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Getting the Right Amount of Vitamin D for *You*

Vitamin D is a fat-soluble vitamin that is naturally present in very few foods, added to others, and available as a nutritional supplement. Vitamin D is naturally produced in the skin from 7-deoxycholesterol when the skin is exposed to UVB rays from sunlight. Vitamin D obtained from sun exposure, food, and supplements is biologically inert and must undergo two reactions in the body for activation. In the liver, vitamin D is converted to 25-hydroxyvitamin D, which is then converted in the kidney to the physiologically active form, 1,25-dihydroxyvitamin D, also known as calcitriol. [5,9]

The Biological Functions of Vitamin D:

The major biologic function of vitamin D is to maintain adequate blood levels of calcium and phosphorus to enable proper mineralization of bone. It does this by promoting calcium absorption in the gut. In children, vitamin D deficiency causes rickets, which results in skeletal deformities. In adults, vitamin D deficiency can lead to osteomalacia, which results in muscular weakness in addition to weak bones. Together with calcium, vitamin D helps protect older adults from osteoporosis.

Vitamin D has other biological roles in the body, including reduction of inflammation, modulation of immune function, muscular function, cell growth, proliferation, differentiation, and apoptosis (programmed cell death), glucose metabolism, and blood pressure. These and other biological functions are relevant for vitamin D's role in viral and bacterial illnesses (e.g. the flu), autoimmune conditions (e.g. multiple sclerosis, type 1 diabetes), cancer prevention (e.g. colon cancer), type 2 diabetes, metabolic syndrome, hypertension, and others. [5, 6]

Causes of Vitamin D Deficiency:

- Inadequate dietary intake (e.g. low fish consumption, vegan diets, anorexia nervosa)
- Inadequate skin synthesis from sun exposure (e.g. living at higher latitudes, winter and spring seasons, darker skin pigmentation, sunscreen use, aging skin)
- Decreased absorption (e.g. cystic fibrosis, celiac disease, Whipple disease's, Crohn's disease, lactose intolerance, gastric bypass), medications that reduce cholesterol absorption (e.g. cholestyramine)
- Obesity - increased fat tissue absorbs more vitamin D and prevents its use by the body
- Medications that increase breakdown of vitamin D (e.g. anticonvulsant medications such as phenytoin & phenobarbital, glucocorticoids such as prednisone, highly active antiretroviral treatment, some immunosuppressants, and other miscellaneous medications such as orlistat)

- Breastfeeding
- Decreased synthesis of 25-hydroxyvitamin D (e.g. liver disease)
- Decreased synthesis of 1,25-dihydroxyvitamin D (e.g. chronic renal disease/failure) [6, 8, 9]

Populations Who May Be At Higher Risk of Vitamin D Deficiency:

- Pregnant or breastfeeding women
- Exclusively breast fed infants
- Children and adolescents
- The elderly
- The critically ill
- Hospitalized, institutionalized, or long-term care patients [8]

Health Conditions Associated With Vitamin D Deficiency or Insufficiency:

- **Musculoskeletal Conditions:** rickets, osteomalacia, low bone mineral density, osteoporosis, fractures, oral bone loss, cartilage loss, knee osteoarthritis, spinal cord injury, low parathyroid hormone (PTH) levels, secondary hyperparathyroidism, pain
- **Autoimmune Conditions:** multiple sclerosis (MS), relapse rate in pediatric-onset multiple sclerosis, type 1 diabetes, rheumatoid arthritis, lupus, sarcoidosis, scleroderma, hypothyroidism (Hashimoto's) [10]
- **Cancer:** colorectal, breast, cervical, prostate, endometrial, esophageal, kidney, ovarian, uterine, pancreatic, and upper gastrointestinal tract cancers, as well as Hodgkin's and non-Hodgkin's lymphoma (note however that some studies have found no association or increased risk between the vitamin D levels and certain cancers, such as kidney, prostate, lip, and salivary gland)
- **Mental & Developmental Disorders:** learning disabilities, cognitive impairment, autism, dementia, mood disorders, psychiatric illness (e.g., schizophrenia)
- **Immune/Infectious Conditions:** asthma, tuberculosis, middle ear infections, periodontal disease
- **Metabolic Disorders:** obesity, type 2 diabetes, metabolic syndrome
- **Cardiovascular Disease:** high blood pressure, cardiovascular disease, stroke, heart failure
- **Other:** increased all-cause mortality, sickle cell disease, chronic obstructive pulmonary disease (COPD) [6, 8], myositis-myalgia (an adverse side effect of cholesterol-lowering statin medications) [2]

Recommendations for Vitamin D Dietary Intake:

Health Canada's [3] current daily Recommended Dietary Allowances for vitamin D are:

Age group	*Recommended Dietary Allowance (RDA)*	*Tolerable Upper Intake Level (UL)*
Infants 0-6 months	**400 IU (10 mcg)***	**1000 IU (25 mcg)**
Infants 7-12 months	**400 IU (10 mcg)***	**1500 IU (38 mcg)**
Children 1-3 years	**600 IU (15 mcg)**	**2500 IU (63 mcg)**
Children 4-8 years	**600 IU (15 mcg)**	**3000 IU (75 mcg)**
Children and Adults 9-70 years	**600 IU (15 mcg)**	**4000 IU (100 mcg)**
Adults > 70 years	**800 IU (20 mcg)**	**4000 IU (100 mcg)**
Pregnancy & Lactation	**600 IU (15 mcg)**	**4000 IU (100 mcg)**

**Adequate Intake rather than Recommended Dietary Allowance. The AI is expected to meet or exceed the needs of most individuals in a specific life-stage and gender group.*

The **RDA** is the average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in a particular life-stage and gender group. The RDA for vitamin D is the average daily dietary intake level that is sufficient to meet the nutrient requirements for bone health. **If you are not optimally healthy or are concerned about aspects of your health beyond bone health, the RDA will likely not meet your needs.**

The **UL** is the highest average daily nutrient intake level likely to pose no risk of adverse health effects to almost all individuals in a given life-stage and gender group. Based on these recommendations the highest safe daily intake of vitamin D for adults is 4000 IU [3]. However, **a review of the evidence found that only daily intakes greater than 10,000 IU of vitamin D are implicated with adverse health effects.** [11]

Dietary Sources:
Vitamin D is naturally present in very few foods – those the highest in vitamin D include fatty fish (e.g. salmon, mackerel), cod liver oil and egg yolks. Because of this, vitamin D is added to various foods such as yogurt, cow's milk, soy/rice/almond milks*, orange juice and cereals. Please use the information below to try and estimate your average dietary intake. Unless you love fish you'll find it difficult to get all the vitamin D you need from food; however, it is worthwhile including these foods in your diet (unless you have a sensitivity or intolerance to these foods or choose to avoid them for other health or personal reasons).
*Note that non-dairy milks may be fortified with the plant-derived vitamin D2, or ergocalciferol, which does not effectively increase vitamin D levels in humans and is not considered an effective source of vitamin D. [1,4]

Food Source	**Vitamin D per serving (IU)**
Cod liver oil, 1 tablespoon	1360
Trout (rainbow), cooked, 3 ounces	645
Salmon (chinook/sockeye), cooked, 3 ounces	583/447
Swordfish, cooked, 3 ounces	566
Salmon, pink, canned, solids with bone & ligament, 3 ounces	465
Mackerel, cooked, 3 ounces	388
Halibut (Atlantic or Pacific), cooked, 3 ounces	196
Flatfish (flounder & sole), cooked, 3 ounces	177
Sardines, canned in oil, drained, 3 ounces	164
Rockfish, cooked, 3 ounces	156
Tuna fish, canned in water, drained, 3 ounces	154
Orange juice fortified with vitamin D, 1 cup (check product labels, as amount of added vitamin D varies)	137
Milk, nonfat, reduced fat, and whole, vitamin D-fortified, 1 cup	115-124
Rice milk, unsweetened, vitamin D fortified, ~1cup	101
Yogurt, fortified with 20% of the daily value (DV) for vitamin D, ~175ml (more heavily fortified yogurts provide more of the DV)	88
Liver, beef, cooked, 3.5 ounces	49
Pork, fresh, loin, cooked, 3 ounces	43
Mushrooms, shiitake, cooked, 1 cup	41
Egg, 1 large (vitamin D is found in yolk)	41
Ready-to-eat cereal, fortified with 10% of the DV for vitamin D, 0.75–1 cup (more heavily fortified cereals might provide more of the DV)	40
Cheese, Swiss, 1 ounce	6

Sun Exposure:
Another way to get your vitamin D is through exposure to the sun. Note that the recommended RDAs are based on the assumption of minimal sunlight exposure. As sunscreens effectively block UVB rays, the use of sunscreens prevents vitamin D production in the body. There is controversy in the scientific community as to the

appropriate recommendations for sunlight exposure, since sunlight allows for vitamin D production, which is protective against internal cancers, while sun exposure is also a risk factor for melanoma (skin cancer).[7] The generally-recommended 10-20 minutes of daily sun exposure to the face, arms and legs, even without sunscreen, may be inadequate to allow for sufficient natural vitamin D production to prevent various diseases. Some interesting long-term melanoma (skin cancer) and internal cancer data have suggested that the benefits of adequate sun exposure (and the associated healthy vitamin D status) may outweigh the risk of skin cancer from sun exposure.[7] Nevertheless, excessive sun exposure is not recommended and regardless of your sun exposure choices, having your vitamin D level tested and taking a vitamin D supplement as needed to maintain a healthy blood level of vitamin D is a proactive approach to many aspects of your health.

Supplementation:
A variety of vitamin D supplements are available, including capsules and liquids (drops). Vitamin D3 is the only effective form of vitamin D supplements; vitamin D2 (from plant sources) does not provide the same physiological vitamin D activity.[4] Vitamin D3 is fat-soluble, meaning it is best absorbed taken with a meal or snack containing fat or oil. Typical dosage units are between 400 IU and 1000 IU vitamin D3 per capsule or per *drop* (not dropper-full) of a liquid supplement. Vitamin D3 is also a natural ingredient of cod liver oil; check the label to determine the quantity of vitamin D3 per dose (e.g. 1 tsp) of cod liver oil.

Testing Your Vitamin D Status:
Serum 25-hydroxyvitamin D, or "25(OH)D", is the accepted test for assessing vitamin D status.[11] Your Naturopathic Doctor (ND) can order this blood test for you. (Note that as of December 2010, vitamin D testing is no longer covered by OHIP for the general population).[12] The serum 25(OH)D test reflects the vitamin D in your body that is produced through sun exposure and absorbed from foods and supplements. It is helpful to test your vitamin D status from time to time to determine whether and how much supplemental vitamin D you may need to take to prevent or treat known vitamin D deficiency-associated health conditions.

Your ND will discuss the results of your vitamin D serum test with you and, if needed, will recommend ways that you can optimize your vitamin D status as an important overall determinant of your health.

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