

# Myths, stories and legends about calcium and vitamin D

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## INTRODUCTION

In recent years there has been an impressive increase in the number of scientific articles related to the metabolism of calcium and vitamin D. We have gained a much deeper knowledge of many patho-physiological aspects. However, and in spite of this, a series of fraudulence, myths and legends have been developed in parallel on both calcium and vitamin D, many of them absolutely unjustified, and others derived from a misunderstanding of some scientific articles. Since this can lead to the abandonment of treatments or taking them in the wrong way, we have developed this article in order to clarify, with scientific evidence, some of these aspects.

## REVIEW OF THE PHYSIOLOGY OF CALCIUM AND VITAMIN D

Calcium absorption depends on vitamin D and is a saturable mechanism. From a certain amount and reach the optimum level of absorption, all calcium that is ingested is not absorbed and is eliminated by feces.

Between 100 and 200 mg of calcium are removed by the kidney on a daily basis under normal conditions. Also, between 800 to 900 mg of calcium is lost by stool, as a result of the secretion of bile salts and pancreatic juices. These are known as “mandatory calcium losses” and together they constitute about 1,000 mg (Figure 1). Calcium cannot be synthesized by any metabolic route and, therefore, must be taken by diet<sup>1</sup>.

Serum calcium levels must remain very stable, with hardly any oscillation between 8.8 and 10.5 mg/dl, because many of the physiological functions vital to the body, such as muscle contraction, nerve transmission, depend on the stability of these figures. and coagulation, just to name a few of them<sup>1</sup>.

If daily losses are not replaced by intake, a negative balance is produced daily and, to maintain stable

serum calcium levels, parathormone (PTH) is activated, which increases bone resorption and normalizes calcemia. If these circumstances are prolonged, in the long term, calcium-poor diets increase the risk of osteoporosis and fragility fractures<sup>2,3</sup>.

## "Humans do not need to drink milk after weaning"

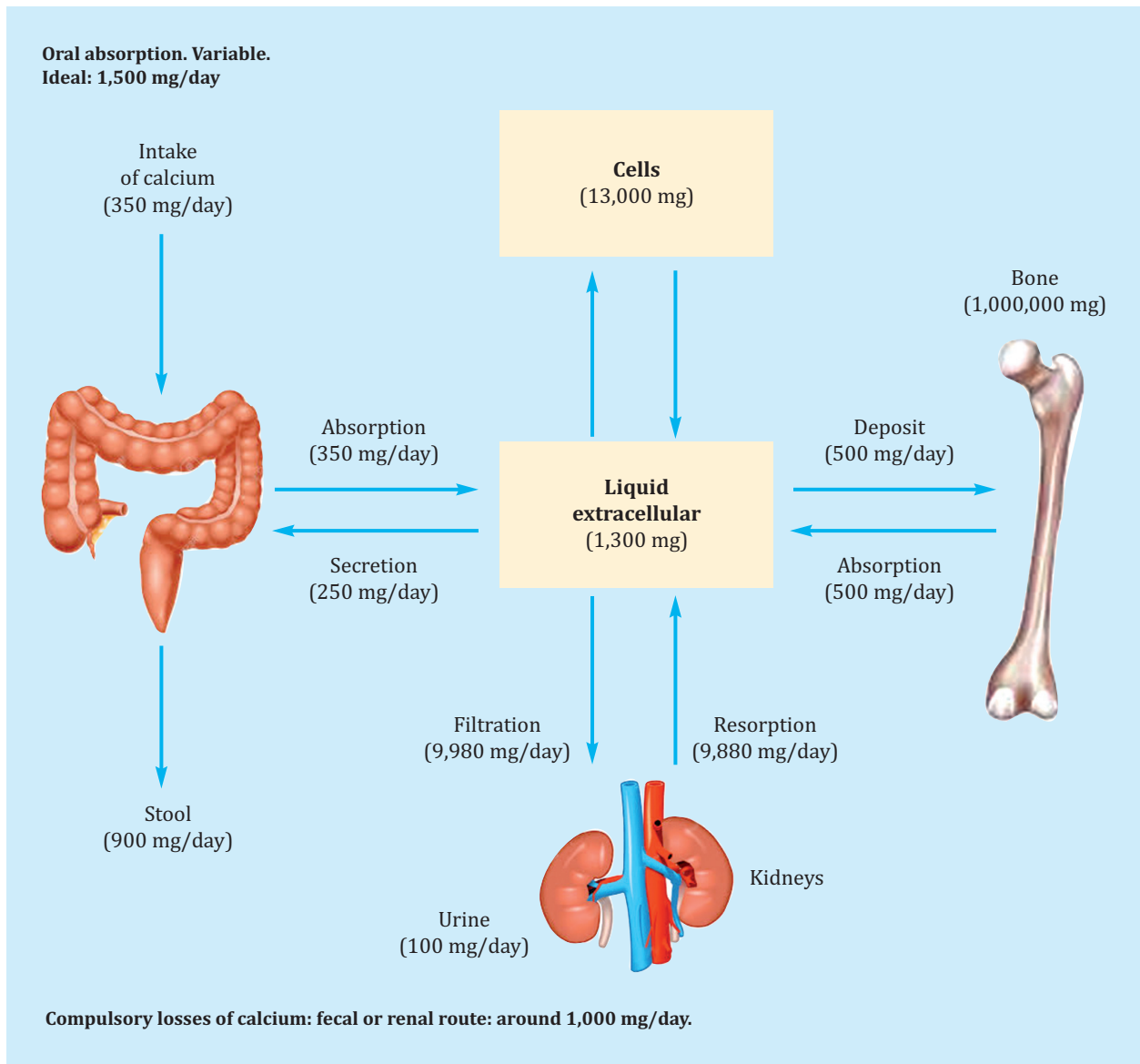
False. Calcium is a mineral that cannot be synthesized by the body. Therefore, it must be ingested. But calcium is present mostly in dairy products, being difficult to reach the required daily amounts with other foods that are not dairy. Table 1 shows a relationship of the calcium content of the main foods, and table 2 shows the daily requirements established by consensus, depending on the different stages of life<sup>4</sup>. By taking 2 daily yogurts and 2 glasses of milk, we would fulfill these requirements.

If we avoid dairy products and eliminate them completely from the diet, a daily negative calcium balance would develop, since the obligatory losses are maintained, regardless of diet. The body cannot allow serum calcium levels to decrease. With a decrease in calcium intake, there is an increase in PTH, which increases bone resorption to avoid hypocalcemia. If this situation persists over a long period of time, a long-term loss of bone mass may occur, which will lead to osteoporosis and increased risk of fragility fractures<sup>5</sup>.

On the other hand, populations with balanced diets rich in calcium, or with an intake of calcium supplements with or without vitamin D, reportedly present an increase in bone mineral density (BMD)<sup>6</sup> and a decrease in the risk of fracture<sup>7</sup>, as well as a decrease in the risk of renal lithiasis<sup>5</sup>.

Animals do not take dairy simply because they have not been able to domesticate other animals.



**Figure 1. Physiology of calcium absorption and excretion**

#### **"CALCIUM WITH OR WITHOUT VITAMIN D SHOULD BE TAKEN WITH DINNER OR ON AN EMPTY STOMACH"**

There is no objective reason to justify this assertion. The most frequently used calcium salt is calcium carbonate, which is best absorbed in acidic media<sup>8</sup>. Therefore, calcium should be taken at the time when there is more acid in the stomach, which is just after lunch. As in our culture the most important meal is made at noon, it is after lunch when calcium should be taken. In the Anglo-Saxon culture, where people generally have a lighter lunch and a more abundant dinner, calcium should be taken after dinner, but always at the end of it.

Other salts such as citrate or calcium pidolate are better absorbed than carbonate, but are more expensive and, therefore, much less used. There is no reason to indicate fasting calcium intake and even less so that it is at night.

#### **"DAIRY INTAKE (BY DIET OR THROUGH SUPPLEMENTS) INCREASES THE RISK OF LITHIASIS AND ISCHEMIC HEART DISEASE"**

It is a mistake to think that the calcium ingested by the diet or by supplements is immediately eliminated by the kidney, and that in the case of taking an excess of this mineral an increase in the risk of lithiasis is observed. All calcium kinetics are strictly regulated by the hormones involved in it: PTH, calcitonin and vitamin D itself, in addition to the kinetics itself that regulates the intra and extracellular flow of calcium.

We should take into account It should be taken into account what is indicated in the second section: a diet low in calcium causes the stimulation of PTH and this increases the urinary excretion of calcium<sup>2</sup>. Conversely, in patients with hypercalciuria, calcium and vitamin D supplementation produced a decrease in calciuria<sup>5</sup> and a decrease in recurrence of renal colic<sup>9,10</sup>.

**Table 1. Calcium content: milligrams per 100 g of edible portion of the product**

| Foods  | Calcium content |
|--|-----------------|
| Cured manchego cheese                        | 1,200           |
| Gruyere cheeses, emmental, roquefort         | 560 – 850       |
| Fresh manchego cheese                        | 470             |
| Sardines in oil                              | 400             |
| Almonds, hazelnuts                           | 240             |
| Crayfish, prawns, prawns...                  | 220             |
| Burgos' cheese                               | 186             |
| Yogurt                                       | 127 – 180       |
| Dried figs                                   | 180             |
| Ice creams                                   | 150             |
| Chickpeas                                    | 145             |
| Custard and flan                             | 140             |
| Pistachios                                   | 136             |
| Cow milk                                     | 130             |
| White beans, dried beans                     | 130             |
| Clams, cockles, chirlas...                   | 120             |
| Milk chocolate                               | 120             |
| Milkshakes                                   | 120             |
| Chard, thistle, spinach, leek...             | 87 – 114        |
| Cheese in portions                           | 98              |
| Nuts, dates, raisins...                      | 70              |
| Olives                                       | 63              |
| Cottage cheese and curd                      | 60              |
| Lobster and lobster                          | 60              |
| Lentils                                      | 56              |
| Chicken egg                                  | 51              |
| Cod  | 51              |
| Cakes, pasta...                              | 48              |
| Sardines                                     | 43              |
| Artichokes, cabbage, cabbage, green beans... | 40              |

**Table 2. Recommended daily amounts of calcium according to age. (National Institutes of Health, NIH)<sup>4</sup>**

| Stage of life  | Recommended amount |
|--|--------------------|
| Babies up to 6 months                                | 400 mg             |
| Babies between 6 months and 1 year                   | 600 mg             |
| Children 1-5 years                                   | 800 mg             |
| Children from 6 to 10 years old                      | 800 – 1,200 mg     |
| Adolescents and young adults from 11 to 24 years old | 1,200 – 1,500 mg   |
| Women from 25 to 50 years old                        | 1,000 mg           |
| Pregnant or breastfeeding women                      | 1,200 – 1,500 mg   |
| Postmenopausal women with estrogenic therapy         | 1,000 mg           |
| Postmenopausal women without estrogen therapy        | 1,500 mg           |
| Men from 25 to 65 years old                          | 1,000 mg           |
| Men and women over 65                                | 1,500 mg           |

In the same way, the ingested calcium will not be deposited directly in the arteries increasing the risk of arteriosclerosis and, underlying, the risk of ischemic heart disease. Some authors have suggested that the use of calcium supplements causes an increased risk of ischemic heart disease, myocardial infarction and sudden death<sup>11-13</sup>. These very alarming studies have had a great impact on the scientific community, are methodologically debatable, since they are mostly meta-analysis. In some of them, the diagnosis of myocardial infarction was self-reported, without medical reports<sup>13</sup>. Almost immediately, other meta-analyses published opposite results. With the data we have today, it should not be feared that calcium supplements, with or without vitamin D, increase the risk of lithiasis or ischemic heart disease<sup>14-18</sup>.

#### **"IN SPAIN THERE IS NO VITAMIN D DEFICIT AS IT IS A VERY SUNNY COUNTRY"**

This is one of the biggest myths. Spain is a world-class tourist destination, especially for its sun. So it is mistakenly thought that we enjoy that sun year round and, the most important mistake, that we take advantage of it properly.

In the first place, the country's location on the Earth, oblique with respect to its axis, means that we can only properly take in the sun's rays during the summer months. Outside this season, above the 35th parallel the sun's rays do not reach earth properly and almost all of Spain is above that parallel<sup>19</sup>, with the exception of the Canary Islands.

Another circumstance that impedes the population from not taking advantage of the hours of sunshine is our lifestyle. We spend most of our life indoors. When we go out we do so fully dressed. In the sunnier months, because of the high temperatures we avoid going out. A fear of skin cancer means what little sun exposure we have is done with sunscreen, which minimizes vitamin D synthesis.

Thus there is a reported vitamin D deficiency in Spain similar to that of other European countries, both in healthy pre- or postmenopausal women<sup>20</sup>, as well as in those with osteoporosis<sup>21</sup>, and much more if they are isolated in chronic centers<sup>22</sup>. In Nordic countries, where they are aware of this problem, supplemented foods are available with vitamin D<sup>23</sup>. Thus, serum levels of the vitamin D or 25 (OH) vitamin D (25(OH)D) reserve are curiously lower in Spain, a "sunny par excellence" country than in the Nordic region. This has been called the "vitamin D paradox"<sup>24</sup>.

Just to offer one example, the medical students of the University of Las Palmas de Gran Canaria, would be ideal candidates to present optimal levels of vitamin D: they are healthy, young, informed about the physiology of vitamin D and with all the hours of sunshine available. However, not taking advantage of these hours (they spend most of their time inside hospitals, classrooms and libraries), an insufficiency was reported –figures below 30 ng/ml of 25(OH)D– in 61% of them<sup>25</sup>. Similar results were found in elite athletes in Spain<sup>26</sup>.

**Table 3. Vitamin D metabolites**

| Metabolite | Name       | Utility                 | Tradename  |
|------------|------------|-------------------------|------------|
| D3         | Calciferol | Substratum              | Cadelius D |
| 25(OH)D    | Calcidiol  | Measure the reservation | Hidroferol |
| 1,25(OH)2D | Calcitriol | Active principle        | Rocaltrol  |

**"ALL VITAMINS D ARE THE SAME"**

The skin synthesizes the first metabolite of vitamin D, which is the substrate, called calciferol. This is transported by a transport protein, the DBP (vitamin D binding protein) to the liver, where hydroxylation occurs, synthesizing calcidiol, which is an ideal metabolite to measure the body's vitamin D pool. Calcidiol is much more active than calciferol. These drugs are equally effective for us<sup>27</sup>.

Finally, with the same transporter protein, 1 alpha hydroxylation is produced in the kidney, the final result being 1.25 dihydroxycholecalciferol or calcitriol, the biologically active metabolite (actually a hormone), which is what binds to the receptors of vitamin D (VDR) in virtually all body tissues<sup>28</sup>.

To estimate serum vitamin D levels, the ideal metabolite is calcidiol<sup>29</sup>. However, for the therapeutic use of vitamin D supplements, the metabolite of choice is calciferol, for two reasons: first, it is the safest, since being at the beginning of the physiolo-

gical chain, the body is able to direct the same towards the production of more or less active metabolites, since it has many reserve metabolites. Second, all the studies carried out in the field of osteoporosis with the reference drugs have been with calciferol<sup>30</sup>.

Calcidiol should be reserved for patients suffering from liver failure and in cases of severe vitamin D deficiency, to obtain a rapid recovery from normal levels. However, given its potency, cases of hypercalcemia have been described with its use<sup>31</sup>, and recently the Spanish Agency for Medicines and Health Products (AEMPS) has published a warning about several cases of poisoning with this drug<sup>32</sup>.

Finally there is calcitriol, the active metabolite and, therefore, the hormone as such<sup>33</sup>. With its use, serum calcium levels should be monitored due to the risk of hypercalcemia. It is a potentially dangerous drug and, therefore, its dispensation is regulated by an inspection visa (see table 3).



**Conflict of interests:** The authors declare no conflict of interest.

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**SELF ASSESSMENT TEST****1. The mandatory calcium losses are:**

- a. *Through the skin, and breathing, about 250 mg daily*
- b. *By stool and breathing, about 500 mg daily*
- c. *In urine, about 400 mg daily*
- d. *Urine and feces, about 1,000 mg daily*

**2. A woman after menopause is advised to take daily:**

- a. *250 mg of calcium*
- b. *500 mg of calcium*
- c. *1,000 mg of calcium*
- d. *1,500 mg of calcium*

**3. The Spanish paradox of vitamin D indicates:**

- a. *That vitamin D is not what it seems to be*
- b. *That vitamin D levels are normal in Spain*
- c. *That vitamin D levels are low in the Nordic countries*
- d. *All of the above is false*

**4. Which of the following foods has a higher calcium content in milligrams per 100 g of edible portion:**

- a. *Olives*
- b. *Sardines*
- c. *Chicken eggs*
- d. *Cured Manchego cheese*

**5. What is the prevalence of hypovitaminosis D in medical students of the University of Las Palmas de Gran Canaria? (25HCC values below 30 ng/mL):**

- a. *15%*
- b. *25%*
- c. *40%*
- d. *61%*

*Correct answers can be found on pages 23 and 24*