

## **Vitamin D and Pregnancy in (Mostly) Plain English** **By Jodilyn Owen**

The year 2010 may be looked back upon as “The Year of vitamin D”. A plethora of newly published research and revelations about the extensive role that vitamin D plays during pregnancy for both maternal and fetal health affords every provider and expectant mother an arsenal of health-promoting knowledge. Combined with the myriad of vitamin D related research completed over the past four years, we now have a very deep understanding of the mechanisms of vitamin D and its critical importance to the fetus. The following provides an overall understanding of the function of vitamin D for expecting women and their developing babies and summarizes the recent research findings and subsequent recommendations.

Vitamin D is a fat soluble vitamin, which means that the body will store some of what is ingested via food or supplements, or converted through exposure to sunlight. When a vitamin is fat soluble, it is important to think about safe upper limits of intake so that one does not tumble into having too much of a good thing which can lead to some unpleasant and unhealthy side effects. The short story on dosing and safe upper limits is that by the end of 2010 the jury is still out, except to say that our current recommended levels do not begin to provide enough for optimal health and that our current upper limit levels are way too low. Some research has pointed to shifting the safe upper limit from 2,000iu to 10,000iu daily (more on this below) and several countries around the world are moving in this direction. In Poland research has led to the recommendation of increasing daily doses in adults from 400iu to 800-1000iu daily with regular monitoring to ensure that optimal serum levels are maintained. Professor Bruce Hollis, PhD, of the Medical University of South Carolina has shown that pregnant and lactating women need at least 5,000 IU daily to help combat the three childhood epidemics most closely associated with gestational and early childhood vitamin D deficiencies. He has also shown that 2000iu daily does not increase a pregnant woman’s serum levels at all. Yet the Food and Nutrition Board has come out with a statement that a pregnant woman needs only 600iu daily. It seems that with the national recommendations at odds with the research, the dosing and management decisions will have to be individualized, with a woman’s midwife or doctor testing her vitamin D levels (a test called Vitamin D Hydroxy 25) to get and keep her in the optimal range. There is a rare outcome of vitamin D intake raising calcium blood levels so it is wise to have those levels (in the form of PTH and calcium blood level tests) monitored. The Vitamin D Council encourages pregnant women to take 5,000iu per day and to maintain serum levels no lower than 50-80 ng/mL.

Vitamin D can be found from three main sources: the sun, food, and supplements. The fastest and easiest way to get Vitamin D into one’s system is by spending time in the sun which creates a process called “vitamin D synthesis”. In 1995, Professor Holick, of Boston University, demonstrated that a brief full-body dose of noonday summer sun generates 20,000iu of vitamin D. Dr. Bruce Hollis states that “from an evolutionary standpoint, humans did not require vitamin D in their food supply, because, over millions of years humans...evolved a photosynthetic mechanism in their skin to produce large amounts of vitamin D-3. Thus, our skin is part of the vitamin D endocrine system, and vitamin D-3 is really a **preprohormone**” (from the symposium “Vitamin D Insufficiency: A Significant Risk Factor in Chronic Diseases and Potential Disease-Specific Biomarkers of Vitamin D Sufficiency” given at the 2004 Experimental Biology meeting on April 18, 2004, Washington, DC.). Fear of skin cancer has lead Americans to use sunscreen daily. Using a sunscreen with as little as a 15-factor protection cuts the skin's vitamin D production by 99 percent, rendering the sun ineffective as a source of vitamin D. Research from around the world has shown that mothers and babies are less likely to have vitamin D deficiencies or insufficiencies when the mother has her baby during the sunny time of the year. Pollution and clouds lower the amount of UVB that can reach a person, and modern windows

filter it out so sitting by the window on a sunny day is not enough (unless the window is open and there is direct sunlight on the body!) If you live locally, you'll notice the large number of days that give Seattle its reputation as Raingear Required. There are entire months where the required level of sun exposure is impossible to achieve here without supplementation. Vitamin D is also found in some foods, here are few samples measured in international units (iu):

- Cod liver oil: 2217
- Wild oysters: 941
- Canned pink salmon: 685
- Halibut: 645
- Silk light plain soymilk: 338
- Orange juice from concentrate fortified with Vitamin D: 259
- Nonfat milk: 246

Finally, vitamin D comes in supplement form. Capsules tend to come in doses of 500iu, 1000iu, or 5000iu. They come with either D2 or D3 and either one works for supplementation, though some of the new research points to D3 as having significant additional benefits, especially when starting off with a deficiency. A good, hypoallergenic encapsulated supplement readily available in our area (at any Pharmaca store and at most health food and vitamin stores and online at [thorne.com](http://thorne.com)) is Thorne (I am not linked with this company financially). Taking capsules everyday with a full glass of water maximizes absorption and many people feel a difference in their energy levels if they split their dose in two, taking one half in the morning and one half in the evening. Mothers should try different combinations to find what feels best for them. It is also available in drops which are taken three times per day in the dose that the provider recommends (every 2 drops of the Thorne brand contain 1,000iu). The amount of vitamin D in prenatal vitamins is not enough to cover the mother's and baby's needs.

Vitamin D is famous for its well known and documented benefits in bone health and its essential role in the absorption of calcium. The awareness of the advantages of vitamin D started back in the 1930's when researchers found that Cod liver oil, which is high in Vitamin D, completely reduced the incidence of children born with Rickets. But what current research has peeled away about the extensive positive effects of Vitamin D in the human body points towards why it is worth the effort to get serum levels up to optimal.

Trying to understand what constitutes optimal levels requires a deeper look into the research and functioning of the labs that process the tests. Looking to a lab result for levels "within normal limits" does not give any information about and is not the same as optimal levels. In a population where as many as 70% of the adults have insufficient or deficient levels of vitamin D, and lab normals are values based on the population, a result that is "normal" is really a result that says "normal within a deficient population". In other words, normal results may indicate insufficiency or even deficiency. In some areas in America, the lowest acceptable "optimal" number cited by researchers, is double the lowest number cited by labs as "normal". Most American labs cite a normal range of 30-74. Recent research points to optimal levels being between 50 and 90. In sun-rich environments where clothing or cultural practices do not prevent sun exposure, levels range from 54-90. Strong research suggests that a level of 80 is needed to avoid the health issues related to vitamin D deficiencies.

*A woman's Vitamin D status does make a difference in her baby's status at birth.* Vitamin D is a pleiotropic hormone—it acts in many ways and has multiple effects throughout the human body including but not limited to bone development and calcium absorption. Vitamin D receptors bind the

active form of vitamin D to create these responses throughout the body. It modulates both the innate and adaptive immune systems and regulates cell multiplication. Research has linked low vitamin D levels to statistically significant increases in risk for:

- gestational diabetes
- glucose intolerance
- Preeclampsia (women with preeclampsia and eclampsia have almost double the risk for future early cardiac disease and peripheral arterial disease)
- bacterial infections in the vagina called bacterial vaginosis (which can lead to preterm delivery)
- reduced fetal growth/low birth weight babies
- bone fragility
- meconium staining of amniotic fluid prior to birth
- cesarean delivery
- altered neonatal development
- neonatal seizures
- incidence of autoimmune diseases
- childhood asthma and allergies
- type 1 diabetes

Research out of Finland showed a positive correlation between maternal vitamin D levels and neonatal skeletal development. An interesting conclusion from this study was that although the mean total intake of vitamin D among the participants met Nordic recommendations, 71% of the women and 15% of the newborns were vitamin D deficient during the pregnancy. This was one of many studies from around the world which illustrated the fact that current nutritional recommendations are not high enough to achieve optimal levels. A study out of the University of Colorado showed that American women need to take higher doses for longer duration than they do currently to create the kind of levels that are best for a pregnant woman and her growing baby.

Vitamin D modulates implantation and production of protein molecules that regulate the immune system. It may also help the placenta create antimicrobial proteins which fight off a number of disease causing organisms, including staphylococcus, streptococcus, and E. coli bacteria. The proper levels of vitamin D also have been shown to help specific genes express themselves in the developing fetus which protect against allergies and allergic responses such as asthma and stuffy, runny noses. In a separate study it was shown to prevent wheezing and eczema in infants.

While the amount of vitamin D a mother transfers to her baby (through the placenta) during pregnancy appears to be more important than how much she transfers during early lactation, according to the CDC, research has shown that vitamin D from breast milk makes a difference for babies as well.

Because calcium demands increase in the third trimester of pregnancy, vitamin D status becomes crucial for maternal health, fetal skeletal growth, and optimal maternal and fetal outcomes during this time. So even if you are (or especially if you are) at the end of your pregnancy when reading this, you can still have an effect on the health of your baby by increasing your intake of vitamin D. A study out of China showed that serious deficiencies in fetal development can be overcome by optimal levels of vitamin D intake by mothers during pregnancy, and that the differences in the skeletal development of babies with mothers who are deficient and optimal levels were most marked during the last trimester.

As for the mother, add oral health to the list of accomplishments of vitamin D. Researchers at the University of North Carolina at Chapel Hill found that there was a link between low vitamin D levels and

periodontal disease. This is important because periodontal disease in pregnancy is directly associated with adverse pregnancy outcomes.

Additionally, many mothers feel pain in their muscles, joints, and bones during pregnancy. While there are a plethora of causes for this kind of pain, researchers have found that vitamin D in combination with physical therapy and pain killers where necessary plays a significant role in alleviating the pain.

The down side to vitamin D comes in the form of vitamin D toxicity. The Food and Nutrition Board reported that vitamin D toxicity might occur at an intake of 10,000iu per day, although they could produce no reproducible evidence that this level has ever caused toxicity in humans and only one poorly conducted study indicating 20,000iu daily may cause mild elevations in serum calcium, but not clinical toxicity. Anorexia, weight loss, nausea and vomiting have been observed in hypercalcemic individuals but the only way to monitor for clinical toxicity of vitamin D/hypercalcemia is to test the PTH and calcium blood level regularly. It has been shown that people with darker skin are more prone to toxicity.

In Canada an estimate of the economic burden and premature deaths due to vitamin D deficiency showed that just by increasing the mean serum rate of vitamin D in Canadians the death rate could fall by 37,000 deaths and the economic burden by 14.4 billion dollars less the cost of implementing a national program to increase vitamin D intake. Other research has shown the need for further investigation regarding apparent connections between vitamin D deficiencies and eclampsia, schizophrenia, and infantile autism.

Dr. John Jacob Cannell, an American researcher specializing in vitamin D and the Executive Director of the Vitamin D Council recently published a paper on vitamin D and influenza and another on vitamin D and autism. Dr. Cannell, states, "The recent discovery--from a meta-analysis of 18 randomized controlled trials--that supplemental cholecalciferol (vitamin D) significantly reduces all-cause mortality emphasizes the medical, ethical, and legal implications of promptly diagnosing and adequately treating vitamin D deficiency...vitamin D deficiency is implicated in most of the diseases of civilization. Vitamin D's final metabolic product...targets more than 200 human genes in a wide variety of tissues, meaning it has as many mechanisms of action as genes it targets. One of the most important genes vitamin D up-regulates is for cathelicidin, a naturally occurring broad-spectrum antibiotic."

In conclusion, the evidence from a variety of recently published research points to the fact that maternal vitamin D status during pregnancy is important for the health of the mother and her children across a range of possible health outcomes and that midwives and OBs should be testing and working with expectant mothers to bring them up to optimal levels for pregnancy and nursing. Expectant mothers should ask their provider to run a vitamin D hydroxy 25 serum level test and take steps to increase vitamin D intake during pregnancy and beyond.

*The information included in this article was derived from the following sources. I did not cite specific sentences throughout this article as I read through all of the research below, taking notes while reading, and sought to summarize it in understandable language and not to recreate a scientific read. I encourage readers to go to these sources to gain a deeper understanding of the issues related to vitamin D.*

Hathcock JN, Shao A, Vieth R, Heaney R. Risk assessment for Vitamin D. *Am J Clin Nutr.* 2007 Jan;85(1):6-18.

Vieth R. Critique of the considerations for establishing the tolerable upper intake level for Vitamin D: critical need for revision upwards. *J Nutr.* 2006 Apr;136(4):1117-22.

*Am J Obstet Gynecol.* 2010 May;202(5):429.e1-9. Epub 2009 Oct 20. Implications of vitamin D deficiency in pregnancy and lactation. Mulligan ML, Felton SK, Riek AE, Bernal-Mizrachi C.

*Am Heart J.* 2008 Nov;156(5):918-30. Epub 2008 Oct 2. Cardiovascular sequelae of preeclampsia/ eclampsia: a systematic review and meta-analyses. McDonald SD, Malinowski A, Zhou Q, Yusuf S, Devereaux PJ.

*Br J Nutr.* 2010 Jul;104(1):108-17. Epub 2010 Mar 2. Maternal early pregnancy vitamin D status in relation to fetal and neonatal growth: results of the multi-ethnic Amsterdam Born Children and their Development cohort. Leffelaar ER, Vrijkotte TG, van Eijsden M.

*J Clin Endocrinol Metab.* 2010 Apr;95(4):1749-57. Epub 2010 Feb 5. Maternal vitamin D status determines bone variables in the newborn. Viljakainen HT, Saarnio E, Hytinantti T, Miettinen M, Surcel H, Mäkitie O, Andersson S, Laitinen K, Lamberg-Allardt C.

Vitamin D insufficiency in pregnant and nonpregnant women of childbearing age in the United States. Ginde AA, Sullivan AF, Mansbach JM, Camargo CA Jr.

*Clin Exp Allergy.* 2010 May;40(5):786-94. Epub 2009 Dec 16. Maternal vitamin D intake during pregnancy increases gene expression of ILT3 and ILT4 in cord blood. Rochat MK, Ege MJ, Plabst D, Steinle J, Bitter S, Braun-Fahrlander C, Dalphin JC, Riedler J, Roponen M, Hirvonen MR, Büchele G, Renz H, Lauener R, Krauss-Etschmann S, von Mutius E; PASTURE Study group. Collaborators (38) Weiss G, Ublagger E, Humer C, Russegger M, Pekkanen J, Juntunen R, Tiihonen R, Tiittanen P, Huttunen K, Virtanen S, Kauppila T, Nevalainen A, Remes S, Tuomainen TP, Karvonen A, Lappalainen M, Dalphin ML, Vuittton D, Piarroux R, Reboux G, Roussel S, Sudre B, Kabesch M, Schmid S, Illi S, Korherr N, Genuneit J, Peter R, Sel S, Blümer N, Pfeifferle P, Brunekreef B, Gehring U, Dockes G, Sennhauser FH, Loeliger S, Frei R, Roduit C.

*Eur Respir J.* 2010 Jun;35(6):1228-34. Epub 2009 Oct 19. Dairy food, calcium and vitamin D intake in pregnancy, and wheeze and eczema in infants. Miyake Y, Sasaki S, Tanaka K, Hirota Y.

*Osteoporos Int.* 2010 Dec;21(12):2003-11. Epub 2010 Feb 5. Reduced tibial speed of sound in Chinese infants at birth compared with Caucasian peers: the effects of race, gender, and vitamin D on fetal bone development. Liao XP, Zhang WL, Yan CH, Zhou XJ, Wang P, Sun JH, Yu XD, Wu MQ.

*Mol Nutr Food Res.* 2010 Aug;54(8):1172-81. An estimate of the economic burden and premature deaths due to vitamin D deficiency in Canada. Grant WB, Schwalfenberg GK, Genuis SJ, Whiting SJ.

*Nutr Clin Pract.* 2010 Oct;25(5):524-7. Maternal vitamin D status in gestational diabetes mellitus. Soheilykhah S, Mojibian M, Rashidi M, Rahimi-Saghand S, Jafari F. Shahid Sadoughi,

*Acta Obstet Gynecol Scand.* 2010 Nov;89(11):1420-3. Decreased 1,25-dihydroxy vitamin D levels in women with intrahepatic cholestasis of pregnancy. Wikström Shemer E, Marschall HU.

*This article may be reprinted for educational purposes. Jodilyn Owen. 2010. seattlebirthnet.com*

- J Matern Fetal Neonatal Med. 2010 Oct;23 Suppl 3:80-3. Fetal and early postnatal life roots of asthma. De Luca G, Olivieri F, Melotti G, Aiello G, Lubrano L, Boner AL.
- Placenta. 2010 Dec;31(12):1027-34. Epub 2010 Sep 22. Vitamin D effects on pregnancy and the placenta. Shin JS, Choi MY, Longtine MS, Nelson DM.
- Med Wieku Rozwoj. 2010 Apr-Jun;14(2):218-23. [Recommendations of prophylaxis of vitamin D deficiency in Poland (2009)]. Charzewska J, Chlebna-Sokół D, Chybicka A, Czech-Kowalska J, Dobrzańska A, Helwich E, Imiela JR, Karczmarewicz E, Książek JB, Lewiński A, Lorenc RS, Łukas W, Łukaszewicz J, Marcinowska-Suchowierska E, Milanowski A, Milewicz A, Płudowski P, Pronicka E, Radowski S, Ryzko J, Socha J, Szczapa J, Weker H.
- Am J Obstet Gynecol. 2010 Oct 6. [Epub ahead of print] Pregnancy-specific association of vitamin D deficiency and bacterial vaginosis. Hensel KJ, Randis TM, Gelber SE, Ratner AJ.
- Best Pract Res Clin Endocrinol Metab. 2010 Aug;24(4):527-39. Vitamin D and pregnancy: An old problem revisited. Barrett H, McElduff A.
- J Periodontol. 2010 Sep 1. [Epub ahead of print] Vitamin D Status and Periodontal Disease Among Pregnant Women. Boggess KA, Espinola JA, Moss K, Beck J, Offenbacher S
- Orthopade. 2010 Nov;39(11):1051-6. [Pregnancy-associated osteoporosis. Differential diagnosis of "common" musculoskeletal pain during pregnancy and lactation]. Heim U, Clauss M, Bürki N, Lutz T, Ilchmann T.
- Altern Med Rev. 2008 Mar;13(1):6-20. Use of vitamin D in clinical practice. Cannell JJ, Hollis BW.
- Dermatoendocrinol. 2009 Jul;1(4):223-8. Epidemiologic evidence supporting the role of maternal vitamin D deficiency as a risk factor for the development of infantile autism. Grant WB, Soles CM.
- Is it time to trial vitamin D supplements for the prevention of schizophrenia? McGrath J. Acta Psychiatr Scand. 2010 May;121(5):321-4.
- Mol Nutr Food Res. 2010 Aug;54(8):1092-102. Vitamin D deficiency and pregnancy: from preconception to birth. Lewis S, Lucas RM, Halliday J, Ponsonby AL.
- Matsuoka, L. Y., Wortsman, J., Hanifan, N. & Holick, M. F. (1988) Chronic sunscreen use decreases circulating concentrations of 25-hydroxyvitamin D: a preliminary study. Arch. Dermatol. 124:1802-1804
- Hollis, B. W. & Wagner, C. L. (2004) Vitamin D requirements during lactation: high-dose maternal supplementation as therapy to prevent hypovitaminosis D in both mother and nursing infant. Am. J. Clin. Nutr. 80:1752S-1758S
- The American Society for Nutritional Sciences J. Nutr. 135:317-322, February 2005