related to bone health, investigated both calcium and vitamin D combined, and very limited dose–response data were available for any of the potential indicators/outcomes. Moreover, many outcomes were studied in the context of serum 25-hydroxyvitamin D (25(OH)D) levels, whereas DRI must be specified in terms of nutrient intakes. The report evaluates, discusses and explains the evidence that was used, presented in Chapter 4 and related appendices. The entire life cycle was considered, from birth to old age and including pregnancy and lactation. Of note, the DRI for vitamin D were derived based on conditions of minimal sun exposure due to wide variability in vitamin D synthesis from UV light and the risks of skin cancer. Chapter 5 presents the reasoning for specifying and the DRI values (EAR and RDA, or AI for children up to 1 year) for each of the age–sex groups to which DRI values are applied.

The question of excess is addressed with a literature review of potential indicators/outcomes and the rationale and specification of UL (Chapter 6). The report on calcium and vitamin D also provides a discussion of new dietary intake data and serum 25(OH)D levels in the USA and Canada (Chapter 7), implications for special populations (Chapter 8) and research needs (Chapter 9). The source of new data on vitamin D intakes and serum 25(OH)D levels in the population was the National Health and Nutrition Examination Survey and Health Canada. An important finding based on these data is that serum 25(OH)D levels in the USA and Canada are, by and large, at levels consistent with intakes of vitamin D at the RDA level, as specified in Chapter 5. Since dietary intakes (known to often be under-reported) averaged below the new RDA levels, it seems highly likely that sunlight plus total dietary intake, together, are maintaining serum 25(OH)D levels, even in northerly regions of the USA and Canada. Throughout the text, the report discusses in detail uncertainties and caveats. The committee also authored two publications that provide a synopsis of the report directed specifically to clinical[9] and dietetic[10] professionals.

In conclusion, we are sure that interested readers will find much in the new report that explains the process, the reasoning and the development of the new DRIs, and the identification of research priorities. As expected, new scientific information was the driving force for the new DRI. Although the committee was not charged with determining standardized values defining risk of deficiency, sufficiency or risk of toxicity for serum 25(OH)D for clinical laboratories, the report does note that no authoritative body has defined appropriate levels and it identifies consensus on this issue as an urgent need. Overall, while the 2011 report on DRI for calcium and vitamin D is now completed, it is expected that new science in the future will continue to probe the biological requirements for these important nutrients.

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Vitamin D

The IOM D-lemma

Madam

It was with great anticipation that the world waited for the release of the recommendations on vitamin D by the Institute of Medicine (IOM), which finally made its debut in November 2010[1]. The committee relied on several large meta-analyses including those from the Agency for Healthcare Research and Quality from the USA and Canada as well as larger randomized controlled trials (RCT), and concluded that the previous recommendations made by the IOM in 1997 were woefully inadequate. The committee recognized that, at a minimum, most

children and adults should increase their vitamin D intake by 200%, i.e. from 5 to 15 μg vitamin D/d to maintain a healthy skeleton. For adults over the age of 70 years the committee recommended 20 μg vitamin D/d. The committee also appreciated that vitamin D is not as toxic as once thought and therefore doubled the tolerable upper limit from 50 to 100 μg/d for most children and all adults.

There are several thousand publications suggesting that vitamin D deficiency and insufficiency defined as 25-hydroxyvitamin D level <30 ng/ml is a pandemic affecting all populations with serious health consequences[2–10]. However the IOM concluded based on its definition of vitamin D deficiency, i.e. 25-hydroxyvitamin D <20 ng/ml, that this is a relatively rare deficiency in the USA. The IOM only recognized that vitamin D was beneficial for musculoskeletal health and dismissed a multitude of association studies and small RCT suggesting other health benefits, including improving immune and neurocognitive functions[1,11,12] and reducing the risk of deadly cancers[13,14], heart disease[2–6], autoimmune diseases[15] and type 2 diabetes[15]. The IOM did recognize that many tissues and cells in the body express a vitamin D receptor and that some cells including macrophages have the capability of activating vitamin D locally[16]. However they did not consider the health implications for why so many cells in the body would have a vitamin D receptor and therefore presumably require 1,25-dihydroxyvitamin D for maximum function and health.

The IOM also suggested based on a few studies that there may be a higher mortality associated with blood levels of 25-hydroxyvitamin D between <20 and >30 ng/ml. However, at least one of the studies it included in the analysis noted there was a lower risk of mortality for 25-hydroxyvitamin D concentrations between 30 and 49 ng/ml and a concentration >50 ng/ml was associated with a higher risk of mortality in women but not in men[4].

There have now been several RCT demonstrating that ingesting between 25 and 50 μg vitamin D/d and/or attaining a blood level of 25-hydroxyvitamin D >30 ng/ml reduces risk for influenza A infection in schoolchildren[12], reduces vascular stiffness in teenagers[6] and reduces risk of cancer in postmenopausal women by 60%[14]. The IOM did not suggest that pregnant and lactating women need more than 15 μg vitamin D/d. However in forty mother–infant pairs where 70% of the women were taking on average 15 μg vitamin D/d, it was reported that 76% of the mothers and 81% of the newborns at the time of birth had 25-hydroxyvitamin D level <20 ng/ml[17]; a level considered to be vitamin D deficient by the IOM committee. Furthermore it was reported that pre-eclampsia[18] and the need for a primary Caesarean section[19] were associated with vitamin D deficiency.

There is no downside to increasing vitamin D intake. The IOM in its wisdom in 1997 suggested that all children and adults up to the age of 50 years required only 5 μg vitamin D/d. However, thankfully, it has now realized what most experts have been recommending: that this is totally inadequate to satisfy even bone health. It is likely that, as more RCT are reported using higher doses of vitamin D demonstrating non-skeletal beneficial effects, the next meeting will likely increase the recommendation by another threefold. To achieve a blood level of 25-hydroxyvitamin D >30 ng/ml, children aged 1 year and older should ingest 25 μg vitamin D/d and teenagers and all adults require 50 μg vitamin D/d. A study in Finland reported that children who ingested 50 μg vitamin D/d during their first year of life had substantially reduced risk for type 1 diabetes 31 years later. Therefore the tolerable upper limit should be at least 50 μg/d for this age group[20]. Studies in children and teenagers have demonstrated that 50 μg vitamin D/d is safe and effective in treating and preventing vitamin D deficiency, and therefore a tolerable upper limit of 125 μg/d would be reasonable. Teenagers and all adults should be able to tolerate up to 250 μg vitamin D/d and this would be a reasonable tolerable upper limit.

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