

Calcium: An Important Macro Mineral For All Age Groups.

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Calcium is the most abundant divalent cation in human body, making up to 1.5-2.0% of its total weight. More than 99% of body calcium is in the skeleton. The remaining 1% is in the blood and extra cellular fluids and within the cells of soft tissues, where it regulates many important metabolic functions. Calcium is responsible for structural functions involving the skeleton and soft tissues and regulatory functions such as neuromuscular transmission of chemical and electrical stimuli, cellular secretions, and blood clotting. The physiological functions of calcium are so vital to survival that in the face of severe dietary deficiency or abnormal losses, the powerful mechanisms of conserving calcium that are possessed by living things, can demineralise bone to prevent even minor hypocalcaemia. Calcium requirements are different for all. The recommended adequate intake level by the IOM for Calcium is:

- 1 -3yrs —500mg/day
- 4 -8yrs —800mg/day
- 9 -18yrs —1300mg/day
- 19-50yrs —1000mg/day
- 51+yrs —1300-1500mg/day

Net calcium absorption can be as high as 60% in infants and young children. Absorption slowly decreases to 15-20% in adulthood and even more as one ages. Because calcium absorption declines with age, recommendations for dietary intake of calcium are higher for adults aged 51 and older. Calcium absorption may be affected by the calcium status of the body, vitamin D status, age, pregnancy, and plant substances in the diet. The amount of calcium consumed at one time such as in a meal can also affect absorption.

Who requires Calcium?

Menopause often leads to increases in bone loss with the most rapid rates of bone loss occurring during the first five years after menopause. Drop in oestrogen production after menopause result in increased bone resorption, and decreased calcium absorption. Annual decreases in bone mass of 3-5% per year are often seen during the years immediately following menopause, with decreases less than 1% per year seen after age.

A medical problem or treatment such as renal failure, surgical removal of the stomach (which significantly decreases calcium absorption), and use of certain types of diuretics (which result in increased loss of calcium and fluid through urine) can cause. Simple dietary calcium deficiency produces no signs at all. Hypocalcaemia can cause numbness and tingling in fingers, muscle cramps, convulsions, lethargy, poor appetite, and mental confusion. It can also result in abnormal heart rhythms and even death. Individuals with medical problems that result in hypocalcaemia should be under a medical doctor's care and receive specific treatment aimed at normalizing calcium levels in the blood.

Calcium helps in weight management too and thus reduces the incidences of obesity. Several studies have linked higher calcium intakes to lower body weights or less weight gain over time. Two explanations have been proposed for how calcium may help to regulate body weight. First, high-calcium intakes may reduce calcium concentrations in fat cells by lowering the production of two hormones (parathyroid hormone and an active form of vitamin D), which in turn increases fat breakdown in these cells and discourages its accumulation. In addition, calcium from food or supplements may bind to small amounts of dietary fat in the digestive tract and prevent its absorption, carrying the fat (and the calories it would otherwise provide) out in the feces.

Calcium prevents Osteoporosis:

Osteoporosis is a disorder characterized by porous, fragile bones. It is a serious public health problem. Osteoporosis is a concern because of its association with fractures of the hip, vertebrae, wrist, pelvis, ribs, and other bones. Each year, Americans suffer from 1.5 million fractures because of osteoporosis. Osteoporosis and osteopenia can result from dietary factors such as:

- chronically low calcium intake
- low vitamin D intake
- poor calcium absorption
- excess calcium excretion

When calcium intake is low or calcium is poorly absorbed, bone breakdown occurs because the body must use the calcium stored in bones to maintain normal biological functions such as nerve and muscle function. Bone loss also occurs as a part of the aging process. A prime example is the loss of bone mass observed in post-menopausal women because of decreased amounts of the hormone estrogen. Researchers have identified many factors that increase the risk for developing osteoporosis. These factors include being female, thin, inactive, of advanced age, cigarette smoking, excessive intake of alcohol, and having a family history of osteoporosis.

Dietary sources of Calcium:

Taking a balanced diet containing large quantities of milk and milk products, soy beans and soy products and vegetables such as kale, broccoli, turnip green and Chinese cabbage will be sufficient to provide adequate calcium as these contain a high level of calcium which is readily available to the body. Although most grains are not high in calcium, they do contribute calcium to the diet.

Tofu is commonly recommended as a good source of calcium. The amount of calcium in Tofu depends on the coagulating agent used to precipitate the soy protein in the process of making tofu. Calcium sulphate and nigari (magnesium chloride) are two commonly used agents. The agent used will be listed on the label under ingredients. Tofu that is prepared with calcium sulphate will contain more calcium than tofu made with nigari. Calcium content will be listed as percent of the Daily Value, multiply the percent Daily Value by 10 will give the amount of calcium (in milligrams) in one serving. For example, tofu with 10% Daily Value for calcium would have 100 mg of calcium in one serving.

Absorption and Regulation of Calcium:

The endocrine system maintains the calcium homeostasis in vertebrates in a very complex manner. It involves the interaction of two polypeptide hormones, parathyroid hormone and calcitonin (CT), and a sterol hormone, 1,25-dihydroxycholecalciferol (calcitriol). In the skin, 7-

dehydrocholesterol is converted by the action of U.V. rays of sunlight to Vitamin D, which further forms calcitriol. The biosynthesis of calcitriol from the major circulating metabolite of vitamin D, 25-hydroxycholecalciferol (calcidiol), takes place in the kidney and is regulated by PTH and CT as well as by concentrations of calcium and phosphate in the extra cellular fluid. Calcitriol increases the uptake of calcium and phosphate by acting on the intestine to increase their absorption and on the bone to increase their mobilization. Parathyroid hormone (PTH), which is released in response to low serum calcium, appears to be the mediator that stimulates the production of calcitriol by the kidney. Thus, it is proposed that a low dietary calcium intake is reflected in lower serum calcium, which in turn affects PTH secretion and a subsequent increase in kidney synthesis of calcitriol.

Calcium is absorbed mainly in the part of duodenum where an acidic medium prevails; consequently absorption is greatly reduced in the lower part of the intestinal tract where the contents are alkaline. However calcium is absorbed only if it is in water-soluble form and is not precipitated by another dietary constituent, such as oxalate.

Factors affecting calcium absorption and excretion:

Phytic acid and oxalic acid, which are found naturally in some plants, may bind to calcium and prevent it from being absorbed optimally. These substances affect the absorption of calcium from the plant itself not the calcium found in other calcium-containing foods eaten at the same time. Examples of foods high in oxalic acid are spinach, collard greens, sweet potatoes, rhubarb, and beans. Cocoa is also high in oxalate; however the amount of cocoa in chocolate milk is not large enough to interfere significantly with calcium absorption. Foods high in phytic acid include whole grain bread, beans, seeds, nuts, grains, and soy isolates. Although soybeans are high in phytic acid, the calcium present in soybeans is still partially absorbed. Fiber, particularly from wheat bran, could also prevent calcium absorption because of its content of phytate. However, the effect of fiber on calcium absorption is more of a concern for individuals with low calcium intakes. In an alkaline medium, calcium with phosphorus forms insoluble calcium phosphate. In individuals with fat malabsorption, calcium absorption decreases because of the formation of calcium fatty acid soaps.

Glucocorticoids decrease calcium absorption. States of glucocorticoid excess are associated with negative calcium balance and a marked increase in fracture risk. In a recent study, oral calcium supplements plus 1,25-dihydroxy vitamin D decreased glucocorticoid-associated bone loss. On the basis of these observations and other studies, oral calcium supplements should be considered in all patients who are receiving exogenous glucocorticoids. The specific disease for which the glucocorticoid therapy is used (e.g., rheumatoid arthritis, inflammatory bowel disease, asthma) can be a determining factor in the occurrence and degree of bone loss.

Calcium insufficiency due to low calcium intake and reduced absorption can translate into an accelerated rate of age-related bone loss in older individuals. Among the homebound elderly and persons residing in long-term care facilities, vitamin D insufficiency has been detected and may contribute to reduced calcium absorption. Calcium intake among women later in the menopause, in the range of 1,500 mg/day, may reduce the rates of bone loss in selected sites of the skeleton such as the femoral neck.

Calcium excretion from the body is affected by many factors including dietary sodium, protein, caffeine and potassium. Typically, dietary sodium and protein increase calcium excretion as the amount of their intake is increased. Increased dietary potassium intake in the presence of a high sodium diet (>5100mg/day) may help decrease the calcium excretion particularly in postmenopausal women. Caffeine has a small effect on calcium absorption; it can temporarily increase calcium excretion and may moderately decrease the calcium absorption. However, 1 cup of coffee or 2 cups of tea per day may have no negative effects on the bones of a young woman who have adequate intake of calcium. Aluminium in the form of antacid medication, when taken in excess, may significantly increase urinary calcium loss.

Alcohol can affect calcium status by reducing the intestinal absorption of calcium. It can also inhibit enzymes in the liver that help convert vitamin D to its active form which in turn reduces calcium absorption. However, the amount of alcohol required to affect calcium absorption is unknown.

Calcium fortified foods and Calcium Supplements:

Although most people know they need dietary calcium for bone health, the actual consumption of calcium rich food is far too low. There is a substantial gap between the RDA of calcium intake and what people actually consume. To counter this disparity a wide variety of calcium fortified foods and beverages are being marketed. Orange juice, juice drinks, cereals, waffles, snack foods, calcium-fortified breads, calcium-fortified soy milk, candy, infant formulas, sports beverages, diet products, dairy foods, water and even pop corns are commonly found to be fortified with calcium. However health professionals recommend giving first priority to foods naturally containing calcium, in meeting calcium needs. Foods naturally containing calcium have high calcium bioavailability and many other essential nutrients, as well as possible other health promoting components, in addition to calcium. Some calcium fortified foods and beverages relate to unknown bioavailability and potentiate negative effects of excessively high calcium diet on other nutrients such as iron, zinc and magnesium.

An enriched insulin formulation developed by Orafit Active Food Ingredients was studied by Baylor college of Medicine in Houston. An 8g/day of product (Raftilose Synergy1) increased calcium absorption by 20%. The ingredient may be used for formulating dairy products such as ice-cream, cheese spreads, yogurt and fluid mil products. In addition it can be easily incorporated into soy products, nutraceutical beverages, bakery product and nutrition bars. In earlier studies, scientists working with Dr. Kendal Hirschi, a plant physiologist at Baylor college of medicine, discovered that turning "on" the product of a protein called CAX1 in the cells of a tiny weed known as *Arabidopsis thaliana* increased the calcium content of the plant's leaf and root cells by 30 to 100 %. Now they have identified a tiny slice of nine amino acids that gives the protein its calcium-boosting prowess, and successfully transferred the slice to similar proteins, called transporters. The researchers believe that these findings are an important step toward the development of vegetable varieties that are "naturally fortified" with calcium.

For some individuals, calcium supplements may be the preferred way to attain optimal calcium intake. In 2002, calcium supplements were the number one selling mineral supplements. Calcium supplements are available as various salts, and most preparations are well absorbed except when manufactured such that they do not disintegrate during oral ingestion. The two main forms of calcium found in supplements are carbonate and citrate. Calcium carbonate is the most common because it is inexpensive and convenient. The absorption of calcium citrate is similar to calcium carbonate. For instance, a calcium carbonate supplement contains 40% calcium while a calcium citrate supplement only contains 21% calcium.

However, you have to take more pills of calcium citrate to get the same amount of calcium as you would get from a calcium carbonate pill since citrate is a larger molecule than carbonate. One advantage of calcium citrate over calcium carbonate is better absorption in those individuals who have decreased stomach acid. Calcium citrate malate is a form of calcium used in the fortification of certain juices and is also well absorbed. Other forms of calcium in supplements or fortified foods include calcium gluconate, lactate, and phosphate.

Absorption of calcium supplements is most efficient at individual doses of 500 mg or less and when taken between meals. Ingesting calcium supplements between meals supports calcium bioavailability, since food may contain certain compounds that reduce calcium absorption (e.g., oxalates). However, absorption of one form of calcium supplementation, calcium carbonate, is impaired in fasted individuals who have an absence of gastric acid. Absorption of calcium carbonate can be improved in these individuals when it is taken with certain food. The potential for calcium supplementation to interfere with iron absorption is an important consideration when it is ingested with meals. Alternatively, calcium supplementation in the form of calcium citrate does not require gastric acid for optimal absorption and thus could be considered in older individuals with reduced gastric acid production. In individuals with adequate gastric acid production, it is preferable to ingest calcium supplements between meals.

Calcium supplements are available without a prescription in a wide range of preparations and strengths, which can make selecting one a confusing experience. Choose calcium supplements with familiar brand names. Look for labels that state “purified” or have the USP (United States Pharmacopoeia) symbol. Avoid calcium from unrefined oyster shell, bone meal, or dolomite without the USP symbol, because it may contain high levels of lead or other toxic metals.

Calcium interactions:

Epidemiological studies suggest that higher dietary calcium is protective against hypercholesteremia, non-insulin dependent diabetes, and colon and rectal cancer. However, extremely high levels of calcium intake have several potential adverse effects. The efficiency of calcium absorption decreases as intake increases, thereby providing a protective mechanism to lessen the chances of calcium intoxication. This adaptive mechanism can, however, be overcome by a calcium intake of greater than approximately 4 g/day. It is well known that calcium toxicity, with high blood calcium levels, severe renal damage, and ectopic calcium deposition (milk-alkali syndrome), can be produced by overuse of calcium carbonate, encountered clinically in the form of antacid abuse. Even at intake levels less than 4 g/day, certain otherwise healthy persons may be more susceptible to developing hypocalcaemia or hypercalcaemia. Likewise, subjects with mild or subclinical illnesses marked by dysregulation of 1,25-dihydroxy vitamin D synthesis (e.g., primary hyperparathyroidism, sarcoidosis) may be at increased risk from higher calcium intakes.

A very high intake of calcium and the presence of high level of vitamin D, which may occur in children receiving supplements, is a potential source of hypocalcaemia. This may lead to excessive calcification in bone and the soft tissues. High intakes of calcium can also interfere with iron absorption. Therefore, when a person needs to consume both as supplements, the iron supplement should be taken at a different time. The same may be true for zinc, because an antagonistic interaction occurs between calcium and zinc when these minerals are ingested in physiologic doses. There is a concern about the use of calcium supplements during pregnancy, when any deficiency of zinc could have serious consequence for the foetus.

Calcium supplements may reduce the absorption of the antibiotic tetracycline. Calcium also interferes with iron absorption. So one should not take a Calcium supplement at the same time as the iron supplement –unless it is calcium citrate. Any medication to be taken on empty stomach should not be taken with Calcium supplements.

It is very important to maintain a balance of calcium since the low levels of calcium can also be equally harmful to health as much as high levels are. Extremely low levels of calcium in the blood may increase the irritability of nerve fibers and nerve centers, resulting in muscle spasms such as leg cramps, a condition known as tetany. It sometimes occurs during pregnancy in women who have consumed too little calcium or too much phosphorus.

In order to achieve healthy bones and maintain overall good health, an individual should take calcium as per the RDA and from natural dietary sources. Also, regular weight bearing exercises such as walking, running or aerobic dance is recommended to promote strong and healthy bones.

References:

1. Krause's Food Nutrition & Diet Therapy
2. Optimal Calcium Intake, NIH. Consensus Statement Online 1994, June 6-8; 12(4); 1-31
3. <http://ods.od.nih.gov/factsheets/vitamind.asp>
4. www.mayoclinic.com/health/calcium/AN01080
5. www.bcm.edu