

Vitamin D insufficiency: no recommended dietary allowance exists for this nutrient

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Rickets, a defect in bone growth during infancy and childhood, was first characterized in 1650. Although cod-liver oil was used as a folk remedy in northern Europe starting in the late 1700s, it was not until 1922 that the medical community realized that something in it prevented and cured rickets.^{1,2} As recently as 4 decades ago, physicians assumed that vitamin D nutrition was adequate if people exhibited no clinical or radiographic signs of rickets.^{3,4} Osteomalacia, the adult counterpart of rickets, was rarely seen, and it was assumed that adults require no more, and usually less, vitamin D than infants do.⁴ It was also assumed that the vitamin D generated in the skin, vitamin D₃, was functionally equivalent to a different molecule, vitamin D₂, generated from lipids in yeast.^{3,4}

Physicians have been able to quantify vitamin D nutritional status in their patients since the 1970s, by measuring the serum concentration of 25(OH)D. A low concentration of 25(OH)D causes a form of secondary hyperparathyroidism, which is thought to accelerate bone loss.⁵ Unfortunately, the practical advice about how to deal with vitamin D nutrition in adults has always been vague and, we think, misleading.

As part of the latest chapter in the history of vitamin D, Rucker and colleagues⁶ now report (page 1517) that a third of healthy Calgary men and women participating in the Canadian Multicentre Osteoporosis Study (CaMos) had vitamin D insufficiency, defined as levels of 25-hydroxy vitamin D [25(OH)D] less than 40 nmol/L, during at least part of the year. From this and other reports,⁷⁻¹¹ it is obvious that a lack of vitamin D is still common at northern latitudes. The mean age was about 64 years. During the study, participants were asked to limit their intake of supplementary vitamin D to no more than 5 µg (200 IU)/day.⁶ Recently, Atkinson and Ward¹² reviewed the latest official vitamin D intake recommendations in the *CMAJ* series on clinical nutrition: 10 µg (400 IU)/day for those 51–70 years of age and 15 µg (600 IU)/day for those over 70 years of age. From these recommendations, one might conclude that if the CaMos participants had taken the amount of supplement recommended for them (i.e., double or triple the 5 µg [200 IU]/day permitted by the study protocol), then vitamin D insufficiency would not have occurred. However, this logic fails, because it assumes that recommendations for supplemental vitamin D were designed to ensure something specific, i.e. vitamin D adequacy.

In fact, current recommendations for vitamin D are not

designed to ensure anything. They are simply based on the old, default strategy for setting a nutritional guideline, which is to recommend an amount of nutrient similar to what healthy people are eating. This approach underlies the circular logic behind a familiar refrain about nutrition: “If you eat a good diet, you won’t need supplements.” By this logic, the answer to the question, “How much nutrient do you need?” is, “Whatever healthy people happen to be eating.” The essential point, lost in the confusing terminology of modern nutrient recommendations, is that a recommended daily allowance (RDA) does not yet exist for vitamin D. Instead, the recommendations for it are referred to as “adequate intake” (AI).^{12,13} The AI for young adults (5 µg or 200 IU) was chosen to approximate twice the average vitamin D intake reported by 52 young women in a questionnaire-based study reported from Omaha, Neb., in 1997.^{13,14} Because the available evidence was acknowledged as weak, the Food and Nutrition Board of the US Institute of Medicine called its recommendation an AI.¹³

The distinction between an RDA and an AI is important. To qualify as an RDA, a dietary recommendation must meet the known needs for the nutrient of practically all healthy people.¹⁵ This is an objective criterion which requires evidence that almost all adults taking the RDA achieve a tangible health benefit or, alternatively, a target blood level that would imply a health benefit. Thus, in contrast to the situation for an RDA, we are not safe in assuming that taking the AI for vitamin D will do anything at all.

For vitamin D in particular, the traditional approach to nutrient recommendations is prone to gross error because most of us acquire far more of this “nutrient” through exposure to sunshine than we do from the diet.¹⁶ Before we can make any definitive statement about an RDA, we need more precise knowledge of the total vitamin D supply in the body, its effects on serum concentrations of 25(OH)D and the associated effects on health.

Because of what was probably a misconception in recent years — that younger adults need less vitamin D than elderly people to bring about a given 25(OH)D concentration — the Food and Nutrition Board in 1997 increased the AI only for elderly people. But even for this age group the board went just part of the way, increasing the AI to only 15 µg (600 IU) daily,¹³ which is less than the 20 µg (800 IU) needed in clinical trials (along with calcium) to prevent os-

teoporotic fractures.^{17,18} Historically, 10 µg (400 IU) of vitamin D was chosen for prophylaxis because it approximated the amount of vitamin D in a teaspoonful of cod-liver oil.³ All relevant studies in recent years have shown that the latest adult AIs for vitamin D have been set much too low. For example, an intervention study of Finnish adolescents¹⁹ and 2 cross-sectional studies^{8,10} showed that 10 µg (400 IU)/day did not prevent wintertime insufficiency. Why should we still expect this dose, originally used to prevent rickets in infants, to be appropriate for adults?

Eventually, an RDA based on objective evidence will replace the current guesstimated AI for vitamin D. One of us recently showed that to ensure a serum 25(OH)D concentration of at least 40 nmol/L, Canadian adults require 25 µg (1000 IU) of vitamin D₃ per day.²⁰ When the RDA for vitamin D is eventually established, it should be at that level — or greater.

We know that many consider vitamin D a toxic pariah among nutrients. However, toxicity has never been observed in the physiologic amounts that can be derived from sunshine — amounts associated with serum 25(OH)D concentrations up to 235 nmol/L.¹⁶ To offer some perspective here, an adult with white skin, exposed to summer sunshine while wearing a bathing suit, generates about 250 µg (10 000 IU) of vitamin D₃ in 15 to 20 minutes; longer exposure generates no more vitamin D.¹⁶ That amount is equivalent to the vitamin D₃ in 25 conventional multivitamin pills or 100 glasses of fortified milk. Long-term use of the official toxic dose, the “lowest observed adverse effect level,” 100 µg (4000 IU) of vitamin D₃ per day, is in reality a physiologic dose that has no effect on calcium levels in serum or urine.²⁰

The vitamin D in the high doses available by prescription (Ostoforte®, 50 000 IU/capsule) is not the same molecule that patients obtain “over the counter.” The physiologic, sun-derived product is vitamin D₃ (cholecalciferol). In Canada, multivitamins and milk almost always contain vitamin D₃. However, when a physician prescribes vitamin D (the nutrient, not the hormone or its analogues) in North America, all the products available contain vitamin D₂ (ergocalciferol), which is less effective than vitamin D₃ at increasing the serum 25(OH)D concentration.¹⁶ All iatrogenic cases of vitamin D toxicity in the literature seen by us have involved vitamin D₂, a product not normally present in humans.¹⁶ Yes, poisonings have occurred with the physiologic molecule, vitamin D₃, but all of those cases involved intake on an “industrial scale,” with unintended, prolonged daily consumption far beyond 1000 µg (> 40 000 IU).²¹

Until vitamin D is consumed by all adults in amounts much greater than is the case today, in accord with an RDA that has not yet been established, many adults at northern latitudes will continue to exhibit undesirably low concentrations of 25(OH)D.⁶⁻¹¹ In the interim, we believe that a daily supplement of 25 µg (1000 IU) of vitamin D₃ is advisable for all adults.

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Competing interests: None declared.

Contributors: Reinhold Vieth was the primary author of this commentary. Donald Fraser was co-writer of the manuscript and provided additional perspectives.

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