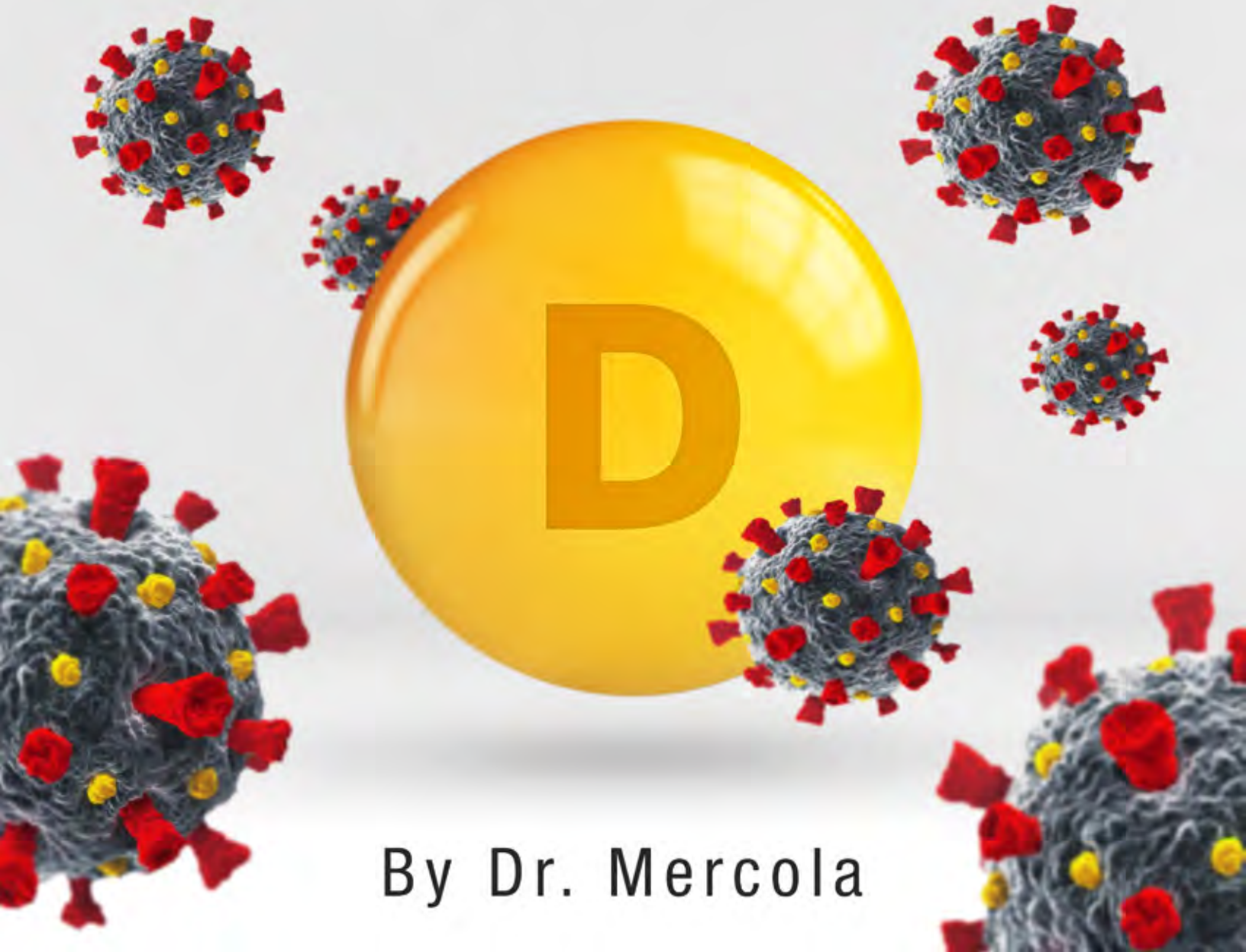
Vitamin D

in the Prevention of

COVID-19



By Dr. Mercola

Contributing Authors

William B. Grant, Ph.D.
Director, Sunlight, Nutrition, and Health Research Center P.O. Box 641603
San Francisco, CA 94164-1603, US www.sunarc.org

Carol L. Wagner, M.D.
Professor of Pediatrics
Associate Director, Nexus Research Center
Medical University of South Carolina

Cedric F. Garland, Dr.P.H., F.A.C.E.
Professor Emeritus Department of Family Medicine and Public Health
University of California San Diego

Lorenz Borsche, Ph.D.

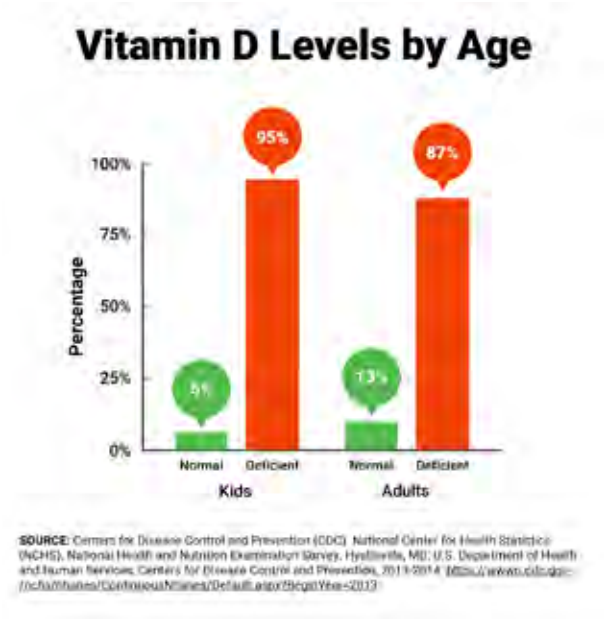
Joseph Mercola, D.O., F.A.C.N.
Family Physician and Founder Mercola.com

The information in this document is a summary of a more comprehensive review of vitamin D and COVID-19 for health professionals. It can be downloaded for free at https://www.stopcovidcold.com/

About 90% of US Is Vitamin D Deficient

The current epidemic of vitamin D deficiency has collided with the COVID-19 pandemic and likely radically increased the number of deaths because of vitamin D insufficiency.[1]

While it will be some time before we know the full extent of SARS-CoV-2, we do know that at least 40% of the population has severe vitamin D deficiency as conservatively defined by a blood level of 25-hydroxyvitamin D below 20 ng/ml (50 nmol/l).[2]



SOURCE: Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2011-2014. https://www.cdc.gov/nchs/nhanes/ContinuousNhanes/Default.aspx?BeginYear=2013

Figure 1

While conventional consensus holds that vitamin D levels over 30 ng/ml are sufficient, many vitamin D researchers believe that blood levels over 40 ng/ml are the ideal vitamin D levels.[3-5]

When we use the optimum vitamin D level as being over 40 ng/ml, as you can see in Figure 1, over 95% of children and 87% of adults have less than the ideal level of vitamin D in their blood, which is 40 ng/ml or 100 nmol/liter.

Only 5% of children and 13% of adults have achieved ideal levels. But this is for all ethnicities. As you can see in Figure 7 at the end of the document, **less than 1% of Black children have achieved this healthy level.**

Do Studies Prove Vitamin D Works for COVID-19?

Although there are currently no prospective controlled studies demonstrating vitamin D's effectiveness in COVID-19, there are many such studies underway. As of early June 2020 there were over 20 studies in progress on the use of vitamin D in COVID-19.[6,7] By the end of 2020 we should have some of the results of these trials that should support vitamin D supplementation.

Vitamin D Deficiency Increases Your Risk for COVID-19

A recent study at the University of Chicago of over 4,000 patients[8] found that untreated vitamin D deficiency was associated with an increased risk for COVID-19 infection. Another observational study involving 212 patients in Southeast Asia found that of those with a critical or severe case of COVID-19, only 4% had normal levels, while 96% of those with a mild case of COVID-19 had normal vitamin D levels. See Figure 2.

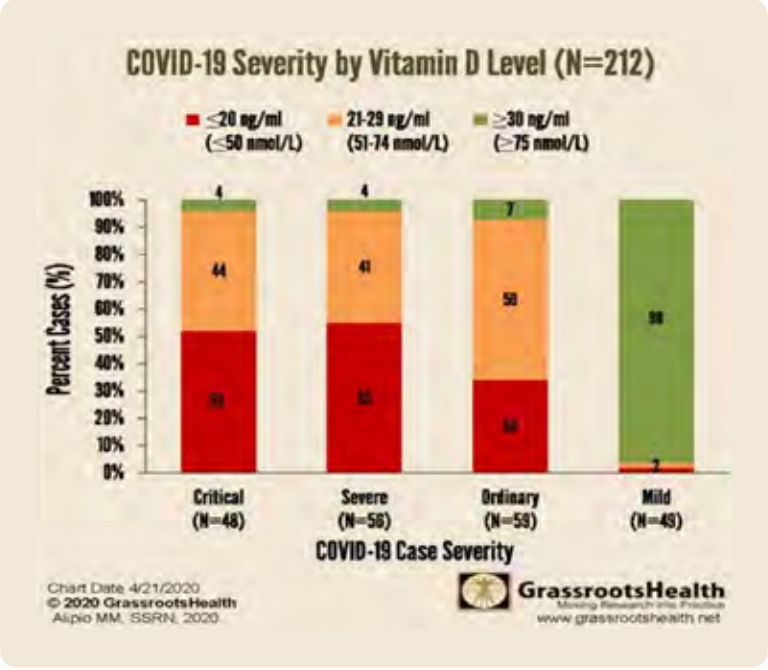


Figure 2

Vitamin D Reduces Your Risk of Viral Infections

There are many reviews that consider the ways in which vitamin D reduces your risk of viral infections.[9-21] Vitamin D likely reduces risk of viral respiratory infections because it influences several of your immune pathways, with the net effect of boosting your mucosal barrier defenses while simultaneously dampening excessive inflammation.[22]

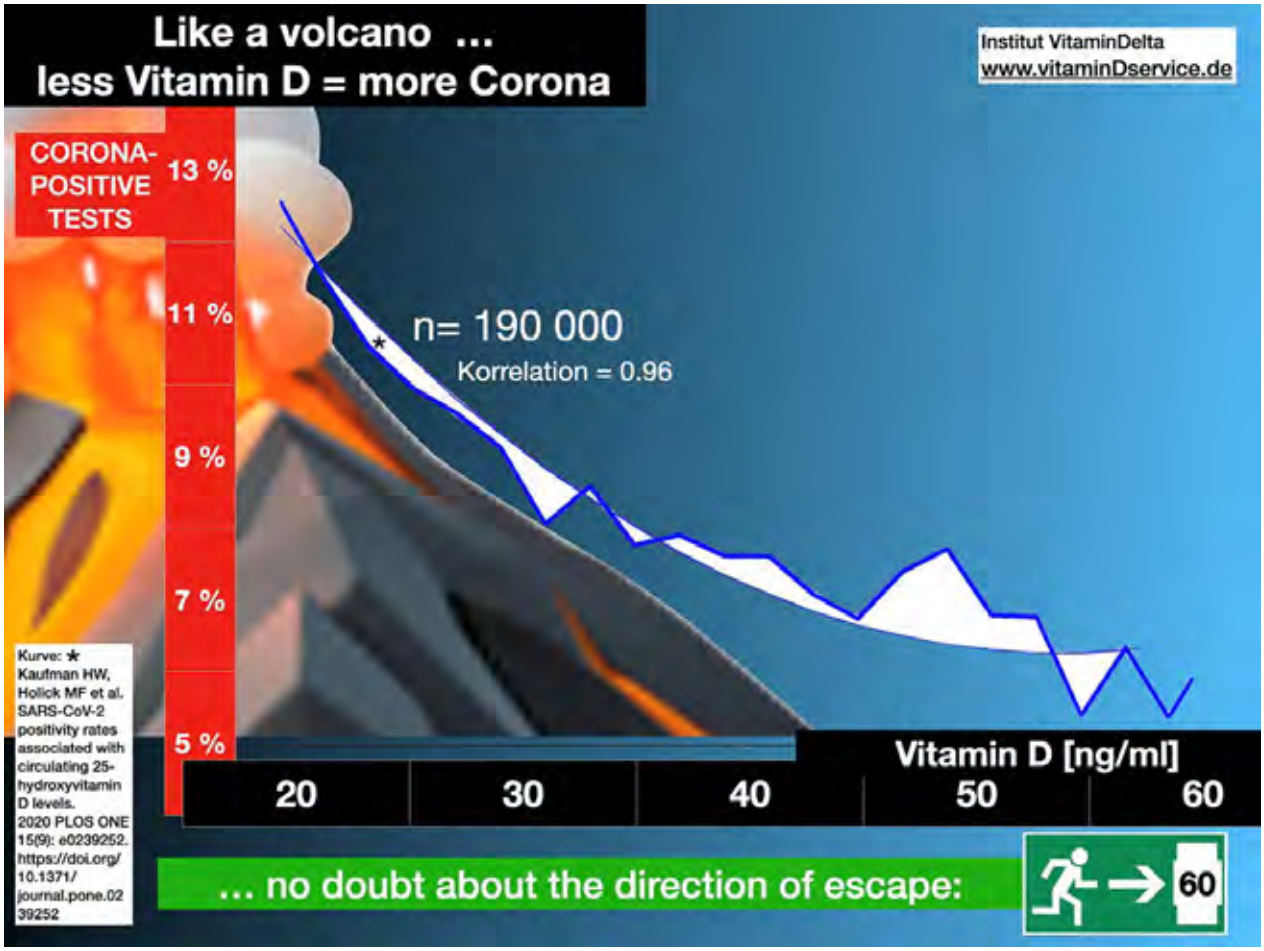


Figure 3

Vitamin D Has Many Benefits Aside From Bone Health and Immune Support

Vitamin D differs from most vitamins in that your body can produce it on its own with exposure to sunlight, and that its primary active metabolite is a steroid hormone. Unlike most vitamins, which

act as antioxidants or enzyme co-factors, the 1,25(OH)$_2$D form of vitamin D works by binding to a vitamin D receptor present in your cells. Once vitamin D activates the receptor, it becomes a master regulator of cell function (Fig. 4).

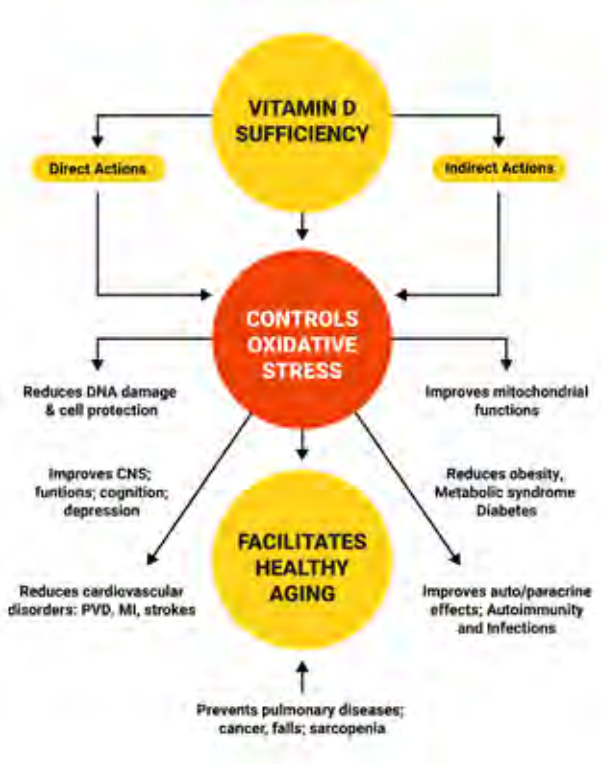


Figure 4

Does Vitamin D Work?

A number of people might be opposed to vitamin D supplementation and counter that there are many vitamin D trials showing it is ineffective with no clinical benefit.[23] In every case, though, this is due to a common flaw in the vitamin D study.

Typically, the studies that fail to show a benefit of vitamin D supplementation use a specific dose of vitamin D rather than adjusting the dose to achieve an optimal vitamin D blood level.

This is because these studies are designed similarly to pharmaceutical trials where participants are randomized to a drug or placebo and all participants start with a baseline concentration of zero. With vitamin D studies, individuals start with varying 25-hydroxyvitamin D levels in their blood, so the dose response will vary according to the blood level.

Studies that show vitamin D doesn't work, fail to adjust the dose based on person's blood level of vitamin D

It is important to understand that any study evaluating the impact of vitamin D supplementation needs to use a design based on blood levels of 25-hydroxyvitamin D concentrations, rather than administered vitamin D doses.[24,25]

Once you understand this and you carefully review the methods section of a study being used to dispute the benefit of vitamin D supplementation, you will find that nearly every negative vitamin D study failed to individualize dosing based on blood levels. Further, one of the biggest omissions was any defined co-factors.[26]

Vitamin D Dosing

Ideally, everyone should test their vitamin D blood level as this will help identify the ideal starting dose. GrassrootsHealth has analyzed data from over 15,000 people taking vitamin D and put together a calculator.

All you need to do is input your weight, current vitamin D level and desired vitamin D level and it will suggest a dosage for you. It can be found at www.grassrootshealth.net/project/dcalculator

Please understand though that this is merely an estimate and it would be ideal to retest in about three to six months since vitamin D levels rise slowly. But as mentioned above, since there is virtually no risk of taking a dose of 8,000 units per day, this seems to be a safe strategy. However, if you are normal body weight or underweight, you can reduce this amount by 1,000-2,000 units per day as less vitamin D is needed.

Most people need about 8,000 units of vitamin D per day to achieve a healthy level of over 40 ng/ml.

If you are unable or unwilling to get a vitamin D test, they have found that the average dose to achieve a healthy vitamin D level of 40 ng/ml is about 8,000 units per day.

If you are underweight you will want to reduce this dose to 6,000-7,000 units per day as heavier people tend to need more vitamin D.

Safety of Vitamin D Supplementation

Some are concerned about overdosing on vitamin D. It is important to place vitamin D supplementation and its potential risk in its proper context. If you search the literature you will not find a single reported death from vitamin D toxicity in the past 10 years. But, there have been nearly half a million deaths from COVID-19 so far this year.

It is also useful to understand that significant levels of vitamin D can be produced from sun exposure during non-winter months. Approximately 10,000 to 25,000 IUs of vitamin D_3 can be produced in a short time in the sun with full-body exposure, so it should be obvious that your body can easily handle high doses of vitamin D.[27]

The U.S. Institute of Medicine issued vitamin D guidelines nearly 10 years ago.[28] The institute admitted that no studies had reported adverse effects of supplementation with less than 10,000 IU/day of vitamin D. Although doses of 15,000 IU/day are rarely needed or recommended, they were found to be safe.[29]

Other Nutrients That May Increase the Effectiveness of Vitamin D Supplementation

Since over half the population does not get enough magnesium, and far more are likely deficient,[30] magnesium supplementation is recommended when taking vitamin D supplements.

This is because magnesium helps to activate vitamin D, as the enzymes that metabolize vitamin D in the liver and kidneys require magnesium.[31] In fact, about half of those taking vitamin D supplements are unable to normalize their vitamin D levels until they take magnesium.[32-34]

GrassrootsHealth found[35] that those who do not take supplemental magnesium need, on average, 146% more vitamin D to achieve a blood level of 40 ng/ml (100 nmol/L), compared to those who take at least 400 mg of magnesium per day.

The dose of magnesium should be around 500 mg/day, but more if you don't have the loose stools that can occur with higher-dose magnesium supplementation. If you have kidney damage, discuss the dose with your physician.

Take at least 500 mg of magnesium with your vitamin D

One can also take 150 to 200 mcg of vitamin K2 per day, as it works synergistically with vitamin D. This will help drive the calcium that vitamin D helps increase in your blood, and drive it into your bones to build healthier bones.[36] The only concern is that if you are on Coumadin, you have to discuss vitamin K2 with your physician as it will interfere with Coumadin.[37]

Vitamin D Campaign to Arm the Susceptible Public

If you have ever traveled by airplane, you will likely recall the safety instructions from flight attendants during take-off which tells you that, in the event of an emergency, an oxygen mask will automatically appear in front of you. But they also tell you that if you are traveling with a child or someone who requires assistance, to be sure to secure your mask first, and then assist the other person.

The lesson here is that it will be important to adopt the vitamin D recommendations and its co-factors in this paper for yourself and family before sharing with your friends and community. But, if we hope to limit the damage from this virus, we need to work together to educate and empower the populations that are most at risk for the next wave of COVID-19.

We need to create an army that can go out and reach these target populations that are at high risk during the next wave of the infection. The target populations are the elderly and people of color, as well as those with chronic diseases, and pregnant and nursing mothers.[38]

It is important to know that YOU can make a difference by taking this information and sharing it with others, especially those who have influence to spread this message to at-risk populations.

By a little investment of your time, you can save many lives at virtually no cost. Remember, if it is the late spring, summer or early fall, you

likely can get enough vitamin D for free by merely going outside around solar noon, just being careful to never get burned.

To help you with these efforts, we have created a Facebook Group page called **Vitamin D in the Prevention of COVID-19** (www.facebook.com/groups/309700403618466)

Black Americans and People of Color Are at Risk of COVID

Collectively, Black Americans represent one-eighth of the population in the U.S., but they have suffered one-fourth of known COVID-19 deaths. They are dying at twice their population share.[39] So what could explain this dramatic difference in death rates between white and Black Americans?

In the graph below that is compiled from approximately 15,000 tests done at GrassrootsHealth over the last 13 years, you will notice that the levels of

25-hydroxyvitamin D (as the measure of vitamin D status based on race in the U.S.) that only 16% of Black adults have adequate vitamin D levels while over three times that number, or nearly 50%, of white adults have vitamin D levels over 30 ng/ml.

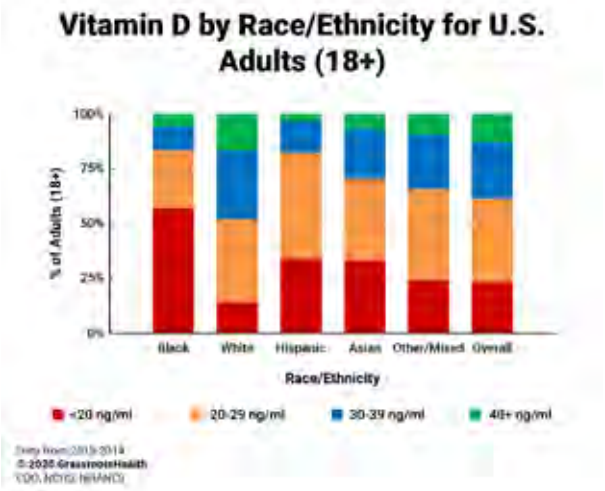


Figure 5

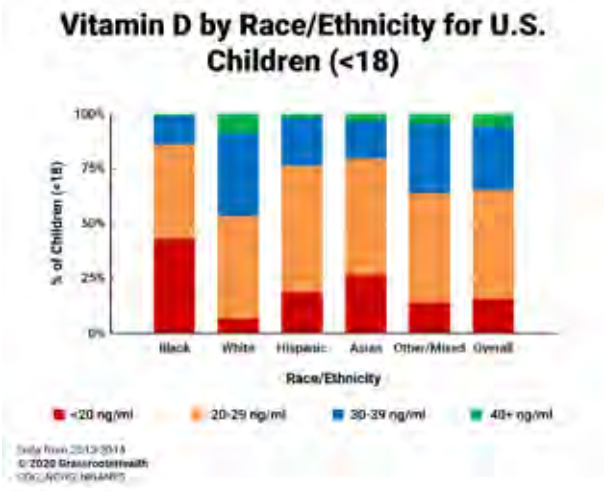


Figure 6

Coordinated efforts to share this important message to those in the Black community could radically reduce deaths. Sharing this important message with your community, churches and other large groups would also be really helpful.

Elderly Focus

Based on a recent analysis of COVID-19 deaths,[40] it is clear that one of the most underappreciated aspect of COVID-19 is its effect on those living in nursing homes and assisted living facilities. This population is particularly at risk of vitamin D deficiency as they are often unable to go outside much, and even if they were able to have sufficient sun exposure, they have a diminished ability to convert that to vitamin D.[41]

COVID-19 affects the elderly far more severely, on average, than younger individuals. Those

living in nursing homes and assisted living facilities seem to be at an extraordinarily increased risk of dying from COVID-19. As of June 2020, 42% of deaths occurred in nursing homes and assisted living facilities.

Our goal is to reach the physicians who care for these patients. Many of these facilities have only a few doctors, but if they are convinced, they can prescribe vitamin D to all of their patients.

You can help by connecting with the managers of these facilities and sharing this document and the far more comprehensive professional version available at www.stopcovidcold.com with them. Let them know you are trying to help protect all the residents by getting them on vitamin D, and ask them to help you connect with the doctors who can facilitate this.

It may seem daunting, but this can go a long way to reducing the illness in the elderly. Remember to join the Facebook support group, where you can share your success and ask questions about how to implement these plans:

Other Strategies to Lower Your COVID-19 Risk

It is very clear that insulin resistance is another important risk factor related to your risk of COVID-19. Approximately 9 out of 10 people in the US are metabolically inflexible and have lost the ability to seamlessly switch between using carbs and fat as their primary fuel.

The most common symptom of insulin resistance is being overweight or obese. Other complications such as diabetes, heart disease, cancer and Alzheimer's are also associated with insulin resistance.

What Can You Do to Improve Insulin Resistance?

There are a number of very effective approaches that will allow your body to develop the ability to burn your body fat as a primary fuel. However, unlike vitamin D correction, this is not a simple or quick process. Below are some of the best strategies.

Reduce Your Eating Window

Most people eat more than 12 hours a day, and for many the only time they aren't eating is when they are sleeping. Some will even wake up during the night and eat something to help them fall back to sleep. The problem with eating all day long is that it will push your body to nearly exclusively burn sugar as your primary fuel and increase your insulin resistance.

Fortunately, there is a simple solution that does not involve calorie restriction but merely narrowing the window of time that you consume calories. A good goal would be 6-8 hours and making sure that your last meal is at least three hours before you go to bed.

This type of eating strategy is called "time-restricted eating" or "intermittent fasting," and has nearly all the same health benefits as calorie restriction, but with none of the downsides.

Eliminate Industrially Processed Vegetable Oils

These are some of the most toxic foods you can eat. This is largely because these foods that contain them are not burned as fuel, but are actually integrated into your cell membranes where they can linger for many months, or even years, causing metabolic havoc.

Most Americans are consuming 20 to 100 times more of these oils today than what was consumed a mere 120 years ago. These oils are loaded with a specific omega-6 fat called linoleic acid that can lead to a host of diseases when consumed in excess, like most do today.

So eliminating oils from soybeans, corn and canola which are typically genetically modified, (GMO) but also sunflower, safflower and sesame oils. Additionally, be careful of olive oil and avocado oils. While these oils are lower in omega-6 fats and typically healthy when consumed in moderation, about 80% of those sold in stores are adulterated and diluted with the other cheaper, unhealthy oils.

Start an Exercise Program

Exercise is a powerful tool to help improve insulin resistance but is rarely effective without integrating the strategies above. The key is to find something you enjoy so you can stick with it as you will ideally need at least five or more hours a week.

This needn't be high intensity workouts. Walking is a wonderful tool to improve health for many. Strength training and body weight exercises are really helpful to improve metabolic fitness. Ideally it would be great to have a personal trainer, but thankfully YouTube offers hundreds of thousands of exercise videos for free.

Avoid Fast Food

Ideally, you should not be eating any fast food as they are loaded with industrially processed vegetable oils that will lead to insulin resistance. They are also highly processed and lack the nutrient density of home-prepared meals. While it requires more time and energy to prepare your own meals it is a great investment in your health.

Get a Good Night's Sleep

Many tend to minimize the importance of sleep for their immune health. If you had the perfect diet and exercise program but lacked quality sleep, you would likely not be very healthy. Your body requires time to repair and regenerate. Scientific studies have shown that fragmented sleep causes chronic inflammation and can contribute to mental health and neurological disorders. Ideally strive for 7-8 hours every night.

Understand and Treat Anxiety/Stress

Emotional stressors can also impair your immune function. There are many methods that can be used to address stress. Prayer and meditation are two strategies that many find useful. Having the perspective that some good can come out of your stressful scenario and seeking to find that benefit can also be helpful in reducing the negative impact of stress.

Sources and References

[1] Chakhtoura, M, et al Commentary: Myths and facts on vitamin D amidst the COVID-19 pandemic Metabolism. 2020 Aug; 109: 154276. doi: 10.1016/j.metabol.2020.154276

[2] Kara, M, et al 'Scientific Strabismus' or two related pandemics: coronavirus disease and vitamin D deficiency Br J Nutr. 2020 May 12 : 1–6. doi: 10.1017/S0007114520001749 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7300194/

[3] Hollis, B, Watner, C, et al M Pediatrics
. 2015 Oct;136(4):625-34. doi: 10.1542/peds.2015-1669. aternal Versus Infant Vitamin D Supplementation During Lactation: A Randomized Controlled Trial https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4586731/

[4] Wagner CL, Hollis BW. The implications of vitamin D status during pregnancy on mother and her developing child. Front Endocrinol (Lausanne) 2018; 9: 500.

[5] Hollis BW, Johnson D, Hulsey TC, Ebeling M, Wagner CL. Vitamin D supplementation during pregnancy: double-blind, randomized clinical trial of safety and effectiveness. J Bone Miner Res 2011; 26: 2341-2357.

[6] https://clinicaltrials.gov/ct2/results?cond=COVID19&term=vitamin+D&cntry=&state=&city=&dist=

[7] Chinese Clinical Trials Registry. The relationship between vitamin D and novel coronavirus pneumonia (COVID-19), 2020. Available: http://www.chictr.org.cn/showprojen.aspx?proj=51390

[8] Meltzer, DO, et al Association of Vitamin D Deficiency and Treatment with COVID-19 Incidence medRxiv preprint doi: https://doi.org/10.1101/2020.05.08.20095893 posted May 13, 2020.

[9] Grant WB, et al. Evidence That Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths Nutrients . 2020 Apr 2;12(4):988. doi: 10.3390/nu12040988.

[10] Gombart, A.F.; Pierre, A.; Maggini, S. A Review of Micronutrients and the Immune System-Working in Harmony to Reduce the Risk of Infection. Nutrients 2020, 12, 236.

[11] Rondanelli, M.; Miccono, A.; Lamburghini, S.; Avanzato, I.; Riva, A.; Allegrini, P.; Faliva, M.A.; Peroni, G.; Nichetti, M.; Perna, S. Self-Care for Common Colds: The Pivotal Role of Vitamin D, Vitamin C, Zinc, and Echinacea in Three Main Immune Interactive Clusters (Physical Barriers, Innate and Adaptive Immunity) Involved during an Episode of Common Colds-Practical Advice on Dosages and on the Time to Take These Nutrients/Botanicals in order to Prevent or Treat Common Colds. Evid. Based Complement. Alternat. Med. 2018, 2018, 5813095.

[12] Gruber-Bzura, B.M. Vitamin D and Influenza-Prevention or Therapy? Int. J. Mol. Sci. 2018, 19, 2419.

[13] Lang, P.O.; Aspinall, R. Vitamin D Status and the Host Resistance to Infections: What It Is Currently (Not) Understood. Clin. Ther. 2017, 39, 930–945

[14] Coussens, A.K. The role of UV radiation and vitamin D in the seasonality and outcomes of infectious disease. Photochem. Photobiol. Sci. 2017, 16, 314–338

[15] Ginde AA, Mansbach JM, Camargo CA. Association between serum 25-hydroxyvitamin D level and upper respiratory tract infection in the Third National Health and Nutrition Examination Survey. Arch Intern Med 2009; 169: 384-390

[16] Jolliffe, DA, et al Vitamin D in the prevention of acute respiratory infection: systematic review of clinical studies J. Steroid Biochem. Mol. Biol., 136 (2013), pp. 321-329, 10.1016/j.jsbmb.2012.11.017

[17] Martineau, AR Vitamin D supplementation to prevent acute respiratory infections: individual participant data meta-analysis Health Technol. Assess., 23 (2019), pp. 1-44, 10.1136/bmj.i6583

[18] Goodall, E.C., et al Vitamin D3 and gargling for the prevention of upper respiratory tract infections: a randomized controlled trial BMC Infect. Dis., 14 (2014), p. 273, 10.1186/1471-2334-14-273

[19] Laaksi I, Ruohola JP, Tuohimaa P, Auvinen A, Haataja R, Pihlajamäki H, Ylikomi T. An association of serum vitamin D concentrations < 40 nmol/L with acute respiratory tract infection in young Finnish men. Am J Clin Nutr 2007; 86: 714-717.

[20] Cannell JJ, Vieth R, Willett W, Zasloff M, Hathcock JN, White JH, Tanumihardjo SA, Larson-Meyer DE, Bischoff-Ferrari HA, Lamberg-Allardt CJ, Lappe JM, Norman AW, Zittermann A, Whiting SJ, Grant WB, Hollis BW, Giovannucci E. Cod liver oil, vitamin A toxicity, frequent respiratory infections, and the vitamin D deficiency epidemic. Ann Otol Rhinol Laryngol 2008; 117: 864-870.

[21] Belančić A, et a lPotential pathophysiological mechanisms leading to increased COVID-19 susceptibility and severity in obesity Obes Med. 2020 Sep; 19: 100259. doi: 10.1016/j.obmed.2020.100259

[22] Parlek, E, et al The Effect of Inflammatory Cytokines and the Level of Vitamin D on Prognosis in Crimean-Congo Hemorrhagic FeverInt J Clin Exp Med 2015; 8:18302-10.

[23] Zabetakism I, et al, COVID-19: The Inflammation Link and the Role of Nutrition in Potential Mitigation Nutrients. 2020 May 19;12(5):E1466. doi: 10.3390/nu12051466.
[24] Infante M, Ricordi C, Baidal DA, Alejandro R, Lanzoni G, Sears B, Caprio M, Fabbri A. VITAL study: an incomplete picture? Eur Rev Med Pharmacol Sci 2019; 23: 3142-3147
[25] Grant WB, Boucher BJ, Bhattoa HP, Lahore H. Why vitamin D clinical trials should be based on 25-hydroxyvitamin D concentrations. J Steroid Biochem Mol Biol 2018; 177: 266-269.
[26] Grant WB, Boucher BJ. Randomized controlled trials of vitamin D and cancer incidence: A modeling study. PLoS One. 2017 May 1;12(5):e0176448. https://doi.org/10.1371/journal.pone.0176448
[27] Holick MF, Chen TC, Lu Z, Sauter E.J Vitamin D and skin physiology: a D-lightful story. Bone Miner Res. 2007 Dec;22 Suppl 2:V28-33
[28] Ross, A.C.; Manson, J.E.; Abrams, S.A.; Aloia, J.F.; Brannon, P.M.; Clinton, S.K.; Durazo-Arvizu, R.A.; Gallagher, J.C.; Gallo, R.L.; Jones, G.; et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: What clinicians need to know. J. Clin. Endocrinol. Metab. 2011, 96, 53–58.
[29] Kimball SM, Mirhosseini N, Holick MF. Evaluation of vitamin D3 intakes up to 15,000 international units/day and serum 25-hydroxyvitamin D concentrations up to 300 nmol/L on calcium metabolism in a community setting. Dermatoendocrinol. 2017;9:e1300213. doi: 10.1080/19381980.2017.1300213
[30] Rosanaff, A, et al Suboptimal Magnesium Status in the United States: Are the Health Consequences Underestimated? Nutr Rev . 2012 Mar;70(3):153-64. doi: 10.1111/j.1753-4887.2011.00465.x.
[31] Uwitonze, A.M.; Razzaque, M.S. Role of Magnesium in Vitamin D Activation and Function. J. Am. Osteopath Assoc. 2018, 118, 181–189.
[32] Ozsoylu S, Hanioğlu N. Serum magnesium levels in children with vitamin D deficiency rickets. Turk J Pediatr. 1977;19(3-4):89-96
[33] Anast CS. Magnesium studies in relation to vitamin D-resistant rickets. Pediatrics. 1967;40(3):425-435
[34] Deng X, Song Y, Manson JE, et al. Magnesium, vitamin D status and mortality: results from US National Health and Nutrition Examination Survey (NHANES) 2001 to 2006 and NHANES III. BMC Med. 2013;11:187. doi: 10.1186/1741-7015-11-187
[35] GrassrootsHealth Is Supplemental Magnesium Important for Vitamin D Levels? https://www.grassrootshealth.net/blog/supplemental-magnesium-important-vitamin-d-levels/
[36] Vermeer, C, et al Role of Vitamin K in Bone Metabolism Annu Rev Nutr . 1995;15:1-22. doi: 10.1146/annurev.nu.15.070195.000245. https://www.annualreviews.org/doi/pdf/10.1146/annurev.nu.15.070195.000245
[37] Theuwissen E, et al Effect of Low-Dose Supplements of menaquinone-7 (Vitamin K2) on the Stability of Oral Anticoagulant Treatment: Dose-Response Relationship in Healthy Volunteers J Thromb Haemost . 2013 Jun;11(6):1085-92. doi: 10.1111/jth.12203. https://onlinelibrary.wiley.com/doi/full/10.1111/jth.12203
[38] McDonnell SL, Baggerly KA, Baggerly CA, Aliano JL, French CB, Baggerly LL, Ebeling MD, Rittenberg CS, Goodier CG, Mateus Niño JF, Wineland RJ, Newman RB, Hollis BW, Wagner CL Maternal 25(OH)D concentrations ≥40 ng/mL associated with 60% lower preterm birth risk among general obstetrical patients at an urban medical center.. PLoS One. 2017 Jul 24;12(7):e0180483.
[39] APM Research Lab The Color of Coronavirus: COVID-19 Deaths by Race and Ethnicity in the US. June 7. 2020 https://www.apmresearchlab.org/covid/deaths-by-race
[40] Givan, G, Roy, A, Nursing Homes & Assisted Living Facilities Account for 42% of COVID-19 Deaths last updated June 2, 2020 https://freopp.org/the-covid-19-nursing-home-crisis-by-the-numbers-3a47433c3f70
[41] MacLaughlin, J Holick. MF Aging Decreases the Capacity of Human Skin to Produce Vitamin D3 J Clin Invest . 1985 Oct;76(4):1536-8. doi: 10.1172/JCI112134. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC424123/