

What's the Difference Between Vitamin D, D2 and D3?

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STORY AT-A-GLANCE

- › Vitamin D3 is significantly more effective than D2 at raising blood vitamin D levels, showing a 40% greater increase in total vitamin D concentrations through supplementation
- › Natural sunlight exposure remains the optimal source of vitamin D, but factors like skin color, geographical location and body composition affect individual vitamin D synthesis
- › Global vitamin D deficiency affects approximately 76.6% of the population, impacting bone health, immune function mental health, and chronic disease risk
- › People consuming diets high in seed oils should limit sun exposure during peak hours, as these oils oxidize under UV light, causing inflammation and DNA damage
- › For optimal health benefits, maintain vitamin D levels between 60 and 80 ng/mL through a combination of sensible sun exposure and vitamin D3 supplementation when necessary

Vitamin D is a nutrient that plays an important role in maintaining bone health, supporting your immune system and regulating mood. It exists primarily in two forms: vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Understanding the differences between these two forms is essential for optimizing your health.

Vitamin D3 is synthesized naturally in your skin when it's exposed to sunlight, specifically ultraviolet B (UVB) rays. It's also found in animal-based foods such as egg yolks, fatty fish like salmon and mackerel and fortified dairy products. On the other

hand, vitamin D2 is typically derived from plant sources, including yeast and mushrooms exposed to UV light, making it a popular option for vegetarians and vegans.

Both forms are available as dietary supplements and are often added to fortified foods. While both vitamin D2 and D3 serve similar functions in your body by supporting calcium absorption and bone mineralization, the two do not, as some have believed, have a similar nutritional value.

Research has uncovered distinct differences in their effectiveness and how they interact with various physiological factors. This deeper understanding is key for making informed decisions about which form of vitamin D supplementation is best suited to your individual health needs.

Vitamin D2 Versus D3: Which Is More Effective?

A study published in *Advances in Nutrition* explored the differences between vitamins D2 and D3 in boosting your serum 25-hydroxyvitamin D (25(OH)D) levels, a key marker of vitamin D status.¹ The research encompassed 20 comparative studies and revealed that vitamin D3 is generally more potent than vitamin D2 in elevating total 25(OH)D concentrations.

Specifically, daily supplementation with vitamin D2 resulted in a 40% lower increase in total 25(OH)D compared to vitamin D3, with an average increase of 4.12 ng/mL (10.39 nmol/L) favoring vitamin D3. This significant difference underscores the superior efficacy of vitamin D3 in enhancing your overall vitamin D levels.

Further, for those with a body mass index (BMI) below 25 kg/m², categorized as having a healthy weight, vitamin D3 demonstrated a markedly superior effect in increasing serum 25(OH)D levels compared to vitamin D2.

This significant difference highlights the importance of considering your body composition along with your vitamin D status. While sun exposure is your best choice to increase your vitamin D levels, for those trying to optimize their vitamin D status via supplementation, vitamin D3 is the more effective choice.

Beyond the overall increase in total 25(OH)D levels, the study looked into how vitamin D2 and D3 specifically influence their respective hydroxylated forms in your bloodstream – 25(OH)D2 and 25(OH)D3.

The findings revealed that both forms of vitamin D have a similar positive impact on their corresponding metabolites. This means that while vitamin D3 is more effective in elevating total 25(OH)D levels, vitamin D2 effectively increases 25(OH)D2 without negatively affecting 25(OH)D3 levels.

Factors Influencing Supplementation Outcomes

The effectiveness of vitamin D supplementation is not solely determined by whether you take D2 or D3, however. Several other factors influence how your body responds to these supplements. The study identified key response modifiers that significantly impact the efficacy of vitamin D2 and D3 in raising serum 25(OH)D levels. These factors include baseline vitamin D status, race, geographical location (latitude), dosage and calcium intake.²

- **Baseline vitamin D status** – Individuals with lower initial levels of 25(OH)D tend to experience more significant increases in serum vitamin D after supplementation. This inverse relationship suggests that those who are deficient may benefit more noticeably from supplementation compared to those with adequate baseline levels.
- **Race and geographical location** – Different races and living at various latitudes affect how your body synthesizes and metabolizes vitamin D. For example, individuals living at higher latitudes with less sunlight exposure may require more supplementation to achieve optimal vitamin D levels.
- **Dosage and supplementation frequency** – The study emphasized that daily dosing regimens may reduce the efficacy gap between vitamin D2 and D3 compared to less frequent dosing schedules like weekly or monthly. Additionally, higher daily doses of vitamin D were associated with smaller differences in efficacy between the two forms.

- **Calcium intake** – Calcium interacts with vitamin D metabolism. The study noted a negative association between calcium intake and serum 25(OH)D levels, particularly in individuals with adequate vitamin D intake. This interplay suggests that maintaining a balanced intake of both calcium and vitamin D is important for optimal health benefits.

The Clear Advantages of Vitamin D3 Over D2

Another compelling study conducted in the Middle East further emphasized the superior efficacy of vitamin D3 over vitamin D2.³ In a randomized controlled trial involving 250 adults with vitamin D deficiency or insufficiency, participants were assigned to receive weekly capsules of either 50,000 IU of D2 or D3 for up to 12 weeks.

The results were striking: after just eight weeks, those in the vitamin D3 group experienced a mean increase of 18.74 ng/mL in their serum 25(OH)D levels, compared to only 5.88 ng/mL in the D2 group. By the 12-week mark, the D3 group's levels had increased by 20.76 ng/mL, whereas the D2 group rose by only 7.93 ng/mL.

This rapid and sustained increase with vitamin D3 is particularly significant for individuals in regions with high rates of deficiency, where factors like limited sun exposure and dietary restrictions exacerbate the issue. The ability of vitamin D3 to elevate and maintain higher serum levels more effectively ensures better protection against the myriad health issues associated with deficiency.

If regular sun exposure isn't an option, the results suggest that choosing vitamin D3 supplements could lead to quicker and more substantial improvements in your vitamin D status more efficiently than vitamin D2.

Vitamin D deficiency is alarmingly prevalent worldwide, and the Middle East region exemplifies this trend with an estimated 81% of the population affected.⁴ High-risk groups include dark-skinned individuals, those with obesity, people taking certain medications that accelerate vitamin D metabolism, institutionalized individuals and

those with limited sun exposure due to protective clothing or consistent use of sunscreens.

Additionally, conditions like inflammatory bowel disease and celiac disease, which impair nutrient absorption, further elevate the risk of deficiency. In the absence of regular sun exposure, vitamin D3's superior efficacy in raising serum 25(OH)D levels makes it an essential tool in combating deficiency in these groups.

The Global Burden of Vitamin D Deficiency

Vitamin D deficiency is not just a localized issue; it poses a significant global health challenge affecting millions worldwide. Recent comprehensive studies, including a pooled analysis of nearly 8 million participants from 81 countries, reveal that approximately 15.7% of individuals have vitamin D levels below 12 ng/mL (30 nmol/L), a critical threshold associated with bone disorders like osteomalacia and rickets.⁵

Further, nearly half of the global population falls below 20 ng/mL (50 nmol/L), and a staggering 76.6% have levels below 30 ng/mL (75 nmol/L).

The consequences of such widespread deficiency extend far beyond bone health. Vitamin D plays a pivotal role in immune function, muscle performance and the prevention of chronic diseases such as cardiovascular disorders, diabetes and cancer.

Recent research also reveals that a lack of vitamin D disrupts the very foundation of your immune system, making you more susceptible to autoimmune conditions where your body mistakenly attacks its own tissues.⁶

Vitamin D deficiency is also prevalent among women with polycystic ovary syndrome (PCOS),⁷ while higher vitamin D levels are associated with improved mental health, particularly in depression. Studies show low vitamin D levels increase depression risk, while supplementation improves symptoms in some cases.⁸

While depression has been the primary focus of [vitamin D research in mental health](#), studies have revealed its potential influence on other conditions as well.⁹ For instance,

vitamin D deficiency has been linked to an increased risk of schizophrenia, with some research suggesting that prenatal vitamin D deficiency may be a risk factor. In bipolar disorder, lower vitamin D levels have also been observed.

Prioritize Sunlight for Optimal Vitamin D Levels

Maximizing your vitamin D through mindful sun exposure is highly recommended, as it offers benefits that extend beyond just vitamin D production. Elevated vitamin D levels are often indicative of healthy sun exposure, which is linked to numerous health advantages traditionally associated with vitamin D, including a reduced risk of cancer and increased longevity.

Consistent sunlight exposure also boosts melatonin production, a powerful anticancer agent.¹⁰ However, while sunlight is essential for vitamin D synthesis and overall health, there are risks if you overdo it. Striking the right balance between protection and benefit is key.

If your diet is high in seed oils, extra caution with sun exposure is necessary. Seed oils are rich in **linoleic acid** (LA), an omega-6 fatty acid that readily oxidizes when exposed to UV light. When UV rays interact with skin containing these oils, it leads to their breakdown, causing inflammation and DNA damage. To mitigate these risks:

- **Avoid peak sun exposure** — If you consume seed oils, avoid peak sunlight hours. In most of the U.S. during summer, this means staying out of direct sun from 11 a.m. to 3 p.m. during Daylight Saving Time, or 10 a.m. to 2 p.m. in Standard Time.
- **Eliminate seed oils** — Avoid peak sun exposure until you have removed seed oils from your diet for four to six months. Over time, as your body detoxes the accumulated seed oils, you can gradually increase your time in the sun. Eventually, you will be able to enjoy an hour or more of peak sunlight hours.

Your body composition, particularly your body fat percentage, also plays a significant role in how you handle sun exposure. Adipose tissue stores fat-soluble substances,

including oxidized seed oils, which prolongs the period of risk even after you adjust your diet.

You should also consider your skin color. Individuals with darker skin tones have higher melanin levels, which require more sun exposure to produce the same amount of vitamin D as those with lighter skin.

Natural Strategies for Sun Protection

It's important to monitor your skin when you're out in the sun, keeping an eye out for redness or burning – a simple "sunburn test" that accounts for the season and your skin type. If your skin remains free of pinkness, your sun exposure is likely safe.

Reducing your body's LA stores significantly lowers your chances of sunburn and skin cancer. Always pay attention to how your skin reacts and seek shade immediately if you notice any redness. By thoughtfully managing your sun exposure, you take a crucial step toward maintaining your health.

If you need to spend time in the sun before your body has fully cleared seed oils, consider adopting protective measures to shield your skin from damage:

- **Astaxanthin** – This acts as a powerful antioxidant that neutralizes free radicals and reduces inflammation, enhancing your skin's resilience against UV radiation. Take 12 milligrams daily to enhance your skin's resistance to sun damage.
- **Niacinamide (vitamin B3) cream** – This protects against UV-induced DNA damage and strengthens your skin's barrier, making it more resistant to sun stressors. Apply the cream topically before sun exposure.
- **Aspirin** – Take a baby aspirin 30 to 60 minutes before sun exposure. This helps inhibit the conversion of LA into harmful oxidized linoleic acid metabolites (OXLAMs), which are linked to skin cancer, providing an additional layer of protection against sun damage.

- **Molecular hydrogen (H₂)** – This molecule reduces oxidative stress by neutralizing free radicals, particularly the highly reactive hydroxyl radical. It penetrates cell membranes to target sources of inflammation and oxidative damage without disrupting beneficial reactive oxygen species (ROS).

Additionally, it boosts energy levels and supports recovery, promoting cellular health against environmental stressors like sun exposure and dietary challenges from seed oils.

Supplementing with Vitamin D When Sunlight Exposure Is Insufficient

When adequate sunlight exposure isn't feasible, vitamin D supplements are helpful to maintain healthy levels. A vitamin D deficiency is defined as having less than 20 ng/mL of vitamin D, but this is inadequate for optimal health and disease prevention. Many individuals may have suboptimal levels even above this threshold.

To ensure you're taking the right amount of vitamin D₃, test your vitamin D levels twice yearly and adjust sun exposure and supplementation accordingly. Retest after three to four months to confirm you've achieved your target level. Optimal ranges are:

- **Ideal for health and disease prevention** – 60 to 80 ng/mL (150 to 200 nmol/L)
- **Sufficiency threshold** – 40 ng/mL (100 nmol/L in Europe)

By carefully balancing sun exposure, adopting protective strategies and supplementing with vitamin D₃ when necessary, you enhance your overall health and well-being while minimizing the potential risks associated with inadequate or excessive sun exposure.

Sources and References

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