

Protein intake and bone health: the influence of belief systems on the conduct of nutritional science^{1,2}

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It was first shown nearly 80 y ago, and has been confirmed many times since, that ingestion of protein increases urinary calcium excretion. Most such work involved isolated protein feedings, and questions arose as to whether protein-containing foods would exert the same effect. Spencer et al (1) showed that hamburger did not induce a rise in urinary calcium, noting that the phosphorus that commonly accompanies animal protein would tend to offset the protein-related calciuria. However, Spencer et al did not measure endogenous fecal calcium loss, which we showed increases with phosphorus intake; hence, a negative effect of meat on calcium balance still could not be excluded. Indeed, my colleagues at Creighton University and I showed, in free-living middle-aged women who were studied in a metabolic ward and ingested diets matched to their home intakes of protein and phosphorus, that urinary calcium was significantly positively correlated with protein intake and that, accordingly, calcium balance was significantly negatively correlated (2). This study, cited extensively since its publication, contributed to the widespread impression that protein is harmful to bone. It is therefore appropriate that I take this opportunity to revisit our original observations in the context of what is now known about the calcium economy.

A sometimes ignored feature of our study's findings was a positive correlation between calcium intake and calcium balance, ie, higher calcium intakes offset the calciuric effects of protein. The mean calcium intake of the women in our study was ≈ 16.5 mmol/d, substantially below intakes now understood to be necessary for bone health. The aggregate effect of protein on calcium balance at such intakes does, indeed, tend to be negative because, at low calcium intakes, the efficiency of intestinal absorption cannot be increased sufficiently to offset an increase in obligatory calcium loss. In brief, if protein exerts a negative effect, it is only under conditions of low calcium intake.

Since our study was reported, an impressive body of literature has proven that protein tends to have a positive effect on bone overall. Two randomized controlled trials showed that increased protein intake dramatically improved outcomes after hip fracture (3, 4), and subsequent work showed that protein supplements reduce bone loss at the contralateral hip in patients with upper femoral fracture (5, 6). The most likely explanation is a protein-induced increase in insulin-like growth factor I (7), which is known to be osteotrophic.

In parallel with this more or less normal advance of the science, a ferment in the larger society has arisen out of opposition

to the use of animal products. Although only a tiny proportion of the general public or the nutritional science community holds this view, the zeal of these groups and their eagerness to exploit any evidence that suggests harmful effects of animal products have had a disproportionate effect both on public consciousness and on the agenda of nutritional science itself.

Sellmeyer et al (8), in this issue of the Journal, report that individuals consuming diets with high ratios of animal to vegetable protein lost bone more rapidly than did those with lower ratios and had a greater risk of hip fracture. It would be surprising if this study had not been influenced to some extent by currents in the larger society. Although the study was well done and interpreted cautiously, it is virtually certain that it will be used by animal activists to "prove" that animal protein is positively harmful. It may contribute to the dialog to point out here that, on entry into the Sellmeyer study, subjects with the highest ratios of animal to vegetable protein intake had marginally higher bone mineral densities (BMDs) at the hip, not lower BMDs as the hypothesis suggests; after multiple adjustments, there was still not a significantly lower baseline BMD in subjects with high ratios of animal to vegetable protein intake compared with subjects with lower ratios. Moreover, because BMD can be estimated with substantially greater accuracy than can change in BMD, one might have expected, if anything, the opposite, ie, a significant difference at baseline but not an association with bone change. This inconsistency therefore raises significant questions about the generalizability of the findings of this study.


On precisely this same point, Hannan et al (9), using a larger cohort of individuals, this time from the Framingham Study, reported effects opposite those of Sellmeyer et al. Bone loss over a 4-y period was greatest in individuals with the lowest protein intakes and the relation showed a stepwise, inverse gradient of loss as a function of protein intake. Additionally, Hannan et al, also undoubtedly influenced by animal-rights activists, looked at animal protein intakes in their subjects but found no deleterious effect. Indeed, because most of the protein in their subjects' diets

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was of animal origin, the apparent beneficial effect of total protein intake had to have been due to its animal component.

Further evidence of the influence of external pressures on the way nutritional science is conducted is found in the discussion by Sellmeyer et al of the metabolism of sulfur-containing amino acids to sulfuric acid, often cited as an explanation of the “harmful” effects of animal protein. Yet a vegan diet with protein derived equally from grains and legumes would deliver at least as many millimoles of sulfur per gram of protein as would a purely meat-based diet, so the discussion by Sellmeyer et al of this point is at the very least a red herring.

Finally, recent sophisticated analyses of the primitive diet, based on ethnographic studies, analysis of the diets of hunter-gatherer societies, and nitrogen isotope ratios of fossil bone collagen, indicate that human physiology evolved in the context of diets with high amounts of animal protein (10–12). Although caution has been urged in the interpretation of such analyses (13), it remains true that there is certainly no evidence that primitive humans had low intakes of either total protein or animal protein. That, coupled with the generally very robust skeletons of our hominid forbears, makes it difficult to sustain a case, either evidential or deductive, for overall skeletal harm related either to protein intake or to animal protein. Indeed, the balance of the evidence seems to indicate the opposite. 

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