The Osteoporosis Education Project

Susan E. Brown, Ph.D.
Director

working with nature to regenerate bone health

Vitamin D: Startling New Research Findings on an Old Bone Builder

Susan E. Brown, Ph.D., CCN

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From the height of the Industrial Revolution until nearly seventy years ago large percentages of urban children in the US and Northern Europe suffered from a mysterious disease. This disease left children with growth retardation and bone deformity so severe that giving birth vaginally was impossible. As a consequence, birth by Caesarian section became widespread in Britain. This bone devastating disease became know as "rickets" in children and "osteomalacia" in adults. After decades of experimentation the cure was found in two things; sunlight exposure and small amounts of cod liver oil.

The First Wave of Vitamin D Awareness (early 1900's to mid 1990's)

Vitamins are nutrients essential for life that cannot be produced within the body. They must be consumed in the diet. Identification of the substance in cod liver oil that cured rickets led to the classification of Vitamin D as a "vitamin". In reality, however, vitamin D is a "prohormone". It is a substance produced in the body upon exposure to ultraviolet solar radiation, which is then converted by the liver and kidneys into an active hormone. With abundant sunlight exposure we need not consume vitamin D. In fact, few sources of human food contain vitamin D, and as a rule 80% or more of our vitamin D is produced from sunlight exposure.

Humans evolved in open sunlight and needed no other source of vitamin D. However, as if nature anticipated the move into colder, darker climates, she provided for limited dietary sources of this vitamin D. While these dietary sources do not provide for optimal levels of vitamin D as does sunlight exposure, they can provide enough vitamin D to prevent bone-damaging deficiency disease.

In the early 1900's discovery of the factor in cod liver oil that cured rickets and osteomalacia was a triumph of early nutrition science. Stemming from this success, the "first wave" of vitamin D awareness pegged the need for vitamin D at the minimal amount which could prevent sunlight deficiency-induced bone disease, roughly

100 International Units (IU) daily.

This "first wave" of vitamin D awareness also brought the realization that vitamin D was fat soluble and stored in the body, and thus had a potential for toxic accumulation. For various reasons, vitamin D toxicity became an issue of exaggerated concern, the extent of which is only now becoming evident. Looking back scientists now realize that vitamin D toxicity is rare and only occurs from unusual oral intake, never from sunlight exposure. The early cases of vitamin D intoxication which formed the basis for the "first wave" toxicity concern generally involved impurities in vitamin D production, or the use of synthetic vitamin D analogues, or accidental use of extremely high doses, or individuals with vitamin D hypersensitivity. (Shils, ME, *Modern Nutrition in Health and Disease,* 1999)

The "Second Wave" of Vitamin D Awareness (mid 1990's to present)

In the mid 1990's key vitamin D researchers began challenging common assumptions about vitamin D. Most importantly they began to question what might be the optimal level of vitamin D, as opposed to the minimal level used to prevent rickets and osteomalacia. This in turn led to a long overdue critical analysis of vitamin D toxicity. Well respected researchers including Dr. Reinhold Vieth of the University of Toronto and US calcium guru Dr. Robert Heaney of Creighton University blazed this exciting new scientific trail.

"New Wave" Findings on Vitamin D

Once these insightful researchers set aside the old assumptions about vitamin D and began to ask new questions, a new wave of information arose. This new wave promises to revolutionize the way medicine looks at, and uses, vitamin D. New wave perspectives include awareness that:

- *Vitamin D is far from just a bone nutrient*

  Receptors for vitamin D have been found all over the body from bone and brain to thymus and uterus. While there is still much to learn, strong evidence suggests that vitamin D is also important as an immune enhancement, anti-cancer and cardio-protective and joint protective agent, as well as being a potent antioxidant.

- *From an anthropological perspective we evolved outdoors exposed to abundant sunlight with attendant "high" vitamin D blood levels*

  Even today farmers and outdoor workers in sunny climates produce an equivalent of 10,000 IU vitamin D a day from solar radiation. These outdoor folks have naturally high vitamin D blood levels, at, or above the high end of normal for the standard laboratory range. These levels are maintained without any toxic effects, in fact, considerable data suggest health-promoting effects of these naturally

occurring high vitamin D levels. (Vieth, R. *Am J Clin Nutr* 69:842-56, 1999); (Holick, MF, *Lancet* 357:4-5. 2001)

- *The optimum, health-promoting level of vitamin D is much higher than expected*

As it now appears the "optimum" blood level of vitamin D falls at the high end of the normal range. (The typical laboratory normal range for vitamin D in the form of 25(OH)D is from 20 to 150 nmol/L or from 8 to 60 ng/ml, depending which unit of measurement is used). In regard to bone health, for example, the optimum level of vitamin D appears to be that level which favorably reduces parathyroid hormone (a hormone which you want low to prevent osteoporosis). Research suggests the blood level of vitamin D needed for this is 100nmol/L (40 ng/ml) or greater. Interestingly, the two well accepted studies showing osteoporosis fracture prevention with vitamin D and calcium supplementation reported that the mean vitamin D concentration of subjects after supplementation exceeded 100nmol/L, measured as 25(OH)D. (Heaney, RP, *Am J Clin Nutr* 69 (5): 825-826, 1999); (Vieth, R. *Am J Clin Nutr* 69:842-56, 1999); (Chapuy, MC, *N Engl J Med* 327: 1637-42, 1992); (Dawson-Hughes, B, *N Engl J Med* 337: 670-676, 1997)

- *It takes much more vitamin D input than expected to gain and maintain this optimum vitamin D level*

Whether our vitamin D comes from sunlight, food or supplements, researchers find we need substantially more vitamin D input than expected to maintain optimum blood levels. Depending on sunlight exposure and vitamin D body stores, maintaining these levels can require anywhere from 0 to 4,000 (IU) of vitamin D daily (Always work with your physician to determined the amount of vitamin D you need). (Vieth, R. *Am J Clin Nutr* 69:842-56, 1999); (Heaney, R, et al. *Am J Clin Nutr,* Forthcoming 2003)

- *The new 1997-2002 US Food and Nutrition Board (FNB) recommendations for oral vitamin D intake are too low*

Dr. Robert Heaney himself was a member of the FNB which set the official vitamin D intake levels. Dr. Heaney now reports, however, that his new research suggests these government recommendations are far too low. As he calculates, our typical diet combined with the recommended supplemental D intake (200 IU, raising to 400 IU at age 51 and 600 IU for 71 years and older) would only provide 15% of an ideal vitamin D blood level. Dr. Heaney himself now classifies the FNB recommendations as "falling into a curious zone between irrelevant and inadequate". For those individuals with extensive solar exposure the governmental intake recommendations add little to their daily production, and for those without exposure the recommended levels are insufficient to ensure desired 25(OH)D blood levels. (Heaney, R, et al. *Am J Clin Nutr,* Forthcoming 2003)

- *The best way to determine vitamin D need and to gauge safety of supplement use is to measure the blood level of the vitamin D metabolite known as 25(OH)D vitamin D*

The only real way to know if you are receiving an adequate and or safe dose of vitamin D is through a blood test for 25(OH)D. Be sure your physician tests for the more stable form of vitamin D known as 25-Hydroxyvitamin D, known as 25(OH)D and not for the transient 1, 25-Dihyrdroxyvitamin D form. Also, it is wise to retest after using vitamin D for a month to make sure that you are not getting too high or too low levels of vitamin D. Occasional retesting thereafter might be recommended by your physician if you are on higher dose therapy.

- *The potential for vitamin D toxicity has been overstated*

While vitamin D can accumulate and become toxic, documented toxicity is rare and often involves either individuals with specific vitamin D hypersensitivity or accidental misuse. As Dr. Veith reports, vitamin D toxicity is always accompanied by serum 25(OH)D levels greater than 220 nmol/L. Further, his exhaustive research finds no cases of D3 toxicity due to intentional consumption (Vieth, R, 2000 Nutritional Aspects of Osteoporosis, ed by Heaney, et al. Academic Press 2001) Of course, everyone's biochemistry is different, so it is wise to have your vitamin D use monitor by your physician.

- *While most of our vitamin D comes from sunlight exposure, winter internal vitamin D production is almost nil in much of the world*

In latitudes 40 degrees either way from the equator (a Northern parallel around Philadelphia or Lisbon) the slant of the sun is such that during winter months we produce very little, if any, vitamin D, even with sunlight exposure. In the winter those in Northern climates depend on vitamin D stores accumulated in the summer.

- *Populations in many parts of the world do not have adequate levels of vitamin D*

Even using the "old wave" traditional standards for vitamin D adequacy nearly one half of US African-American women ages 15 to 49 were recently found to be vitamin D deficient. Further, 30% of African-American women who were consuming more than 200 IU of vitamin D from supplements were still found to have low vitamin D levels. . (Nesby-O'Dells, S, et al., Am J Clin Nutr, 76(1):187-192, 2002) In another study thirty-four percent of Canadians surveyed had inadequate Vitamin D levels. In a Boston study of elderly people who took vitamin D supplements or drank 2-3 glasses of vitamin D fortified milk, 80% were overtly or borderline vitamin D deficient at the end of winter. (Holick, MF, Am J Clin Nutr 76(1): 3-4, 2002) Further, in an area as diverse as Israel large portions of the population are reported to be vitamin D deficient.

- *Types of Vitamin D Supplements*

  There are two common forms of vitamin D supplements. One, known as D_3 (cholecaliferol) is a natural form of the vitamin. D_3 is most commonly derived from lanolin from sheep's wool and can be also produced from fish oil. The other common form of vitamin D is known as D_2 (ergocalciferol). D_2 is a synthetic form of the vitamin. It is roughly half as potent as natural vitamin D_3. When possible we prefer to use fish oil based natural vitamin D_3, which also offers good levels of the important Omega 3 essential fatty acids. A good, purified, low in vitamin A, and carefully packaged cod liver oil (such as Carlson's) is an excellent source of natural vitamin D.

Stay Tuned For The New Vitamin D Research

The "first wave" of vitamin D awareness gifted humans with a cure for one devastating bone disease. The currently unfolding "second wave", is guaranteed to move us closer to a cure for the modern day osteoporosis epidemic. For research updates and guidelines for monitoring your vitamin D use visit us at betterbones.com and susanbrownphd.com.

Byline

Susan E. Brown, Ph.D., C.C.N., directs the Osteoporosis Education Project (OEP), a non-profit research and education organization dedicated to exploring the human potential for bone health regeneration. Dr. Brown's book, *Better Bones, Better Body: (Keats 2000)* and the *Better Bones Better Body pH Test Kit* and her publication, *Rethinking Vitamin D, Rebuilding Bone* are available from the Osteoporosis Education Project, Inc. in East Syracuse, NY, 315-437-9384. Their website, www.betterbones.com, offers extensive information on regenerating bone health.

Tips on Vitamin D Supplementation

- Use the natural D3 cholecalciferol from of D, it is more effective and safer than the synthetic D2 (ergocalciferol)
- Avoid vitamin D supplementation containing very much vitamin A (for bone health limit total vitamin A supplementation to 2,500 IU)
- Begin with 400, or possible 800 IU if sun exposure is minimal
- Ask your doctor to test your blood 25(OH)D level at base line and then after at least four weeks of supplement use, and adjust dose accordingly and retest as necessary
- Do not use D supplements without your doctor's supervision if you have kidney problems, kidney stones or any disease such as sarcoidosis which makes you hypersensitive to vitamin D

Guidelines for Sunlight Exposure

- Short periods, 15-20 minutes daily, of near full body exposure are best for light skinned people (without sunscreen)
- Use sunscreen after this initial period, so as not burn your skin
- Very dark skinned people require 4-6 times more sunlight exposure than light skinned people
- In Northern areas longer exposure is needed, especially during the winter
- The useful ultraviolet rays are strongest between 10 am and 2 pm

Vitamin D Toxicity

- First symptoms of toxicity include anorexia (loss of appetite), nausea, vomiting followed by excessive urination, weakness and nervousness
- Elevated serum calcium levels of 12 to 16 mg/dl are constant findings when toxic symptoms occur (normal calcium levels are 8.5 to 10.5 mg/dl)
- There is no evidence of adverse effects with serum 25(OH)D levels less than 140 nmol/l
- Intoxication is usually associated with 25(OH)D concentrations above 375 nmol/L with attendant high blood calcium and phosphate levels

Food Sources of Vitamin D

Food	International Units
Dairy	
Milk, nonfat, reduced fat, and whole, vitamin D fortified, 1 cup	98 IU
Margarine, fortified, 1 Tbs.	60 IU
Butter, 1 Tbs.	10 IU
Fish and seafoods	
Cod liver oil, 1 Tbs.	1360 IU
Salmon, cooked 3 ½ oz.	360 IU
Mackerel, cooked 3 ½ oz.	345 IU
Sardines, canned in oil, drained, 3 ½ oz.	270 IU
Eel, cooked 3 ½ oz.	200 IU
Atlantic Herring (Pickled), 3 ½ oz.	680 IU
Eastern Oysters (Steamed), 3 ½ oz.	642 IU
Catfish (Steamed/Poached), 3 ½ oz.	500 IU
Skinless Sardines (Water Packed), 3 ½ oz.	480 IU
Mackerel (Canned/Drained), 3 ½ oz.	450 IU
Smoked Chinook Salmon, 3 ½ oz.	320 IU
Small Clams (Steamed/Cooked Moist), 3 ½ oz.	8 IU
Blue Crab (Steamed), 3 ½ oz.	4 IU
Fortified Cold Cereals	
Dry Cereal, fortified w/ 40 IU of vitamin D, ¾ cup	40-50 IU
Organ meats	
Beef Liver (Braised), 3 ½ oz.	12-30 IU
Beef Liver (Fried), 3 ½ oz.	12 IU
Pork Liver (Braised), 3 ½ oz.	12 IU
Chicken Liver (Simmered), 3 ½ oz.	12 IU
Lamb Liver (Braised), 3 ½ oz.	20 IU
Beef Tripe (Raw), 3 ½ oz.	12 IU
Beef Kidney (Simmered), 3 ½ oz.	12 IU
Eggs:	
Egg, 1 whole (vitamin D is present in yolk)	25 IU

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