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Vitamin D: How to Translate the Science of the New Dietary Reference Intakes for This Complex Vitamin—More Is Not Always Better!

Kathleen T. Morgan
Chair, Family and Community Health Sciences
Rutgers Cooperative Extension
Rutgers, the State University of New Jersey
New Brunswick, New Jersey
morgan@njaes.rutgers.edu

Abstract: Vitamin D has long been known for its role in bone health. Before the recent Institute of Medicine (IOM) guidelines, there were conflicting messages about its other benefits. The IOM experts' exhaustive review of the evidence maintained the importance of calcium and vitamin D in promoting bone growth and maintenance. New Daily Reference Intakes were recommended. The report indicated that individuals seem to get meaningful amounts of vitamin D from sun exposure. Higher levels were not shown to provide a greater benefit. Extension professionals have the capacity to train professionals and consumers about the new vitamin D reference intakes.

Introduction

Vitamin D has long been known as an essential nutrient for bone health. In the past several years, there have been conflicting messages about other potential benefits of vitamin D. Consumption of vitamin D was linked to reduced risk of colon cancer, diabetes, and heart health. In light of this, individuals began to increase their daily vitamin D supplementation more than the recommended daily amount. There was much confusion about exactly how much vitamin D was necessary. The Extension professional is one of the most valued educators when it comes to health promotion and disease prevention (Siewe, 2001). Extension has tremendous capacity to collaborate with agencies that can make the difference to disseminate critical health information.

Institute of Medicine

The United States and Canadian governments asked the Institute of Medicine (IOM) to assess the current data on health outcomes associated with vitamin D. The IOM tasked a committee of experts with reviewing the evidence, as well as updating the nutrient reference values, known as Dietary Reference Intakes (DRI's). These values are used widely by government agencies, for example in setting standards in school meals or specifying the nutrition label on foods (IOM, Vit D, 2010).

The committee provided an exhaustive review of studies on potential health outcomes and found that the evidence supported a role for these nutrients in bone health but not in other health conditions. Even more, there is emerging evidence that too much of vitamin D may be harmful (IOM, Vit D, 2010).

Vitamin D is a fat-soluble vitamin that is naturally present in very few foods, added to others, and available as a dietary supplement. It is also produced endogenously when ultraviolet rays from sunlight strike the skin and trigger vitamin D synthesis. (IOM Vit D, 2010).

The main role of vitamin D is to promote calcium absorption. This role is extremely important for calcium homeostasis. Vitamin D also maintains adequate serum (blood) calcium and phosphate concentration to enable normal mineralization of bone.

Vitamin D plays an essential role in bone growth and the bone remodeling process. Being deficient in vitamin D can cause bones to become thin, brittle, or misshapen. In children, this deficiency is known as "rickets"; in adults the deficiency is known as "osteomalacia." Together with calcium, vitamin D plays a critical role in protecting older adults from osteoporosis (IOM Vit D, 2010).

Breast milk alone does not provide infants with an adequate intake of vitamin D. Vitamin D deficiency rickets among breastfed infants is rare, but it can occur if an infant does not receive additional vitamin D from a vitamin supplement or from adequate exposure to sunlight.

Serum (blood) concentration of 25(OH)D is the best indicator of vitamin D status. It reflects vitamin D produced on the skin by the sun, vitamin D obtained from food and supplements (Cranney, Horsely, O'Donnell, Weiler, Ooi, & Atkinson, et al., 2007).

Based on its review of data of vitamin D needs, a committee of the Institute of Medicine developed the following guidelines to determine appropriate serum concentrations of vitamin D.

Table 1.
Serum 25-Hydroxyvitamin D [25(OH)D] Concentrations and Health*

nmol/L**	ng/mL*	Health status
<30	<12	Associated with vitamin D deficiency, leading to rickets in infants and children and osteomalacia in adults
30–50	12–20	Generally considered inadequate for bone and overall health in healthy individuals

≥50	≥20	Generally considered adequate for bone and overall health in healthy individuals
>125	>50	Emerging evidence links potential adverse effects to such high levels, particularly >150 nmol/L (>60 ng/mL)
* Serum concentrations of 25(OH)D are reported in both nanomoles per liter (nmol/L) and nanograms per milliliter (ng/mL). ** 1 nmol/L = 0.4 ng/mL		

Reference Intakes

Intake reference values for vitamin D and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (IOM Vit D, 2010). DRI is the general term for a set of reference values used to plan and assess nutrient intakes of healthy people. These values, which vary by age and gender, include:

- Recommended Dietary Allowance (RDA): average daily level of intake sufficient to meet the nutrient requirements of nearly all healthy people.
- Adequate Intake (AI): established when evidence is insufficient to develop an RDA and is set at a level assumed to ensure nutritional adequacy.
- Tolerable Upper Intake Level (UL): maximum daily intake unlikely to cause adverse health effects (IOM Vit D, 2010).

The Food and Nutrition Board (FNB) established an RDA for vitamin D representing a daily intake that is sufficient to maintain bone health and normal calcium metabolism in healthy people. RDAs for vitamin D are listed in both International Units (IUs) and micrograms (mcg); the biological activity of 40 IU is equal to 1 mcg (Table 2). The vitamin D RDA's are set on the basis of minimal sun exposure (IOM Vit D, 2010).

Table 2.
Recommended Dietary Allowances (RDAs) for Vitamin D

Age	Male	Female	Pregnancy	Lactation
0–12 months*	400 IU (10 mcg)	400 IU (10 mcg)		
1–13 years	600 IU (15 mcg)	600 IU (15 mcg)		
14–18 years	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)

19–50 years	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)
51–70 years	600 IU (15 mcg)	600 IU (15 mcg)		
>70 years	800 IU (20 mcg)	800 IU (20 mcg)		
* Adequate Intake (AI)				

Sources of Vitamin D

Very few foods contain vitamin D naturally. Vitamin D is in fatty fish (salmon, tuna, and mackerel), and fish liver oils are among the best sources. Fortified food in the diet provides most of the vitamin D in the American diet. Most of the U.S. milk supply is voluntarily fortified with 100IU/cup of milk. Ready-to-eat breakfast cereals often contain added vitamin D, as do some brands of orange juice, yogurt, margarine, and other food products. Infant formula is fortified with vitamin D (IOM Vit D, 2010).

Table 3.
Selected Food Sources of Vitamin D

Food	**IUs per serving***	**Percent DV****
Cod liver oil, 1 tablespoon	1,360	340
Salmon (sockeye), cooked, 3 ounces	447	112
Mackerel, cooked, 3 ounces	388	97
Tuna fish, canned in water, drained, 3 ounces	154	39
Milk, nonfat, reduced fat, and whole, vitamin D-fortified, 1 cup	115-124	29-31
Orange juice fortified with vitamin D, 1 cup (check product labels, as amount of added vitamin D varies)	100	25
Yogurt, fortified with 20% of the DV for vitamin D, 6 ounces (more heavily fortified yogurts provide more of the DV)	80	20
Margarine, fortified, 1 tablespoon	60	15
Liver, beef, cooked, 3.5 ounces	49	12

Sardines, canned in oil, drained, 2 sardines	46	12
Egg, 1 large (vitamin D is found in yolk)	41	10
Ready-to-eat cereal, fortified with 10% of the DV for vitamin D, 0.75-1 cup (more heavily fortified cereals might provide more of the DV)	40	10
Cheese, Swiss, 1 ounce	6	2

* IUs = International Units.
** DV = Daily Value. DVs were developed by the U.S. Food and Drug Administration to help consumers compare the nutrient contents among products within the context of a total daily diet. The DV for vitamin D is currently set at 400 IU for adults and children age 4 and older. Foods providing 20% or more of the DV are considered to be high sources of a nutrient, but foods providing lower percentages of the DV also contribute to a healthful diet.

Sun Exposure

Individuals who are outside for short periods of time with uncovered skin can get some of their Daily Reference Intake of vitamin D through sun exposure.

Dr. Michael Holick, a well-known vitamin D expert, advises spending 20-30 minutes in the sun with arms and legs exposed (not face) between the hours of 11 a.m. and 3 p.m. two to three times a week from March through May and September through October, but only 15-20 minutes in July and August when the sun in strongest. Apply sunscreen if outdoors for longer periods (Holick, 2010). The American Academy of Dermatology advises that photoprotective measures be taken regarding the use of sunscreen, whenever one is exposed to the sun (AAD, 2008).

Complete cloud cover reduces Ultra Violet (UV) energy by 50% (Wharton, 2003). UVB radiation can penetrate through a window but does not produce vitamin D (Holick, 2005). Individuals with limited sun exposure need to be sure to include good sources of vitamin D in their diet or take a supplement.

Dietary Supplements

Two forms are important in humans: ergocalciferol (vitamin D_2) and cholecalciferol (vitamin D_3). Vitamin D_2 is synthesized by plants. The two forms have traditionally been regarded as equivalent based on their ability to cure rickets. Both forms (as well as vitamin D in foods and from cutaneous synthesis) effectively raise serum 25(OH)D levels (Cranney, Horsely, O'Donnell, Weiler, Ooi, & Atkinson, et al., 2007). However, it appears that at nutritional doses, vitamins D_2 and D_3 are equivalent, but at high doses vitamin D_2 is less potent.

Vitamin D Deficiency

Nutrient deficiencies are usually the result of dietary inadequacy, impaired absorption and use, increased requirement, or increased excretion. Vitamin D-deficient diets are associated with milk allergy, lactose intolerance, ovo-vegetarianism, and veganism (IOM Vit D, 2010).

Groups at Risk of Vitamin D Deficiency

Populations who may be at a high risk for vitamin D deficiencies include:

- The elderly
- Obese individuals
- Exclusively breastfed infants
- Those who have limited sun exposure
- Individuals who have fat malabsorption syndromes or inflammatory bowel disease are at risk
- People with dark skin

Conclusion

Scientific evidence indicates that calcium and vitamin D play key roles in bone health. The current evidence does not support other benefits from vitamin D intake. Higher levels of vitamin D have not been shown to confer greater benefits, and in fact, they have been linked to other problems, challenging the concept that "more is better" (IOM, 2010). Extension professionals can play an integral role in the health and wellness of the people they serve. When Extension professionals learn the new Vitamin D RDA's and incorporate them into their programs, the education can go a long way in reducing the risk of disease and improving the health of Americans.

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