

Vitamin D and Your Health

Chances are if you have been to the doctor lately, you have been told your vitamin D levels are low. It turns out most Americans have lower than recommended vitamin D levels. What is vitamin D and how much do you need?

Vitamin D is a fat-soluble vitamin that is not found naturally in very many foods. It is added to some foods such as milk, some yogurt, some orange juice and some ready-to-eat cereals. It is also available as a dietary supplement either alone or as part of multi-vitamin/mineral supplements. Our bodies can produce some vitamin D when our skin is exposed to ultraviolet rays from sunlight. The vitamin D produced from sun exposure is called **cholecalciferol** or **vitamin D₃**. Vitamin D₃ is also found in a few animal products and in supplements. **Vitamin D₂** or **ergocalciferol** is found in plants and fungus and some supplements. Both forms have to go through a couple of reactions in the body for them to become the active form of the vitamin called **calcitriol**. These reactions occur first in the liver and then in the kidney.

We have known for a long time that vitamin D is needed for calcium to be absorbed by the intestine and for maintaining normal calcium and phosphate concentrations in the blood. It is also needed for bone growth and bone remodeling, where it helps prevent bones from becoming thin and brittle. Adequacy of vitamin D used to be based on the amount needed to prevent rickets in children and osteomalacia in adults. More recently, scientists have discovered other roles for vitamin D.

Vitamin D is involved in:

- controlling nerve and muscle function;
- proper immune function;
- reduction of inflammation;
- optimal bone health;
- mental performance and mood; and
- reducing the risk of some types of dementia and autoimmune diseases such as rheumatoid arthritis and type 1 diabetes.

A person's vitamin D status can be determined by measuring the amount of vitamin D in the blood serum. Blood levels reflect vitamin D produced in the skin and that obtained from food and supplements. Serum vitamin D levels are generally measured in nanograms per milliliter (ng/mL) or nanomoles per liter (nmol/L). You might see it written either way. One ng/mL is equal to 2.5 nmol/L. A concentration of less than 20 ng/mL is considered low because it is generally not enough to prevent rickets or keep bones healthy. Many nutrition experts believe we need serum levels of between 30 ng/mL and 40 ng/mL for overall health and to prevent diseases such as diabetes and certain cancers.

How Much Vitamin D Do You Need?

The Food and Nutrition Board (FNB) at the Institute of Medicine has set Adequate Intakes (AI) for vitamin D for various age groups. AI represents a daily intake that is sufficient to maintain bone health and normal calcium metabolism in healthy people. AIs for vitamin D are listed in Table 1 in both micrograms (mcg) and International Units (IUs). One mcg is equal to 40 IU. In setting the AIs for vitamin D, the FNB did not include the potential vitamin D made by exposure to sunlight. The AI is based on getting all vitamin D from food and supplements.

Table 1: Adequate Intakes (AIs) for Vitamin D Established by the FNB

| Age | Children | Men | Women | Pregnancy | Lactation |
|-------------------|-------------------|--------------------|--------------------|-------------------|-------------------|
| Birth to 13 years | 5 mcg (200 IU) | | | | |
| 14-18 years | | 5 mcg (200 IU) | 5 mcg (200 IU) | 5 mcg (200 IU) | 5 mcg (200 IU) |
| 19-50 years | | 5 mcg (200 IU) | 5 mcg (200 IU) | 5 mcg (200 IU) | 5 mcg (200 IU) |
| 51-70 years | | 10 mcg (400 IU) | 10 mcg (400 IU) | | |
| 71+ years | | 15 mcg (600 IU) | 15 mcg (600 IU) | | |

In 2008, the American Academy of Pediatrics (AAP) recommended increasing vitamin D intakes above the FNB recommendations. The AAP recommendations are based on more recent research and the history of safe use of 400 IU/day of vitamin D in children. AAP recommends that breastfed infants receive supplements of 400 IU/day of vitamin D shortly after birth and continue to receive these supplements until they are weaned and consume 1,000 mL/day or more of vitamin D-fortified formula or whole milk. Similarly, all formula-fed infants eating less than 1,000 mL/day of vitamin D-fortified formula or milk should receive a vitamin D supplement of 400 IU/day. AAP also recommends that older children and adolescents who do not obtain 400 IU/day through vitamin D-fortified milk and foods should take a 400 IU vitamin D supplement daily.

Many well-known nutrition scientists believe current vitamin D recommendations are outdated and should be updated based on recent studies. In order to achieve optimal blood levels of vitamin D (36 ng/mL or higher), some experts recommend 3,000 to 4,000 IUs per day. Because vitamin D is not found in a lot of foods, many physicians are now recommending their patients take supplements with 1,000 to 2,000 IU/day.

Sources of Vitamin D

Food

Very few foods in nature contain vitamin D. Fish such as salmon, tuna and mackerel and fish liver oils are among the best sources. There are small amounts of vitamin D in beef liver, cheese and egg yolks. Vitamin D in these foods is mainly in the form of vitamin D₃ (cholecalciferol). Some mushrooms provide vitamin D₂ (ergocalciferol) in variable amounts.

Fortified foods provide most of the vitamin D in the American diet. For example, almost all of the U.S. milk supply is fortified with 100 IU/cup of vitamin D. Some, but not all, yogurt is fortified; so make sure to check the label and buy the ones that are. Other dairy products made from milk, such as cheese and ice cream, are generally not fortified. Ready-to-eat breakfast cereals often contain added vitamin D, as do some brands of orange juice and margarine. Several food sources of vitamin D are listed in Table 2.

Sun Exposure

Vitamin D needs can potentially be met through exposure to sunlight. Ultraviolet (UV) B radiation from the sun penetrates uncovered skin and changes a form of cholesterol in the skin to previtamin D₃, which then becomes active vitamin D. Many factors influence the skin's ability to make vitamin D including season, geographic location, time of day, cloud cover, smog, skin pigment, age and the use of sunscreen. The UV energy in northern parts of the U.S., such as the states along the

Table 2: Selected Food Sources of Vitamin D

| Food | IUs Per Serving* | Percent DV** |
|--|-------------------------|---------------------|
| Cod liver oil, 1 tablespoon | 1,360 | 340 |
| Salmon, cooked, 3.5 ounces | 360 | 90 |
| Mackerel, cooked, 3.5 ounces | 345 | 90 |
| Tuna fish, canned in oil, 3 ounces | 200 | 50 |
| Sardines, canned in oil, drained, 1.75 ounces | 250 | 70 |
| Milk, nonfat, reduced fat, and whole, vitamin D-fortified, 1 cup | 98 | 25 |
| Fortified yogurt, 1 cup | 100 | 25 |
| Fortified orange juice, 1 cup | 100 | 25 |
| Margarine, fortified, 1 tablespoon | 60 | 15 |
| Ready-to-eat cereal, fortified with 10% of the DV for vitamin D, 0.75 to 1 cup (more heavily fortified cereals might provide more of the DV) | 40 | 10 |
| Egg, 1 whole (vitamin D is found in yolk) | 20 | 6 |
| Liver, beef, cooked, 3.5 ounces | 15 | 4 |
| Cheese, Swiss, 1 ounce | 12 | 4 |

*IUs = International Units.

**DV = Daily Value. DVs were developed by the U.S. Food and Drug Administration to help consumers compare the nutrient contents of products within the context of a total diet. The DV for vitamin D is 400 IU for adults and children age 4 and older. Food labels, however, are not required to list vitamin D content unless a food has been fortified with this nutrient. Foods providing 20 percent or more of the DV are considered to be high sources of a nutrient.

U.S./Canadian border, is not sufficient to make vitamin D during the winter months. In southern parts of the U.S., such as Arkansas and other southern states, the UV energy can produce vitamin D in the skin throughout the year. Research shows that a light-skinned person can make 10,000 IUs of vitamin D in 20 minutes of midday summer sun exposure. Persons with dark skin need longer exposure.

On a completely cloudy day, UV energy is reduced by 50 percent, so less vitamin D will be produced. Sunscreens with a sun protection factor (SPF) of 8 or more block vitamin D-producing UVB rays. Exposure to sunshine indoors through a window does not produce vitamin D at all because UVB radiation does not penetrate glass.

It is difficult to provide general guidelines for sun exposure. Some vitamin D researchers say 5 to 30 minutes of sun exposure between 10 a.m. and 3 p.m. at least twice a week to the face, arms, legs or back without sunscreen will usually make enough vitamin D. Commercial tanning beds that emit 2 to 6 percent UVB radiation are also effective but not necessarily recommended.

Because UV radiation is linked to most skin cancers in the United States, vitamin D experts recommend that healthy individuals leave sunscreen off different areas of exposed skin such as the face, arms, legs or back for 15 to 20 minutes two times a week and then apply sunscreen to the exposed area. Rotate the areas left bare so no one area is overexposed.

Dietary Supplements

Some vitamin D experts recommend that just about everyone take a vitamin D supplement. Two forms, D₂ (ergocalciferol) and D₃ (cholecalciferol), are used in supplements and fortified foods. The two forms have been thought to be equal based on their ability to cure rickets. But newer research suggests that vitamin D₃ could be more than three times as effective as vitamin D₂ in raising serum vitamin D concentrations and maintaining those levels for a longer time. Look for vitamin D₃ or cholecalciferol when purchasing supplements.

Vitamin D Intakes and Status

According to national nutrition and health data (2000-2004 NHANES), as many as 90 percent of U.S. adults have less than optimal levels of vitamin D. Generally, younger people have higher serum vitamin D levels than older people, males have higher levels than females and non-Hispanic whites have higher levels than Mexican Americans, who have higher levels than African Americans.

Vitamin D Deficiency

A vitamin D deficiency can occur when a person does not get enough dietary vitamin D or has limited exposure to sunlight, the kidneys cannot change vitamin D to its active form, or vitamin D is not well-absorbed from the digestive tract. People who might have vitamin D-deficient diets are those with milk allergies or lactose intolerance and those who are strict vegetarians.

Rickets and osteomalacia are the classical vitamin D deficiency diseases. The fortification of milk with vitamin D has made rickets a rare disease in the United States, but it does still occur, particularly among African American infants and children and children with limited exposure to the sun. Osteomalacia among adults causes achy bone pain and muscle weakness. Often symptoms go undetected in the early stages.

Who Is at Risk?

Americans aged 50 and older have an increased risk for low vitamin D status. As people age, skin cannot make vitamin D as efficiently and the kidney is less able to convert vitamin D to its active hormone form. As many as half of older adults in the United States with hip fractures could have low serum vitamin D levels.

Higher amounts of the pigment melanin reduce the skin's ability to make vitamin D from sunlight exposure. Some studies suggest that older adults, especially women, with darker skin are at high risk of developing vitamin D insufficiency.

Vitamin D requires some dietary fat in the intestine to be absorbed. People with a reduced ability to absorb dietary fat, such as those with pancreatic enzyme deficiency, Crohn's disease, cystic fibrosis, celiac disease, surgical removal of part of the stomach or intestines and some forms of liver disease might require vitamin D supplements.

Vitamin D and Health

Osteoporosis

Osteoporosis is an example of a long-term effect of calcium and vitamin D insufficiency. Supplements of calcium and vitamin D are often recommended to prevent osteoporosis.

Normal bone is constantly being broken down and rebuilt. During menopause, the balance between these processes changes, resulting in more bone being lost than rebuilt. A recent review of research concluded that supplements of both vitamin D₃ (at 700 to 800 IU/day) and calcium (500 to 1,200 mg/day) decreased the risk of falls, fractures and bone loss in elderly individuals aged 62 to 85 years. Women should consult their healthcare providers about their needs for vitamin D (and calcium) as part of an overall plan to prevent or treat osteoporosis.

Cancer

Some research suggests that vitamin D has a protective effect against colon, prostate and breast cancer. The data is stronger for reducing the risk of colon cancer than prostate and breast cancer. Further research is needed to determine the effects of vitamin D on cancer risk.

Other Conditions

A growing body of research suggests that vitamin D might play some role in the prevention and treatment of type 1 and type 2 diabetes, hypertension, glucose intolerance, multiple sclerosis and other medical conditions. However, more research is needed to confirm these associations.

Health Risks From Excessive Vitamin D

Too much vitamin D is rare. Some symptoms include nausea, vomiting, poor appetite, constipation, weakness and weight loss. Too much vitamin D can raise blood levels of calcium, causing mental status changes such as confusion and heart rhythm abnormalities. Excessive vitamin D levels can also cause calcium and phosphate to deposit in the kidneys and other soft tissue. Vitamin D toxicity is not going to be a problem for most people unless large amounts of cod liver oil or high levels of vitamin D supplements are consumed.

Interactions With Medications

Vitamin D supplements have the potential to interact with several types of medications. A few examples are provided below. Individuals taking these medications on a regular basis should discuss vitamin D intake with their healthcare providers.

Corticosteroid medications such as prednisone, often prescribed to reduce inflammation, can reduce calcium absorption and impair vitamin D metabolism. These effects can further contribute to the loss of bone and the development of osteoporosis associated with their long-term use.

Both the weight-loss drug orlistat (brand names XENICAL[®] and alli[™]) and the cholesterol-lowering drug cholestyramine (brand names Questran[®], LoCholest[®] and Prevalite[®]) can reduce the absorption of vitamin D and other fat-soluble vitamins. The anti-seizure medications phenobarbital and phenytoin (brand name Dilantin[®]) increase vitamin D metabolism in the liver to inactivate it, which can reduce calcium absorption.

Summary

We are learning more about vitamin D every day. There has been a lot of research in the past 10 years that may result in an increase in the recommended daily intake for vitamin D. In the meantime, the best ways to ensure you get enough are: eat foods that are naturally rich in vitamin D such as wild salmon, tuna and mackerel, and foods fortified with vitamin D such as milk and some yogurt, orange juice and cereal; expose bare skin to midday sunlight for 15 to 20 minutes twice a week; and take a vitamin D₃ supplement in an amount recommended by your doctor.

Adapted from *Dietary Supplement Fact Sheet: Vitamin D*. Available at <http://ods.od.nih.gov/factsheets/vitamind.asp>. Office of Dietary Supplements, National Institutes of Health. Posted 4/18/2008. Updated 12/11/2008. Accessed 5/18/09.

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