



Health Connections

LINKING NUTRITION RESEARCH TO PRACTICE

Expanded Functions and Benefits of Vitamin D

Research supports vitamin D's expanded role beyond disease prevention to the promotion of optimal health, which has led to a ground swell among some experts to call for an increase in its dietary requirement. This issue of *Health Connections* summarizes research on this important vitamin's broad health benefits and suggests ways health professionals can help clients improve their vitamin D status.

Introduction

The index deficiency disease for vitamin D is rickets in childhood, or osteomalacia—potentially leading to osteoporosis—in adults. Vitamin D's well-understood endocrine function is to tightly regulate the calcium pool by stimulating absorption from the intestine, increasing retention by the kidneys and mobilizing calcium from bone if necessary.

A decade ago, the Institute of Medicine (IOM) set the Adequate Intake (AI) for vitamin D at 200 IU daily for everyone under age 50, 400 IU for ages 51-70, 600 IU for ages 70 and older and the tolerable upper-intake level (UL) at 2,000 IU. Many experts now consider this recommendation inadequate and maintain that public health is best served by higher intakes—perhaps 1,000 to 2,000 IU daily with a UL as high as 10,000 IU.¹ Risk-assessment toxicity studies² have provided evidence of the safety and efficacy of these levels.

Vitamin D Basics

Popularly called the sunshine vitamin, 'vitamin D' without a subscript refers to either or both biologically inactive precursors: D₃ (cholecalciferol), produced naturally in skin exposed to ultraviolet-B light and found in animal products; and vitamin D₂ (ergocalciferol) derived from ergosterol, a plant and fungal sterol precursor activated upon UV exposure. Vitamin D has no hormone activity until it is metabolized to 25-hydroxyvitamin D [25(OH)D] in the liver and then to the active form 1,25-dihydroxyvitamin D [1,25(OH)₂D], also called calcitriol, in the kidney.

Vitamin D Status and Related Health Benefits

The clinical indicator of vitamin D adequacy, serum 25(OH)D concentration, represents the combined contribution from sun exposure, D₂ and D₃ from animal sources, fortified foods and supplements. Optimum levels have yet to be defined officially, but based on health outcomes for bone mineral density, lower extremity function, dental health, minimizing risk of falls, fractures and colorectal cancer, the most advantageous serum concentrations are believed to be between 75 and 100 nmol/L.³

Decades ago, geographic epidemiology suggested a decreasing gradient of mortality for colon cancer in the U.S. from north to south.⁴ Subsequent epidemiology added prostate and breast cancer, hypertension and multiple sclerosis as conditions associated with living at higher latitudes.⁵ Adding to these earlier epidemiological observations, a randomized, controlled trial found that improving calcium and vitamin D status in postmenopausal women using a supplement with 1,000 IU of vitamin D₃—a dose sufficient to raise serum 25(OH)D above 80 nmol/L—substantially reduced all cancers.⁶

Research is also discovering vitamin D's role in improving immune function, cognitive performance and mood, while reducing the risk of some types of dementia, autoimmune diseases, type 1 diabetes and periodontal disease.⁷ These benefits,

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seemingly unrelated to vitamin D's endocrine role in calcium balance, emerged with the discovery of a vitamin D receptor (VDR), evidence that cells other than the kidney can make the active form of vitamin D for their own use with sufficient levels of serum 25(OH)D. A blood concentration of 25(OH)D above 78 nmol/L is required for the extrarenal production of 1,25(OH)₂D in a wide variety of tissues and cells. When vitamin D status

is not optimal, these health-promoting functions may not be fully realized.

Despite the growing body of research supporting increased intakes, revised recommendations for vitamin D may be several years away. Still, health professionals can help clients improve their vitamin D status now using Dr. Whiting's information as well as the Practice Points below.



Susan J. Whiting, PhD

Interview: Susan J. Whiting, Ph.D., College of Pharmacy and Nutrition, University of Saskatchewan, Saskatoon, Canada and a member of Osteoporosis Canada Scientific Advisory Board.

Q. Why does the current AI for vitamin D need revision?

A. The current AI is not high enough to increase serum 25(OH)D concentrations to 75-80 nmol/L or higher. Research indicates that providing 400 IU daily for months does little to change 25(OH)D concentration in adults.⁸ Ten years ago, the AI levels were set to support 30 nmol/L concentrations, prior to knowing the extrarenal functions of vitamin D and the benefits of higher serum levels. Over the past decade, the use of 25(OH)D levels to determine adequacy has become more prevalent and research now supports the benefits and safety of higher intake levels.

When working with clients, I encourage health professionals to use the full range of the current DRI from 200 IU to the UL of 2,000 IU, which is a safe level. This continuum enables health professionals to customize recommendations using the higher level for those with little or no sun exposure and the lower level for those with greater sun exposure.

Q. How can vitamin D status be improved?

A. The AI was set assuming no sun exposure. Therefore, individuals can improve their vitamin D status through safe exposure to sun (see Sidebar), by dietary intake or a combination of both, although there are challenges to

any of these approaches. **Commuting and working indoors, clothing choices reflecting culture or fashion, ethnicity and age make it difficult for many individuals to rely on the sun to raise serum levels of 25(OH)D.**

Regarding dietary intake, there is a significant disparity between the amount of vitamin D consumed and that which is needed for healthy circulating levels of 25(OH)D. Current mean intake according to NHANES is 200 IU.⁹ Few foods are naturally rich in vitamin D and natural concentrations can vary by season, climate and production method. For example, farmed fish have less vitamin D than their wild counterparts. Naturally rich sources such as fatty fish or organ meats are not frequently consumed. Fortified foods are common sources of vitamin D; fortified milk is the major source of vitamin D in the U.S., and some orange juices, margarines, breakfast cereals, soy beverages and rice drinks also are fortified. These products generally provide 10 percent to 25 percent of the 400 IU Daily Value used for labeling (Table 1).

However, not all product categories eligible for fortification are fortified and not all foods within the same product category are fortified, which can be confusing to consumers. Food manufacturers are working to bring some

Table 1: Selected Food Sources of Vitamin D

FOOD	SERVING SIZE	IU/SERVING	PERCENT DV
Salmon, cooked.....	3 ¹ / ₂ oz.....	360.....	90
Tuna fish, canned in oil.....	3 oz.....	200.....	50
Fortified milk.....	1 cup.....	100.....	25
Fortified orange juice.....	1 cup.....	100.....	25
Fortified yogurt.....	1 cup.....	100.....	25
Fortified soy milk.....	1 cup.....	80-120 (varies).....	20-30
Fortified breakfast cereal.....	³ / ₄ - 1 cup.....	40.....	10

Source: Reference 10 and Nutrition Facts labels.

consistency to these product offerings. **Introduction of more fortified foods in the marketplace, including products that provide options to meet ethnic, cultural and personal preferences, can help consumers meet their requirements through dietary means.** For now, because there is little vitamin D information in current nutrient databases, health professionals should frequently read product labels in order to guide clients in their food choices.

Q. What are some of the issues to consider when the DRI for vitamin D is reviewed?

- A. Research that demonstrated a cancer protective effect with intake levels of 1,000 IU⁹ suggest that the new recommendation will be within a range that is achievable with diet and supplementation. The range could likely be 500 IU to 4,000 IU, with the low end for young, white adults with sun exposure in the summer and the higher value for persons with no sun exposure all year, such as older, darkly pigmented persons in the northeastern U.S. or Canada. Consideration must also be given to risk levels for infants and children, since the current risk analyses on toxicity have only involved adults.

Research since the IOM established the current AI could support the establishment of an RDA for different circumstances, considering sun exposure, skin pigmentation and cultural practices. We need to develop some rational sun-exposure messages—not prolonged burning in the sun, but more than brief exposure of face and hands.

Q. What are the concerns of getting too much vitamin D?

- A. If consumed at excessively high intakes over time, vitamin D could lead to high blood and

urine calcium levels, kidney stones and/or possible kidney failure and a deterioration of muscle and bone mass. Prolonged exposure to the sun is not thought to result in accumulation of toxic levels because additional exposure results in biologically inert photoproducts. However, as we all know, too much sun exposure is to be avoided anyway.

In the U.S. and Canada, the addition of vitamin D to foods is carefully regulated, with products generally providing 40 to 100 IU per defined serving size. Growing evidence supports a low risk of toxicity associated with fortification or supplementation. **As noted previously, the mean intake of vitamin D is one-tenth of the current UL and efforts to increase intake represent an important public health initiative.** Nevertheless, we should discourage consumers from mega-dosing and relying only on supplements. We know that supplement use is sporadic and often those who have reasonably adequate diets are the ones who use supplements. Foods containing vitamin D, such as milk and fish, are healthy choices.

Sidebar 1: Sun Exposure

Initial exposure to 10-15 minutes of sunlight allows adequate time for vitamin D synthesis in young, white adults. Those with sensitive skin require a shorter time and those who are darkly pigmented likely need more time. This should be followed by application of a sunscreen with an SPF of at least 15 to protect the skin. With the exception of the winter months, this brief sun exposure at least two times a week to the face, arms, hands or back without sunscreen is usually sufficient to synthesize adequate vitamin D.¹⁰

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PRACTICE POINTS FOR THE HEALTH PROFESSIONAL

- Counseling clients regarding vitamin D needs to be highly individualized, since status depends not only on dietary intake but also lifestyle parameters. Consider use of sunscreen, time spent outdoors, and even locale (e.g., urban vs. suburban or latitude).
- Advise adults age 50 and over and individuals with darker skin to consume extra vitamin D from fortified foods and/or supplements.
- When conducting dietary intake assessments, remember that not all foods high in calcium contain vitamin D. Both are needed for optimum health.
- Assessing vitamin D status based on dietary intake may not be adequate. Suggest a serum 25(OH)D test for a more accurate assessment.
- Query clients on their use of supplements. Keep in mind that supplement use may help increase intake of vitamin D but long-term compliance is generally inconsistent and supplements do not substitute for nutritious food sources.