Calcium-HealthProfessional

https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/  
  
  
Calcium  
Fact Sheet for Health Professionals  
  
This is a fact sheet intended for health professionals. For a general overview, see our consumer fact sheet.  
  
Introduction  
Calcium, the most abundant mineral in the body, is found in some foods, added to others, present in some medicines (such as antacids), and available as a dietary supplement.  
  
Calcium makes up much of the structure of bones and teeth and allows normal bodily movement by keeping tissue rigid, strong, and flexible [1]. The small ionized pool of calcium in the circulatory system, extracellular fluid, and various tissues mediates blood vessel contraction and dilation, muscle function, blood clotting, nerve transmission, and hormonal secretion [1,2].  
  
Calcium from foods and dietary supplements is absorbed by both active transport and by passive diffusion across the intestinal mucosa [1,3]. Active transport is responsible for most absorption when calcium intakes are lower, and passive diffusion accounts for an increasing proportion of calcium absorption as intakes rise. Vitamin D is required for calcium to be absorbed in the gut by active transport and to maintain adequate calcium levels in blood [1].  
  
Almost all (98%) calcium in the body is stored in the bones, and the body uses the bones as a reservoir for, and source of, calcium to maintain calcium homeostasis [1]. More than 99% of calcium in the body is in the form of calcium hydroxyapatite, an inorganic matrix of calcium and phosphate that is stored in the bones and teeth [1,4,5]. Unlike teeth, bone undergoes continuous remodeling, with constant resorption and deposition of calcium into new bone [4]. Bone remodeling is required to change bone size during growth, repair damage, maintain serum calcium levels, and provide a source of other minerals [4].  
  
At birth, the body contains about 26 to 30 g calcium. This amount rises quickly after birth, reaching about 1,200 g in women and 1,400 g in men by adulthood [1]. These levels remain constant in men, but they start to drop in women as a result of increases in bone remodeling due to decreased estrogen production at the start of menopause [1].  
  
An inverse relationship exists between calcium intake and absorption. Absorption of calcium from food is about 45% at intakes of 200 mg/day but only 15% when intakes are higher than 2,000 mg/day [6]. Age can also affect absorption of dietary calcium [1,4]. Net absorption of dietary calcium is as high as 60% in infants and young children, who need substantial amounts to build bone, but it decreases to about 25% in adulthood and continues to decline with age [1].  
  
Total calcium levels can be measured in serum or plasma; serum levels are typically 8.8 to 10.4 mg/dL (2.2 to 2.6 mmol/L) in healthy people [1,7]. However, serum levels do not reflect nutritional status because of their tight homeostatic control [4]. Levels of ionized (or free) calcium, the biologically active form, in serum are also used to measure calcium status. The normal range of ionized calcium in healthy people is 4.6 to 5.3 mg/dL (1.15 to 1.33 mmol/L) [7]. Dual x-ray absorptiometry testing of bone mineral density can be used to assess cumulative calcium status over the lifetime because the skeleton stores almost all calcium in the body [3].  
  
Recommended Intakes  
Intake recommendations for calcium and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the National Academies of Sciences, Engineering, and Medicine [1]. DRI is the general term for a set of reference values used for planning and assessing nutrient intakes of healthy people. These values, which vary by age and sex, include the following:  
  
Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97% 98%) healthy individuals; often used to plan nutritionally adequate diets for individuals  
Adequate Intake (AI): Intake at this level is assumed to ensure nutritional adequacy; established when evidence is insufficient to develop an RDA  
Estimated Average Requirement (EAR): Average daily level of intake estimated to meet the requirements of 50% of healthy individuals; usually used to assess the nutrient intakes of groups of people and to plan nutritionally adequate diets for them; can also be used to assess the nutrient intakes of individuals  
Tolerable Upper Intake Level (UL): Maximum daily intake unlikely to cause adverse health effects  
Table 1 lists the current RDAs for calcium [1]. For adults, the main criterion that the FNB used to establish the RDAs was the amount needed to promote bone maintenance and neutral calcium balance. For infants age 0 to 12 months, the FNB established an AI that is equivalent to the mean intake of calcium in healthy, breastfed infants. For children and adolescents, the RDAs are based on intakes associated with bone accumulation and positive calcium balance.  
  
Table 1: Recommended Dietary Allowances (RDAs) for Calcium [1]  
Age Male Female Pregnant Lactating  
0 6 months\* 200 mg 200 mg  
7 12 months\* 260 mg 260 mg  
1 3 years 700 mg 700 mg  
4 8 years 1,000 mg 1,000 mg  
9 13 years 1,300 mg 1,300 mg  
14 18 years 1,300 mg 1,300 mg 1,300 mg 1,300 mg  
19 50 years 1,000 mg 1,000 mg 1,000 mg 1,000 mg  
51 70 years 1,000 mg 1,200 mg  
>70+ years 1,200 mg 1,200 mg  
\*Adequate Intake (AI)  
  
Sources of Calcium  
Food  
Milk, yogurt, and cheese are rich natural sources of calcium [1]. In the United States, approximately 72% of calcium intakes come from dairy products and foods with added dairy ingredients [1]. Nondairy sources include canned sardines and salmon with bones as well as certain vegetables, such as kale, broccoli, and Chinese cabbage (bok choi). Most grains do not have high amounts of calcium unless they are fortified. However, they contribute to calcium intakes, even though they contain small amounts of calcium, because people consume them frequently [1]. Foods fortified with calcium in the United States include many fruit juices and drinks, tofu, and ready-to-eat cereals [1,8]. Calcium citrate malate is a well-absorbed form of calcium used in some fortified juices [3].  
  
Calcium absorption varies by type of food. The absorption of calcium from dairy products and fortified foods is about 30% [1]. Certain compounds in plants (e.g., oxalic acid, phytic acid) can decrease calcium absorption by forming indigestible salts with calcium, decreasing its absorption [3]. As a result, absorption of calcium is only 5% for spinach, whereas it is much higher, at 27%, for milk [3]. In addition to spinach, foods with high levels of oxalic acid include collard greens, sweet potatoes, rhubarb, and beans [1]. The bioavailability of calcium from other plants that do not contain these compounds including broccoli, kale, and cabbage is similar to that of milk, although the amount of calcium per serving is much lower [3]. When people eat many different types of foods, these interactions with oxalic or phytic acid probably have little or no nutritional consequences. Net absorption of dietary calcium is also reduced to a small extent by intakes of caffeine and phosphorus and to a greater extent by low status of vitamin D [9-11].  
  
A variety of foods and their calcium content are listed in Table 2.  
  
Table 2: Calcium Content of Selected Foods [12]  
Food Milligrams (mg)  
per serving Percent DV\*  
Yogurt, plain, low fat, 8 ounces 415 32  
Orange juice, calcium fortified, 1 cup 349 27  
Yogurt, fruit, low fat, 8 ounces 344 27  
Mozzarella, part skim, 1.5 ounces 333 26  
Sardines, canned in oil, with bones, 3 ounces 325 25  
Milk, nonfat, 1 cup\*\* 299 23  
Soymilk, calcium fortified, 1 cup 299 23  
Milk, whole (3.25% milk fat), 1 cup\*\* 276 21  
Tofu, firm, made with calcium sulfate, cup\*\*\* 253 19  
Salmon, pink, canned, solids with bones, 3 ounces 181 14  
Cottage cheese, 1% milk fat, 1 cup 138 11  
Tofu, soft, made with calcium sulfate, cup\*\*\* 138 11  
Soybeans, cooked, cup 131 10  
Breakfast cereals, fortified with 10% of the DV for calcium, 1 serving 130 10  
Spinach, boiled, drained, cup 123 9  
Frozen yogurt, vanilla, soft serve, cup 103 8  
Turnip greens, fresh, boiled, cup 99 8  
Kale, fresh, cooked, 1 cup 94 7  
Chia seeds, 1 tablespoon 76 6  
Chinese cabbage (bok choi), raw, shredded, 1 cup 74 6  
Beans, pinto, canned, drained, cup 54 4  
Tortilla, corn, one, 6 diameter 46 4  
Sour cream, reduced fat, 2 tablespoons 31 2  
Bread, whole wheat, 1 slice 30 2  
Kale, raw, chopped, 1 cup 24 2  
Broccoli, raw, cup 21 2  
Apple, golden delicious, with skin, 1 medium 10 0\* DV = Daily Value. The U.S. Food and Drug Administration (FDA) developed DVs to help consumers compare the nutrient contents of foods and dietary supplements within the context of a total diet. The DV for calcium is 1,300 mg for adults and children age 4 years and older [13]. FDA requires food labels to list calcium content. Foods providing 20% or more of the DV are considered to be high sources of a nutrient, but foods providing lower percentages of the DV also contribute to a healthful diet.  
\*\* Calcium content varies slightly by fat content; the more fat in the food, the less calcium it contains.  
\*\*\* Calcium content is for tofu processed with a calcium salt. Tofu processed with other salts does not provide significant amounts of calcium.  
The U.S. Department of Agriculture s (USDA s) FoodData Centralexternal link disclaimer lists the nutrient content of many foods and provides a comprehensive list of foods containing calcium arranged by nutrient content and by food name.  
  
Dietary supplements  
Calcium is available in many dietary supplements, including multivitamin/mineral products and supplements containing calcium only or calcium plus vitamin D [14]. Amounts of calcium in supplements vary widely; multivitamin/mineral supplements commonly contain about 200 to 300 mg, and common amounts in calcium or calcium plus vitamin D supplements are 500 or 600 mg [14].  
  
The two most common forms of calcium in supplements are calcium carbonate and calcium citrate [1]. In people with low levels of stomach acid, the solubility rate of calcium carbonate is lower, which could reduce the absorption of calcium from calcium carbonate supplements unless they are taken with a meal [3]. Calcium citrate is less dependent on stomach acid for absorption than calcium carbonate, so it can be taken without food [1]. In general, however, absorption of calcium supplements is greater when they are taken with food, regardless of whether the user s gastric acid is low [3]. Other calcium forms in supplements include calcium sulfate, ascorbate, microcrystalline hydroxyapatite, gluconate, lactate, and phosphate [14].  
  
The forms of calcium in supplements contain varying amounts of elemental calcium. For example, calcium carbonate is 40% calcium by weight, whereas calcium citrate is 21% calcium [1]. Elemental calcium is listed in the Supplement Facts panel, so consumers do not need to calculate the amount of calcium supplied by various forms of calcium in supplements.  
  
The percentage of calcium absorbed from supplements, as with that from foods, depends not only on the source of calcium but also on the total amount of elemental calcium consumed at one time; as the amount increases, the percentage absorbed decreases. Absorption from supplements is highest with doses of 500 mg or less [15]. For example, the body absorbs about 36% of a 300 mg calcium dose and 28% of a 1,000 mg dose [16].  
  
Some individuals who take calcium supplements might experience gastrointestinal side effects, including gas, bloating, constipation, or a combination of these symptoms. Calcium carbonate appears to cause more of these side effects than calcium citrate, especially in older adults who have lower levels of stomach acid [1]. Symptoms can be alleviated by switching to a supplement containing a different form of calcium, taking smaller calcium doses more often during the day, or taking the supplement with meals.  
  
Medicines  
Because of its ability to neutralize stomach acid, calcium carbonate is contained in some over-the-counter antacid products, such as Tums and Rolaids. Depending on its strength, each chewable pill or soft chew provides about 270 to 400 mg of calcium [14].  
  
Calcium Intakes and Status  
A substantial proportion of people in the United States consume less than recommended amounts of calcium. An analysis of 2007 2010 data from the National Health and Nutrition Examination Survey (NHANES) found that 49% of children age 4 18 years and 39% of all individuals age 4 and older consume less than the EAR for calcium from foods and supplements [17].  
  
Average daily intakes of calcium from foods and beverages are 1,083 mg for men age 20 and older and 842 mg for women [18]. For children age 2 19, mean daily intakes of calcium from foods and beverages range from 965 to 1,015 mg [18]. Approximately 22% of men, 32% of women, and 4% to 8% of children take a dietary supplement containing calcium [18]. Average daily calcium intakes from both foods and supplements are 1,156 mg for men, 1,009 mg for women, and 968 to 1,020 mg for children [18].  
  
According to 2009 2012 NHANES data, rates of calcium inadequacy (intakes below the EAR) are higher among non-Hispanic Blacks and non-Hispanic Asians (47% 48%) than among Hispanics (30%) and non-Hispanic Whites (24%) in the United States [19]. Poverty is also associated with a higher risk of inadequacy. NHANES data from 2007 to 2014 show that the risk of inadequate calcium intakes (less than 800 to 1,100 mg) is 11.6% higher among adults age 50 and older in households earning less than $20,000 per year than other households [20].  
  
Calcium Deficiency  
Calcium deficiency can reduce bone strength and lead to osteoporosis, which is characterized by fragile bones and an increased risk of falling [1]. Calcium deficiency can also cause rickets in children and other bone disorders in adults, although these disorders are more commonly caused by vitamin D deficiency. In children with rickets, the growth cartilage does not mineralize normally, which can lead to irreversible changes in the skeletal structure [1]. Another effect of chronic calcium deficiency is osteomalacia, or defective bone mineralization and bone softening, which can occur in adults and children [1]. For rickets and osteomalacia, the requirements for calcium and vitamin D appear to be interrelated in that the lower the serum vitamin D level (measured as 25-hydroxyvitamin D [25(OH)D]), the more calcium is needed to prevent these diseases [21].  
  
Hypocalcemia (serum calcium level less than 8.5 mg/dL [2.12 mmol/L] or an ionized calcium level below 4.61 mg/dL [1.15 mmol/L]) is usually a result of a vitamin D or magnesium deficiency, impaired parathyroid hormone production leading to hypoparathyroidism, impaired bone resorption of calcium, critical illness, or use of certain medications (e.g., bisphosphonates, cisplatin, or proton pump inhibitors) [22,23]. Hypocalcemia can be asymptomatic, especially when it is mild or chronic [23]. When signs and symptoms do occur, they can range widely because low serum calcium levels can affect most organs and symptoms [24]. The most common symptom is increased neuromuscular irritability, including perioral numbness, tingling in the hands and feet, and muscle spasms [23]. More severe signs and symptoms can include renal calcification or injury; brain calcification; neurologic symptoms (e.g., depression and bipolar disorder); cataracts; congestive heart failure; paresthesia; seizures; and, in rare cases, coma [22,24].  
  
Groups at Risk of Calcium Inadequacy  
The following groups are among those most likely to need extra calcium.  
  
Postmenopausal women  
Menopause leads to bone loss because decreases in estrogen production reduce calcium absorption and increase urinary calcium loss and calcium resorption from bone [1]. On average, women lose approximately 1% of their bone mineral density (BMD) per year after menopause [25]. Over time, these changes lead to decreased bone mass and fragile bones [1]. About 30% of postmenopausal women in the United States and Europe have osteoporosis, and at least 40% of those with this condition develop at least one fragility fracture (a fracture that occurs after minor trauma, such as a fall from standing height or lower) [26]. The calcium RDA is 1,200 mg for women older than 50 years (vs. 1,000 mg for younger women) to lessen bone loss after menopause [1].  
  
Individuals who avoid dairy products  
People with lactose intolerance, those with an allergy to milk, and those who avoid eating dairy products (including vegans) have a higher risk of inadequate calcium intakes because dairy products are rich sources of calcium [1,27]. Options for increasing calcium intakes in individuals with lactose intolerance include consuming lactose-free or reduced-lactose dairy products, which contain the same amounts of calcium as regular dairy products [1,3]. Those who avoid dairy products because of allergies or for other reasons can obtain calcium from nondairy sources, such as some vegetables (e.g., kale, broccoli, and Chinese cabbage [bok choi]), canned fish with bones, or fortified foods (e.g., fruit juices, breakfast cereals, and tofu) [1]. However, these individuals typically need to eat foods fortified with calcium or take supplements to obtain recommended amounts [28].  
  
Calcium and Health  
This section focuses on six health conditions and diseases in which calcium might play a role: bone health in older adults, cancer, cardiovascular disease (CVD), preeclampsia, weight management, and metabolic syndrome.  
  
Bone health in older adults  
Bone is constantly being remodeled. Declining levels of estrogen in women during menopause and for approximately 5 years afterward lead to rates of bone resorption that are higher than rates of bone formation, resulting in a rapid decrease in bone mass [7]. Over time, postmenopausal women can develop osteoporosis, in which bone strength is compromised because of lower BMD and bone quality [1]. Age-related bone loss can also occur in men and lead to osteoporosis, but fracture risk tends to increase in older men about 5 to 10 years later than in older women [1]. Osteoporosis increases the risk of fractures, especially of the hip, vertebrae, and forearms [1,7].  
  
FDA has approved a health claim for the use of supplements containing calcium and vitamin D to reduce the risk of osteoporosis [29]. However, not all research supports this claim.  
  
Bone mineral density  
In spite of the importance of calcium in bone health, observational evidence is mixed on the link between calcium intakes and measures of bone strength in older adults. Support for such a link comes from an analysis of 2001 2006 NHANES cross-sectional data on 2,904 adults age 60 and older (54.6% women) showing an association between higher dietary calcium intakes and greater lumbar spine BMD, but only in women [30]. In contrast, an analysis of baseline data from a randomized trial in Australia in 1,994 women older than 65 years whose average dietary calcium intake was 886 mg/day found no association between quintile of calcium intake and BMD at any site, even after adjustment for such factors as age, physical activity, height, and weight [31]. Results were similar in 698 of the women who were followed for 6 years, even though mean daily intakes of calcium dropped by an average of 40 mg during this period.  
  
Some but not all clinical trials have found that calcium supplementation can improve bone health in older adults. A post-hoc analysis of data from a double-blind, randomized controlled trial (RCT) of 1,000 mg elemental calcium in the form of calcium carbonate and 400 International Units (IU) (10 microgram [mcg]) vitamin D3 daily or placebo in 36,282 women age 50 79 years enrolled in the Women s Health Initiative (WHI) found that the supplementation did not prevent height loss after a mean follow-up period of 5.9 years [32]. On average, women lost 1.28 mm/year of height in the supplementation group and 1.26 mm/year in the placebo group. However, a 2-year RCT in 500 healthy postmenopausal women showed that daily intakes of 500 ml/day skimmed milk enriched to provide 900 mg calcium and 15 mcg (600 IU) vitamin D led to increased BMD at the femoral neck [33].  
  
Several recent systematic reviews and meta-analyses have found that supplementation with calcium alone or a combination of calcium and vitamin D increases BMD in older adults. For example, a systematic review and meta-analysis included 15 RCTs in postmenopausal women (but did not include the two studies described in the previous paragraph) in 78,206 women, of which 37,412 were in the intervention group and 40,794 were in the control group [34]. Supplementation with both calcium and vitamin D or consumption of dairy products fortified with both nutrients increased total BMD as well as BMD at the lumbar spine, arms, and femoral neck. However, in subgroup analyses, calcium had no effect on femoral neck BMD. Earlier systematic reviews and meta-analyses found a positive relationship between calcium and vitamin D supplementation and increased BMD in older males [35] and between higher calcium intakes from dietary sources or supplements and higher BMD in adults older than 50 [25]. However, whether these BMD increases were clinically significant is not clear.  
  
Fractures  
As with the evidence on the link between increased calcium intakes and reductions in BMD loss, the findings of research on the use of calcium supplementation to prevent fractures in older adults are mixed.  
  
For the most part, the observational evidence does not show that increasing calcium intakes reduces the risk of fractures and falls in older adults. For example, a longitudinal cohort study of 1,490 women age 42 to 52 years at baseline who were followed for 10 12 years found that fracture risk was not significantly different in calcium supplement users (some of whom also took vitamin D supplements) and nonusers, even though supplement use was associated with less BMD loss throughout the study period [36].  
  
Some clinical trial evidence shows that supplements containing a combination of calcium and vitamin D can reduce the risk of fractures in older adults. For example, a meta-analysis of 8 RCTs in 30,970 adults older than 50 years found that 500 to 1,200 mg/day calcium and 400 to 800 IU/day (10 to 20 mcg/day) vitamin D supplementation for 1 to 7 years reduced the risk of total fractures by 15% and hip fractures by 30% [37]. However, findings were negative in another systematic review and meta-analysis that included 14 RCTs of calcium supplementation and 13 trials comparing calcium and vitamin D supplements with hormone therapy, placebo, or no treatment in participants older than 50 years [38]. The results showed that calcium supplementation alone had no effect on risk of hip fracture, and supplementation with both calcium and vitamin D had no effect on risk of hip fracture, nonvertebral fracture, vertebral fracture, or total fracture. Similarly, a systematic review of 11 RCTs in 51,419 adults age 50 and older found that supplementation with vitamin D and calcium for 2 to 7 years had no impact on risk of total fractures or of hip fractures [39].  
  
The U.S. Preventive Services Task Force (USPSTF) concluded with moderate certainty that daily doses of less than 1,000 mg calcium and less than 400 IU (10 mcg) vitamin D do not prevent fractures in postmenopausal women and that the evidence on larger doses of this combination is inadequate to assess the benefits in this population [40]. The USPSTF also determined the evidence on the benefits of calcium supplementation alone or with vitamin D to be inadequate to assess its effect on preventing fractures in men and premenopausal women.  
  
Additional research is needed before conclusions can be drawn about the use of calcium supplements to improve bone health and prevent fractures in older adults.  
  
Cancer  
Calcium might help reduce the risk of cancer, especially in the colon and rectum [1]. However, evidence on the relationship between calcium intakes from foods or supplements and different forms of cancer is inconsistent [4].  
  
All-cancer incidence and mortality  
Most clinical trial evidence does not support a beneficial effect of calcium supplements on cancer incidence. A 4-year study of 1,500 mg calcium and 2,000 IU (50 mcg) vitamin D or placebo daily for 4 years in 2,303 healthy women age 55 years and older showed that supplementation did not reduce the risk of all types of cancer [41]. The large WHI study described above also found no benefit of supplemental calcium and vitamin D on cancer incidence [42]. In addition, a meta-analysis of 10 RCTs that included 10,496 individuals who took supplements containing 500 mg calcium or more (without vitamin D) for a mean of 3.9 years found that calcium supplementation did not change the total cancer risk [43]. However, one large clinical trial did find that calcium supplements reduce cancer risk. In this 4-year trial, by the same investigators as the 4-year trial above, 1,179 women age 55 years or older in Nebraska took 1,400 to 1,500 mg calcium alone; 1,400 to 1,500 mg calcium plus 1,100 IU (27.5 mcg) vitamin D3; or placebo daily. Cancer incidence from all causes was 60% lower in women who took the combination and 47% lower in those who took calcium-only supplements than in the placebo group [44]. Some scientists have questioned these findings because of the lack of statistical power (the studies were designed to detect differences in bone health measures, not cancer incidence), details from the investigators on the study sample, and randomization procedures [45,46].  
  
Observational evidence does not support an association between higher calcium intakes and a lower risk of cancer mortality. An analysis of data on 132,823 participants in the Cancer Prevention Study II Nutrition Cohort, who were followed for an average of 17.5 years, found no association between total dietary and supplemental calcium intakes and risk of cancer-related death or death from lung, colorectal, breast, or prostate cancer in men or women [47]. A systematic review and meta-analysis of 22 observational studies in 2,346,368 participants age 8 and older followed for 4.6 to 28 years also found no association between total dietary and supplemental calcium intake and cancer mortality [48].  
  
Clinical trials have also not shown that supplemental calcium alone or combined with vitamin D has an impact on risk of mortality from all cancers. An RCT in 5,292 adults age 70 years or older (85% women) in the United Kingdom compared the effects of 1,000 mg calcium, 8,000 IU (200 mcg) vitamin D3, both, or placebo for 24 to 62 months [49]. Rates of cancer incidence and cancer mortality did not differ between those who did and those who did not receive calcium supplements. In the WHI trial, 36,282 postmenopausal women were randomly assigned to daily supplementation with a combination of 1,000 mg calcium and 400 IU (10 mcg) vitamin D3 or placebo [42]. After an average of 7 years, risk of cancer mortality did not differ between groups. The meta-analysis of 10 RCTs that included 10,496 individuals described above found no impact of calcium supplementation on cancer mortality rates [43].  
  
Colorectal cancer  
A substantial body of evidence has addressed the role of calcium in preventing colorectal cancer or its precursor, adenomas.  
  
Much but not all of the observational evidence supports a link between higher calcium intakes and lower risk of colorectal cancer. A cohort study in 77,712 adults found that over a mean of 7.8 years, the highest total intake of dietary and supplemental calcium (median of 1,999 mg/day) was associated with a 26% lower risk of colon cancer than the lowest quintile (587 mg/day) but had no association with risk of rectal cancer [50]. In a dose-response meta-analysis of 15 prospective cohort studies in 1,415,597 participants (mean total dietary and supplemental calcium intake 250 to 1,900 mg/day) followed for 3.3 to 16 years, risk of colorectal cancer dropped by 8% with each 300 mg/day increase in total calcium intake [51]. Findings were similar for dietary intakes of calcium in two other meta-analyses [52,53].  
  
In spite of the observational evidence supporting an association between higher calcium intakes and lower colorectal cancer risk, clinical trials investigating calcium supplements for prevention of colorectal cancer or adenomas have had mixed results. A 2013 follow-up study by Cauley and colleagues evaluated outcomes 4.9 years after completion of the 7-year WHI trial of 1,000 mg/day calcium plus 400 IU (10 mcg)/day vitamin D3 or placebo in 36,282 postmenopausal women [54]. Colorectal cancer rates did not differ between groups. Similarly, in a follow-up study an average of 55 months after administration of 1,200 mg/day calcium, 1,000 IU (25 mcg)/day vitamin D3, or both for 3 to 5 years in 1,121 participants, supplements had no effect on risk of recurrent adenomas [55]. However, a systematic review and meta-analysis of four RCTs (not including the 2013 study by Cauley and colleagues) found that daily supplementation with 1,200 to 2,000 mg elemental calcium for 36 to 60 months reduced the likelihood of recurrent adenomas by 11%, although the supplements had no effect on risk of advanced adenomas [56].  
  
Other cancers  
Several observational studies have shown that the risk of prostate cancer might be higher with higher calcium intakes, but possibly only when the calcium comes from dairy foods. In an analysis of data from 2,776 men who participated in the French SU.VI.MAX (Supplementation en Vitamines et Min raux Antioxydants) prospective study and were followed for an average of 7.7 years, prostate cancer risk was higher with higher calcium intakes [57]. The risk was 2.4 times higher in men in the highest quartile of intake (more than 1,081 mg/day) than those with the lowest quartile (less than 725 mg/day). However, in analyses of results for various sources of calcium, only calcium from dairy foods was significantly associated with prostate cancer risk (2.9 times higher in men with intakes greater than 696 mg/day than in those with intakes less than 354 mg/day); calcium intakes from nondairy sources were not significantly associated with prostate cancer risk. In a systematic review and meta-analysis of nine cohort studies in 750,275 men, the risk of prostate cancer was 2% higher for each 400 mg/day increment in total dietary and supplemental calcium intake, but nondairy and supplemental calcium intakes were not associated with prostate cancer risk [58].  
  
A meta-analysis included 15 epidemiological studies of calcium intake and ovarian cancer risk in 493,415 women who developed 7,453 cases of ovarian cancer [59]. In this meta-analysis, ovarian cancer risk was 20% lower in participants in the highest category of dietary calcium intakes (more than 820 1,500 mg/day, depending on the study) than the lowest intake category (less than 362 800 mg/day, depending on the study). However, the difference in risk was not statistically significant when both dietary and supplemental calcium intakes were considered.  
  
For breast cancer, observational studies have had mixed findings on whether higher calcium intakes are associated with a lower risk. A meta-analysis of 11 prospective cohort studies in 872,895 women who developed 26,606 cases of breast cancer over 7 to 25 years found that women with the highest calcium intakes had an 8% lower risk of breast cancer [60]. However, the WHI (described above) found similar incidence rates of invasive breast cancer in the supplement and placebo groups [61].  
  
Conclusion  
Additional well-designed randomized trials are needed to determine whether dietary or supplemental calcium intakes increase, decrease, or have no effect on risk of cancer in general or of specific types of cancer, or on cancer mortality.  
  
Cardiovascular disease  
Calcium binds fatty acids, so it can reduce lipid absorption and might therefore lower CVD risk [1,4]. However, the findings from research on the role of dietary calcium and calcium supplements in reducing CVD have been mixed, and some evidence indicates that calcium supplements might even increase CVD risk.  
  
Several large observational studies have shown an association between lower calcium intakes and higher risk of hypertension, stroke, and atherosclerosis. For example, an analysis of 1999 2010 NHANES data from 14,408 adults (mean age 54 years) with obesity found that calcium intakes were 10% lower in adults with obesity and hypertension than in those without hypertension [62]. This association was strongest in women, adults age 20 44 years, those who did not have diabetes, and especially women age 20 44 years. A prospective cohort study that followed 41,514 adults age 40 to 69 years in Australia for 13 years found a 25% lower rate of stroke in adults in the highest calcium intake quartile (mean of 1,076 mg/day) than in the lowest quartile (mean of 641 mg/day) [63]. However, the study found no association between calcium intakes and risk of CVD mortality or myocardial infarction. The risk of atherosclerosis over 10 years in a study of 5,448 adults age 45 84 years was 27% lower in the highest quintile of calcium intake (mean of 2,157 mg/day) than in the lowest quintile (mean of 313 mg/day) [64]. Furthermore, a systematic review and meta-analysis that included 27 observational studies found no consistent dose-response relationships between total, dietary, or supplemental calcium intakes and CVD mortality [65]. Evidence on dose-response relationships between calcium intakes and risk of stroke or stroke mortality was inconsistent.  
  
A diet containing more calcium than the typical U.S. diet because of added low-fat or nonfat dairy products lowered systolic blood pressure by an average of 5.5 mmHg and diastolic blood pressure by 3.0 mmHg [66]. However, this Dietary Approaches to Stop Hypertension (DASH) diet also increases intakes of other nutrients, such as potassium and magnesium, that are associated with reductions in blood pressure, so any independent contribution of calcium cannot be determined.  
  
Some clinical trials have shown that calcium supplements are associated with decreased hypertension risk or decreased cholesterol levels, but others have had more mixed findings. A Cochrane Review of 16 trials in 3,048 adults with a median follow-up period of 3.5 months found that calcium supplementation (typically 1,000 to 2,000 mg/day) reduced systolic blood pressure by 1.43 mmHg and diastolic blood pressure by 0.98 mmHg [67]. Effects were greatest in adults younger than 35 years and with doses higher than 1,500 mg/day calcium. A meta-analysis of 23 RCTs in 4,071 participants showed that calcium supplements providing 162 to 2,000 mg/day (combined with vitamin D in 10 RCTs) for 2 weeks to 5 years was associated with low-density lipoprotein cholesterol levels that were 4.6 mg/dL lower and high-density lipoprotein cholesterol levels that were 1.9 mg/dL higher [68].  
  
Findings were mixed in two analyses of data from the WHI. One analysis of results from 35,983 women age 50 to 79 years randomly assigned to 1,000 mg/day calcium and 400 IU (10 mcg)/day vitamin D supplements or placebo for 10 years found no reduction in risk of heart failure [69]. However, the calcium and vitamin D supplements were associated with 5% lower heart failure risk in participants who had no pre-existing heart failure risk factors (coronary heart disease, diabetes, or hypertension). In another secondary analysis of data on 16,801 WHI participants, the supplements had no association with atrial fibrillation risk [70]. Similarly, an evidence report and systematic review conducted for the USPSTF that included 11 RCTs of vitamin D, calcium, or both for 2 to 7 years in 51,419 adults age 50 years and older found that supplementation with vitamin D alone or combined with calcium had no effect on CVD incidence [39].  
  
In contrast, several prospective cohort studies and RCTs have shown that calcium supplements increase the risk of CVD. A meta-analysis of 14 RCTs (including one study that administered supplements providing 20 mcg [800 IU] vitamin D per day) in 28,935 healthy postmenopausal women found that calcium supplements providing 500 to 2,000 mg/day calcium for 1 to 7 years increased CVD risk by 15% and coronary heart disease risk by 16% [71]. In addition, when 132,823 adults (mean age 63 years) were followed for an average of 17.5 years, the risk of CVD mortality was 22% higher in men with calcium supplement intakes of 1,000 mg/day or more than in those not taking calcium supplements [47]. However, in women, the CVD mortality rate was 16% lower with supplemental calcium intakes of 1,000 mg/day than with no supplemental calcium intakes.  
  
Other studies have found no association between calcium supplements and CVD risk or CVD outcomes. After 24 years of follow-up of 74,245 women age 30 to 55 years at baseline who participated in the Nurses Health Study, women taking more than 1,000 mg/day calcium supplements did not have a higher risk of CVD than those taking no supplemental calcium [72].  
  
An expert panel convened by the National Osteoporosis Foundation and American Society for Preventive Cardiology determined, on the basis of moderate-quality evidence, that calcium intakes with or without vitamin D from foods or supplements neither increase nor decrease the risk of CVD or CVD mortality [73]. The societies therefore concluded that calcium intakes that do not exceed the UL are safe from a cardiovascular standpoint.   
  
Preeclampsia  
Preeclampsia is defined as hypertension and proteinuria or thrombocytopenia during pregnancy, usually after 20 weeks gestation [74]. It is a leading cause of maternal and neonatal morbidity and mortality that affects about 4% of pregnancies in the United States [75].  
  
Calcium supplementation during pregnancy might reduce the risk of preeclampsia, but the benefits might apply only to women with inadequate calcium intakes, and much of this evidence comes from studies with methodological weaknesses [76,77].  
  
A Cochrane Review included 27 RCTs of calcium supplements during pregnancy in 18,064 women to prevent hypertensive disorders and related problems [78]. In the 13 studies none of which administered vitamin D supplements that evaluated high doses (at least 1,000 mg/day calcium) in 15,730 women, supplementation reduced the risk of high blood pressure by 35% and, in women with low dietary calcium intakes (less than 900 mg/day; 8 trials in 10,678 women), the risk of preeclampsia by 64%. However, the quality of this evidence was low. In 12 trials in 2,334 women, doses of less than 1,000 mg/day (usually 500 mg/day) reduced the risk of high blood pressure by 47% and of preeclampsia by 62%. However, most of these studies recruited women at high risk of preeclampsia and had a high risk of bias. An earlier systematic review and meta-analysis of 10 RCTs in 24,787 women also found that calcium supplementation (1,500 to 2,000 mg/day) reduced the risk of preeclampsia by 38% and, in women at increased risk of any hypertensive disorder of pregnancy, by 64% [79]. However, when the analysis was restricted to trials with 4,000 or more women, the effect was no longer statistically significant. An RCT in 1,355 women in Argentina, South Africa, and Zimbabwe also found that 500 mg/day calcium supplementation starting before conception made no difference in the risk of preeclampsia [80,81].  
  
Several professional organizations recommend calcium supplements during pregnancy for women with low calcium intakes to reduce the risk of preeclampsia. For example, the American College of Obstetrics and Gynecology states that daily supplementation with 1,500 2,000 mg calcium might reduce the severity of preeclampsia in pregnant women who have calcium intakes of less than 600 mg/day [76]. The World Health Organization recommends 1,500 2,000 mg/day calcium for pregnant women with low dietary calcium intakes to reduce preeclampsia risk [82]. The Canadian Hypertensive Disorders of Pregnancy Working Group [83], the International Society for the Study of Hypertension in Pregnancy [84], and the Society of Obstetric Medicine of Australia and New Zealand [85] have similar recommendations.  
  
Weight management  
Observational and clinical trial evidence linking higher calcium intakes from dairy products or supplements to lower body weight or less weight gain over time is mixed.  
  
An observational study found an association between higher calcium intakes and lower prevalence of overweight or obesity in 6,696 children (51% male, mean age 6 years) in eight European countries, of whom 2,744 were re-examined 6 years later [86]. The prevalence of overweight or obesity at 6-year follow-up was lower in boys (16%) and girls (18%) in the highest tertile of calcium intake (664 mg/1,000 kcal for boys and 667 mg/1,000 kcal for girls) than in boys (26%) and girls (25%) in the lowest tertile (249 mg/1,000 kcal for both boys and girls). In contrast, a longitudinal study in 2,159 participants in Portugal evaluated at ages 13 and 21 years found no association between total dietary and supplemental calcium intake at age 13 and body mass index (BMI) at age 21 after the analysis was adjusted for energy intake [87]. The study also found no associations between consumption of dairy foods (milk, yogurt, and cheese) at age 13 and BMI at age 21.  
  
Clinical trials and meta-analyses of RCTs assessing the impact of calcium supplements or increased intakes of calcium from dairy products on prevention of weight gain or promotion of fat loss or weight loss have had mixed results [88-92]. For example, postmenopausal women who took 1,000 mg calcium and 400 IU (10 mcg) vitamin D daily for 3 years in the WHI whose daily intakes were less than 1,200 mg calcium at baseline were 11% less likely to gain 1 kg of weight or more than those who took placebo during this period [90]. A systematic review and meta-analysis of 41 RCTs that examined the effect of dairy foods or calcium supplements (at least 300 mg/day) in 4,802 adults found that higher calcium intakes from dairy foods had no impact on body weight or body fat, although they did reduce body fat when combined with an energy-restricted diet [91]. In addition, calcium supplements had no effect on body weight or body fat.  
  
For additional information on calcium and weight management, see the health professional fact sheet on weight loss.  
  
Metabolic syndrome  
Metabolic syndrome is a set of at least three risk factors for heart disease, stroke, and diabetes large waistline, high triglyceride level, low high-density lipoprotein cholesterol level, high blood pressure, and high fasting blood sugar level. Some observational evidence links higher calcium intakes with lower risk of metabolic syndrome.  
  
An analysis of 2001 2010 NHANES data on 9,148 adults found that women in the highest quintile (at least 1,172 mg/day) of calcium intake, based on 24-hour recall, had a 27% lower risk of metabolic syndrome than those in the lowest quintile (less than 547 mg/day) [93]. Furthermore, women who met the RDA for calcium for adults (1,000 to 1,200 mg/day, depending on age) had an 18% lower risk of metabolic syndrome, but the association was not statistically significant in men who met the RDA for calcium. In a meta-analysis of eight cross-sectional studies and two prospective cohort studies in 63,017 participants age 20 years and older, 14,906 participants developed metabolic syndrome [94]. For each 300 mg/day increase in dietary calcium intake, risk of metabolic syndrome dropped by 7%. Subgroup analyses suggested that the inverse association between dietary calcium intakes and metabolic syndrome risk was stronger in women than men.  
  
Clinical trial evidence on the link between calcium and metabolic syndrome is very limited. In one placebo-controlled clinical trial in Iran in 66 adults who were overweight and had type 2 diabetes and coronary heart disease, supplements of 5 mcg (200 IU) vitamin D, 90 mcg vitamin K, and 500 mg calcium for 12 weeks significantly reduced maximum levels of left carotid intima media thickness and improved metabolic status (including improvements in insulin resistance, insulin concentrations, beta-cell function, and quantitative insulin sensitivity check index) [95].  
  
More evidence, including from well-designed clinical trials, is needed to determine whether higher intakes of calcium can reduce the risk of metabolic syndrome.  
  
Health Risks from Excessive Calcium  
Hypercalcemia (serum levels greater than 10.5 mg/dL [2.63 mmol/L]) and hypercalciuria (urinary calcium levels higher than 250 mg/day in women and 275 mg/day in men) are rare in healthy people and usually result from cancer, primary hyperparathyroidism, and other conditions [1,4]. Hypercalcemia and hypercalciuria can cause poor muscle tone, renal insufficiency, hypophosphatemia, constipation, nausea, weight loss, fatigue, polyuria, heart arrhythmias, and a higher risk of CVD mortality [1,4,48].  
  
High calcium intakes might also increase the risk of CVD (see section on CVD in Calcium and Health section above) [39,62,67,69,70] and prostate cancer (see Other Cancers in Calcium and Health section above for more details) [57,58], although not all studies confirm these findings.  
  
The ULs for calcium established by the FNB are listed in Table 3. They are based on observational evidence from the WHI showing a link between higher intakes of supplemental calcium (1,000 mg/day for 7 years) and a greater risk of kidney stones [96,97]. However, two subsequent systematic reviews of the evidence from 10 studies in more than 8,000 adults with osteoporosis who took 120 to 1,500 mg supplemental calcium daily for 3 days to 3 years [98] and 11 RCTs in 51,419 adults 50 years and older who took 1,000 to 1,600 mg calcium with or without vitamin D for 2 to 7 years [39] found no such association.  
  
Table 3: Tolerable Upper Intake Levels (ULs) for Calcium [1]  
Age Male Female Pregnant Lactating  
0 6 months 1,000 mg 1,000 mg  
7 12 months 1,500 mg 1,500 mg  
1 8 years 2,500 mg 2,500 mg  
9 18 years 3,000 mg 3,000 mg 3,000 mg 3,000 mg  
19 50 years 2,500 mg 2,500 mg 2,500 mg 2,500 mg  
51+ years 2,000 mg 2,000 mg  
Interactions with Medications  
Calcium has the potential to interact with certain medications, and several types of medications might adversely affect calcium levels. A few examples are provided below. Individuals taking these and other medications on a regular basis should discuss their calcium status with their health care providers.  
  
Dolutegravir  
Dolutegravir (Dovato, Tivicay) is an HIV integrase inhibitor used in adults and children. Concomitant use of calcium supplements and dolutegravir can reduce blood levels of dolutegravir substantially, apparently through chelation [99,100]. The labels approved by the FDA for dolutegravir advise patients to take dolutegravir 2 hours before or 6 hours after taking calcium supplements [101,102].  
  
Levothyroxine  
Calcium carbonate supplements can interfere with the absorption of levothyroxine (Synthroid, Levoxyl, and others), a thyroid hormone used to treat hypothyroidism and thyroid cancer [103-105]. The FDA-approved label for this medication instructs patients taking calcium carbonate supplements to avoid taking levothyroxine within 4 hours of taking the supplement [106].  
  
Lithium  
Long-term use of lithium (Eskalith, Lithobid), a treatment for bipolar disorder, can lead to hypercalcemia, and use of both lithium and calcium supplements could increase this risk [107].  
  
Quinolone antibiotics  
Simultaneous use of calcium supplements and quinolone antibiotics such as ciprofloxacin (Cipro), gemifloxacin (Factive), and moxifloxacin (Avelox) can reduce the absorption of quinolones [108,109]. Taking the antibiotic 2 hours before or 2 hours after calcium supplements prevents this effect [108].  
  
Calcium and Healthful Diets  
The federal government s 2020 2025 Dietary Guidelines for Americans notes that Because foods provide an array of nutrients and other components that have benefits for health, nutritional needs should be met primarily through foods. In some cases, fortified foods and dietary supplements are useful when it is not possible otherwise to meet needs for one or more nutrients (e.g., during specific life stages such as pregnancy).  
  
For more information about building a healthy dietary pattern, refer to the Dietary Guidelines for Americansexternal link disclaimer and the USDA s MyPlateexternal link disclaimer.  
  
The Dietary Guidelines for Americans describes a healthy eating pattern as one that  
  
Includes a variety of vegetables, fruits, whole grains, fat-free or low-fat milk and milk products, and oils.  
Many dairy products, such as milk, cheese, and yogurt, are rich sources of calcium. Some vegetables provide significant amounts of calcium, as do some fortified cereals and juices.  
Includes a variety of protein foods, including seafood, lean meats and poultry, eggs, legumes (beans and peas), nuts, seeds, and soy products.  
Tofu made with calcium salts is a good source of calcium (check the label), as are canned sardines and canned salmon with edible bones.  
Limits foods and beverages higher in added sugars, saturated fat, and sodium.  
Limits alcoholic beverages.  
Stays within your daily calorie needs.  
References  
Institute of Medicine. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: The National Academies Press; 2011.  
Heaney RP. Calcium. In: Coates PM, Betz JM, Blackman MR, et al., eds. Encyclopedia of Dietary Supplements. 2nd ed. London and New York: Informa Healthcare; 2010:101-6.  
Weaver CM, Heaney RP. Calcium. In: Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR, eds. Modern Nutrition in Health and Disease. 11th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2014:133-49.  
Weaver CM. Calcium. In: Marriott BP, Birt DF, Stallings VA, Yates AA, eds. Present Knowledge in Nutrition. 11th ed. Cambridge, Massachusetts: Wiley-Blackwell; 2020:321-48.  
Wawrzyniak N, Suliburska J. Nutritional and health factors affecting the bioavailability of calcium: a narrative review. Nutr Rev 2021. [PubMed abstract]  
Fairweather-Tait SJ, Teucher B. Iron and calcium bioavailability of fortified foods and dietary supplements. Nutr Rev 2002;60:360-7. [PubMed abstract]  
Song L. Calcium and bone metabolism indices. Adv Clin Chem 2017;82:1-46. [PubMed abstract]  
Cormick G, Betr n AP, Metz F, Palacios C, Beltr n-Velazquez F, Garc a-Casal MLN, et al. Regulatory and policy-related aspects of calcium fortification of foods. Implications for implementing national strategies of calcium fortification. Nutrients 2020;12. [PubMed abstract]  
Wongdee K, Rodrat M, Teerapornpuntakit J, Krishnamra N, Charoenphandhu N. Factors inhibiting intestinal calcium absorption: hormones and luminal factors that prevent excessive calcium uptake. J Physiol Sci 2019;69:683-96. [PubMed abstract]  
Wikoff D, Welsh BT, Henderson R, Brorby GP, Britt J, Myers E, et al. Systematic review of the potential adverse effects of caffeine consumption in healthy adults, pregnant women, adolescents, and children. Food Chem Toxicol 2017;109:585-648. [PubMed abstract]  
Gallagher JC, Yalamanchili V, Smith LM. The effect of vitamin D on calcium absorption in older women. J Clin Endocrinol Metab 2012;97:3550-6. [PubMed abstract]  
U.S. Department of Agriculture. FoodData Centralexternal link disclaimer. 2021.  
U.S. Food and Drug Administration. Food Labeling: Revision of the Nutrition and Supplement Facts Labelsexternal link disclaimer. 2016.  
Office of Dietary Supplements, National Institutes of Health. Dietary Supplement Label Database. 2021.  
Institute of Medicine SCotSEoDR, Intakes,. Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. Washington, DC: National Academies Press; 1997.  
Heaney RP, Dowell MS, Barger-Lux MJ. Absorption of calcium as the carbonate and citrate salts, with some observations on method. Osteoporos Int 1999;9:19-23. [PubMed abstract]  
Wallace TC, McBurney M, Fulgoni VL, 3rd. Multivitamin/mineral supplement contribution to micronutrient intakes in the United States, 2007-2010. J Am Coll Nutr 2014;33:94-102. [PubMed abstract]  
U.S. Department of Agriculture, Agricultural Research Service. What We Eat in America, 2017-2018external link disclaimer. 2020.  
Blumberg JB, Frei B, Fulgoni VL, III, Weaver CM, Zeisel SH. Contribution of dietary supplements to nutritional adequacy in race/ethnic population subgroups in the United States. Nutrients 2017;9. [PubMed abstract]  
Marshall K, Teo L, Shanahan C, Legette L, Mitmesser SH. Inadequate calcium and vitamin D intake and osteoporosis risk in older Americans living in poverty with food insecurities. PLoS One 2020;15:e0235042. [PubMed abstract]  
Sempos CT, Durazo-Arvizu RA, Fischer PR, Munns CF, Pettifor JM, Thacher TD. Serum 25-hydroxyvitamin D requirements to prevent nutritional rickets in Nigerian children on a low-calcium diet a multivariable renanalysis. Am J Clin Nutr 2021;114:231-7. [PubMed abstract]  
Fong J, Khan A. Hypocalcemia: updates in diagnosis and management for primary care. Can Fam Physician 2012;58:158-62. [PubMed abstract]  
Bove-Fenderson E, Mannstadt M. Hypocalcemic disorders. Best Pract Res Clin Endocrinol Metab 2018;32:639-56. [PubMed abstract]  
Pepe J, Colangelo L, Biamonte F, Sonato C, Danese VC, Cecchetti V, et al. Diagnosis and management of hypocalcemia. Endocrine 2020;69:485-95. [PubMed abstract]  
Tai V, Leung W, Grey A, Reid IR, Bolland MJ. Calcium intake and bone mineral density: systematic review and meta-analysis. BMJ 2015;351:h4183. [PubMed abstract]  
Cano A, Chedraui P, Goulis DG, Lopes P, Mishra G, Mueck A, et al. Calcium in the prevention of postmenopausal osteoporosis: EMAS clinical guide. Maturitas 2018;107:7-12. [PubMed abstract]  
Boaventura RM, Mendonca RB, Fonseca FA, Mallozi M, Souza FS, Sarni ROS. Nutritional status and food intake of children with cow s milk allergy. Allergol Immunopathol (Madr) 2019;47:544-50. [PubMed abstract]  
Bakaloudi DR, Halloran A, Rippin HL, Oikonomidou AC, Dardavesis TI, Williams J, et al. Intake and adequacy of the vegan diet. A systematic review of the evidence. Clin Nutr 2021;40:3503-21. [PubMed abstract]  
U.S. Food and Drug Administration. Small Entity Compliance Guide: Health Claims on Calcium and Osteoporosis; and Calcium, Vitamin D, and Osteoporosisexternal link disclaimer. 2009.  
Yao X, Hu J, Kong X, Zhu Z. Association between Dietary calcium intake and bone mineral density in older adults. Ecol Food Nutr 2020:1-12. [PubMed abstract]  
Bristow SM, Horne AM, Gamble GD, Mihov B, Stewart A, Reid IR. Dietary calcium intake and bone loss over 6 years in osteopenic postmenopausal women. J Clin Endocrinol Metab 2019;104:3576-84. [PubMed abstract]  
Crandall CJ, Aragaki AK, LeBoff MS, Li W, Wactawski-Wende J, Cauley JA, et al. Calcium plus vitamin D supplementation and height loss: findings from the Women s Health Initiative Calcium and Vitamin D clinical trial. Menopause 2016;23:1277-86. [PubMed abstract]  
Reyes-Garcia R, Mendoza N, Palacios S, Salas N, Quesada-Charneco M, Garcia-Martin A, et al. Effects of daily intake of calcium and vitamin d-enriched milk in healthy postmenopausal women: a randomized, controlled, double-blind nutritional study. J Womens Health (Larchmt) 2018;27:561-8. [PubMed abstract]  
Liu C, Kuang X, Li K, Guo X, Deng Q, Li D. Effects of combined calcium and vitamin D supplementation on osteoporosis in postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. Food Funct 2020;11:10817-27. [PubMed abstract]  
Silk LN, Greene DA, Baker MK. The effect of calcium or calcium and vitamin d supplementation on bone mineral density in healthy males: a systematic review and meta-analysis. Int J Sport Nutr Exerc Metab 2015;25:510-24. [PubMed abstract]  
Bailey RL, Zou P, Wallace TC, McCabe GP, Craig BA, Jun S, et al. Calcium supplement use is associated with less bone mineral density loss, but does not lessen the risk of bone fracture across the menopause transition: data from the Study of Women s Health Across the Nation. JBMR Plus 2020;4:e10246. [PubMed abstract]  
Weaver CM, Alexander DD, Boushey CJ, Dawson-Hughes B, Lappe JM, LeBoff MS, et al. Calcium plus vitamin D supplementation and risk of fractures: an updated meta-analysis from the National Osteoporosis Foundation. Osteoporos Int 2016;27:367-76. [PubMed abstract]  
Zhao JG, Zeng XT, Wang J, Liu L. Association between calcium or vitamin D supplementation and fracture incidence in community-dwelling older adults: a systematic review and meta-analysis. Jama 2017;318:2466-82. [PubMed abstract]  
Kahwati LC, Weber RP, Pan H, Gourlay M, LeBlanc E, Coker-Schwimmer M, et al. Vitamin D, calcium, or combined supplementation for the primary prevention of fractures in community-dwelling adults: evidence report and systematic review for the US Preventive Services Task Force. Jama 2018;319:1600-12. [PubMed abstract]  
U. S. Preventive Services Task Force, Grossman DC, Curry SJ, Owens DK, Barry MJ, Caughey AB, et al. Vitamin D, calcium, or combined supplementation for the primary prevention of fractures in community-dwelling adults: US Preventive Services Task Force Recommendation Statement. JAMA 2018;319:1592-9. [PubMed abstract]  
Lappe J, Watson P, Travers-Gustafson D, Recker R, Garland C, Gorham E, et al. Effect of vitamin D and calcium supplementation on cancer incidence in older women: a randomized clinical trial. JAMA 2017;317:1234-43. [PubMed abstract]  
Brunner RL, Wactawski-Wende J, Caan BJ, Cochrane BB, Chlebowski RT, Gass ML, et al. The effect of calcium plus vitamin D on risk for invasive cancer: results of the Women s Health Initiative (WHI) calcium plus vitamin D randomized clinical trial. Nutr Cancer 2011;63:827-41. [PubMed abstract]  
Bristow SM, Bolland MJ, MacLennan GS, Avenell A, Grey A, Gamble GD, et al. Calcium supplements and cancer risk: a meta-analysis of randomised controlled trials. Br J Nutr 2013;110:1384-93. [PubMed abstract]  
Lappe JM, Travers-Gustafson D, Davies KM, Recker RR, Heaney RP. Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial. Am J Clin Nutr 2007;85:1586-91. [PubMed abstract]  
Schabas R. Artifact in the control group undermines the conclusions of a vitamin D and cancer study. The American Journal of Clinical Nutrition 2008;87:792-. [PubMed abstract]  
Ojha RP, Felini MJ, Fischbach LA. Vitamin D for cancer prevention: valid assertion or premature anointment? The American Journal of Clinical Nutrition 2007;86:1804-5. [PubMed abstract]  
Yang B, Campbell PT, Gapstur SM, Jacobs EJ, Bostick RM, Fedirko V, et al. Calcium intake and mortality from all causes, cancer, and cardiovascular disease: the Cancer Prevention Study II Nutrition Cohort. Am J Clin Nutr 2016;103:886-94. [PubMed abstract]  
Asemi Z, Saneei P, Sabihi SS, Feizi A, Esmaillzadeh A. Total, dietary, and supplemental calcium intake and mortality from all- causes, cardiovascular disease, and cancer: A meta-analysis of observational studies. Nutr Metab Cardiovasc Dis 2015;25:623-34. [PubMed abstract]  
Avenell A, MacLennan GS, Jenkinson DJ, McPherson GC, McDonald AM, Pant PR, et al. Long-term follow-up for mortality and cancer in a randomized placebo- controlled trial of vitamin D(3) and/or calcium (RECORD trial). J Clin Endocrinol Metab 2012;97:614-22. [PubMed abstract]  
Tantamango-Bartley Y, Knutsen SF, Jaceldo-Siegl K, Fan J, Mashchak A, Fraser GE. Independent associations of dairy and calcium intakes with colorectal cancers in the Adventist Health Study-2 cohort. Public Health Nutr 2017;20:2577-86. [PubMed abstract]  
Keum N, Aune D, Greenwood DC, Ju W, Giovannucci EL. Calcium intake and colorectal cancer risk: dose-response meta-analysis of prospective observational studies. Int J Cancer 2014;135:1940-8. [PubMed abstract]  
Huncharek M, Muscat J, Kupelnick B. Colorectal cancer risk and dietary intake of calcium, vitamin D, and dairy products: a meta-analysis of 26,335 cases from 60 observational studies. Nutr Cancer 2009;61:47-69. [PubMed abstract]  
Heine-Broring RC, Winkels RM, Renkema JM, Kragt L, van Orten-Luiten AC, Tigchelaar EF, et al. Dietary supplement use and colorectal cancer risk: a systematic review and meta-analyses of prospective cohort studies. Int J Cancer 2015;136:2388-401. [PubMed abstract]  
Cauley JA, Chlebowski RT, Wactawski-Wende J, Robbins JA, Rodabough RJ, Chen Z, et al. Calcium plus vitamin D supplementation and health outcomes five years after active intervention ended: the Women s Health Initiative. J Womens Health (Larchmt) 2013;22:915-29. [PubMed abstract]  
Calderwood AH, Baron JA, Mott LA, Ahnen DJ, Bostick RM, Figueiredo JC, et al. No evidence for posttreatment effects of vitamin D and calcium supplementation on risk of colorectal adenomas in a randomized trial. Cancer Prev Res (Phila) 2019;12:295-304. [PubMed abstract]  
Bonovas S, Fiorino G, Lytras T, Malesci A, Danese S. Calcium supplementation for the prevention of colorectal adenomas: A systematic review and meta-analysis of randomized controlled trials. World J Gastroenterol 2016;22:4594-603. [PubMed abstract]  
Kesse E, Bertrais S, Astorg P, Jaouen A, Arnault N, Galan P, et al. Dairy products, calcium and phosphorus intake, and the risk of prostate cancer: results of the French prospective SU.VI.MAX (Supplementation en Vitamines et Mineraux Antioxydants) study. Br J Nutr 2006;95:539-45. [PubMed abstract]  
Aune D, Navarro Rosenblatt DA, Chan DS, Vieira AR, Vieira R, Greenwood DC, et al. Dairy products, calcium, and prostate cancer risk: a systematic review and meta-analysis of cohort studies. Am J Clin Nutr 2015;101:87-117. [PubMed abstract]  
Song X, Li Z, Ji X, Zhang D. Calcium intake and the risk of ovarian cancer: a meta-analysis. Nutrients 2017;9. [PubMed abstract]  
Hidayat K, Chen GC, Zhang R, Du X, Zou SY, Shi BM, et al. Calcium intake and breast cancer risk: meta-analysis of prospective cohort studies. Br J Nutr 2016;116:158-66. [PubMed abstract]  
Chlebowski RT, Johnson KC, Kooperberg C, Pettinger M, Wactawski-Wende J, Rohan T, et al. Calcium plus vitamin D supplementation and the risk of breast cancer. J Natl Cancer Inst 2008;100:1581-91. [PubMed abstract]  
Chen Y, Strasser S, Cao Y, Wang KS, Zheng S. Calcium intake and hypertension among obese adults in United States: associations and implications explored. J Hum Hypertens 2015;29:541-7. [PubMed abstract]  
Khan B, Nowson CA, Daly RM, English DR, Hodge AM, Giles GG, et al. Higher dietary calcium intakes are associated with reduced risks of fractures, cardiovascular events, and mortality: a prospective cohort study of older men and women. J Bone Miner Res 2015;30:1758-66. [PubMed abstract]  
Anderson JJ, Kruszka B, Delaney JA, He K, Burke GL, Alonso A, et al. Calcium intake from diet and supplements and the risk of coronary artery calcification and its progression among older adults: 10-year follow-up of the Multi-Ethnic Study of Atherosclerosis (MESA). J Am Heart Assoc 2016;5. [PubMed abstract]  
Chung M, Tang AM, Newberry SJ. Calcium intake and cardiovascular disease risk. Ann Intern Med 2017;166:686-7. [PubMed abstract]  
Champagne CM. Dietary interventions on blood pressure: the Dietary Approaches to Stop Hypertension (DASH) trials. Nutr Rev 2006;64:S53-6. [PubMed abstract]  
Cormick G, Ciapponi A, Cafferata ML, Beliz n JM. Calcium supplementation for prevention of primary hypertension. Cochrane Database of Systematic Reviews 2015. [PubMed abstract]  
Chen C, Ge S, Li S, Wu L, Liu T, Li C. The effects of dietary calcium supplements alone or with vitamin d on cholesterol metabolism: a meta-analysis of randomized controlled trials. J Cardiovasc Nurs 2017;32:496-506. [PubMed abstract]  
Donneyong MM, Hornung CA, Taylor KC, Baumgartner RN, Myers JA, Eaton CB, et al. Risk of heart failure among postmenopausal women: a secondary analysis of the randomized trial of vitamin D plus calcium of the women s health initiative. Circ Heart Fail 2015;8:49-56. [PubMed abstract]  
Boursiquot BC, Larson JC, Shalash OA, Vitolins MZ, Soliman EZ, Perez MV. Vitamin D with calcium supplementation and risk of atrial fibrillation in postmenopausal women. Am Heart J 2019;209:68-78. [PubMed abstract]  
Myung S-K, Kim H-B, Lee Y-J, Choi Y-J, Oh S-W. Calcium supplements and risk of cardiovascular disease: a meta-analysis of clinical trials. Nutrients 2021;13:368. [PubMed abstract]  
Paik JM, Curhan GC, Sun Q, Rexrode KM, Manson JE, Rimm EB, et al. Calcium supplement intake and risk of cardiovascular disease in women. Osteoporos Int 2014;25:2047-56. [PubMed abstract]  
Kopecky SL, Bauer DC, Gulati M, Nieves JW, Singer AJ, Toth PP, et al. Lack of evidence linking calcium with or without vitamin D supplementation to cardiovascular disease in generally healthy adults: a clinical guideline from the National Osteoporosis Foundation and the American Society for Preventive Cardiology. Ann Intern Med 2016;165:867-8. [PubMed abstract]  
Leeman L, Dresang LT, Fontaine P. Hypertensive disorders of pregnancy. Am Fam Physician 2016;93:121-7. [PubMed abstract]  
Ananth CV, Keyes KM, Wapner RJ. Pre-eclampsia rates in the United States, 1980-2010: age-period-cohort analysis. Bmj 2013;347:f6564. [PubMed abstract]  
American College of Obstetricians and Gynecologists Task Force on Hypertension in Pregnancy. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists Task Force on Hypertension in Pregnancy. Obstet Gynecol 2013;122:1122-31. [PubMed abstract]  
World Health Organization. Guideline: Calcium Supplementation in Pregnant Women. Geneva: World Health Organization; 2013. [PubMed abstract]  
Hofmeyr GJ, Lawrie TA, Atallah , Torloni MR. Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database of Systematic Reviews 2018. [PubMed abstract]  
Tang R, Tang IC, Henry A, Welsh A. Limited evidence for calcium supplementation in preeclampsia prevention: a meta-analysis and systematic review. Hypertens Pregnancy 2015;34:181-203. [PubMed abstract]  
Hofmeyr GJ, Betran AP, Singata-Madliki M, Cormick G, Munjanja SP, Fawcus S, et al. Prepregnancy and early pregnancy calcium supplementation among women at high risk of pre-eclampsia: a multicentre, double-blind, randomised, placebo-controlled trial. Lancet 2019;393:330-9. [PubMed abstract]  
Hofmeyr GJ, Manyame S, Medley N, Williams MJ. Calcium supplementation commencing before or early in pregnancy, for preventing hypertensive disorders of pregnancy. Cochrane Database of Systematic Reviews 2019. [PubMed abstract]  
World Health Organization. WHO Recommendation: Calcium Supplementation During Pregnancy for Prevention of Pre-eclampsia and Its Complications. Geneva: World Health Organization; 2018. [PubMed abstract]  
Magee LA, Pels A, Helewa M, Rey E, von Dadelszen P. Diagnosis, evaluation, and management of the hypertensive disorders of pregnancy: executive summary. J Obstet Gynaecol Can 2014;36:416-41. [PubMed abstract]  
Tranquilli AL, Dekker G, Magee L, Roberts J, Sibai BM, Steyn W, et al. The classification, diagnosis and management of the hypertensive disorders of pregnancy: A revised statement from the ISSHP. Pregnancy Hypertens 2014;4:97-104. [PubMed abstract]  
Lowe SA, Bowyer L, Lust K, McMahon LP, Morton M, North RA, et al. SOMANZ guidelines for the management of hypertensive disorders of pregnancy 2014. Aust N Z J Obstet Gynaecol 2015;55:e1-29. [PubMed abstract]  
Nappo A, Sparano S, Intemann T, Kourides YA, Lissner L, Molnar D, et al. Dietary calcium intake and adiposity in children and adolescents: Cross- sectional and longitudinal results from IDEFICS/I.Family cohort. Nutr Metab Cardiovasc Dis 2019;29:440-9. [PubMed abstract]  
Marabujo T, Ramos E, Lopes C. Dairy products and total calcium intake at 13 years of age and its association with obesity at 21 years of age. Eur J Clin Nutr 2018;72:541-7. [PubMed abstract]  
Shahar DR, Schwarzfuchs D, Fraser D, Vardi H, Thiery J, Fiedler GM, et al. Dairy calcium intake, serum vitamin D, and successful weight loss. Am J Clin Nutr 2010;92:1017-22. [PubMed abstract]  
Li P, Fan C, Lu Y, Qi K. Effects of calcium supplementation on body weight: a meta-analysis. Am J Clin Nutr 2016;104:1263-73. [PubMed abstract]  
Caan B, Neuhouser M, Aragaki A, Lewis CB, Jackson R, LeBoff MS, et al. Calcium plus vitamin D supplementation and the risk of postmenopausal weight gain. Archives of Internal Medicine 2007;167:893-902. [PubMed abstract]  
Booth AO, Huggins CE, Wattanapenpaiboon N, Nowson CA. Effect of increasing dietary calcium through supplements and dairy food on body weight and body composition: a meta-analysis of randomised controlled trials. Br J Nutr 2015;114:1013-25. [PubMed abstract]  
Chen M, Pan A, Malik VS, Hu FB. Effects of dairy intake on body weight and fat: a meta-analysis of randomized controlled trials. Am J Clin Nutr 2012;96:735-47. [PubMed abstract]  
Moore-Schiltz L, Albert JM, Singer ME, Swain J, Nock NL. Dietary intake of calcium and magnesium and the metabolic syndrome in the National Health and Nutrition Examination (NHANES) 2001-2010 data. Br J Nutr 2015;114:924-35. [PubMed abstract]  
Han D, Fang X, Su D, Huang L, He M, Zhao D, et al. Dietary calcium intake and the risk of metabolic syndrome: a systematic review and meta-analysis. Sci Rep 2019;9:19046. [PubMed abstract]  
Asemi Z, Raygan F, Bahmani F, Rezavandi Z, Talari HR, Rafiee M, et al. The effects of vitamin D, K and calcium co-supplementation on carotid intima-media thickness and metabolic status in overweight type 2 diabetic patients with CHD. Br J Nutr 2016;116:286-93. [PubMed abstract]  
Jackson RD, LaCroix AZ, Gass M, Wallace RB, Robbins J, Lewis CE, et al. Calcium plus vitamin D supplementation and the risk of fractures. N Engl J Med 2006;354:669-83. [PubMed abstract]  
Wallace RB, Wactawski-Wende J, O Sullivan MJ, Larson JC, Cochrane B, Gass M, et al. Urinary tract stone occurrence in the Women s Health Initiative (WHI) randomized clinical trial of calcium and vitamin D supplements. Am J Clin Nutr 2011;94:270-7. [PubMed abstract]  
Candelas G, Martinez-Lopez JA, Rosario MP, Carmona L, Loza E. Calcium supplementation and kidney stone risk in osteoporosis: a systematic literature review. Clin Exp Rheumatol 2012;30:954-61. [PubMed abstract]  
Song I, Borland J, Arya N, Wynne B, Piscitelli S. Pharmacokinetics of dolutegravir when administered with mineral supplements in healthy adult subjects. J Clin Pharmacol 2015;55:490-6. [PubMed abstract]  
Jalloh MA, Gregory PJ, Hein D, Risoldi Cochrane Z, Rodriguez A. Dietary supplement interactions with antiretrovirals: a systematic review. Int J STD AIDS 2017;28:4-15 [PubMed abstract]  
U.S. Food and Drug Administration. Tivicay Labelexternal link disclaimer. 2020.  
U.S. Food and Drug Administration. Dovato Labelexternal link disclaimer. 2019.  
Morini E, Catalano A, Lasco A, Morabito N, Benvenga S. L-thyroxine malabsorption due to calcium carbonate impairs blood pressure, total cholesterolemia, and fasting glycemia. Endocrine 2019;64:284-92. [PubMed abstract]  
Singh N, Singh PN, Hershman JM. Effect of calcium carbonate on the absorption of levothyroxine. Jama 2000;283:2822-5. [PubMed abstract]  
Schneyer CR. Calcium carbonate and reduction of levothyroxine efficacy. Jama 1998;279:750. [PubMed abstract]  
U.S. Food and Drug Administration. LEVO-T Labelexternal link disclaimer. 2017.  
Jones BJ, Twomey PJ. Requesting patterns for serum calcium concentration in patients on long-term lithium therapy. Int J Clin Pract 2009;63:170-2. [PubMed abstract]  
Pletz MW, Petzold P, Allen A, Burkhardt O, Lode H. Effect of calcium carbonate on bioavailability of orally administered gemifloxacin. Antimicrob Agents Chemother 2003;47:2158-60. [PubMed abstract]  
Kays MB, Overholser BR, Mueller BA, Moe SM, Sowinski KM. Effects of sevelamer hydrochloride and calcium acetate on the oral bioavailability of ciprofloxacin. Am J Kidney Dis 2003;42:1253-9. [PubMed abstract]  
Disclaimer  
This fact sheet by the National Institutes of Health (NIH) Office of Dietary Supplements (ODS) provides information that should not take the place of medical advice. We encourage you to talk to your health care providers (doctor, registered dietitian, pharmacist, etc.) about your interest in, questions about, or use of dietary supplements and what may be best for your overall health. Any mention in this publication of a specific product or service, or recommendation from an organization or professional society, does not represent an endorsement by ODS of that product, service, or expert advice.