

Calcium

Physiological Functions

Calcium is a primary structural constituent of the skeleton, but it is also widely distributed in soft tissue where it is involved in neuromuscular, enzymatic, hormonal, and other metabolic activity. The skeleton serves as a reservoir of calcium and other minerals. Labile reserves consist of calcium ions loosely held by electrostatic attraction to bone surface anions. These reserves are in dynamic equilibrium with ionized calcium in plasma. Labile reserves are continuously in flux, declining as tissue demand draws calcium from plasma, and subsequently replenished when calcium becomes available from intestinal absorption. Stable reserves consist of calcium in the mineral matrix of bone. Only when labile reserves are fully depleted will stable reserves be tapped to maintain plasma calcium levels. Release of calcium from stable reserves involves accelerated rates of bone resorption of bone in response to increased osteoclastic activity invoked by parathyroid hormone and vitamin D.

Just 1% of the total body pool of calcium is utilized to support nerve transmission, muscle contraction (including normal heart rhythm), blood clotting, and regulation of enzyme and hormone activities. Membrane calcium transport systems are involved in regulation of cellular osmolarity and peripheral vascular resistance. Additionally, this mineral assists in transport of nutrients and other substances across cell membranes and is required for binding of intrinsic factor to ileal receptors for absorption of vitamin B₁₂.

Factors Affecting Availability

Calcium absorption and bioavailability is influence by numerous factors which are outlined in the table below.

| Increase Absorption | Decrease Absorption |
|---|-----------------------------------|
| Vitamin D | Excess magnesium intake |
| Gastric acid (e.g., consume with foods) | Sedentary or nonambulatory status |
| Acidic foods (e.g., orange juice) | Oxalates (e.g., spinach or cocoa) |
| Weight bearing activity | Tetracycline |
| Poor calcium status | |
| Estrogen | |

Deficiency

Calcium deficiency is not associated with clinical symptoms until extensive bone mass is lost. When skeletal calcium reserves are depleted, minimal stress can promote bone fracture. Since calcium deficiency cannot be detected by clinical symptoms until it is advanced, assessment of calcium balance can provide information about the potential for calcium losses in the early stages when corrective action can be taken to prevent significant loss of skeletal mass. Calcium balance can be ascertained using dietary recall to estimate intake and identification of lifestyle and other factors that are known to influence urinary calcium losses. These factors are summarized in the table below.

| Increase Excretion | Decrease Excretion |
|----------------------------|--------------------|
| High sodium intakes | Vitamin D status |
| High phosphate intakes | Magnesium status |
| Excess alcohol consumption | |
| Cigarette smoking | |
| Low urinary pH | |

Inadequate calcium intakes have also been associated with increased risk of pre-eclampsia, hypertension, and colon cancer.

Toxicity

In individuals who are prone to renal stone formation, excess calcium intake (usually in supplement form at doses 2500 mg/day) may promote development of renal calculi. High calcium intakes may also cause constipation and interfere with absorption of iron and magnesium.

- ❖ *The upper limit of safety for calcium established by the Food and Nutrition Board of the Institute of Medicine is approximately 2,500 mg daily for adults. See table below for age- and gender specific guidelines.*

| Calcium Tolerable Upper Intake Levels | |
|---------------------------------------|--------------|
| Life Stage | Calcium mg/d |
| Infants | |
| 0-6 mo | N/A |
| 7-12 mo | N/A |
| Children | |
| 1-3 y | 2500 |
| 4-8 y | 2500 |
| Males, Females | |
| 9-13 y | 2500 |

| | |
|-----------|------|
| 14-18 y | 2500 |
| 19-70 y | 2500 |
| 70 y | 2500 |
| Pregnancy | |
| ≤ 18 y | 2500 |
| 19-50 y | 2500 |
| Lactation | |
| ≤ 18 y | 2800 |
| 19-50 y | 3000 |

Requirements

The Daily Reference Intakes (DRI) for calcium are shown in the table below.

| Calcium Requirements | |
|-------------------------|---------------|
| Daily Reference Intakes | |
| Life Stage | Calcium mg |
| Infants | |
| 0-6 mo | 210 |
| 7-12 mo | 270 |
| Children | |
| 1-3 y | 500 |
| 4-8 y | 800 |
| Males | |
| 9-13 y | 1300 |
| 14-18 y | 1300 |
| 19-30 y | 1000 |
| 31-50 y | 1000 |
| 51-70 y | 1200 |
| 70 y | 1200 |
| Females | |
| 9-13 y | 1300 |
| 14-18 y | 1300 |
| 19-30 y | 1000 |
| 31-50 y | 1000 |
| 51-70 y | 1200 |
| 70 | 1200 |
| Pregnancy | |
| 18 y | 1300 |
| 19-30 y | 1000 |
| 31-50 y | 1000 |
| Lactation | |
| 18 y | 1300 |
| 19-30 y | 1000 |
| 31-50 y | 1000 |

Dietary Sources

Milk and other dairy products are the richest sources of calcium. Milk is an optimal calcium source because it is also fortified with vitamin D and also provides phosphate or sodium in amounts which favor calcium retention. Calcium-fortified orange juice, tofu and other soybean products, dried beans (pinto, navy, black, red, white), collard or mustard greens, and nuts are good non-dairy sources of dietary calcium. See table below for a detailed listing of dietary calcium sources.

| Dietary Sources of Calcium | |
|-------------------------------------|-------------------------|
| FOOD | Calcium (mg) |
| Yogurt, low fat, with fruit, 1` cup | 448 |
| Salmon, canned, with bones, 3 _ oz | 380 |
| Molasses, blackstrap, 2 Tbl | 350 |
| Milk, skim, 1 cup | 300 |
| Ice milk, soft-serve, 1 cup | 274 |
| Cheese, Swiss, 1 oz | 272 |
| Yogurt, frozen, 1 cup | 240 |
| Sardines, 3.5 oz with bones | 240 |
| Cheese, cheddar, 1 oz | 204 |
| Cheese, cheddar, 1 oz | 204 |
| Ice cream, vanilla, 1 cup | 176 |
| Rhubarb, cooked, _ cup | 174 |
| Cheese, cottage, 2% fat, 1 cup | 155 |
| Spinach, frozen, cooked, _ cup | 140 |
| Tofu, regular, _ cup | 130 |
| Soynuts, _ cup | 119 |
| Collard greens, _ cup cooked | 100 |
| Almonds, _ cup | 92 |
| Ice cream, vanilla, regular, _ cup | 85 |
| Navy or baked beans, _ cup | 64 |
| Mustard greens, _ cup, cooked | 51 |
| Orange, 1 medium | 52 |
| Okra, _ cup cooked | 50 |
| Halibut, baked, 3 oz | 51 |
| Kale, fresh, cooked, _ cup | 47 |

| | |
|------------------------------------|----|
| Broccoli, cooked from fresh, _ cup | 42 |
|------------------------------------|----|