to-protein ratio that is comparable between lactovegetarians and omnivores (25).

Hormones

The presence of steroid hormones in milk has been of concern to some. The concentration of 17ß-estradiol in 206 samples of whole cow milk was reported (26). The 17ß-estradiol concentration averaged 1.4 ± 0.2 pg/mL (range: 0–22.9 pg/mL). A 1-cup serving of milk would average ~330 pg and the 3 cups recommended in the food guidance system for most energy requirements would contain <1 ng. To compare against endogenous production of 17ß-estradiol in humans, a prepubertal girl produces ~400 ng/d and an adult woman in late pregnancy is as high as 37.8 mg/d. Thus, the presence of 17ß-estradiol is very low, and skim milk would be even lower. 17ß-estradiol is fat soluble and is consistent with finding a significant correlation of serum 17ß-estradiol with milk fat content (r = 0.20, P < 0.01).

The concentrations of hormones in milk from cows given recombinant bovine somatotropin, a biotech-derived growth hormone, to increase milk production is indistinguishable from concentrations in untreated cows (27). Nevertheless, consumer demand for milk not treated with recombinant bovine somatotropin is increasing which will undoubtedly increase the cost of milk.

Prostate cancer

Although some epidemiologic studies have shown a relation between dairy consumption and prostate cancer risk (28), more recent studies have shown no relation or a reduction of risk with dairy consumption (29, 30) which may vary with fat content (31). Among the proposed mechanisms for a relation between dairy consumption and prostate cancer are the presence of estrogens (discussed earlier), the presence of insulin-like growth factor I (IGF-I), and calcium suppression of 1,25-dihydroxyvitamin D production. Oral IGF-I is not absorbed (32). Increased dietary protein can increase serum IGF-I concentrations (33), but calcium can suppress the production of parathyroid hormone that up-regulates IGF-I synthesis, so the relation of dairy product consumption to cancer risk is unclear. Low calcium intakes lead to falling serum calcium concentrations that lead to activation of vitamin D to restore serum calcium concentrations to normal. 1,25-Dihydroxyvitamin D is associated with decreased proliferation and apoptosis and with protection against prostate cancer. However, local production of 1,25-dihydroxyvitamin D by 1x hydroxylase in the prostate is independent of dietary calcium concentration (34). Furthermore, milk is fortified with vitamin D in the United States and has another chemoprotective constituent, conjugated linoleic acid.

CONCLUSIONS

Milk is the most economical source of many limiting nutrients, especially calcium, potassium, and magnesium. Milk and milk products have protective effects for bone disorders, IRS, and stroke. Observational studies show protective, neutral, and negative effects with various cancers. The main concerns brought against including milk products in the diet lack strong and mechanistic support. Some previous concerns, including protein-induced calciuria and the presence of 17ß-estradiol, have recently been resolved. Vegans have reduced bone mineral density, increased incidence of fracture, and other health risks compared with omnivores or lactovegetarians. [Other articles in this supplement to the Journal include references 35–61. See the article by Lanou (49) for the counterpoint.]

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REFERENCES
