SUPPLEMENT FACTS ..... Vitamin D

What is vitamin D?
Vitamin D is a fat-soluble vitamin that is converted to a hormone.

What is a hormone?

Hormones are chemical messengers that we produce in our body tissues. They have wide-ranging effects. Hormones can affect metabolic processes in many parts of the body.

How do we get vitamin D?

There are two sources of vitamin D: your diet and your exposure to sunlight.

If your skin is exposed to sunlight, ultraviolet B (UVB) radiation is absorbed by provitamin D in your skin and converted to vitamin D_3.

A few foods are natural sources of vitamin D_3. These include oily fish like sardines, salmon, and mackerel, cod liver oil, and egg yolks. Fish generally contains 400–500 international units (IU) per 3.5 ounces or teaspoon (tsp) of oil. Egg yolks contain roughly 100 IU. Irradiated mushrooms are a source of vitamin D_2, another form of vitamin D that can be used by the body.

Foods in the United States are generally fortified with vitamin D_3, while many supplements and multivitamin preparations use vitamin D_2. In the United States milk and orange juice are fortified (100 IU/8 ounces). Some cereals, yogurts, and breads also may have added vitamin D of various levels, but you must check the labels to be sure. According to research published in 2009, vitamin D_3 and D_2 appear equally effective in maintaining blood levels of vitamin D.

What is an IU?

IU is shorthand for international unit, which is used to estimate biological activity. An IU for vitamin D is the biological equivalent of 0.025 micrograms of cholecalciferol (vitamin D_3) or ergocalciferol (vitamin D_2).

How is vitamin D from the skin or diet metabolized in the body?

The vitamin D_3 or D_2 you eat is carried to your liver, where it is converted to 25-hydroxyvitamin D, or 25(OH)D for short. This then travels through the blood and can be taken up and converted to 1,25-dihydroxyvitamin D ($1,25[OH]_2D$) in various tissues.

$1,25(OH)_2D$ is the "active" form of the vitamin and has the most effect on cellular functions. Until recently this conversion to $1,25(OH)_2D$ was thought to mainly occur in the kidney. Now scientists have found that $1,25(OH)_2D$ can be made in breast, colon, prostate, skin, and ovary tissue in addition to the kidney. Conversion in the kidney is tightly regulated and affects mainly calcium and phosphate metabolism.

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What does vitamin D do for me?

Some impacts, such as those for bone health, are well established. Vitamin D (1,25 $[OH]_2D$) maintains calcium and phosphate levels in the blood in cooperation with parathyroid hormone (PTH). Vitamin D increases the absorption of calcium from the intestine by 50–80 percent and of phosphorus by 20 percent. Without vitamin D only 10–15 percent of dietary calcium is absorbed. Without adequate vitamin D, the calcium necessary to keep serum calcium at desired levels is taken from the bone through actions of PTH.

In adults, vitamin D deficiency can result in osteopenia and osteoporosis, plus increased risk of fracture. Adults can also develop osteomalacia, a condition similar to rickets in children.

In adolescents, vitamin D deficiency can lead to rickets. Signs include bone pain or tenderness, muscle weakness, increased tendency for fractures, and skeletal deformity such as bowed legs or knocked knees.

Other effects of vitamin D are emerging because scientists now realize that many body tissues can make 1,25$(OH)_2D$ from 25(OH)D. Many of these new findings about effects of vitamin D are not based on actual tests in humans. Instead they are based on epidemiological studies of adults, experiments with animal cells, or whole-animal experiments. Epidemiological studies only establish associations between a characteristic, like getting less sunlight and occurrence of a disease. They do not establish cause and effect. However, higher vitamin D intake has been associated with the following:

- Lower risk of certain types of cancer (colorectal, prostate, and breast). Those living in the south or at lower latitudes have lower risk of these cancers. This is attributed to greater sunlight exposure. A study that compared women taking 1,100 IU/day for five years to a control group that did not found a 77 percent reduction in cancer risk for the vitamin D dose. This anticancer effect is thought to be due to the ability of 1,25$(OH)_2D$ produced in these tissues to decrease rapid cell division, a characteristic of cancer cells. However, studies do not consistently show a protective effect of vitamin D. Some studies with smokers actually suggest high intakes of vitamin D may increase risk of certain cancers.
- Reduced risk of cardiovascular disease, including high blood pressure. When hypertensive patients received UVB irradiation that raised blood levels of 25(OH)D, their blood pressure was reduced compared to hypertensives that did not receive UVB treatment. Vitamin D is also thought to affect blood pressure regulation and reduce the inflammation responsible for heart disease.
- Lower risk of type 1 diabetes. Children who received the recommended vitamin D dose as a supplement in the first year of life had an 80 percent lower risk of developing type 1 diabetes in the next thirty-one years.
- Lower risk of autoimmune diseases like rheumatoid arthritis, multiple sclerosis, and Crohn's disease and of acquiring active tuberculosis.

How much vitamin D do I need?

Determining how much vitamin D you need depends whether you are deficient or sufficient in vitamin D. A sufficient blood level of vitamin D is more than 30 ng/ml (nanograms per milliliter). For an adult or child with sufficient blood levels of vitamin D, 800–1,000 IU of vitamin D daily will generally maintain that level. If your blood level of 25(OH)D is below 30 ng/ml, then see answers to questions below.

How can I determine if I am vitamin D deficient?

Your doctor can prescribe a test to determine the level of vitamin D in your blood. Blood levels of 25(OH)D are the best indicator of vitamin D status. Currently, the following blood levels of 25(OH)D are considered:

- Deficient = less than 20 ng/ml (less than 50 nmol/L [nanomoles per liter])
- Insufficient = between 21 and 29 ng/ml (52.5–72.5 nmol/L)
- Sufficient = 30 ng/ml or greater (more than 75 nmol/L)

What should I do if I am vitamin D deficient?

Your doctor should prescribe a vitamin D supplement. The dose needed to bring blood 25(OH)D to satisfactory levels may vary from 3,800 to 5,000 IU per day. This should be done under a doctor's supervision.

Why does the recommendation of 800–1,000 IU of vitamin D per day for adults differ from the Dietary Reference Intakes?

Scientists are debating whether the Dietary Reference Intakes (DRIs) for vitamin D, established by the Food and Nutrition Board of the National Academy of Sciences, are sufficient. The current recommendations are:

- Birth to 50 years = 200 IU per day (regardless of sex, pregnant, or lactating)
- Age 51–70 = 400 IU per day
- Age 71+ = 600 IU per day

Recent studies indicate that more people are vitamin D deficient than anticipated. Fortification of foods does not seem to be preventing this. In the United States, fortification rules allow manufacturers the option of adding vitamin D to fluid milk (400 IU/qt) and other dairy products in smaller amounts. Vitamin D fortification is only required of evaporated or dry milk. Under food additive regulations, regulated amounts of vitamin D may be added to juice or cereals. In reality, in addition to canned fish, only milk, cereal, and some orange juices are reliable sources of vitamin D in your supermarket. Because higher intakes of vitamin D have been associated with less risk of some chronic diseases, the Food and Nutrition Board is reviewing the research data to see if the DRIs should be increased.

What is the recommended level of vitamin D for children?

In the past it was assumed that vitamin D fortification would supplement sun exposure and prevent vitamin D deficiencies in children. Unfortunately, cases of rickets continue to be reported in children and adolescents. As a result, in 2008 the American Academy of Pediatrics recommended that all children, including those exclusively breastfed, and adolescents get 400 IU of vitamin D per day.

How much sunlight is needed to produce sufficient vitamin D?

Production of vitamin D in the skin depends on how far north or south you live (latitude), cloud cover, time spent outdoors, clothing, skin pigmentation, your age, and use of sunscreens. In the spring, summer, and fall, exposing your arms and legs to sunlight without sunscreen for 15–30 minutes between 10:00 AM and 3:00 PM will provide all the daily need of vitamin D. Any excess is stored in body fat and released in the winter.

However, if you live above 35°N latitude, the sun's radiation that reaches the Earth's surface in the winter is so reduced by ozone levels that production of vitamin D_3 in winter is virtually zero. This applies to three-quarters of the United States (see **www.enchantedlearning.com/usa/activity/latlong**). This happens because the northern hemisphere is tilted away from the sun, so the UV rays have longer to travel to the Earth's surface in the winter.

Individuals of African or East Asian origin have melanin levels that act like sunscreen with protection levels of 8. They have reduced capacity to make vitamin D in the skin. Aging also reduces our capacity to produce provitamin D and thus our ability to produce vitamin D in our skin. However, even elderly exposed to sunlight can still produce some vitamin D and increase blood levels.

How does sunscreen affect the skin's ability to make vitamin D?

Proper use of a sunscreen with a protection factor equal to 8 or higher will reduce skin synthesis of vitamin D by more than 95 percent. Sunscreen with higher protection will reduce it to near zero.

Who is particularly at risk for vitamin D deficiency?

Those with kidney disease are at risk because the kidney is one of the major sites for conversion of 25(OH)D to its active form. Obese individuals can be deficient as they store their vitamin D in body fat, making it less available for use. Certain medications (e.g., cholestyramine) can prevent its absorption or cause its breakdown (e.g., antiepileptic medications, corticosteroids, rifampicin, certain herbal supplements). Always check with your doctor or pharmacist about side effects of any medication.

The largest group at risk are those who get little sun exposure any time of the year, eat few food sources, and do not take a vitamin supplement containing vitamin D_3 or D_2.

What level of vitamin D is toxic?

Toxic levels are never produced in the skin. Dietary sources can be toxic if eaten daily in large amounts, usually considered more than 10,000 IU per day.

While healthy adults have taken 10,000 IU per day for five months with no toxic symptoms, the Food and Nutrition Board has set upper tolerable limits for vitamin D intake at 2,000 IU per day. This recommendation should be considered in any long-term treatment for vitamin D deficiency.

The effects of taking high levels (5,000–10,000 IU) daily for years are not known. There is no scientific data to support such intake levels. Vitamin D is converted to a hormone and has widespread effects in the body. We are still learning about the effects of this hormone, some of which could be undesirable.

Quick Facts

- Provitamin D (7-dehydrocholesterol): found in your skin
- Vitamin D_3 (also called cholecalciferol): produced in your skin from provitamin D through UVB irradiation
- Vitamin D_2 (also called ergocalciferol): produced in fungi like mushrooms from UVB irradiation action on ergosterol
- 25-hydroxyvitamin D (25[OH]D): produced in the liver from D_2 or D_3 you eat or make in your skin; amount of this compound in your blood determines your vitamin D status
- 1,25-dihydroxyvitamin D ($1,25[OH]_2D$), or calcitriol: the "active" product made from 25(OH)D in your kidneys or other tissues

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