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New Dietary Reference Intakes for Vitamin D Released in 2010

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The new Dietary Reference Intake (DRI) levels for vitamin D are based solely on bone health indicators. The RDA for infants is 400 IU, for everyone else; the RDA is 600 IU for ages 1-70y; and thereafter, 800 IU. These dietary recommendations assume minimal sun exposure, and were set to achieve 50 nmol/L of plasma 25-hydroxyvitamin D. New Upper Levels for vitamin D are 4,000 IU for ages 9y and over, with lower levels for younger ages. More research is needed to determine non-skeletal benefits of vitamin D, and whether different intake levels are needed to satisfy those actions.

New DRIs for Vitamin D

New reference values for vitamin D that apply to Canada and the United States were released by the Institute of Medicine (IOM) in November 2010 and published by the National Academy Press (dated 2011)[1]. These revised DRIs generated much discussion, some of it in support for providing evidence-based deliberations[2], and others being critical of the way in which the evidence for new roles of vitamin D were dismissed[3].

Dietary Reference Intakes provide the reference values for assessment and planning functions in nutrition[4]. The Estimated Average Requirement (EAR) is the median requirement; the Recommended Dietary Allowance (RDA) is the amount that meets the needs of almost all (97.5%) healthy persons in the population; the Adequate Intake (AI) is set for infants age 0 to 1y; and the Tolerable Upper-Intake Level (UL) is set at a level that poses no risk for adverse effects.

In the past decade, evidence emerged suggesting a need to revise the 1997 DRI values for vitamin D[5,6]. National survey data showed that vitamin D status was poor, especially in subpopulations in Canada and the United States[7,8] and emerging data suggested the need for higher dietary vitamin D requirements[5,6]. There were also concerns that UL set in 1997 was too low[9].

In considering the revision of the DRIs for vitamin D, two commissioned evidence-based reports that examined the evidence for vitamin D on health outcomes, relying primarily on randomized controlled trials, were made available to the IOM[10]. The committee also used other data in its deliberations. Although the committee acknowledged that vitamin D can be made through skin synthesis, however, intake values were made for minimal sun exposure, thus not promoting sun exposure that goes against current cancer messaging[11]. Many studies designed to provide evidence for dietary effects on bone had given both calcium and vitamin D, so isolating vitamin D's effects were a challenge. Further, when vitamin D status is poor, bone health can be maintained with high intakes of calcium, thus making the link between vitamin D and bone health dependent on background calcium intakes.

New Recommended Intake DRI Values for Vitamin D

The biomarker of exposure for vitamin D status, 25-hydroxyvitamin D [25(OH)D], is the transport form of vitamin D that is made in the liver from the parent compounds. Cholecalciferol (vitamin D_3) is either made in the skin or obtained from the diet. Ergocalciferol (vitamin D_2) is only obtained from dietary or supplement sources that used irradiated yeast or fungi-derived molecules[12]. Differences in metabolism between vitamin D_2 and D_3 do exist, however, both are effective in raising 25(OH)D levels, and the DRI report did not distinguish between these forms in its recommendations. The transport form of vitamin D, 25(OH)D, is delivered to tissues throughout the body which contain the mitochondrial enzymes needed to further hydroxylate it to the active form, 1,25-dihydroxyvitamin D [1,25$(OH)_2$D]. However, only the endocrine pathway of 1-hydroxylation was considered by the DRI committee, whereby the formation of plasma 1,25$(OH)_2$D occurs in the kidney in response to the body's need for calcium or phosphate[13]. It is not possible to distinguish the contribution to 25(OH)D levels from sun-induced synthesis of vitamin D_3 vs. from ingested vitamin D_3, except in studies where 25(OH)D is measured in winter in subjects where other sources of exposure such as trips to sun destinations or use of tanning beds are not confounders.

The values for each age/sex group for EAR, RDA and UL are in Table 1. The level of 25(OH)D that represented adequacy for almost everyone (i.e., the RDA) was defined as a serum level of 25(OH)D at or above 50 nmol/L. This was deemed the adequate level needed for; maximal calcium absorption, minimal risk of rickets in children, reduced fracture risk in adults, and minimal risk of osteomalacia in adults. Using data from studies conducted in winter time or at very high latitudes where sun exposure is assumed to be minimal, the IOM committee used simulated dose-response prediction equations to find the intake of vitamin D that would achieve a mean 25(OH)D level of 50 nmol/L in almost everyone, and this was found to be 600 IU, irrespective of age. There was recognition that older adults demonstrated a high degree of variability in attaining 25(OH)D in studies, thus the RDA for 70y+ was set at 800 IU. The level to achieve 40 nmol/L is 400 IU which is the EAR.

The vitamin D recommendation of 400 IU for infants is an AI, and it too is based on maintaining adequate serum 25(OH)D above 50 nmol/L. Recommended values during pregnancy and lactation are not different from other women in the same age group. A study showed that fetal outcomes were compromised when maternal 25(OH)D was below 40 nmol/L[14]. During lactation, increases in maternal 25(OH)D do not impact breast milk content or infant 25(OH)D unless intakes of vitamin D by mothers is over 4,000 IU[15].

New Upper Level Values for Vitamin D

The indicators of excess vitamin D include hypercalcemia and hypercalcuria. In adults, doses of vitamin D below 10,000 IU/d were not associated with toxicity while intakes above 50,000 IU/d were linked to side effects including hypercalcemia. UL values for infants 0-6 mo and 6-12 mo were set at 1,000 and 1,500 IU, respectively, based on case reports of hypercalcemia. Using published data[16], the committee determined that 4,000 IU was safe (i.e., would not raise 25(OH)D levels above 125-150 nmol/L). For children under 9y, the committee chose to "scale down" the adult UL, as shown in Table 1[1].

Summary and Next Steps

New recommendations for vitamin D indicate that in the absence of sun, healthy Canadians ages 1y and older need 600 IU per day to maintain bone health. Intake studies show that on average, Canadians ingest only 200 IU - 300 IU from foods[8]. Although Canadians and Americans appear to have adequate vitamin D status[1], the Canadian Health Measures Survey (CHMS) data on plasma levels of 25(OH)D indicate that 25% of Canadians have levels < 50 nmol/L[18] . Omitting participants who used supplemental sources of vitamin D from the analysis, the prevalence of inadequate vitamin D status rises to 37%, and when only non-white Canadians are considered, prevalence of inadequacy is 60%[18]. Clearly dietary sources are inadequate to provide vitamin D for many Canadians, especially during winter months.

The committee identified many gaps including absence of trials in which dose response relationships for vitamin D could be identified. More randomized controlled trials are needed to show efficacy of vitamin D in non-skeletal functions. Ways to improve vitamin D, whether through foods, supplements and/or appropriate and safe light therapy, are needed to correct the inadequacies in vitamin D that now have been clearly identified.

TABLE 1
The 2010 Dietary Reference Intake values for vitamin D

Age/Sex Group	EAR IU/day	RDA (AI*) IU/day	UL IU/day
0 – 6 mo M&F	na	(400*)	1,000
6 – 12 mo M&F	na	(400*)	1,500
1 – 3 y M&F	400	600	2,500
4 – 8 y M&F	400	600	3,000
9 – 18 y M&F†	400	600	4,000
19 – 50 y M&F†	400	600	4,000
51 – 70 y M	400	600	4,000
51 y and over F	400	600	4,000
Over 70 y M	400	800	4,000

To convert to micrograms, divide IU values by 40.
na = not applicable
* infant values are AIs which are based on the composition of breast milk
† includes pregnancy and lactation values

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