Vitamin D acts like a hormone and has a steroid-like structure. The process of making vitamin D begins in the skin from its precursor, a derivative of cholesterol, through the action of UVB sunlight.[2] The second stage of vitamin D occurs in the liver, with the formation of calcidiol.[3] Calcidiol is the storage form of vitamin D and is also the marker used to measure vitamin D status, through a blood test called 25-hydroxyvitamin D. This molecule, 25-hydroxyvitamin D (abbreviated as “25(OH)D”) circulates in the blood and is converted to activated vitamin D in the kidneys.[2] Activated vitamin D is also known as 1,25-hydroxyvitamin D or calcitriol.[2, 3]

Now activated, vitamin D circulates to tissues as distant as the heart, arteries, lungs, brain, ovaries, and breast tissue.[2, 4, 5] Cells that are affected by vitamin D possess a vitamin D receptor (VDR).[2] The VDR communicates the effects of vitamin D into the cell. Recently, scientists have discovered that the VDR is present on many different kinds of cells in the body, including kidney cells, parathyroid cells, immune cells, cells of the heart and arteries, neurons, pancreatic cells, and cells lining the respiratory tract.[2] This seems to indicate that vitamin D is critical for the normal, healthy functioning of all these cells.

Traditionally, vitamin D has been regarded primarily for its role in bone health. Historically,
vitamin D deficiency has been defined as the level associated with rickets in children or osteomalacia in adults.[6] Blood levels corresponding to these diseases are around 30 nmol/L. This is the equivalent of 10 ng/mL in American units. As we have just seen, however, vitamin D’s role in other areas of the body is becoming better recognized. Among vitamin D scientists, it is well-accepted that while 30 nmol/L may be sufficient for bone health, it is nowhere near what is needed for other tissues. Therefore, there is a growing recognition among these scientists that therapeutic blood levels should be at least 75 nmol/L (30 ng/mL).[7]

Furthermore, not only is the therapeutic level higher than what has been traditionally thought, but recent evidence suggests that supplementation with traditional low-dose supplements may not be sufficient to adequately increase your blood levels. Traditionally, vitamin D was typically supplemented in units of 400, 800, or 1000 IU.[1] Today we know that some people may require higher amounts to reach therapeutic blood levels.[7] We also know that the precise amount needed varies from person to person.[7] For this reason, it is important to have your vitamin D levels checked periodically, in order to determine the most appropriate dosing strategy for you.

In part II we will explore the role of vitamin D on mood!

References
Vitamin D

A Cure for the Mid-Winter “Blahs”

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Part II: Vitamin D and Mood

Having explored the extent of vitamin D activity in the body, and the question of therapeutic blood levels/supplementation, we now turn our attention to the role of vitamin D in regulation of mood, in particular depression. Vitamin D becomes especially important as we head into the winter months; because of reduced sun exposure during the winter, a person’s vitamin D levels tend to be lowest in the winter months and into the spring. In Canada, the prevalence of low vitamin D levels is higher than in southern climates.[1] This may play a role in seasonal affective disorder (SAD), or the less severe but still unpleasant “winter blahs”.[2]

As discussed above, cells in the brain express the VDR and therefore respond to vitamin D. A large study investigated the association between vitamin D blood levels and risk of depression.[3] Over 7300 adults with existing cardiovascular disease (e.g. angina, heart attack, stroke) were assessed for their blood vitamin D levels and whether or not they had depression as defined according to medical diagnostic criteria. Vitamin D status was divided into four categories:

1. Optimal: > 125 nmol/L (50 ng/mL)
2. Normal: between 76–125 nmol/L (31–50 ng/mL)
3. Low: between 38–75 (16–30 ng/mL)
4. Very low: ≤ 37 nmol/L (15 ng/mL).

Researchers found that when compared to those with optimal levels, patients with low and very low vitamin D levels were at elevated risk of having depression, with risk increasing more than twofold in each group.[3]

A study examined the effect of vitamin D supplementation on depressive symptoms during the winter months among nine women with blood vitamin D levels < 100 nmol/L
(40 ng/ml). After vitamin D supplementation, levels increased by almost 50 nmol/L and there was a 10-point decline in depression score, measured as the Beck Depression Inventory, a standardized depression rating scale.[2]

Another larger, randomized controlled trial assessed the effects of vitamin D supplementation among over 440 overweight or obese adults with depression.[4] The dose was either 20,000 or 40,000 IU vitamin D per week for one year. This is approximately equal to 3000–6000 IU per day. After one year, there was a significant improvement in depression score (on Beck Depression Inventory) in both groups given vitamin D, but not in the placebo group.

Finally, a newer randomized controlled trial assessed the effectiveness of vitamin D in combination with an antidepressant medication (fluoxetine), compared to the medication alone.[5] A total of 42 patients with a diagnosis of major depressive disorder based on DSM-IV criteria were randomly assigned into two groups to receive daily either 1500 IU vitamin D₃ plus 20 mg fluoxetine or fluoxetine alone for eight weeks. In this study, depression severity was measured with both the Beck Depression Inventory as well as the Hamilton Depression Rating Scale. The results showed that fluoxetine combined with vitamin D was superior to fluoxetine alone, beginning about four weeks in.

In part III we will discuss the role of vitamin D on cognitive function…

References
Part III: Vitamin D and Cognitive Function

The role of vitamin D in older patients with mild cognitive impairment (MCI) or Alzheimer’s disease (AD) is beginning to receive more attention among researchers. For instance, a recent lab-based study showed that vitamin D may help protect neurons from degeneration caused by amyloid-β (implicated in Alzheimer’s) and glutamate (a potentially toxic excitatory chemical in the brain).[1]

Exploratory studies have shown an association between blood vitamin D levels and mild cognitive impairment. One study found an association between vitamin D levels and cognitive impairment defined as Montreal Cognitive Assessment score (MoCA) < 26 among a group of 165 patients with type 2 diabetes.[2] Another study followed over 10,000 Danish people for 30 years.[3] This study found that vitamin D levels at the outset were significantly associated with risk of developing Alzheimer’s or vascular dementia 30 years later!

Recently, a systematic review analyzed the link between vitamin D and memory and various “executive functions” such as processing speed, mental shifting, and information updating.[4] In this study, researchers found that “although episodic memory disorders showed only modest association with lower 25(OH)D concentrations, […] associations of greater magnitude were found with executive dysfunctions”.[4] Lower vitamin D levels were associated with increased risk of poor executive functions. On the other hand, vitamin D repletion resulted in improved executive functions although this was not significant compared to control groups.

Finally, a prospective study assessed the ability of blood vitamin D levels to predict risk of developing non-Alzheimer’s dementia.[5] Forty high-functioning older women,
average age 78.4 years, were divided into two groups based on whether they had vitamin D deficiency at baseline. This was defined as blood levels below 25 nmol/L (equal to 10 ng/ml). At the end of the seven-year follow-up period, researchers found an association between the presence of vitamin D deficiency at baseline and an almost 20-fold increase in the onset of non-Alzheimer’s dementia. This suggests that having optimal vitamin D levels may be an important protective factor against cognitive decline and dementia, even within a relatively short time period of seven years.

The first human trial of high-dose vitamin D in the treatment of Alzheimer’s is currently underway.[6]

Part IV is a discussion of vitamin D and immunity.

References

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Part IV: Vitamin D and Immunity

In addition to mood and cognitive function, another important role of vitamin D that comes to the fore this time of year is modulation of immune function. Interestingly, vitamin D can both improve low immune function and resistance to infection, while simultaneously decreasing inappropriate immune reactivity, such as in autoimmune disease or asthma/allergy.
Vitamin D supplementation during the winter has been shown to reduce upper respiratory tract infections such as the cold and flu. For instance, one study assessed the effects of giving 1200 IU vitamin D to school-children from the months of December through March.[1] This study assessed specifically for incidence of influenza A, diagnosed with influenza antigen testing with a nasopharyngeal swab specimen. Results showed that influenza A occurred in only 10.8% of children in the vitamin D group compared with 18.6% of children in the placebo group; a 40% reduction in risk. There was also a secondary reduction in asthma attacks among children with a previous diagnosis of asthma, with more than an 80% reduction.

A German study has assessed the effect of vitamin D in combination with other micronutrients, namely vitamin C, folic acid, and selenium, on immune function in 192 patients prone to recurring upper-respiratory-tract infections.[2] The study found that among subjects who initially had at least two common-cold symptoms, symptom improvement was significantly greater in the supplement group compared to placebo. Vitamin D and micronutrient supplementation also improved the frequency and severity of symptoms.

Asthma is a condition of immune hyperreactivity; in this condition, the airways become inflamed, produce excess mucus, and constrict in response to environmental triggers such as dust and allergens as well as cold temperatures. This leads to wheezing and difficulty breathing, which is typically treated with inhaled medications called “puffers.” Vitamin D has been shown to improve symptoms and immune function in patients with asthma.

A study assessing over 1000 children found that vitamin D deficiency (< 50 nmol/L or 20 ng/mL) was associated with worse lung-function outcomes compared to vitamin D–sufficient children.[3] Among children taking inhaled corticosteroids, FEV₁[1] an important measure of lung function, increased by only 140 ml in the vitamin D–deficient group, compared to 290 mL in the vitamin D–sufficient group. This means that the lung function of the vitamin D–deficient children was less than half that of the vitamin D–sufficient kids, and that vitamin D may improve the effectiveness of corticosteroid therapy.

Another study found that vitamin D supplementation in children with asthma may reduce asthma exacerbations experienced when the children get a cold or flu.[4] Vitamin D deficiency in adults has also been associated with poorer lung function, increased airway hyperresponsiveness, and poorer response to corticosteroid treatment.[5] Evidence such as this has even experts asking the question of whether vitamin D deserves to have a role in standard asthma care.[6]

These are only a few of the benefits of vitamin D. An assessment of your vitamin D status (a blood test that can be run by your medical doctor or naturopathic doctor) can help guide you in taking the most appropriate dose of vitamin D for you.
References


