Vitamin D: What's Enough?

Many people may need much more

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Second in a two-part series. Part I: "Vitamin Boost" is available at http://www.sciencenews.org/articles/20041009/bob8.asp.

A few minutes of sun exposure on a summer day can generate huge quantities of vitamin D in a person's body. A cholesterol-like substance in the skin absorbs ultraviolet (UV) energy and creates vitamin D. Then, a cascade of chemical reactions turns vitamin D into a surprisingly versatile hormone—one that has long been recognized to help the body absorb calcium from the diet to build strong bones. Recent work, however, indicates that vitamin D also bolsters muscle strength, insulin action, immune health, and the body's natural defenses against cancer.

Inhabitants of the tropics typically have plenty of vitamin D, says Robert P. Heaney of Creighton University in Omaha, Neb. However, studies are now showing that people throughout the industrial world lag far behind. Many in temperate and colder climates don't reach the doses currently recommended to protect bone health, much less the far-higher amounts that research has been linking to additional health-promoting functions.

Some scientists are campaigning for additional vitamin-D enrichment of foods. Others advocate that people spend more time outdoors to increase vitamin D–producing sun exposure. Many hold that the boost must come largely from supplements.

What researchers who study vitamin D do agree on is that many people would benefit from more of the vitamin. At issue is only how much.

Out of the tropics

The Food and Nutrition Board of the National Academies in Washington, D.C., currently recommends that people from infancy through age 50 get 200 international units (IU) of vitamin D per day, that those ages 51 through 70 receive 400 IU daily, and that anyone over 70 get a net of 600 IU from sun, food, and supplements.

That's easy enough to do if you're, say, a white person working outdoors during the summer in New Jersey. In shorts and a T-shirt, such a person can soak up enough ultraviolet rays to produce 12,000 IU of vitamin D within 20 minutes, notes Reinhold Vieth of the University of Toronto.

That production would plummet if the person stayed indoors or slathered on UV-blocking sunscreen or covered up with clothing when out of doors, as recommended for protection against skin cancer.

Global location and skin color also affect the amount of vitamin D a person's skin manufactures. UV intensity falls as one moves from the equator toward Earth's poles, increasing latitude. Evolution compensated by selecting for increasingly unpigmented skin in northern populations, says Boston University endocrinologist Michael F. Holick.

Melanin pigment protects the skin from the damage of UV rays but also lowers the skin's production of vitamin D. In the March *American Journal of Clinical*

Nutrition, Holick quantifies this effect: Fair-skinned people who sunburn easily and rarely tan need just 2 to 10 percent as much sun exposure to produce a unit of vitamin D as do people with the darkest skin.

Season also matters. Holick has found that from the latitude of San Francisco northward—or from Buenos Aires southward—for 3 to 6 months a year, no amount of exposure will generate substantial vitamin D in even the palest skin. Holick composed a map of North America that shows the minutes of exposure each skin type needs to generate some 1,000 IU of vitamin D without risking sunburn. For instance, a dark-skinned individual living in Anchorage can get that amount in 20 to 30 minutes midday in July, Holick reports in his new book *The UV Advantage* (2004, with Mark Jenkins, ibooks). A pale person in Honolulu might do it in 1 minute.

Finding sufficiency

Severe vitamin D deficiency softens bones. In children, the result is rickets, characterized by malformed legs. Adults may develop a rare condition called osteomalacia, distinguished by weakened muscles as well as bones. Seventy-five years ago, when the cause of rickets and osteomalacia was first recognized, the remedy was vitamin D–rich cod liver oil. Later, the United States mandated that dairies fortify milk with 100 IU of vitamin D per 8 ounces, and rickets essentially disappeared.

However, rickets has staged a comeback in the U.S. There is no national count, but according to Laurence Grummer-Strawn of the Centers for Disease Control in Atlanta, between 1997 and 1999, "5 per million Georgia children were hospitalized with rickets due to vitamin D deficiency." All were African American, 8 to 21 months old. Numbers could be higher in more-northern locales.

Scientists offer several explanations for rickets' reemergence. Vieth notes that breast-feeding has had a revival and that mother's milk delivers little vitamin D. And Holick points out that doctors have been discouraging parents from letting babies get sun without liberal doses of sunscreen. The Food and Nutrition Board last reviewed its vitamin D recommendations in 1997. As part of that effort, a panel of experts including Vieth, Holick, and Heaney was charged to define how the vitamin should be monitored in people. The active form wasn't deemed suitable because it's manufactured in the body on demand, so it doesn't directly correlate with vitamin D intake and production. The panel concluded that the best way to evaluate a person's vitamin D status would be to measure concentrations of an inactive form known as 25-hydroxy-vitamin D (25-D) that circulates in the blood.

However, Heaney adds, "we didn't say how much an individual should have—because we didn't know."

In North America, a typical 25-D blood concentration is 40 nanomoles per liter (nmol/l), and scientists long assumed that amount was adequate.

Last year, in a roundtable discussion at an osteoporosis conference in Lausanne, Switzerland, Vieth, Holick, Heaney, and others agreed that an optimal 25-D blood concentration for most people is 75 to 80 nmol/l. Most panelists, therefore, recommended that people strive for 800 to 1,000 IU of

Vitamin D daily to achieve it.

That conclusion rests on a variety of experiments. David Hanley of the University of Calgary in Alberta cites studies focusing on parathyroid hormone, one of the factors regulating the natural breakdown of bone that constantly occurs throughout a healthy body. When a person's 25-D concentration dips too low, parathyroid hormone concentration in the blood rises and triggers excessive bone loss. Hanley says that several studies indicate that most people need 75 to 80 nmol/l of 25-D in their blood to protect their bones. However, people 70 years old and older may need more than 100 nmol/l of 25-D to hold parathyroid hormone at healthy concentrations. Vieth and his colleagues reported this finding, which was based on a study of 1,700 people ages 19 to 97, in the January 2003 *Journal of Clinical Endocrinology and Metabolism*.

Low 25-D concentrations may identify apparently healthy individuals who are at risk for type 2 diabetes as well as for bone problems. In the May 1 *American Journal of Clinical Nutrition*, Ken C. Chiu and his colleagues at the University of California, Los Angeles report that the lower the 25-D in study participants, the less likely they were to produce adequate amounts of insulin or to show sufficient sensitivity to insulin. Chiu's team found that increasing a person's blood concentration of 25-D from 25 nmol/l to about 75 nmol/l would "improve insulin sensitivity by 60 percent," which is a greater increase than many antidiabetes drugs provide.

In people over age 60, 25-D blood concentrations correlate with leg strength, according to studies by Bess Dawson-Hughes of the Agriculture Department's Human Nutrition Research Center on Aging in Boston and her colleagues. In one study, they examined data from 4,100 adults representing a cross-section of the U.S. population. People with 25-D concentrations of 40 nmol/l or less walked more slowly and had more trouble rising from a chair than did people with concentrations higher than 86 nmol/l. The results took into account differences between the groups in age, arthritis, weight, and use of a cane, according to the team's report in the Sept. 1 *American Journal of Clinical Nutrition*.

A third recent study of 25-D links low blood concentrations to colorectal cancer in women. Diane Feskanich of Brigham and Women's Hospital in Boston and her coworkers compared blood tests from 193 cancer patients with those of age-matched women who were cancerfree. All the women were participating in the long-running Nurses' Health Study. In the September *Cancer Epidemiology, Biomarkers & Prevention*, the researchers report that women in the highest 25-D group—with about 100 nmol/l—had only about half the cancer risk of women in the lowest group, averaging 40 nmol/l.

Silent epidemic

Few people have the blood concentrations of 25-D that researchers recommend. For instance, Hanley described findings from 200 Calgary adults at the Experimental Biology meeting in Washington, D.C., last April. A third of the study's population showed less than 30 nmol/l during at least part of the year. "The average level of 25-D through the four seasons was in the low 60s

[nmol/l]," Hanley told *Science News*. If 80 nmol/l is taken as the cutoff for adequate 25-D, "virtually 100 percent of the population is vitamin D–deficient at least part of the year," he says.

In the March 2003 *Nutrition Reviews*, Mona Calvo of the U.S. Food and Drug Administration coauthored a review of five studies on vitamin D status in Canada and the United States. They described data indicating a high incidence of vitamin D insufficiency in almost all populations.

In one of those studies, Calvo notes, 42 percent of African American women were 25-D deficient, compared with just 4 percent of their white counterparts. That study defined deficiency as concentrations below 37.5 nmol/l. Calvo says that she prefers to use 80 nmol/l as the minimum adequate blood concentration of 25-D.

The remedy?

Some researchers propose that fortified milk and other foods can cover vitamin D shortfalls. However, the current diet offers, at most, 200 to 400 IU per day. Furthermore, Calvo has new data showing that "African Americans do not consume [vitamin-D] fortified foods." She suspects that many blacks avoid milk, the most highly enriched food, because they have difficulty digesting it.

Harold L. Newmark of Rutgers University in New Brunswick, N.J., and his colleagues propose a new food-enrichment scheme in the Aug. 1 *American Journal of Clinical Nutrition*. They argue that the best way to help vulnerable groups get enough vitamin D would be to mandate fortification of grain-based products, such as wheat flour, corn meal, and pasta.

Newmark and his colleagues estimate that the cost could be as low as 7 cents per person per year if U.S. foods were fortified to the maximum amount allowed by law (see **Should Foods Be Fortified Even More?**). They calculate that this would increase vitamin D daily dietary intake by 50 to 200 IU.

Vieth and Holick are among the scientists who advocate increasing "sensible" outdoor activity so people can boost their sun exposure and thus vitamin D supply.

The amount of sun required would pose virtually no increased cancer risk, Holick says. "We evolved in sunlight, and so our whole system is dependent on some exposure to sunlight," he says. In fact, "our health depends on it," he adds.

Most researchers recommend that people get much of their vitamin D intake from supplements and recommend that they boost daily vitamin D intakes to around 1,000 IU.

Holick says that physicians could measure 25-D in blood and prescribe increasing doses of the vitamin until 80 nmol/l is reached. Such personalized prescriptions could take into account lifestyle and pigmentation. For instance, Heaney's research in Omaha indicates that elderly, dark-skinned women could require up to 2,000 IU of vitamin D to keep 25-D concentrations around 80 nmol/l.

Linda D. Meyers, director of the Food and Nutrition Board, which sets the

government's recommended daily intake values for all vitamins and some minerals, agrees that "it really is time to look at those [intake standards] again for vitamin D." The standard probably needs to be higher, she acknowledges. In December, the board will begin discussions with nutrition experts on which nutrients need to be reevaluated. Considering the wealth of data that has been coming out, "I'm thinking vitamin D might even offer a case study to help us," says Meyers.

"[Vitamin D] deserves to be in the first group reexamined," she told *Science News*. "It really is time to look at that one again."

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