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Patient information: Vitamin D deficiency (Beyond the Basics)

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INTRODUCTION

Vitamin D plays an important role in many places throughout the body, including the development and calcification of the bones.

Adequate exposure to sunlight and the use of dairy products with vitamin D have significantly reduced the incidence of vitamin D deficiency. However, vitamin D deficiency is still a common problem in many populations, particularly older adults.

This topic reviews the major causes of vitamin D deficiency, including how it is diagnosed and treated, and safe ways to prevent vitamin D deficiency.

WHAT IS VITAMIN D?

Vitamin D is an oil-soluble vitamin that has several important functions in the body:

- It helps to absorb dietary calcium and phosphorus from the intestines.
- It suppresses the release of parathyroid hormone, a hormone that causes bone resorption.

Through these actions, vitamin D keeps the calcium and phosphate levels in the blood normal, thereby promoting bone health. Vitamin D may have other benefits, such as improving muscle and immune function, but these areas require more research.

Natural sources of vitamin D — Vitamin D is made in the skin under the influence of sunlight. The amount of sunlight needed to synthesize adequate amounts of vitamin D varies, depending upon the person's age, skin color, sun exposure, and underlying medical problems. The production of vitamin D from the skin decreases with age. In addition, people who have darker skin need more sun exposure to produce adequate amounts of vitamin D, especially during the winter months.

Another important source of vitamin D is foods, where it may occur naturally (in fatty fish, cod-liver oil, and [to a lesser extent] eggs). In the United States, commercially fortified cow's milk is the largest source of dietary vitamin D, containing approximately 100 International Units of vitamin D per 8 ounces. Vitamin D intake can be estimated by multiplying the number of cups of milk consumed per day by 100 (two cups milk = 200 International Units vitamin D). In other parts of the world, cereals and bread products are often fortified with vitamin D.

Although vitamin D is found in cod liver oil, some fish oils also contain high doses of vitamin A. Excessive vitamin A intake can be associated with side effects, including liver damage and fractures.

CAUSES OF VITAMIN D DEFICIENCY

The main reasons for low levels of vitamin D are:

- Lack of vitamin D in the diet, often in conjunction with inadequate sun exposure
- Inability to absorb vitamin D from the intestines
- Inability to process vitamin D due to kidney or liver disease

Inadequate intake — Infants, children, and elderly adults are at risk for low vitamin D levels because of inadequate vitamin D intake. Human breast milk contains low levels of vitamin D and most infant formulas do not contain adequate vitamin D. Elderly adults often do not consume enough vitamin D rich foods, and even when they do, absorption may be limited.

Inadequate sun exposure — Parents of infants and children are often advised to keep their child out of the sun, which reduces vitamin D synthesis from the skin. Exposure to the sun is not recommended as a source of vitamin D for infants and children due to the potential long-term risks of skin cancer. (See ["Patient information: Sunburn \(Beyond the Basics\)"](#).)

Adults who have limited sun exposure are also at increased risk of vitamin D deficiency, especially if their skin is dark. In addition, reduced amounts of vitamin D are made in the skin and stored in the body as we age. This is especially true in the winter months in some northern areas, such as Boston, Massachusetts and Edmonton, Alberta, where the skin virtually ceases to produce vitamin D between October and April. In the summer months, the use of sunscreen limits vitamin D synthesis.

Diseases or surgery that affect fat absorption — Certain diseases affect the body's ability to absorb adequate amounts of vitamin D through the intestinal tract. Examples of these include celiac disease, Crohn's disease, and cystic fibrosis.

Surgery that removes or bypasses portions of the stomach or intestines can also lead to low vitamin D levels. An example of this type of surgery is gastric bypass. (See ["Patient information: Weight loss surgery \(Beyond the Basics\)"](#).)

Kidney and liver disease — The liver and kidney have important enzymes that change vitamin D from the sun or food to the biologically active form of vitamin D. People with chronic kidney and liver disease are at increased risk of low active vitamin D levels because they lack these enzymes.

Less common causes of vitamin D deficiency include familial diseases that impair the enzymes in the liver or kidney that create the biologically active form of the vitamin. This results in inadequate amounts of active vitamin D.

POTENTIAL COMPLICATIONS OF VITAMIN D DEFICIENCY

The most serious complications of vitamin D deficiency are low blood calcium (hypocalcemia), low blood phosphate (hypophosphatemia), rickets (softening of the bones during childhood), and osteomalacia (softening of the bones in adults). However, these complications have become less common over time because many foods and drinks have added vitamin D.

"Subclinical" vitamin D deficiency or vitamin D insufficiency is common, and is defined as a lower than normal vitamin D level that has no visible signs or symptoms. However, vitamin D insufficiency is

associated with reduced bone density (osteopenia or osteoporosis), a mild decrease of the blood calcium level, elevated parathyroid hormone (which accelerates bone resorption), an increased risk of falls, and possibly fractures, all of which can seriously affect a person's quality of life.

Thus, identifying and treating vitamin D insufficiency or deficiency is important to maintain bone strength. Treatment may even improve the health of other body systems, such as the immune, muscular, and cardiovascular systems, although more research is needed in these areas.

DIAGNOSIS OF VITAMIN D DEFICIENCY

A low vitamin D level can be diagnosed with a blood test called 25 hydroxyvitamin D or 25OHD (OH = hydroxy, D = vitamin D). Although there is no formal definition of vitamin D deficiency, some groups use the following values in adults:

- A normal level of vitamin D is defined as a 25OHD concentration greater than 30 ng/mL (75 nmol/L).
- Vitamin D insufficiency is defined as a 25OHD concentration of 20 to 30 ng/mL (50 to 75 nmol/L).
- Vitamin D deficiency is defined as a 25OHD level less than 20 ng/mL (50 nmol/L).

Who needs testing for vitamin D? — Testing for vitamin D deficiency or insufficiency is not recommended for everyone, but may be advised for people who are home-bound or in a long term care facility (eg, nursing home), if the person has a medical condition that increases the risk of vitamin D deficiency or insufficiency, and for anyone with osteoporosis or a past history of a low-trauma fracture (eg, fracture after fall from standing), low blood calcium (hypocalcemia) or phosphate (hypophosphatemia). (See "[Patient information: Bone density testing \(Beyond the Basics\)](#)" and "[Patient information: Osteoporosis prevention and treatment \(Beyond the Basics\)](#)".)

TREATMENT OF VITAMIN D DEFICIENCY

Vitamin D supplements — There are many types of vitamin D preparations available for the treatment of vitamin D deficiency or insufficiency. The two commonly available forms of vitamin D supplements are ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3). We suggest vitamin D3 when possible, rather than vitamin D2, because vitamin D3 is the naturally occurring form of the vitamin and it may raise vitamin D levels more effectively.

Dosing — The recommended dose of vitamin D depends upon the nature and severity of the vitamin D deficiency.

In people who do not have problems absorbing vitamin D:

- In people whose 25OHD is <20 ng/mL (50 nmol/L), treatment usually includes 50,000 International Units of vitamin D2 or D3 by mouth once or more per week for six to eight weeks, and then 800 to 1000 (or more) International Units of vitamin D3 daily thereafter.
- In people whose 25OHD is 20 to 30 ng/mL (50 to 75 nmol/L), treatment usually includes 800 to 1000 International Units of vitamin D3 by mouth daily, usually for a three month period. However, many individuals will need higher doses. The "ideal" dose of vitamin D is determined by testing the individual's 25OHD level, and increasing the vitamin D dose if the level is not within normal limits.

- In infants and children whose 25OHD is <20 ng/mL (50 nmol/L), treatment usually includes 1000 to 5000 International Units of vitamin D2 by mouth per day (depending on the age of the child) for two to three months.

In people who have diseases or conditions that prevent them from absorbing vitamin D normally (eg, kidney or liver disease), the recommended dose of vitamin D will be determined on an individual basis.

In people whose vitamin D level is normal (>30 ng/mL [≥ 75 nmol/L]), a dose of 800 International Units of vitamin D per day is usually recommended. (See '[Prevention of vitamin D deficiency](#)' below.)

Do I need other vitamins or minerals? — During treatment for vitamin D deficiency, it is important to consume at least 1000 mg of calcium per day (for premenopausal women and men) and 1200 mg per day (for postmenopausal women).

Calcium can be found in food sources ([table 1](#)) or dietary supplements ([table 2](#)). (See "[Patient information: Calcium and vitamin D for bone health \(Beyond the Basics\)](#)".)

Monitoring — A blood test is recommended to monitor blood levels of 25OHD three months after beginning treatment. The dose of vitamin D may need to be adjusted based on these results.

Side effects — Side effects of vitamin D are uncommon unless the 25OHD level becomes very elevated (>100 ng/mL or 250 nmol/L) and the person is taking high dose calcium supplements. However, it is important to follow dosing instructions closely and to avoid taking multiple products that contain vitamin D (eg, multivitamin and vitamin D).

If 25OHD levels do become very elevated, complications such as high blood calcium levels or kidney stones can develop.

PREVENTION OF VITAMIN D DEFICIENCY

As mentioned previously, the amount of vitamin D you need per day to maintain a normal level of 25OHD depends upon your skin color, sun exposure, diet, and underlying medical conditions.

In general, adults are advised to take a supplement containing 800 International Units of vitamin D per day to maintain a normal vitamin D level. Older people who are confined indoors may have vitamin D deficiency even at this intake level. (See '[Vitamin D supplements](#)' above.)

All infants and children are advised to take a vitamin D supplement containing 400 International Units of vitamin D, starting within days of birth. For infants and children, vitamin D is included in most non-prescription infant multivitamin drops. In some countries, it is possible to buy infant drops that contain only vitamin D. (See "[Patient information: Breastfeeding guide \(Beyond the Basics\)](#)" and "[Patient information: Starting solid foods during infancy \(Beyond the Basics\)](#)".)

Exposure to the sun or tanning beds is not recommended as a source of vitamin D because of the risk of skin cancer.

WHERE TO GET MORE INFORMATION

Your healthcare provider is the best source of information for questions and concerns related to your medical problem.

This article will be updated as needed on our web site (www.uptodate.com/patients). Related topics for patients, as well as selected articles written for healthcare professionals, are also available. Some of the most relevant are listed below.

Patient level information — UpToDate offers two types of patient education materials.

The Basics — The Basics patient education pieces answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials.

[Patient information: Vitamin D deficiency \(The Basics\)](#)

[Patient information: Osteoporosis \(The Basics\)](#)

[Patient information: Calcium and vitamin D for bone health \(The Basics\)](#)

Beyond the Basics — Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are best for patients who want in-depth information and are comfortable with some medical jargon.

[Patient information: Sunburn \(Beyond the Basics\)](#)

[Patient information: Weight loss surgery \(Beyond the Basics\)](#)

[Patient information: Bone density testing \(Beyond the Basics\)](#)

[Patient information: Osteoporosis prevention and treatment \(Beyond the Basics\)](#)

[Patient information: Calcium and vitamin D for bone health \(Beyond the Basics\)](#)

[Patient information: Breastfeeding guide \(Beyond the Basics\)](#)

[Patient information: Starting solid foods during infancy \(Beyond the Basics\)](#)

Professional level information — Professional level articles are designed to keep doctors and other health professionals up-to-date on the latest medical findings. These articles are thorough, long, and complex, and they contain multiple references to the research on which they are based. Professional level articles are best for people who are comfortable with a lot of medical terminology and who want to read the same materials their doctors are reading.

[Causes of hypophosphatemia](#)

[Causes of vitamin D deficiency and resistance](#)

[Epidemiology and etiology of osteomalacia](#)

[Clinical manifestations, diagnosis, and treatment of osteomalacia](#)

[Endocrine dysfunction in the nephrotic syndrome](#)

[Etiology of hypocalcemia in adults](#)

[Geriatric nutrition: Nutritional issues in older adults](#)

[Overview of vitamin D](#)

[Pathogenesis of renal osteodystrophy](#)

[Treatment of vitamin D deficiency in adults](#)

The following organizations also provide reliable health information.

- Mayo Clinic

www.mayoclinic.com/health/vitamin-d/NS_patient-vitamind

- National Institutes of Health Office of Dietary Supplements

<http://ods.od.nih.gov/factsheets/vitamind.asp>

- American Academy of Dermatology

(www.aad.org/media/background/factsheets/fact_vitamind.htm)

- National Osteoporosis Foundation

(www.nof.org/aboutosteoporosis/prevention/healthyliving)

[1-3]

Literature review current through: Apr 2012. |This topic last updated: Feb 28, 2012.

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References

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2. Holick MF. Vitamin D deficiency. *N Engl J Med* 2007; 357:266.
3. Dawson-Hughes B, Heaney RP, Holick MF, et al. Estimates of optimal vitamin D status. *Osteoporos Int* 2005; 16:713.

GRAPHICS

Foods and drinks with calcium

Food	Calcium, milligrams
Milk (skim, 2 percent, or whole, 8 oz)	300
Yogurt (6 oz)	250
Orange juice (with calcium, 8 oz)	300
Tofu with calcium (1/2 cup)	435
Cheese (1 oz)	195 to 335 (hard cheese = higher calcium)
Cottage cheese (1/2 cup)	130
Ice cream or frozen yogurt (1/2 cup)	100
Soy milk (1 cup)	300
Beans (1/2 cup cooked)	60 to 80
Dark, leafy green vegetables (1/2 cup cooked)	50 to 135
Almonds (24 whole)	70
Orange (1 medium)	60

Elemental calcium content per pill of different calcium supplements

	Elemental Ca/tablet	Ca compound	Vitamin D
Caltrate + D	600 mg	Carbonate	800 Units
OsCal 500	500 mg	Carbonate	
OsCal 500 + D	500 mg	Carbonate	200 Units
Oscal 500 + Extra D	500 mg	Carbonate	400 Units
Oscal Ultra	600 mg	Carbonate	500 Units
Tums	200 mg	Carbonate	
Tums EX	300 mg	Carbonate	
Tums Ultra	400 mg	Carbonate	
Citracal Ultradense Petites	200 mg	Citrate	250 Units
Citracal caplets + D	315 mg	Citrate	250 Units
Citracal 250 + D	250 mg	Citrate	200 Units
Citracal + D Slow Release	600 mg	Citrate	500 Units
Caltrate 600 + soy	600 mg	Carbonate	200 Units
Cal-100 with vitamin D	1000 mg	Carbonate	400 Units
Citracal gummy	250 mg	Tricalcium phosphate	250 Units
Viactiv plus D + K	500 mg	Carbonate	500 Units

Units: International Units.