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Vitamin D Shows Promise in Targeting Aging's Biological Mechanisms, Study Finds

Analysis by Dr. Joseph Mercola | May 06, 2024

STORY AT-A-GLANCE

- Vitamin D may help modulate many of the 12 hallmarks of aging, which is crucial in older adults who make less vitamin D, activate less vitamin D from food, supplements and sunshine, and need more vitamin D as an effective strategy to slow aging and protect health
- Each of the 12 hallmarks of aging may be discussed independently, but most act synergistically with one or more other hallmarks. Optimal levels of vitamin D may improve genomic instability, reduce epigenetic alterations associated with disease, improve mitochondrial function, decrease cellular senescence and improve gut dysbiosis
- Measurement of DNA methylation is a more accurate measure of biological health than telomere length and is positively influenced by vitamin D optimization
- Consistent sunshine exposure is the best option to raise insufficient vitamin D levels. In northern climates, this can be challenging so you might consider near-infrared light therapy or oral vitamin D3 supplementation

A 2024 paper[1] published in Nutrients by Italian scientists summarized the current knowledge of how vitamin D might modulate some of the hallmarks of aging. Vitamin D, also called calciferol, is present in some foods. However, more is produced by your body after exposure to sunlight.

In the initial stage,[2] the vitamin D you get from supplements, foods, or sun exposure must undergo two changes to be activated and used. The first happens in the liver where

vitamin D is converted to 25-hydroxyvitamin D and the second happens in the kidney where it forms 1, 25-dihydroxyvitamin D, also called calcitriol.

Importance of Aging and Vitamin D Deficiency

Long before the COVID-19 pandemic, researchers were concerned about vitamin D deficiency. According to a 2011 paper,[3] based on data from the National Health and Nutrition Examination Survey 2005 to 2006, found 41.6% of the general population had deficient serum concentrations, defined as of 20 nanograms per milliliter (ng/mL) or less. The highest rate of deficiency was seen in Blacks at 82.1% and Hispanics at 69.2%.

Using data that spanned 1998 to 2005, a 2021 paper reported that the prevalence of vitamin D deficiency may range from 40% to 100%, and correcting this deficiency would be "a cost-effective intervention."[4] Yet, despite evidence to the contrary, mainstream media, such as the New York Times,[5] advises readers "**to get absolutely no sun this summer**."

The American Academy of Dermatology Association also recommends sunscreen on any bit of skin not covered by clothing anytime you're outside.[6] In the following discussion of how vitamin D may mitigate some of the hallmarks of aging, it's important to note that as you age, the production of the active form of vitamin D is typically reduced by 50% due to age-related decline in renal function.[7]

The results of the 5th International Conference "Controversies in Vitamin D" held in September 2021 was a consensus statement by physicians on vitamin D supplementation in older individuals. The scientists agreed "Of three possible strategies to establish vitamin D sufficiency — sunshine exposure, food fortification, and supplementation — the latter seems to be the most effective and practical in the aging population."[8]

What Processes Contribute to Aging?

The aging process is marked by a decline in organ function and the development of age-related illness. Researchers in the current study noted that aging is a multifactorial process characterized by 12 hallmarks:[9]

Genomic instability — Increased mutation frequency in the genome	**Telomere attrition —** Telomere shortening leads to cellular aging and dysfunction
Epigenetic alterations — Changes in gene expression without DNA modification	**Loss of proteostasis —** Disruption in the dynamic regulation of proteins
Disabled macroautophagy — Impaired process of recycling cellular components	**Deregulated nutrient sensing —** Disruption of cellular response to nutrients impairing metabolism
Mitochondrial dysfunction — Impaired energy production and increased oxidative stress	**Cellular senescence —** Cessation of cell division
Stem cell exhaustion — Depletion of stem cells, impairing tissue repair and regeneration	**Altered intercellular communication —** Disrupted signaling, leading to inflammation and tissue dysfunction
Chronic inflammation — Persistent, low-grade inflammation triggering tissue damage	**Dysbiosis —** Imbalanced microbial communities affecting health and disease

The featured research noted that while these manifestations can be discussed independently, they do not act as a single cause but are highly interrelated. Either independently or synergistically they lead to molecular and cellular damage. By understanding the relationships, researchers hope to identify interventions that could mitigate the processes.

Vitamin D has a significant impact on musculoskeletal structure and function, and other studies have noted the role it plays in multiple other organs and systems, including endothelial cells, cardiomyocytes, neural stem cells, neurons, osteoblasts, monocytes, macrophages, and epithelial cells adipocytes. These actions have suggested that vitamin D may attenuate some pathological changes associated with the aging process.

How Optimal Vitamin D Levels May Target the Hallmarks of Aging

Past research has identified the impact vitamin D has on aging adults, finding that older individuals have a risk of suboptimal vitamin D levels resulting from decreased synthesis and intake.[10] Lower levels are associated with signs of aging, such as depression, heart disease, cancer and cognitive decline.

Research in the International Journal of Molecular Sciences characterizes aging as "a physiological progression of biomolecular damage and the accumulation of defective cellular components, which trigger and amplify the process, toward whole-body function weakening."[11] The review identified the biomolecular pathways that are the foundation of immunosenescence and inflammaging as biotargets of vitamin D.

They caution that while research has progressed, limitations still exist in being able to translate this knowledge into clinical practice. The researchers in the featured study[12] identified the changes that vitamin D supplementation makes on the main hallmarks of aging and detailed those descriptions from past studies.

For example, the potential for modulating genomic instability has been evaluated in Type 2 diabetes, finding that vitamin D supplementation leads to a decrease in nitric oxide and an increase in reduced glutathione, which decreases oxidative processes overall.

A positive correlation was identified between telomere length and serum levels of 25(OH)D, which equated to a five-year difference in telomeric aging.[13] An analysis of older adults found a positive association at baseline but an inconsistent relationship at later measurements. Further studies found no causal effect. Supplementation did

increase telomerase activity, supporting the theory that vitamin D beneficially affects telomere wellness.

Epigenetic alterations are associated with several diseases,[14] the cumulative effects of which are highly correlated with chronological age. In one study of pregnant women, vitamin D supplementation was associated with bone mass in the infant and had implications for the development of the lung, metabolic and nervous systems.

Additionally, the researchers found evidence in past studies[15] that vitamin D significantly impacts mitochondrial function, including reducing oxidative stress, mitigating damage in neurodegenerative and heart diseases, and improving muscle and lung function.

The research[16] also identified the impact vitamin D supplementation might have on decreasing cellular senescence and senescence-associated secretory phenotype (SASP). SASP is a phenomenon where senescent cells do not die but begin to secrete inflammatory cytokines, proteases and other molecules into the surrounding environment.

This can influence the behavior of nearby cells and contribute to a variety of physiological and pathological processes. The data has shown that vitamin D supplementation shows promise in reducing these effects. Researchers also identified data that showed vitamin D counteracts dysbiosis in individuals with HIV-1 infection.[17]

Biological Aging and DNA Methylation

As researchers in the featured study noted, the hallmarks of aging have a strong connection to each other, contributing to and exacerbating the effects of others. One of those effects is mitochondrial dysfunction and a rise in reactive oxygen species (ROS) that induces epigenetic changes through DNA methylation.[18]

In my interview[19] with Ryan Smith, founder of TruDiagnostic, a commercial testing system that tests your biological age, he discussed the idea of **DNA methylation**. Every cell in your body has the same DNA but expresses it in different ways. That expression

is regulated, in part, epigenetically. With differentiation, cells change their epigenetic expression to regulate the genes that are turned off and turned on.

DNA methylation silences gene transcription. At the beginning of a DNA strand is a promoter site and methylation is measured at those sites. The level of methylation correlates to the degree of actual expression of DNA. In the past, telomere length had been used to measure biological aging. However, Smith and I agree that epigenetic clocks are far superior.

The first low-risk strategy Smith recommends that lowers your biological age is vitamin D optimization. Ideally, you want to maintain a blood level of 60 ng/mL to 80 ng/mL. In the interview, Smith cited an interventional trial[20] in which overweight individuals reduced their biological age by 1.85 years on average by taking 4,000 international units (IUs) of oral vitamin D each day for 16 weeks.

There were 51 participants included in that short-term study. After adjustments of multi-covariates, serum concentrations of 25(OH)D were significantly associated with a reduction in Horvath ΔAge, also called delta age. The Horvath epigenetic clock is a biomarker that measures the methylation of specific DNA sites to estimate biological age.

Supplementation Is Acceptable in Northern Climates but Sunshine Is Better

As noted in the featured study:

> *"Considering how much VitD is related to several chronic inflammatory diseases and how negatively low-grade chronic inflammation impacts general health, adequate VitD storage should be a priority."*[21]

The ideal way to optimize your vitamin D level is by getting regular sun exposure on bare skin. There are also health benefits associated with sun exposure that go far beyond

vitamin D production. I highly encourage you to read the article "**Benefits of Sunshine on Your Bare Skin**," in which I detail many of those benefits.

For example, sunlight can positively affect your microbiome, mitochondria and melatonin production. Yet, depending on where you live, your ability to get good sun exposure may be limited to just three to four months each year.

When you can't get outside, your next-best choice may be red and near-infrared light therapy, which can mimic some of the benefits of natural sunlight. In my interview with Ari Whitten, author of "The Ultimate Guide to Red Light Therapy," we discuss how red light and near-infrared light are forms of nutrition for the body.

Photoreceptors on your mitochondria capture photons of red and near-infrared light to produce energy more efficiently. Light therapy might also help modulate gene expression, one of the hallmarks of aging.

As Ari explains, one of the biggest challenges with sun exposure is the infrequency of exposure, which tends to be more problematic than being outdoors regularly. Intermittent exposure increases your likelihood of burning and causing damage to the skin, while regular exposure ameliorates the risk and engages your innate adaptive systems explicitly designed to prevent DNA damage from UV light exposure.

Before jumping into building your red light or near-infrared light therapy box at home, I encourage you to watch the interview and read about "**The Benefits of Red Light and Near-Infrared Light Therapy**." In the interview, we talk about the fallacy that more is better. That's a hazardous assumption since you can overdo the effects of light therapy.

If you can't get enough sun exposure and don't have access to a red light or near-infrared light sauna, consider taking an oral vitamin D3 supplement. In "**Magnesium and K2 Optimize Your Vitamin D Supplementation**," I discuss the supplements that can be taken together to boost your vitamin D absorption and activation within your body.

Long-term deficiency is known to contribute to health problems like rickets, heart disease and autoimmune diseases, but even insufficiency can contribute to depression,

slow wound healing, muscle weakness, fatigue and impaired cognition. In the article hyperlinked above are clear guidelines on how to determine your vitamin D level and the approximate dosage that can get you into the optimal range of 60 ng/mL to 80 ng/mL.

Sources and References

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