

Letter to the Editor

Vitamin D

The vitamin D requirement during human lactation: the facts and IOM's 'utter' failure

Madam

The new Institute of Medicine (IOM) recommendation for vitamin D intake is stated to be 400 and 400–600 IU/d for the newborn infant and lactating mother, respectively⁽¹⁾, and represents only a marginal change from its previous recommendations⁽²⁾. We have no issue with respect to the infant recommendations; however, the lactating woman's recommendation is another matter. Our lab has been investigating this area for more than three decades and was the first to actually quantify the vitamin D compounds in human milk⁽³⁾. Surprisingly, most of our data have been ignored in favour of the original recommendation – or, more appropriately, 'the estimation' – by Blumberg, Forbes and Fraser in 1963⁽⁴⁾.

As a graduate student in human nutrition in the 1970s (B.W.H.), the senior investigator in our lab Dr Hollis was struck by the teaching that human milk was the 'perfect' food for the human neonate with one exception: it was inadequate with respect to vitamin D content, and rickets could result in the nursing infant if not provided with exogenous vitamin D supplementation. How could this be? What did these infants do prior to the discovery of vitamin D and how could nature have allowed this to happen? Actually, the answer is quite simple: we in medicine believed our own dogma instead of actually following the science, and thus we tried to 'fit' our 400 IU/d recommendation to the physiology instead of applying the physiology to discover the true recommendation.

First, it was said that milk had plenty of vitamin D due to the presence of vitamin D-sulfate. In fact, research 'conveniently' demonstrated that vitamin D-sulfate provided activity of about 400 IU/d in human milk⁽⁵⁾. The problem was that this research was faulty: vitamin D-sulfate did not exist in milk at all⁽⁶⁾, so we were back to the drawing board. Accurate assessment had shown the vitamin D content of human milk in 'normal' lactating women to be less than 100 IU/l^(3,7). We had shown that lactating women exposed to UV light or given high oral doses of vitamin D to control hypoparathyroidism could produce milk that contained extremely high levels of antirachitic activity of up to 8000 IU/l^(8,9). This increase in activity was almost totally due to the parent compound, vitamin D, gaining access to the milk and not the major circulating form, 25-hydroxyvitamin D (25(OH)D)^(8,9). But, how could this knowledge be applied to 'normal'

women since it was 'well known' that intakes of vitamin D in excess of 2000 IU/d would result in toxicity?⁽²⁾ Because of this belief, this area of research lay dormant for nearly two decades; our laboratory being as guilty as anyone else's for believing it. Fortunately, our view on this matter changed when Vieth *et al.*⁽¹⁰⁾ published a seminal paper in 2001 that demonstrated oral intakes of vitamin D₂ up to 4000 IU/d were safe.

Let us piece together the physiology for vitamin D metabolism in the human female. The parent compound, vitamin D₃, is mostly derived from human skin following exposure to UV light, which can result in the release of several thousand IU/d into the circulation⁽¹¹⁾. This vitamin D₃ is 'loosely' bound to the vitamin D-binding protein (DBP) with a circulating half-life of approximately 1 d⁽¹²⁾. A portion of this parent compound is metabolized to 25(OH)D, which is 'tightly' bound to the DBP with a circulating half-life of approximately 3 weeks⁽¹²⁾. Here is where one has to pay attention to the physiology. While 25(OH)D is the major circulating form of vitamin D, it is poorly transferred into human milk while the parent vitamin D is readily transferred^(8,9,13). The problem is that because the half-life of vitamin D is so fast, it has to be replenished daily to be effective and this replenishment has to be several thousand IU/d and NOT the 'artificial' requirement of 400 IU/d, which does nothing to raise the circulating parent vitamin D₃ levels in the mother. In fact, one can use all this data and simply calculate that for each 1000 IU intake of vitamin D by the mother daily she will deposit approximately 100 IU of antirachitic activity into a litre of her milk. Thus, one can supplement the lactating women with vitamin D at 6000 IU/d or let her obtain significant sun exposure and she will not only replete herself but also supply her nursing infant with vitamin D in her milk at 500 IU/l or so. The sun exposure part does not currently fit into our culture but it was how vitamin D was obtained for untold thousands of years before we became civilized and warned that sunlight was a carcinogen to be avoided.

Clinically, this fact has been clearly demonstrated in a recent publication from our group that effectively raised the antirachitic activity of human milk to a level that sustains the nursing infant with no harm to the mother⁽¹⁴⁾. Subsequently we received a large grant from the National Institutes of Health to study this approach further, in which we give mothers 2000 or 6000 IU vitamin D₃/d compared with controls receiving 400 IU vitamin D₃/d (and concomitant vitamin D₃ drops of 0 IU to the infants of mothers in the high-dose groups and 400 IU/d to the

infants whose mothers are receiving 400 IU/d) to sustain not only maternal circulating levels of vitamin D and 25(OH)D, but also her nursing infant's. The 5-year project is nearing completion and we have not encountered a single adverse event related to high-dose maternal vitamin D supplementation. It should be noted, however, that we had to terminate the 2000 IU/d arm of the trial because through our DSMC it was determined that this dose was 'inadequate' at supplying the nursing infant with sufficient amounts of vitamin D to maintain normal infant total circulating 25(OH)D level. Why, because a 200 IU/d intake even for a neonate is not an adequate amount. Just think, only a few years ago, that 2000 IU/d dose was thought to cause vitamin D toxicity. Isn't science a wonderful force if one actually pays attention and follows the data?

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