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RESEARCH

Commentary

The 2011 Dietary Reference Intakes for Calcium and Vitamin D: What Dietetics Practitioners Need to Know*

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ABSTRACT

The Institute of Medicine Committee to Review Dietary Reference Intakes for Calcium and Vitamin D comprehensively reviewed the evidence for both skeletal and nonskeletal health outcomes and concluded that a causal role of calcium and vitamin D in skeletal health provided the necessary basis for the 2011 Estimated Average Requirement (EAR) and Recommended Dietary Allowance (RDA) for ages older than 1 year. For nonskeletal outcomes, including cancer, cardiovascular disease, diabetes, infections, and autoimmune disorders, randomized clinical trials were sparse, and evidence was inconsistent, inconclusive as to causality, and insufficient for Dietary Reference Intake (DRI) development. The EAR and RDA for calcium range from 500 to 1,100 and 700 to 1,300 mg daily, respectively, for ages 1 year and older. For vitamin D (assuming minimal sun exposure), the EAR is 400 IU/day for ages older than 1 year and the RDA is 600 IU/day for ages 1 to 70 years and 800 IU/day for 71 years and older, corresponding to serum 25-hydroxyvitamin D (25OHD) levels of 16 ng/mL (40 nmol/L) for EARs and 20 ng/mL (50 nmol/L) or more for RDAs. Prevalence of vitamin D inadequacy in North America has been overestimated based on serum 25OHD levels corresponding to the EAR and RDA. Higher serum 25OHD levels were not consistently associated with greater benefit, and for some outcomes U-shaped associations with risks at both low and high levels were observed. The Tolerable Upper Intake Level for calcium ranges from 1,000 to 3,000 mg daily, based on calcium excretion or kidney stone formation, and from 1,000 to 4,000 IU daily for vitamin D, based on hypercalcemia adjusted for uncertainty resulting from emerging risk relationships. Urgently needed are evidence-based guidelines to interpret serum 25OHD levels relative to vitamin D status and intervention.
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**This article is a summary of the Institute of Medicine report entitled* Dietary Reference Intakes for Calcium and Vitamin D *(available at http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-Calcium-and-Vitamin-D.aspx) for dietetics practitioners; a similar summary for clinicians has also been published (Ross AC, Manson JE, Abrams SA, Aloia JF, Brannon PM, Clinton SK, Durazo-Arvizu RA, Gallagher JC, Gallo RL, Jones G, Kovacs CS, Mayne ST, Rosen CJ, Shapses SA. The 2011 report on Dietary Reference Intakes for calcium and vitamin D from the Institute of Medicine: What clinicians need to know.* J Clin Endocrinol Metab. *2011;96:53-58).*

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The Institute of Medicine released the *Dietary Reference Intakes for Calcium and Vitamin D* report (1) (available at www.iom.edu/vitamind) on November 30, 2010. The Institute of Medicine, at the request of agencies of the US and Canadian governments, assembled a committee of 14 scientists with the necessary range of expertise to review the increasing body of research on these nutrients over the past 14 years and update the 1997 Dietary Reference Intakes (DRIs) (2). Detailed in the report and summarized in this article is the DRI process, following a Risk Assessment Framework by which the Committee (a) identified health outcome "indicators" that are consistently and causally linked to calcium or vitamin D; (b) determined the Estimated Average Requirement (EAR) that meets the needs of 50% of the healthy population (the median) and the Recommended Dietary Allowance (RDA) that meets the needs of 97.5% of the healthy population; and (c) identified the health outcome "indicators" of adverse effect and the Tolerable Upper Intake Level (UL) corresponding to the highest daily intake that likely poses no risk of adverse effect. In addition, the Committee assessed the dietary intakes of calcium and vitamin D in the US and Canadian populations and identified research needs and public health implications.

ASSESSMENT OF HEALTH OUTCOMES

The Committee extensively and comprehensively reviewed the existing evidence on vitamin D and calcium in relation to diverse health outcomes. It used two key systematic reviews conducted by the Agency for Healthcare Research and Quality in 2007 (3) and 2009 (4) on calcium and vitamin D regarding both skeletal and nonskeletal chronic disease outcomes. The Committee considered a wide range of chronic disease and other outcomes (reviewed in detail in the report), including bone health (bone mineral content and density, fracture risk, rickets/osteomalacia, calcium absorption and balance, and measures such as serum 25-hydroxyvitamin D [25OHD] and parathyroid hormone), cancer prevention and site-specific neoplasms, cardiovascular disease, hypertension, diabetes, metabolic syndrome, falls and physical performance, autoimmune disorders, infectious diseases, neuropsychological functioning (including autism, cognition, and depression), and disorders of pregnancy (preeclampsia, obstructed delivery, and intrauterine growth retardation).

After careful evaluation of the evidence, the Committee concluded that bone health was the only outcome for which causality was established and sufficient dose-response evidence was available to meet the criteria as a health outcome "indicator" and support DRI development. Serum 25OHD levels were considered the most useful marker of total vitamin D exposure from both endogenous synthesis and dietary intake from foods, fortified products, and/or supplements. For other health outcomes considered (cancer, cardiovascular disease, diabetes, falls, physical performance, autoimmune disorders, and other nonskeletal chronic disease), the evidence was inconsistent, inconclusive as to causality, and insufficient to serve as a basis for DRI development. Randomized trial evidence was also sparse, and few studies had been done with these nonskeletal outcomes as the primary prespecified outcomes. The Agency for Healthcare Research and Quality systematic review of 2009 (4) also concluded that the evidence for an association between these nutrients and nonskeletal outcomes was inconsistent and inconclusive.

Challenges encountered in the evidence included: the strong interrelationship between calcium and vitamin D and the difficulty in separating their effects in many studies; the limited data allowing for assessment of dose-response relationships; the complexity arising from endogenous and dietary sources for vitamin D; and the potential for confounding in observational studies due to obesity, physical activity, race/skin pigmentation, and nutritional status including supplementation practices. Further, despite the usefulness of serum 25OHD as a marker of exposure, the Committee understood its limitations as a biomarker of effect. The fact that correlation does not prove causation underscored the need for caution in interpretation of observational study findings. These potential biases were carefully considered in interpretation of observational studies, and the Committee was aware that promising effects of many other micronutrients in observational studies (eg, beta carotene, vitamins C and E, folic acid, and selenium) did not withstand rigorous testing in clinical trials (5,6).

2011 ADEQUATE INTAKES, ESTIMATED AVERAGE REQUIREMENTS, AND RECOMMENDED DIETARY ALLOWANCES

The DRIs for each nutrient shown in the Table are intakes based on bone health, assuming adequate intake for the other nutrient. New evidence available since the 1997 DRIs allowed estimation of EARs and RDAs for all life-stage groups except infants, for whom Adequate Intake is provided based on the calcium intakes from human milk and intakes to maintain vitamin D stores, respectively. The EAR and RDA for calcium, based on calcium-balance studies for ages 1 to 50 years and observational and clinical trial evidence after age 50 years, range from 500 to 1,100 mg/day and 700 to 1,300 mg/day, respectively. For vitamin D, based primarily on the integration of bone health outcomes, 25OHD levels of 16 ng/mL (40 nmol/L) and more than 20 ng/mL (50 nmol/L) provide the EAR and RDA, respectively. Vitamin D intakes to achieve these serum 25OHD concentrations are shown in the Table, based on a simulation of available data across ages under conditions of minimal sun exposure (due to the variation in endogenous synthesis as well as the public health concerns about sun exposure and skin cancer). After age 1 year, the RDA is 600 IU/day for all life-stage groups except men and women age 71 years and older, for whom the RDA is 800 IU/day. The Committee did not find compelling evidence that serum 25OHD levels or dietary intakes more than these levels were associated with greater benefit for bone health or other outcomes. The 2011 RDAs for vitamin D are less than those proposed by some in the current literature; the latter are based on higher target serum 25OHD levels that the Committee found were not justified by the evidence.

TOLERABLE UPPER INTAKE LEVELS

To determine Tolerable Upper Intake Levels (UL), the Committee considered the "indicators" of hypercalcemia,