BUILDING AND MAINTAINING STRONG BONES: A CASE FOR BALANCE IN DIETARY MINERAL CONSUMPTION

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Recently, the importance of dietary calcium has increased because research has established that calcium is not only essential for bone growth and development, it is important for regulation of cell function, nerve conduction, muscle contraction, and blood coagulation (Food and Nutrition Board, 1989). In addition, calcium provides a protective role against osteoporosis, essential hypertension, gestational hypertension, hypercholesterolemia, certain cancers (colon and mammary) and possibly gallstones (Miller et al., 1994; Barger-Lux and Heaney, 1994; Moerman et al., 1994). The RDAs for calcium are shown below:

Daily Calcium Intake Recommendations (mg)

Age	1994 NIH Consensus*	1989 RDAs
6-10	800-1,200	800
11-24	1,200-1,500	1,200
25-65/men and 25-50/women	1,000	800
pregnant and lactating women	1,200-1,500	1,200
postmenopausal women on estrogen	1,000	800
postmenopausal women not on estrogen and men over 65	1,500	800

*The amount of dietary calcium recommended by the National Institutes of Health (NIH) is designed to provide the optimal amount of calcium needed at different ages and stages of life.

Several of the population segments mentioned above have low calcium intake. These groups have been targeted for education and now have an increased awareness that calcium is critical, particularly in prevention of osteoporosis. Thus, calcium supplementation and fortification has become increasingly important and calcium is being incorporated into many food products around the world. Calcium supplements/fortificants are usually calcium salts such as calcium citrate, calcium lactate, calcium carbonate, and calcium phosphate.

In spite of the increased awareness of calcium, the dietary intake levels of calcium are still low for some segments of the US population (Hallfrisch and Muller, 1993; Morgan et al., 1985) and for many groups of people throughout the world (Hendrix et al., 1995; Tranquilli et al. 1994).

In the hype that has surrounded calcium supplementation and fortification, one of the basic principles of nutrition, balance, has been neglected and overlooked. If one examines the composition of bone, one finds that bone is comprised of living cells that are embedded in a specialized mineral matrix. The mineral composition of bone is well understood and is shown below:

Mineral	Percentage
Calcium	25%
Phosphorus	12%
Magnesium	0.37%
Potassium	0.7%
Zinc	0.009%
Copper	0.0005%

Obviously, to maintain proper composition of mineral in the bone, there must be adequate absorption and delivery of all bone minerals to bone sites in the human body. The scientific literature is lacking substantial information concerning maintenance of appropriate dietary mineral balances, particularly in relation to bone health.

Phosphorus is required for bone growth and maintenance, but in the US, phosphorus is not an element that is lacking in the diet, in fact, when it occurs in the form of ortho and polyphosphates, it can actually impede the absorption of calcium. Thus most recommendations for phosphorus are to maintain a dietary calcium:phosphorus ratio of 2:1 (even though the RDIs for calcium and phosphorus are equivalent at 1000 mg/day).

There are numerous studies on calcium and bone health, but few concerning the other minerals and required dietary ratios of such minerals. The most disconcerting item was discussed by Seelig (1993). She points out that to compensate for loss of Ca from osteoporotic bones, oral treatment with Ca is common and that the effect of high Ca intakes on Mg requirements or on the importance of Mg in maintaining normal bone matrix is not considered. High dietary Ca/Mg

ratios interfere with Mg absorption, because Ca and Mg share common intestinal absorption pathways (Alcock and MacIntyre, 1962; Heaton and Fourman, 1965). When Ca is elevated with respect to Mg, Ca outcompetes Mg for the absorption pathways and hypomagnesemia (low magnesium in the blood) results. Some early experimental studies (Cunngingham, 1933; Orent et al. 1934, and Watchorn and McCane, 1937) were based on feeding rats diets with high Ca/Mg ratios. Even though vitamin D also was high in these diets, the rat bones became hypermineralized (high calcium in the bone) and the bones became brittle. It is disturbing to note that follow up experiments in humans have not been done, especially given the tendency for segments of the US population, that consumed low Ca and are adjusting with Ca supplementation, also are consuming Mg well below recommended levels (USDA, 1980; Morgan et al., 1985; Abdulla et al., 1989). I again point out that the calcium supplements being consumed are in the form of calcium carbonate, calcium citrate, calcium lactate, and calcium phosphate, none of which contain any magnesium, potassium, zinc and other minerals required for good bone health.

In considering the potential for high dietary Ca and low dietary Mg in some segments of our population, Seelig (1993) says that, “This may be pertinent to the current encouragement of women to consume substantial amounts of Ca; regard is not given to probable low dietary Mg, as indicated by dietary surveys and the inadequate current RDA for Mg.” Hypomagnesemia exhibits other interesting phenomena, that of reducing the absorption of Ca, causing vitamin D to form hormonally inactive metabolites, and impairing the release of parathyroid hormone. Magnesium supplementation will restore activity of vitamin D and parathyroid hormone (Heaton et al., 1964) both of which are involved in bone mineralization processes. Additionally, there is an increased need for magnesium when calcium and estrogen are used to treat osteoporosis (Seelig, 1990). Based on the available data, Celotti and Bignamini (1999) concluded that high daily doses of calcium may be unsafe because of, “an imbalance in the ratio of calcium to magnesium” and they recommend that magnesium be supplemented along with calcium.

Along with recommending higher levels of Ca in the diet, nutrition researchers also are promoting increased levels of vitamin D, magnesium, and potassium (Swaminathan, 1999). Particularly, potassium bicarbonate has been shown to reduce hypertension, prevent formation of kidney stones by suppressing excretion of calcium, and protect against osteoporosis by increasing renal retention of calcium and phosphorus (Morris et al. 1999). Again, the appropriate ratios of minerals for optimal bone health aren’t readily apparent and, even though

research is available showing the importance of these minerals, the information seems to be swallowed up in the wave of calcium research and education.

Just as Ca/Mg/K ratios have received little attention among researchers in the osteoporosis area, ratios of the required micronutrients also have received little attention. The effects of calcium supplementation with and without zinc, copper and manganese showed that bone loss in postmenopausal women could be only partly arrested by Ca supplementation, but to fully maintain bone mass, trace minerals were required (Strause et al., 1994). Further evidence for the importance of trace minerals (Zn and Cu) has been given by Saltman and Strause (1993). One of the markers of osteoporosis is a loss of Zn from bone followed by excretion through the urine (Szathmari et al. 1993). Nonosteoporotic women showed substantially lower excretion levels of Zn.

From the above discussion, I conclude that many minerals are required for optimal bone growth and health, but that the extreme focus on only calcium has, in a sense, inhibited the promotion of a balanced approach for mineral supplementation, particularly for segments of the population that are at risk for osteoporosis.

One mineral supplement that has been widely accepted in Asia and is recognized there as the “premier” bone building supplement is “milk calcium” (more accurately called milk mineral). It has been recently shown by several studies that milk mineral contains, at least as far as we have information, the appropriate balance of minerals for optimal bone health. Milk has long been recognized as providing a great mineral balance for optimal bone health. However, as milk consumption has declined over the last two decades, many people are not getting the “balanced” dietary minerals that milk provides. Milk mineral is an ingredient that retains the mineral balance of milk while allowing for mineral supplementation into products that traditionally do not contain good ratios of bone building minerals. XtraCal is the first such product to be manufactured in the US.

Composition of XtraCal

Component	Percentage
Total Mineral Content	79%
Ash	70%
Calcium	25%
Phosphorus	14%
Ca/P	1.79
Ca/PO4	0.58
Magnesium	1.5%
Sodium	0.65%
Potassium	0.83%
Zn (mg/100g)	27.4
Cu (mg/100g)	0.37
Fe (mg/100g)	1.88
Organic mineral (citrate)	9%
Protein	5%
Fat	1%

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