Vitamin D in the spotlight

An expanded role emerges for promoting health.

Vitamin D is best known for its key role in forming and maintaining strong bones. Yet research is revealing that vitamin D may play additional roles in a growing list of benefits, and experts around the world are calling for a reassessment of dietary recommendations for vitamin D.

Vitamin D is involved in regulating cell growth and differentiation and in essential immune system functions. With this knowledge, scientists are exploring links between low vitamin D status and increased risk for a number of chronic diseases, including some types of cancer, heart disease, type 1 diabetes, rheumatoid arthritis, and multiple sclerosis. It also may be important for the maintenance of physical strength and balance in the elderly. Concurrently, evidence is mounting that higher amounts of vitamin D may be required to maintain blood levels in a range that maximizes calcium absorption and supports these health benefits. However, many people do not consume the recommended amount of vitamin D, and some populations may not get enough from the sun.

VITAMIN D BASICS AND BEYOND

The two primary forms of vitamin D are vitamin D$_3$ (cholecalciferol), derived from animal sources, and vitamin D$_2$ (ergocalciferol), derived from plant and yeast sources. Vitamin D is found naturally in a limited number of foods in the form of vitamin D$_3$, and select foods are fortified with vitamin D$_2$ or D$_3$. Vitamin D$_3$ can also be produced in skin cells when the body is exposed to sunlight, through conversion of a cholesterol-like molecule that is naturally present in the skin. Regardless of the source, food or sunlight, vitamin D$_2$ or D$_3$ is converted in the liver to its circulating form, 25-hydroxyvitamin D (25(OH)D). While this is not the active form of vitamin D, it is the form used as the clinical indicator of vitamin D status.

After traveling to the kidney, circulating vitamin D is converted to the active form of vitamin D, 1,25-dihydroxyvitamin D (1,25(OH)$_2$D). While this is not the active form of vitamin D, it is the form used as the clinical indicator of vitamin D status.

VITAMIN D DEFICIENCY: CAUSES AND CONSEQUENCES

A number of factors can lead to vitamin D insufficiency and deficiency. These factors include limited vitamin D in the diet, extensive use of sunscreens, dark skin pigmentation, living at high latitude, and diminished outdoor activity. In a recent analysis of vitamin D intakes by children and adults, adolescent girls and adult women had the lowest intakes of vitamin D from food. Among adults, only 4% of men and 1% of women aged 50 and older met or exceeded the recommended intake. Deficiency is prevalent in sole-
**Recommended adequate intake for vitamin D**

<table>
<thead>
<tr>
<th>Age</th>
<th>Children (IU/day)</th>
<th>Men (IU/day)</th>
<th>Women (IU/day)</th>
<th>Pregnancy &amp; lactation (IU/day)</th>
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</thead>
<tbody>
<tr>
<td>Birth to 13 years</td>
<td>200 IU</td>
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<tr>
<td>14 to 18 years</td>
<td>200 IU</td>
<td>200 IU</td>
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<td>19 to 50 years</td>
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<td>51 to 70 years</td>
<td>400 IU</td>
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<tr>
<td>71+ years</td>
<td>600 IU</td>
<td>600 IU</td>
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Furthermore, a study of postmenopausal women who increased their vitamin D intake by 1,100 IU reduced their risk of all cancers by 60 to 70%.

Cardiovascular disease. The exact mechanism of how vitamin D protects against cardiovascular disease and hypertension is not well understood. Vitamin D is known to be a potent hormone for regulating renin, a blood pressure hormone, in the kidneys. It has been observed that people living at higher latitudes are at increased risk of developing hypertension, suggesting that sun exposure and vitamin D may protect against hypertension. One study found that patients with cardiovascular disease are more likely to develop heart failure if they are vitamin D deficient.

Autoimmune and infectious diseases. The role of vitamin D in the prevention of autoimmune disease requires further study, but studies suggest multiple sclerosis, rheumatoid arthritis, and type 1 diabetes may be associated with vitamin D deficiency. Living at a latitude above 37° has been shown to increase risk of developing multiple sclerosis by 100%. A multivitamin supplement with 400 IU of vitamin D reduced risk by 40% in one study.

Similarly, women taking 400 IU of vitamin D in a multivitamin supplement decreased their risk of rheumatoid arthritis by about 40%. Even more compelling is the observation that children in Finland who received 2,000 IU of vitamin D daily beginning at one year of age had an 80% reduced risk of developing type 1 diabetes over 25 years compared to children who were vitamin D deficient.

Recent research is emerging showing 1,25(OH)2D may also boost the immune system. Studies show that 1,25(OH)2D makes a protein that kills the bacterium that causes tuberculosis. This mechanism may explain why African-Americans, who are more likely to be vitamin D deficient, are more prone to contracting tuberculosis than Caucasians, and tend to have a more aggressive form of the disease.

**HOW MUCH IS ENOUGH?**

The current Adequate Intake (AI) for vitamin D is between 200 and 600 IU.
per day depending on an individual’s age and sex. However, some experts recommend a minimum of 1,000 IU per day for adults to maintain a healthy level of circulating vitamin D, in addition to exposure to sunlight for five to 15 minutes per day (between 10 AM and 3 PM). If outdoor activity lasts longer than five to 15 minutes, use of sunscreen is advised to reduce the risk of skin cancer.

Food sources of vitamin D are limited, and thus obtaining vitamin D solely through dietary sources can be challenging. Naturally occurring sources are limited mostly to oily fish (salmon, mackerel, sardines) and cod liver oil. Fortified foods and supplements are major dietary sources of vitamin D. Milk is fortified with vitamin D at 100 IU per cup. Some cereals and orange juices are also fortified.

In the United States and Canada, the current dietary recommendations for vitamin D were set in 1997 by the Institute of Medicine. The AI for vitamin D was based on the intake necessary to achieve the estimated “normal” ranges of serum 25-hydroxyvitamin D concentrations assuming that there was no synthesis of vitamin D through sun exposure.

Since 1997, progress has been made toward determining optimal serum 25-hydroxyvitamin D concentrations. Many scientists believe an optimal level is 60-75 nmol/L or higher, which most experts agree cannot be reached with the currently recommended dietary intakes of vitamin D. Researchers recommend that blood concentrations of 25(OH)D be measured annually and if low, addressed with supplementation and/or increased sun exposure to raise serum levels.

Currently, the Tolerable Upper Intake Level (UL) for vitamin D is 2000 IU/day for all individuals one year and older. Yet, research has revealed that many individuals require a level of vitamin D above the UL to achieve optimal serum 25-hydroxyvitamin D concentrations.

Risk assessment for higher intakes of vitamin D, based on the review of human intervention studies, found the absence of toxicity at vitamin D doses of 10,000 IU/day.

Increasing vitamin D intake is an easy measure to adopt that can have a positive impact on health status. To maximize vitamin D status, health experts recommend increasing vitamin D intake from vitamin D fortified foods, including milk, and vitamin D supplements, in combination with sensible sun exposure. Further review of vitamin D requirements could likely support an increase in recommended daily intakes of this important vitamin.

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Calendar (cont.)


May 18–22. Society of Tribologists and Lubrication Engineers Annual Meeting & Exhibition, Cleveland Convention Center, Cleveland, Ohio, USA. Information: www.stle.org; fax: +1-847-825-1456; phone: +1-847-825-5536; e-mail: info@stle.org.


CONTINUED ON PAGE 200

Bold type: new listing; ⚡: AOCS event; visit http://aocs.org/meetings/calendar.asp for more.