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REVIEW ARTICLE

Calcium supplementation during pregnancy and lactation: Effects on the mother and the fetus

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Calcium consumption is essential for bone development and maintenance throughout life, yet more than one half of the female population in the United States does not consume the recommended amount of calcium. Calcium intake is especially crucial during pregnancy and lactation because of the potential adverse effect on maternal bone health if maternal calcium stores are depleted. There is often a transient lowered bone mineral density and increased rate of bone resorption, with the greatest consequence during the third trimester and throughout lactation. Studies indicate that calcium consumption should be encouraged, especially during pregnancy and lactation, to replace maternal skeletal calcium stores that are depleted during these periods. Because the fetus in utero and the neonate through breast-feeding are dependent on maternal sources for the total calcium load, adequate maternal calcium intake also can affect fetal bone health positively. Proper calcium consumption can be attained through the diet by the consumption of dairy products or leafy greens (such as kale), the consumption of fortified foods, or by supplementation with widely available calcium-containing supplement products. Because many women experience heartburn during pregnancy, calcium-based antacids are ideal for providing heartburn relief, and they offer a calcium supplement to ensure maternal and fetal bone health, without the danger of adverse effects on the neonate.

Calcium is a critical component of human bone and contributes 1% to 2% of body mass.[1] Calcium is necessary for numerous physiologic functions. Because calcium cannot be manufactured within the body, all needed calcium must be consumed dietarily through the gastrointestinal tract, after which it is transferred to the skeletal system, where 98% of the calcium is stored.[2] In addition to contributing to skeletal strength, calcium stores are concentrated in teeth and bone serve as reservoirs for a variety of physiologic functions during periods of decreased calcium consumption or increased calcium mobilization. As such, when insufficient calcium is consumed to meet these needs, depletion of calcium stores in the bone can weaken the skeletal system.[3] Bone is in a dynamic constructive and destructive balance. This is relevant to both the young and old when this equilibrium is compromised by the stress of gaining or losing bone mass. Increased calcium intake is well-recognized as necessary in perimenopausal women to reduce skeletal weakening and is associated with a decreased

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Table I Dietary calcium sources

Food source	Serving size (oz)	Calcium content per serving (mg)
Low-fat plain yogurt	8	415
Low-fat yogurt with fruit	8	245-384
Sardines	3	324
Cheddar cheese, shredded	1.5	306
Skim milk	8	302
2% Low-fat milk	8	297
Whole milk	8	291
Buttermilk	8	285
Mozzarella, part skim	1.5	275
Tofu, firm	4	205
Orange juice, calcium fortified	6	200-260
Salmon with bones	3	181
Pudding, chocolate w/2% milk	4	153
Cottage cheese 1% milk fat	8	138
Tofu, soft	4	138
Spinach, cooked	4	120
Frozen yogurt, vanilla, soft serve	4	103
Turnip greens, boiled	4	99
Kale, cooked	8	94
Kale, raw	8	90
Ice cream, vanilla	4	85
Bread, white	1	31
Broccoli, raw	4	21

Adapted from the Office of Dietary Supplements, 2004. Available at: http://ods.od.nih.gov/factsheets/calcium.asp.

Table II Calcium Recommendations for Women

Age (years)	Adequate Daily intakes (mg/day)	Mean Daily intake (mg/day)
14-18	1300	793
19-39	1000	797

Adapted from the DRI reports at the USDA Food and Nutrition Information Center, 2004 and Ervin, 2004.

fracture risk, which is a consequence of osteopenia and osteoporosis.[4,5] An inverse correlation also exists between calcium consumption and other ailments, which include colon cancer,[6] thereby making calcium intake important beyond bone health at all stages of life.

The benefits of calcium are well-recognized by the general public. However, turning this high awareness into action has proved difficult, which is exemplified by the fact that less than one half of the female population meets the recommended intake. In fact, studies show that only 16% of women consume the minimum 2 recommended servings of dairy each day (Table I).[7] Ironically, 63.5% of adults who believe that they consume the correct amount of calcium actually consume less than the recommended daily levels,[8] which suggests that education regarding an individual's calcium "state" would be beneficial. Furthermore, at no stage in a woman's life are the recommended intake levels for calcium achieved.[9] As a result, there are important implications during particular life stages (eg, pregnancy, lactation, and menopause).

Important points at which calcium intake is critical are pregnancy and nursing. During pregnancy, the growing fetus receives its total nourishment from maternal sources.[1] The dynamic balance between skeletal calcium storage and fetal nutritional needs can affect the maternal calcium equilibrium adversely. Therefore, if adequate bone has not been built before pregnancy and adequate calcium is not part of the maternal diet, bone can be degraded as calcium is taken from the maternal skeleton.

This maternal calcium deficit during pregnancy and lactation greatly depletes maternal calcium stores as the fetus accumulates 25 to 30 g of calcium over the course of pregnancy.[10] The greatest maternal-fetal calcium transfer occurs during the third trimester.[11] At 20 weeks of gestation, the fetal calcium accretion rate is 50 mg/d and increases to 330 mg/d at 35 weeks.[2] During the postpartum period, a large amount of calcium is transferred to the neonate through nursing, which accounts for approximately 210 mg/d.[1] Fetal calcium needs are met through the extraction of calcium from maternal bone mass, increased intestinal absorption, or decreased renal excretion.[12]

To meet this increased skeletal stress, the Institute of Medicine currently recommends 1000 mg/d of calcium for pregnant and lactating women who are 19 to 50 years old and 1300 mg/d for pregnant and lactating women who are <19 years old.[1] The failure to meet this guideline is highlighted by the fact that only 6% of childbearing women report consuming the recommended daily amount of calcium,[13] with actual daily intakes near 50% to 70% of the recommended intake (Table II).[14-16]

According to the Women Physicians' Health Study, 47% of the 87 pregnant female physicians consumed calcium-containing supplements, compared with only 29% of 1148 nonpregnant 30- to 40-year-old physicians who were surveyed. Also, 36% of the 30- to 40-year-old pregnant physicians averaged >1 calcium supplement each day; only 15% of the 30- to 40-year-old nonpregnant physicians used them with the same frequency.[17] Physicians' personal health practices are of particular interest because they affect their patient care. A direct relationship exists between physicians' personal health behaviors and their ability to motivate patients.[18] Also, physicians who practice a certain behavior, such as calcium supplementation use, are more likely to speak to their patients about the behavior, which increases compliance and awareness.[19]