



Calcium (Ca) - description, effects on the body, best sources

Eliseeva Tatyana, editor-in-chief of the project EdaPlus.info

Mironenko Anastasia, nutritionist

Email: eliseeva.t@edaplus.info, myronenko.a@edaplus.info

Abstract. The article discusses the main properties of calcium (Ca) and its effect on the human body. A systematic review of modern specialized literature and relevant scientific data was carried out. The best natural sources of calcium are indicated. The use of the mineral in various types of medicine and the effectiveness of its use in various diseases are considered. The potentially adverse effects of calcium vitamins on the human body under certain medical conditions and diseases are analyzed separately.

Keywords: calcium, calcium, Ca

Calcium is the 5th most abundant mineral in the body, with over 99% found in the skeleton as the complex calcium phosphate molecule. This mineral provides bone strength, the ability to move, and plays a role in a wide range of other functions. Calcium is healthy bones, blood vessels, hormonal metabolism, absorption of trace elements and transmission of nerve impulses. Its metabolism is regulated by three main transport systems: intestinal absorption, renal reabsorption, and bone metabolism. ^[one]

Table 1. **Foods rich in calcium** (according to Food+).

Product	Calcium content (mg/100 gr)
poppy seeds	1438
Parmesan cheese	1184
Sesame	975
tofu cheese	683
chia seeds	631
Canned sardines in oil	382
Almond	269
curly cabbage	254
Dried figs	162
Arugula	160

Yogurt	121
Cow's milk, whole	113
Spinach	99
White beans, boiled	90
Rhubarb	86
Cottage cheese	80
Sunflower seeds	70
Orange	70
Dates	64
edamame beans	63
Oatmeal	58
Horseradish	56
Chicken egg	56
Dried apricots	55
sea kale	54
Broccoli	47
Quinoa	47
Artichoke	44
Trout	43
scallops	39
Lentils	35
Sweet potato	thirty
Raisin	28
Radish	25
Raspberry	25
Cauliflower	22
Strawberry	16
Avocado	13
Blueberry	6

daily requirement

Age	Daily calcium requirement (mg/day)
0-6 months	210
7-12 months	270
1-3 years	500
4-8 years old	800
9-13 years old	1300
14-18 years old	1300
19-30 years old	1000
31-50 years old	1000
51-70 years old	1200
over 70 years	1200
Pregnancy	
less than 18 years old	1300
19-50 years old	1000
Lactation	
less than 18 years old	1300
19-50 years old	1000

There is no exact data on how much calcium should be consumed each day. With a few exceptions, such as extreme starvation or hyperparathyroidism, circulating calcium levels in the blood remain adequate even in chronic deficiency, as the body uses calcium from the bones to maintain health. Therefore, the daily requirement for calcium is based on calculations in relation to a healthy population without chronic diseases. In addition, this amount suggests that for some people, even smaller doses of calcium intake are sufficient.

During pregnancy, the maternal skeleton is not used as a reserve for the calcium needs of the fetus. Calcium-regulating hormones regulate the efficiency of absorption of the mineral in the mother so that calcium intake during pregnancy does not need to be significantly increased. Increasing dietary calcium intake will not prevent its loss from the maternal skeleton during lactation, but lost calcium is usually restored after weaning. Thus, the daily calcium requirement for lactating women is the same as for non-lactating women.

Increasing the amount of calcium intake may be considered in such cases:

- in amenorrhea: caused by excessive physical activity or anorexia, amenorrhea leads to a decrease in the level of stored calcium, poor absorption, and a general decrease in bone mass;
- at menopause: Decreased estrogen production at menopause is associated with accelerated bone loss over 5 years. Low estrogen levels are accompanied by low calcium absorption and increased bone turnover.
- Lactose intolerance: People who are lactose intolerant and avoid dairy products may be at risk of calcium deficiency. It is interesting to note that even with lactose intolerance, the calcium present in milk is normally absorbed;
- with a vegetarian or vegan diet: calcium bioavailability may decrease with a vegetarian diet due to increased intake of oxalic and phytic acid found in many vegetables and beans;
- Feeding multiple babies: Because of the increased production of breast milk when feeding multiple babies, doctors may consider supplementing calcium and magnesium during lactation.

[2]

Useful properties of calcium and its effect on the body

The body of an adult contains about 1200 g of calcium, which is about 1-2% of body weight. Of these, 99% is found in mineralized tissues such as bones and teeth, where it is present as calcium phosphate and a small amount of calcium carbonate, providing rigidity and structure to the skeleton. 1% is found in the blood, extracellular fluid, muscles and other tissues. It plays a role in mediating vascular contraction and relaxation, muscle contraction, nerve signal transmission, and glandular secretion. [5]

Sufficient intake of calcium has many benefits for the body. Calcium helps:

- ensure the growth and maintenance of healthy bones and teeth;
- support the work of tissues whose cells constantly require its intake - in the heart, muscles and other organs;
- the work of blood vessels and nerves in the transmission of impulses;
- absorb micronutrients such as vitamins D, K, magnesium and phosphorus;
- keep under control the processes of thrombosis;
- support the normal functioning of digestive enzymes [4].

Calcium is absorbed by active transport and passive diffusion across the intestinal mucosa. Active calcium transport requires an active form of vitamin D and provides most of the absorption of calcium at low to moderate levels of intake, as well as during periods of acute need such as growth, pregnancy or lactation. Passive diffusion becomes more important with sufficient and high calcium intake.

With a decrease in calcium intake, the efficiency of calcium absorption increases (and vice versa). However, this increased efficiency of calcium absorption is generally insufficient to compensate for the loss of absorbed calcium that occurs when dietary calcium intake is reduced. Calcium absorption decreases with age in men and women. Calcium is excreted in urine and feces ^[2].

Healthy Food Combinations with Calcium

- **Calcium + Inulin**

Inulin is a type of fiber that helps balance the "good" bacteria in your gut. In addition, it helps strengthen bones by promoting calcium absorption. Inulin is found in foods such as artichokes, onions, garlic, green onions, chicory, banana, whole grain wheat, and asparagus.

- **Calcium + Vitamin D**

These two elements are directly related to each other. The body needs adequate levels of vitamin D in order to absorb calcium. ^[6].

- **Calcium + Magnesium**

Magnesium promotes the absorption of calcium from the blood into the bones. Without magnesium, the process of calcium metabolism is practically impossible. Healthy sources of magnesium include green leafy vegetables, broccoli, cucumber, green beans, celery, and a variety of seeds. ^[7].

Calcium absorption depends on vitamin D intake and status. Absorption efficiency is related to physiological calcium requirements and is dose dependent. Dietary calcium absorption inhibitors include substances that form complexes in the gut. Protein and sodium can also alter calcium bioavailability, as high levels of calcium increase urinary excretion. Although the amount absorbed in the intestine is increased, the end result may be a decrease in the proportion of calcium directly used by the body. Lactose, on the contrary, promotes the absorption of calcium ^[8].

Calcium absorption across the intestinal membrane occurs through both the vitamin D-dependent and vitamin D-independent pathways. The duodenum is the main source of calcium absorption, although the rest of the small and large intestine also contribute. Approximately 60-70% of calcium is passively reabsorbed in the kidneys by a specific substance produced during the reabsorption of sodium and water. Another 10% is absorbed in nephron cells ^[9].

Cooking rules

Numerous studies have been conducted in order to find out how cooking affects the change in the amount of minerals and vitamins in food. Like other minerals, calcium is destroyed by 30-40 percent compared to raw foods. The losses were especially high in vegetables. Among various cooking methods, the loss of minerals was highest with squeezing after boiling and soaking in water after slicing, followed by frying, frying and stewing. Moreover, the results were the same both when cooking at home and in mass production. In order to minimize the loss of calcium during cooking, it is advised to eat boiled food with broth, add a small amount of salt when cooking, do not overcook food, and choose cooking methods that preserve the beneficial properties of food as much as possible ^[10].

Application in official medicine

Calcium is essential for the growth and maintenance of healthy bones and teeth. Studies show that, especially when combined with vitamin D, calcium may reduce the risk of osteoporosis. Osteoporosis is a disease that is influenced by many factors. It is most common among women during menopause. There are several ways to reduce the likelihood of bone damage associated with osteoporosis, including achieving maximum bone mass and limiting bone loss later in life. For this, calcium is the

most important material, and a sufficient amount of vitamin D ensures optimal absorption of calcium in the body.

There are several ways to achieve higher peak bone mass, including sports such as running and strength training combined with adequate calcium (1200 mg/day) and vitamin D (600 IU/day) at a young age. Although physical activities such as walking, swimming, and cycling have a positive effect on health, their effect on bone loss is negligible.

Calcium, like other micronutrients, may have some effect on the development of colon cancer. Dietary supplementation of 1200-2000 mg of calcium per day has been shown to slightly reduce the incidence of bowel cancer in controlled clinical trials. Participants with the highest intake of calcium (1087 mg/day from food and supplements) were 22% less likely to develop cancer compared to those with the lowest intake (732 mg/day). Most studies have noted only a modest reduction in risk with calcium supplementation. This can be explained by the different response to calcium in different people. ^[4].

Some research suggests that calcium supplementation may play a role in preventing high blood pressure in pregnancy and preeclampsia. This is a serious condition, usually occurring after the 20th week of pregnancy, in which a pregnant woman develops hypertension and excess proteins in her urine. It is the leading cause of maternal and neonatal morbidity and mortality, affecting about 5-8% of pregnancies in the US and up to 14% of pregnancies worldwide. Studies show that calcium supplementation during pregnancy reduces the risk of preeclampsia, but these benefits are seen only in groups with insufficient calcium intake. For example, in a randomized clinical trial in 524 healthy women in India with a mean baseline calcium intake of just 314 mg/day, daily calcium supplementation of 2,000 mg from 12-25 weeks of gestation until delivery significantly reduced the risk of preeclampsia and preterm birth compared to placebo. In turn, a similar study in the United States (where daily calcium intake is usually normal) did not show any results. The most significant results were in women with intakes of less than 900 mg of calcium per day ^[11].

There is an opinion that women who consume calcium supplements and prefer a balanced diet have a lower risk of stroke for 14 years. However, doctors warn that this increases the risk of developing cardiovascular disease ^[4].

calcium during pregnancy

Several professional organizations recommend calcium supplementation during pregnancy for women with low calcium intake to reduce the risk of preeclampsia. For example, the American College of Obstetricians and Gynecology (ACOG) states that daily calcium supplements of 1500-2000 mg can reduce the severity of preeclampsia in pregnant women whose calcium intake is less than 600 mg/day. Similarly, the World Health Organization (WHO) recommends 1500-2000 mg of calcium for pregnant women with low dietary calcium intake, especially those at increased risk of gestational hypertension. The WHO recommends dividing the total daily dose into three doses, preferably taken with food, from the 20th week of pregnancy until childbirth. WHO also recommends splitting calcium and iron supplements for pregnant women into multiple doses to minimize the inhibitory effect of calcium on iron absorption. But some researchers argue that this interaction is of minimal clinical significance, and argue that this is why manufacturers do not advise patients to split supplements in order to simplify the regimen and improve adherence to the treatment regimen. The Canadian Working Group on Hypertensive Disorders in Pregnancy, the International Society for the Study of Hypertension in Pregnancy, and the Obstetrics Society of Australia and New Zealand have issued similar guidelines ^[11].

Calcium in folk medicine

Traditional medicine recognizes calcium as a very important mineral for the health of bones, muscles, teeth, and the cardiovascular system. Many folk recipes are used to strengthen the skeleton - among them the use of eggshells, lactic acid products (for example, the so-called "kefir diet", in which the patient consumes 6 glasses of low-fat kefir per day to avoid hypertension, diabetes, atherosclerosis). An increase in calcium intake is also advised to patients with any form of tuberculosis. In addition, folk recipes consider the consequences of excessive calcium intake - such as, for example, kidney stones. With such a diagnosis, it is also advised, in addition to drug treatment, to change the diet. It is recommended to introduce wholemeal bread into food, avoid refined carbohydrates, sugar and milk ^[12]

Calcium in recent scientific research

- Researchers have found that excess calcium in brain cells can lead to the formation of toxic clusters that are a hallmark of Parkinson's disease. An international team led by the University of Cambridge found that calcium can mediate the interaction between small membrane structures inside nerve endings that are important for neuron signaling in the brain and alpha-synuclein, a protein associated with Parkinson's disease. Excess levels of calcium or alpha-synuclein can cause a chain reaction leading to brain cell death. Understanding the role of alpha-synuclein in physiological or pathological processes may help develop new treatments for Parkinson's disease. For example, there is a possibility that drugs designed to block calcium in heart disease may also have potential against Parkinson's disease ^[15].
- A new scientific study presented at the American College of Cardiology Science Sessions at the Intermountain Institute of Health in Salt Lake City shows that detecting the presence or absence of calcium in the coronary arteries can help determine the risk of cardiovascular disease. Moreover, this study can be carried out not only to determine future diseases, but also when the symptoms are already present. The experiment involved 5547 patients with no history of heart disease who presented to the medical center with chest pain between April 2013 and June 2016. Patients who had calcium in their coronary artery on scans were found to have a higher risk of having a heart attack within 90 days compared to patients whose CT showed no calcium. The researchers also found that calcium-detected patients also had higher rates of obstructive coronary artery disease, revascularization, and/or other serious adverse cardiac events in later years ^[14].
- Eating a calcium-rich diet or supplementing with calcium does not increase the risk of age-related macular degeneration, according to a study conducted by the US National Eye Institute. The disease is the leading cause of vision loss and blindness among people aged 65 and over in the United States. The results were published in the journal JAMA Ophthalmology. The findings contradict an earlier study indicating that high calcium levels were associated with an increased prevalence of age-related macular degeneration, and at the same time prove that calcium, on the contrary, plays a protective role in this case ^[13].

The use of calcium in cosmetology

In addition to its key role in the health of bones, teeth and body organs, calcium is also of great importance for the skin. Most of it is found in the outermost layer of the skin (epidermis), where calcium has been shown to be responsible for restoring barrier function and homeostasis (the self-healing process in which the number of cell divisions in the skin compensates for the number of lost cells). Keratinocytes - cells of the epidermis - differently need calcium concentrations. Despite constant renewal (almost every 60 days, the epidermis is completely renewed, replacing over 80 billion keratinocytes in the adult human body), our skin eventually succumbs to aging as the turnover rate of keratinocytes slows dramatically. Aging is associated with thinning of the epidermis, elastosis, reduced barrier function, and loss of melanocytes. Since the differentiation of keratinocytes is strictly

dependent on calcium, it is also involved in skin aging. The epidermal calcium gradient in the skin, which promotes the growth of keratinocytes and allows their differentiation, has been shown to be lost during skin aging.^[16]

In addition, calcium oxide is used in cosmetology as an acidity regulator and absorbent. It is found in products such as make-up, bath salts, shaving foams, oral and hair care products^[17].

Weight regulation

Several studies have suggested that calcium supplementation may help with weight loss. This hypothesis was based on the fact that high calcium intake can reduce the concentration of calcium in fat cells, reducing the production of parathyroid hormone and the active form of vitamin D. A decrease in intracellular calcium concentration, in turn, can increase the breakdown of fat and prevent the accumulation of fat in these cells. In addition, calcium from food or supplements can bind small amounts of dietary fat in the digestive tract and interfere with absorption of that fat. Dairy products, in particular, may contain additional components that have an even greater impact on body weight than their calcium content would suggest. For example, protein and other components of dairy products can modulate appetite-regulating hormones.

A 2014 randomized crossover study in 15 healthy young men found that diets high in milk or cheese (providing a total of 1,700 mg/day of calcium) significantly increased fecal fat excretion compared to a control diet that provided 500 mg calcium/day. However, the results of clinical trials that examined the effect of calcium on body weight were mostly negative. For example, a 1500 mg/day supplement was studied in 340 overweight or obese adults with mean baseline calcium intakes of 878 mg/day (treatment group) and 887 mg/day (placebo group). Compared with placebo, calcium supplementation for 2 years had no clinically significant effect on weight.

Contraindications and warnings

Signs of calcium deficiency

Chronic calcium deficiency can occur due to insufficient calcium intake or poor absorption in the intestines. Also, chronic kidney failure, vitamin D deficiency, and low magnesium levels in the blood can be causes. During chronic calcium deficiency, the mineral is absorbed from the skeleton to maintain normal levels of calcium circulation, thereby impairing bone health. As a result, chronic calcium deficiency leads to a decrease in bone mass and osteoporosis. The consequences of calcium deficiency are osteopenia, osteoporosis and an increased risk of bone fractures.^[2]

Symptoms of hypocalcemia include finger numbness, muscle cramps, convulsions, lethargy, poor appetite, and an abnormal heart rhythm. If not treated promptly, calcium deficiency can be fatal. Therefore, it is very important to contact your doctor if you suspect a lack of calcium^[4].

Signs of excess calcium

The available data on the adverse effects of excess calcium intake in humans are mainly from studies of dietary supplements. Among the many side effects of excess calcium in the body, the three most studied and biologically significant are:

- stones in the kidneys;
- hypercalcemia and renal failure;
- interaction of calcium with the absorption of other trace elements^[2].

Other symptoms of excess calcium can be loss of appetite, nausea, vomiting, confusion, coma.

The cut-off calcium intake is 1000-1500 mg/day in infants, 2,500 mg/day in children 1 to 8 years of age, and 3000 mg/day in children 9 years of age and adolescents up to 18 years of age. In adults, this rate is 2,500 mg / day, and after 51 years - 2,000 mg / day ^[4].

Interaction with other elements

- **Caffeine.** Caffeine can increase urinary calcium loss and reduce calcium absorption. It should be noted that the effect of caffeine remains relatively modest, this effect was primarily noted in women who consume insufficient calcium during menopause.
- **Magnesium.** Moderate or severe magnesium deficiency can lead to hypocalcemia. However, according to a 3-week study in which magnesium was artificially excluded from the diet, it was found that even a small decrease in the amount of magnesium consumed can lead to a rather serious decrease in serum calcium concentration.
- **Oxalic acid** can interfere with the absorption of calcium. Foods rich in oxalic acid are spinach, sweet potatoes, rhubarb and beans.
- **Phosphorus.** Excessive phosphorus intake can interfere with calcium absorption. However, if the amount of calcium consumed is sufficient, then the likelihood of this decreases. Phosphorus is found primarily in dairy products, cola and other soft drinks, and meat.
- **Phytic acid.** May interfere with calcium absorption. Found in unleavened bread, raw beans, nuts, grains and soy products.
- **Protein.** There is an opinion that dietary protein can lead to increased excretion of calcium in the urine. This question is still being investigated by scientists.
- **Sodium.** Moderate and high consumption of sodium chloride (salt) leads to an increase in the amount of calcium excreted from the body in the urine. Indirect evidence has been found that salt can adversely affect bones. So far, no recommended doses of calcium intake have been published in relation to salt intake.
- **Zinc.** Calcium and zinc are absorbed in the same part of the intestine, so they can mutually influence the metabolic process. Large doses of zinc consumed can interfere with the absorption of calcium. Particular attention should be paid to this in older women, in whom the level of calcium in the body is low on its own, and with the additional intake of zinc preparations, it can decrease even more.
- **Iron.** Calcium can impair the absorption of iron in the body ^[3].

Interaction with medications

Some medications can interfere with calcium metabolism, primarily by increasing the level of calcium in the urine and thereby leading to calcium deficiency. It is widely known, for example, the effect of glucocorticoids on the occurrence of osteoporosis and bone loss, regardless of age and sex. Corticosteroids increase the amount of calcium not only in the urine, but also in the feces, and as a result, negatively affect the level of calcium.

Literature

1. Weaver CM, Peacock M. Calcium. *Advances in nutrition* (Bethesda Md.), 2(3), 290-292. doi:10.3945/an.111.000463
2. Jennifer J. Otten, Jennifer Pitz Hellwig, and Linda D. Meyers. Calcium. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. 2006. 286-95.
3. Kipple, Kenneth F, and Orneals, Kriemhild Conee. Calcium. *The Cambridge World History of Food*. Cambridge: Cambridge UP, 2012. 785-97. *The Cambridge World History of Food*.
4. Nutri-Facts, [source](#)

5. Cashman, K. (2002). Calcium intake, calcium bioavailability and bone health. *British Journal of Nutrition*, 87(S2), S169-S177. doi:10.1079/BJN/2002534
6. 7 Super-Powerful Food Pairings, [Source](#)
7. Diet and Nutritional Tips for Women, [source](#)
8. SJ Fairweather-Tait, S. Southon. *Encyclopedia of Food Sciences and Nutrition* (Second Edition), 2003.
9. MR Clarkson, CN Magee, BM Brenner. *Pocket Companion to Brenner and Rector's The Kidney*. 2nd Edition, 2011.
10. Kimura M., Itokawa Y. Cooking losses of minerals in foods and its nutritional significance. *Journal of Nutritional Science Vitaminol.* 1990; 36. Supplement 1: S25-32; discussion S33.
11. National Institutes of Health. Office of Dietary Supplements. Calcium. Factsheet for Health Professionals. <https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/#h7>
12. Uzhegov, G. *Folk medicine: The most complete encyclopedia*. 2007
13. Alanna K. Tisdale, Elvira Agron, Sarah B. Sunshine, Traci E. Clemons, Frederick L. Ferris, Emily Y. Chew. Association of Dietary and Supplementary Calcium Intake With Age-Related Macular Degeneration. *JAMA Ophthalmology*, 2019; <https://doi.org/10.1001/jamaophthalmol.2019.0292>
14. Intermountain Medical Center. "Calcium in arteries is shown to increase patients' imminent risk of a heart attack." *ScienceDaily*. March 16, 2019
15. Janin Lautenschläger, Amberley D. Stephens, Giuliana Fusco, Florian Ströhl, Nathan Curry, Maria Zacharopoulou, Claire H. Michel, Romain Laine, Nadezhda Nespovitaya, Marcus Fantham, Dorothea Pinotsi, Wagner Zago, Paul Fraser, Anurag Tandon, Peter St George-Hyslop, Eric Rees, Jonathan J. Phillips, Alfonso De Simone, Clemens F. Kaminski, Gabriele S. Kaminski Schierle. C-terminal calcium binding of α -synuclein modulates synaptic vesicle interaction. *Nature Communications*, 2018; 9(1) <https://doi.org/10.1038/s41467-018-03111-4>
16. Calcium Skincare Product Benefits - Repairs Aging Skin - L'Oréal Paris, [source](#)
17. Calcium Oxide, [source](#)
18. Dietary Supplements for Weight Loss. Fact Sheet for Health Professionals, [source](#)
19. Facts About Calcium, [source](#)

[An extended HTML version of this article](#) is available on the website edaplust.info.

Calcium (Ca, calcium) - description, effect on the body, best sources

Eliseeva Tatyana, editor-in-chief of the project EdaPlus.info

Myronenko Anastasiia, nutritionist

E-mail: eliseeva.t@edaplust.info, myronenko.a@edaplust.info

Received 05/23/2019

Abstract. The article discusses the main properties of calcium (Ca) and its effect on the human body. A systematic review of modern specialized literature and relevant scientific data was carried out. The best natural sources of calcium are indicated. The use of the mineral in various types of medicine and the effectiveness of its use in various diseases are considered. The potentially adverse effects of calcium vitamins on the human body under certain medical conditions and diseases are analyzed separately.