BEEF FACTS: Nutrition

Meat Protein and Calcium Balance

Interactions among certain nutrients influence nutrient bioavailability through their effects on absorption and excretion (1). For this reason, consuming a well-balanced diet is important and dietary recommendations have taken into consideration the known interactions of nutrients (1,2). Nutrient interactions that significantly increase or decrease nutrient bioavailability may lead to adverse health effects (1).

One of the most frequently reported and misunderstood nutrient interactions is that between dietary protein and calcium. Many research reports document that increasing dietary protein intake increases urinary calcium excretion (3-7). This effect of protein has led to the suggestion that intake of high protein foods such as meat increases calcium loss leading to a negative calcium balance and health disorders such as osteoporosis. However, scientific data indicate that consuming meat such as beef as recommended does not adversely affect bone status (8,9). Moreover, meeting protein needs is beneficial to bone health (6,10-13).

Bone Loss and Calcium Balance

Osteoporosis, a bone-thinning disease leading to fractures, affects about 28 million Americans, mostly postmenopausal white women (14). This disease also affects women of other age, racial, and ethnic groups, as well as men and children (14). Bone health is influenced by three major interacting factors: diet, exercise, and estrogen status. Among dietary factors, calcium and vitamin D are *essential*, whereas protein, phosphorus, and sodium are major *interactive*, factors (14). High dietary intakes of these three nutrients can adversely affect calcium balance in individuals with low calcium intakes (14). The goal is to maintain calcium balance by increasing calcium intake or decreasing calcium excretion from the body. Nutrient interactions can have an important influence on calcium balance.

In early studies, which used purified proteins, a positive association between dietary protein intake and calcium loss in the urine was demonstrated. Several groups of investigators have found that each gram of protein metabolized increases urinary calcium by about 1 mg. Therefore, doubling protein intake results in roughly a 50% increase in urinary calcium excretion (1,3,4,6). Protein's effect on urinary calcium excretion is attributed to the associated increase in acid load caused by increased sulfate production from the metabolism of sulfur-containing amino acids (6). Despite the belief by some that animal protein in particular contributes to this acid load and that diets with a high ratio of animal to vegetable protein are harmful to bones (15), scientific evidence fails to support this suggestion (7). On the contrary, substantial evidence supports animal protein's beneficial effect on skeletal health (7).

Effect of Meat's Phosphorus on Calcium Excretion

Because protein is rarely ingested as an isolated nutrient, its interaction with calcium metabolism becomes more complex. Protein is typically consumed as foods, particularly meat and dairy products, which contain other nutrients. Among these other nutrients is phosphorus, a mineral known to *decrease* urinary calcium loss. In fact, studies with high phosphorus diets and with meat diets have demonstrated reduced urinary calcium excretion (4,6,16,17).

Although phosphorus in protein-rich foods blunts the increase in urinary calcium, it also increases the calcium content of digestive secretions, thereby increasing the loss of calcium through the feces (3-5). Because these two effects of phosphorus are approximately equal in magnitude, the same net protein-induced negative calcium balance remains (6).

Protein intake increases urinary calcium loss and does not increase calcium absorption (18), but whether or not a negative calcium balance results depends on dietary calcium intake (1,18). Higher calcium intakes offset the calciuric effects of protein. Thus, when calcium intake is adequate, protein intake does not adversely affect calcium balance (1,7,18).

Dietary Calcium to Protein Ratio

The effect of protein intake on calcium balance is often interpreted as negative, especially in the consumer press. However, this is a classic case of a nutrient-nutrient interaction and should be viewed in terms of the *calcium to protein intake ratio* (4). The calcium:protein ratio of the diet has been found to be more closely related (positively) to rate of bone gain than either calcium intake (positive) or protein intake (negative) alone (19).

Typically, Americans' *protein intakes are above* and their *calcium intakes are well below* recommended dietary intake levels (20-22). Based on current dietary recommendations for calcium (1) and protein (2), a dietary calcium to protein ratio of 16:1 (mg:g) or higher likely provides adequate protection for the skeleton and can be considered optimal for adults (Table 1). However, nutrient intake data from USDA's 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII) (20) reveal that a calcium to protein ratio of about half the optimal ratio is achieved by adults (Table 1). Similar findings are observed from the Third National Health and Nutrition Examination Survey (21,22). Although protein intakes are somewhat higher than recommended, low calcium intake is the real problem (5).

Protein's Positive Effect on Bone

Protein intakes of most adult Americans exceed recommended intake levels (20,21). According to data from the CSFII, females 20 years and older consumed an average of 63 g protein per day (126-137% of the RDA), while males 29 years and older consumed an average of 95 g protein per day (151-164% of the RDA) (20).

Table 1. Optimal vs. Actual Dietary Calcium: Protein Ratio (mg:g) for Adults (1,2,20)

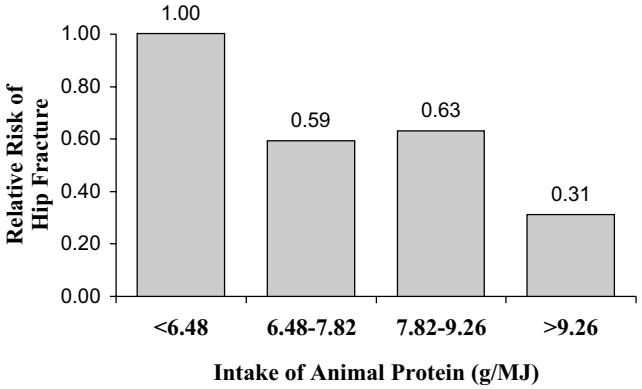
Sex/Age Group	Optimal Calcium: Protein Ratio[1] (mg:g)	Calcium Intake (mg)	Protein Intake (g)	Dietary Calcium: Protein Ratio (mg:g)
Males				
30-39	16	951	102.7	9.3
40-49	16	876	95.3	9.2
50-59	19	791	90.3	8.8
60-69	19	796	83.5	9.5
70+	19	746	72.9	10.2
Females				
30-39	20	661	65.3	10.1
40-49	20	634	63.5	10.0
50-59	24	630	64.1	9.8
60-69	24	604	60.4	10.0
70+	24	584	56.6	10.3

[1]Based on DRI for Calcium (1) and RDA for protein (2).

While excess protein intake is common for the average American, consuming too little protein, especially from animal sources, can increase the risk for weakened bones and osteoporosis (6,10-13). In older adults, protein intake has been found to be positively correlated with bone mineral density and inversely related to rates of bone loss (10-13). A 6-month, randomized, double-blind, placebo-controlled trial of 82 older adults who had suffered a hip fracture found that increasing protein intake decreased loss of leg bone density by 50%, increased blood levels of insulin-like growth factor, which promotes bone gain, and reduced the stay in the rehabilitation hospital by 10 days (11).

In the Iowa Women's Health Study of more than 32,000 women, higher intakes of protein, especially from animal sources, were associated with reduced risk of hip fractures in postmenopausal women (Figure 1) (12). Women with hip fractures consumed less red meat (beef, lamb, pork) than women who did not suffer hip fractures.

Figure 1. Relative Risk of Hip Fracture in Postmenopausal Women According to Quartile of Animal Protein Intake (12)



According to data from 615 older adults participating in the Framingham Osteoporosis Study, those who reported the lowest daily protein intakes lost significantly more bone in the hip and spine four years later than those with the highest intakes of protein, most of which was of animal origin (13).

Evidence to date fails to support the suggestion that intake of protein, including animal protein, is harmful to the skeleton (5,7). On the contrary, evidence indicates just the opposite (7). Protein's beneficial effect on bone may be explained by a protein-induced increase in insulin-like growth factor, which increases bone formation (23).

Meat Diets and Bone Health

Studies indicate that intake of meat does not increase calcium requirements or adversely affect bone status (8,9). In a recent controlled feeding study, healthy postmenopausal women consumed either a low meat (1.5 oz/day) or a high meat (10 oz/day) diet with 700 mg calcium for 8 weeks each (9). Calcium retention, biomarkers of bone formation and bone resorption, as well as urinary calcium excretion did not differ between the two dietary treatments. These findings support those of an earlier metabolic study involving women aged 51 to 70 years who consumed either a high meat (10 oz/day) or low meat (1.5 oz/day) diet for 7 weeks in random order (8). The high meat diet did not adversely affect calcium balance or metabolic markers associated with calcium metabolism (8). Dietary protein in the form of meat may be beneficial to bone health because this food contains other nutrients such as zinc, which is important for bone building (5).

Putting Meat Protein in Perspective

The average American's diet is unbalanced when compared to the recommended servings from the Food Guide Pyramid (24). Meat, which often is perceived as being consumed in excess amounts, is part of the only food group actually eaten in close to recommended amounts. In contrast, major calcium sources (milk group foods and certain vegetables) are underconsumed (24). Also, if one examines the source of protein, meat contributes only 21.2% of the protein available in the U.S. food supply (25). Thus, if total protein were to be reduced, meat is certainly not the source to limit.

Recommendations

For many Americans, maintaining calcium balance is a problem. Protein intake can increase urinary calcium excretion, but no adverse effect on calcium balance or bone health occurs if adequate calcium is consumed. The calciuretic effect of protein is no reason to reduce intake of this nutrient or protein-rich foods such as meat (e.g., beef). In fact, an adequate intake of protein supports bone health. There is no evidence that consuming 2 to 3 servings/day from the Meat Group, as recommended in the Food Guide Pyramid (26), is harmful to bone health.

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