

## Vitamin D - Wellness Vitamin?

by Ann Gerhardt, MD

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**Bottom Line at the Top: Vitamin D prevents all kinds of diseases, from cancer to infections to osteomalacia. You may need supplements to optimize your health. Be sure to work with your physician to make sure you have enough.**

Vitamin D used to be a vitamin. Now it's a hormone, but people still call it a vitamin. Previously relegated to the bone and calcium category, we now know it benefits all the tissues of the body. It helps to prevent cancer, boost the immune system without letting it run amok, and keep the pancreas making insulin, the thyroid making thyroid and the muscles flexing when you need them.

It does all this and more by telling immature cells to grow up into functioning tissue and regulating cell growth. It tells cells to die when they are old and damaged. By taming unruly, immature cells and eliminating senescent cells, it keeps organs and tissue on a healthy path.

The definition of a vitamin is an "organic substance present in minute amount in natural foodstuffs, which is essential to normal metabolism, and the lack of which in the diet causes deficiency disease". Vitamin D satisfies requirements of being organic, present in small amounts in the diet (the only natural food sources are fatty fish, egg yolk and liver) and essential to metabolism. It doesn't satisfy the requirement that we must get it from food, however. We make vitamin D when sun-light converts a steroid in the skin to cholecalciferol (vitamin D<sub>3</sub>).

It also differs from most vitamins in how it works. Most vitamins act as an essential cog in an engine in which enzymes make things happen – things like metabolism, tissue building, infection fighting and organ function. Vitamin D doesn't work with enzymes. Instead it regulates DNA, our genetic material, to tell cells what to do.

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MIND AND BODY**

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Vitamin D requires conversion in the liver to the form that we measure in blood and is stored in fat and liver, called 25-OH- vitamin D. The kidney converts that form to active vitamin D (1,25-diOH-vitamin D). Active vitamin D made in the kidney travels in the blood to act on distant cells, like bone and intestine, to regulate their growth and function. Substances made in one part of the body but acting at distant locations are called hormones. We now call active vitamin D a hormone.

We previously believed that only the kidney made active vitamin D, but now we know that many cell types do. Other tissues differ from the kidney in that the active vitamin D they make stays local. Animals and humans without functioning kidneys have no circulating active vitamin D, which causes calcium and bone problems, but, with adequate vitamin D supply, their other tissues can keep making active vitamin D and stay healthy.

**Vitamin D does regulate calcium levels**, by telling the intestine to absorb calcium from food. It virtually yells at the intestine to bump up absorption if our dietary and blood calcium levels are low. Active vitamin D also regulates how much calcium we deposit in bone. Without it, children grow up with rickets, and adult bone grows weak with osteomalacia, a condition of plenty of bone protein matrix, but too little calcium attached to it.

**Rickets:** In the 1800's, as families moved to urban areas, sunlight-deprived children experienced an epidemic of rickets' soft, deformed bone. In the early 1900's scientists figured out that sunlight cures rickets. Irradiated food also did the trick. When vitamin D was isolated, food manufacturers fortified everything from hot dogs and peanut butter to soda and beer. When unregulated fortification led to vitamin D intoxication in young children, the fortification boom calmed down. The U.S. settled on cereal and milk fortification at safer levels.

**Osteoporosis:** Vitamin D does not cure osteoporosis. Bone consists of a protein matrix, to which calcium is attached. In osteoporosis we lose protein matrix and big holes appear, like Swiss cheese. There is nothing to

which calcium can attach. We need vitamin D to calcify bone, but to cure osteoporosis, we need to build matrix and calcify it.

**Cancer: THIS IS BIG.** With high levels of Vitamin D you are much less likely to get colon, pancreas, breast and prostate cancers.

As far back as 1941 a scientist noted that people in Northern states like Vermont suffered more cancer deaths than did people living in the deep South. This was in spite of more skin cancer in Southerners. It wasn't until 1980 that scientists found a possible connection with vitamin D.

Cells start out as immature stem cells, with no purpose or function except to mature into something else, like a muscle, skin, bone, immune system or liver cell. The maturation process is called differentiation. Active vitamin D signals cells to differentiate – To be all they can be as mature cells. Without the push toward functional cells, organs function less well and contain more immature cells with cancer potential.

Active vitamin D also tells defective cells to die, preempting their conversion cancer cells. Active vitamin D also pushes cells to firm up molecular defenses against oxidative stress. By promoting healthy cell maturation and differentiation, bolstering the anti-oxidant enzyme system and weeding out the “downers,” active vitamin D prevents cancer.

In a test tube active vitamin D tames leukemic cells into normal white blood cells. But it failed miserably in leukemic patients to cure their cancer, and induced a coma from severely high calcium levels. After all, raising calcium levels is one of active vitamin D's main functions.

Women consuming more vitamin D-fortified foods or exposed to more sunlight have less breast cancer. Active vitamin D enables breast cell maturation, controls cell growth and enables damaged cells to die. It is non-discriminatory in these effects, exerting population control on both estrogen-responsive and non-responsive cells. Animals lacking either the vitamin D receptor or the activating enzyme develop abnormal breast architecture, and more aggressive cancers.

The one cancer type that increases with higher vitamin D levels is skin cancer. The same sunlight that makes vitamin D in our skin causes radiation damage, leading to cancer. Sun worshipers may have a nice tan and high levels of vitamin D, but that vitamin D can't protect

against all the radiation damage. And using sun screen to prevent skin cancer reduces vitamin D levels, increasing risk of other cancers. The alternative is to use sun screen and eat fatty fish and fortified foods.

**Heart disease:** Vitamin D (but not calcium) seems to protect against high blood pressure and possibly heart disease. Blood pressure rises when the vitamin D level falls below 15 ng/ml or when someone lacks the enzymes that convert vitamin D to its active form. Active vitamin D blocks renin, a hormone the kidney releases to boost blood pressure.

The data about preventing heart disease is less convincing and lacks a plausible mechanism, but study results lean in the direction of benefit. Some people think that the fact that acute heart attacks peak in winter, when sunlight and vitamin D levels are low, points to a protective effect. People with chronic kidney disease treated with a vitamin D-like drug have heart muscle hypertrophy. The small number of studies and unresolved issues about the optimal dose of vitamin D pose obstacles to drawing firm conclusions.

Concerning heart attacks, we know that heart disease deaths have fallen off over the last decade, most likely due to statin use and better medical treatment. Could vitamin D supplements that people increasingly take to preserve their bones also be contributing? Some believe so. Whether or not optimal vitamin D levels can overcome lousy diets and lifestyles and truly reduce diabetes and vascular disease is currently unknown.

**Diabetes:** The data about vitamin D and diabetes are inconclusive at best. So far adequate vitamin D levels seem to improve insulin sensitivity, enable insulin secretion and be associated with less diabetes.

**Weight:** Vitamin D helps those who restrict calories to slim down. People with better vitamin D status lose more of their waistline than others with similar weight loss. It may also preserve muscle mass as people lose weight, without an effect on muscle strength.

**Infection:** It's well known that people catch fewer colds in the summer, when people emerge into the sun-light to make more vitamin D. People with higher year-round blood vitamin D levels also have fewer infections all year. For years patients with tuberculosis were sent to sanitariums in which they laid in beds out in the sun for their cure. Doctors presumed that sun exposure killed tubercle bacilli, but scientists now know that the extra sun-induced vitamin D boosted the immune system to

fight off the infection. The race is on to fully elucidate vitamin D's role in the immune system.

**Autoimmune disease:** Vitamin D may boost the immune system to fight an infection, but it squelches attacks on the body's own tissue. Vitamin D deficiency predisposes someone to autoimmune diseases like rheumatoid arthritis and lupus. Vitamin D selectively turns on growth of certain cells, called regulatory T lymphocytes. This type of white blood cell keeps us from attacking our own body, which is what an autoimmune disease does. Optimal vitamin D levels help to prevent these devastating inflammatory.

**Psoriasis:** Active vitamin D converts out-of-control skin cells, that would otherwise proliferate into psoriatic patches, into normal skin cells. Dermatologists now routinely use a number of vitamin D look-alikes to erase ugly psoriasis patches.

**How much is enough:** It's hard, living in the U.S.'s temperate climate to make all the vitamin D we need. We used to think levels of 20 ng/ml were adequate, but now we know that is nowhere near the level to optimize bone calcium (35 ng/ml) or prevent cancer (>50 ng/ml). To get to 50 ng/ml, you would need to sun-bathe, naked, every day for the four hours of the day in which the sun is most overhead. North of the equator the sun's rays are just not direct enough to stimulate much vitamin D synthesis. And forget even trying in the winter.

Some people have low vitamin D levels no matter how much sun they get. Naturally dark skin blocks UV radiation, reducing vitamin D synthesis. A prevalent idea in the vitamin D science community is that this is why African-Americans have more severe high blood pressure and heart disease. Some individuals naturally have an excess amount of CYP24A1, a protein that chews up vitamin D, depleting levels. People with malabsorption or celiac disease have trouble absorbing vitamin D from food. All these types of people often need mammoth vitamin D supplement doses.

The recommended daily allowance depends on age, from 200 IU (10 mcg) in children to 600 IU in the elderly. This dose was established to prevent rickets, not cancer. With plenty of sun and vitamin D in the diet, one *may* be able to get to a desirable vitamin D level with the RDA. Often it takes much more, on the order of 1000-2000 IU per day. Even then, older people are resistant to active vitamin D's action on the gut - Even with good levels and conversion to the active form, calcium absorption may be inadequate.

Natural vitamin D in humans and other animals is **cholecalciferol (vitamin D<sub>3</sub>)**. Dietary sources of vitamin D<sub>3</sub> are cod liver oil, fatty fish (which can deliver the recommended allowance in one serving), egg yolk, liver, and fortified food - milk, orange juice, ready-to-eat cereal, margarine and yogurt.

**Ergocalciferol is called vitamin D<sub>2</sub>, but it is not vitamin D and is not bio-equivalent.** It is made from irradiating the sterols in foods, primarily in fungi. One IU of vitamin D<sub>3</sub> from cod liver oil is as good as four IU from irradiated foods. Some stores sell irradiated mushrooms as sources of vitamin D. It is available as 50,000 IU capsules by prescription. Vitamin D<sub>2</sub> is less efficiently converted by the liver to circulating vitamin D, binds less well to the protein that carries it to cells and disappears from the blood sooner than vitamin D<sub>3</sub>.

Some propose a dose of 4000 IU per day for lactating women. That's a high dose, far more than previously ever used or recommended, because of worry that extra vitamin D would dangerously elevate blood calcium levels, sending us into a coma. Turns out that that only happens if you have an underlying disorder, such as parathyroid tumor, that raises calcium levels. You wouldn't know that you have one of these conditions unless you check, so if you start high dose vitamin D, ask your doctor to check a calcium level once for safety. Or wait to get loopy and drift into off to sleep.