

Vitamin D and Exercise Performance

INTRODUCTION

Vitamin D has been a “hot topic” for a number of years, and more physicians are having their patients get their blood levels of vitamin D tested to ensure that they are not vitamin D deficient. Vitamin D is a required nutrient, but it also is a secosteroid hormone (a secosteroid has a “broken ring” on its structure). The basic definition of a hormone is that it is produced in one area of the body but elicits its effects on another part of the body. Vitamin D is synthesized in the liver and the kidneys. The more active forms of vitamin D are synthesized in the kidney (calcitriol or 1,25-dihydroxyvitamin D₃, the most active form); however, the vitamin D that is synthesized in the liver (25-hydroxyvitamin D or calcidiol) is the form measured in the blood because of its longer half-life. This means that it stays in the blood longer than the other forms of vitamin D and, thus, can be better measured.

The Dietary Reference Intake for vitamin D is 600 International Units (IU) for individuals 1 through 70 years of age (3). Vitamin D can be acquired from food (Table) or through the sun on the skin. When the sun hits the skin, its ultraviolet B waves convert 7-dehydrocholesterol to pre-vitamin D (Figure). Note that from November to March, those living at or above the 35th to 40th latitude, have no conversion of vitamin D on their skin. Thus, acquiring it through the summer months and ensuring adequate consumption of vitamin D in the winter months can help prevent vitamin D deficiency.

Once vitamin D is absorbed, the body takes it through the aforementioned conversions in the liver and kidneys. The body then uses vitamin D for many purposes, including bone metabolism, protein synthesis, and muscle function. It is in this latter role of vitamin D, its involvement

in muscle function, that this *Nutritionist's View* column will focus.

VITAMIN D AND MUSCLE FUNCTION

During the winter months, even athletes can exhibit vitamin D deficiency, especially if they live above the 35th to 40th parallel. Wyon *et al.* (5) studied the influence of winter vitamin D supplementation on muscle function and injury in elite ballet dancers. The researchers studied 24 elite classical ballet dancers (17 were supplemented with 2000 IU of vitamin D₃ for 4 months, whereas 7 ballet dancers were given placebo for the same length of time). Note that vitamin D₃ is better absorbed than vitamin D₂. The main outcome measures of this study were isometric muscular strength and vertical jump height taken at baseline and at the end of the 4-month study. They also recorded injury rates.

These researchers reported significantly greater isometric strength (18.7% greater than the control group; $P < 0.01$) and vertical jump height (7.1% greater than the control group; $P < 0.01$) in the supplemented group compared with the control group. Wyon *et al.* (5) also reported significantly less injuries in the supplemented group compared with the control group.



Close *et al.* (2) also wanted to examine the effect of vitamin D supplementation in professional athletes during the winter months, who lived at the 53rd latitude in the United Kingdom. They supplemented their athletes with 5,000 IU/day of vitamin D₃ for 8 weeks and reported significant increases in blood levels of 25-hydroxyvitamin D as well as significantly improved 10-m sprint times and vertical jumps. A placebo control group showed

TABLE: Sources of Vitamin D

Source	Serving/Dose	Vitamin D, IU
Pink salmon, canned	3 oz	530
Sardines, canned	3 oz	231
Cow's milk (vitamin D fortified)	8 oz	98
Soy milk (vitamin D fortified)	8 oz	100
Orange juice (vitamin D fortified)	8 oz	100
UVB (arms, face, legs)	~10–15 minutes	10,000–25,000

The daily dietary reference intake for vitamin D is 600 IU (Adapted from: <http://lpi.oregonstate.edu/infocenter/vitamins/vitaminD/>). IU, International Units.

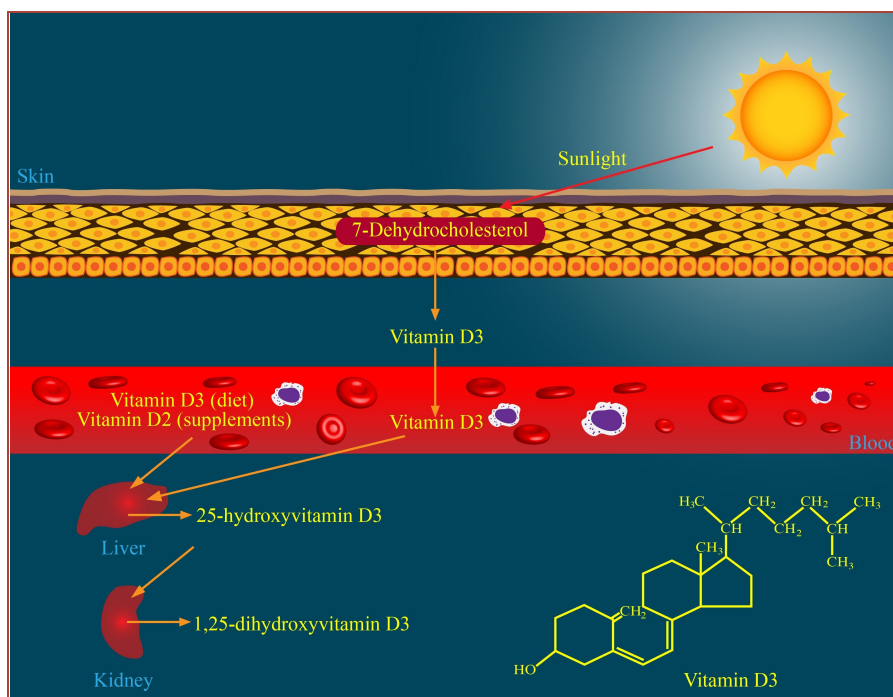


Figure. Conversion and absorption of vitamin D in the body.

no changes in blood levels of vitamin D or physical performance.

These studies demonstrate that more research is required involving larger sample sizes and with different types of athletes. More data also are needed that evaluate vitamin D status and effects of supplementation in athletes during the winter months, particularly those living above the 35th to 40th latitudes.

In 2012, Shuler *et al.* (4) published a review article on the sports health benefits of vitamin D. Like Wyon *et al.* (5), they wanted to evaluate the effects of vitamin D deficiency in young active healthy individuals and compare that with musculoskeletal injury. Shuler *et al.* (4) searched PubMed for the following terms: “vitamin D and skeletal muscle,” “vitamin D and athletic performance,” and “vitamin D review articles.” They included research from the 1930s through 2012 for their review article.

Based on their review of the literature, they reported a strong correlation between

sufficient blood levels of 25-hydroxyvitamin D (>30 ng/mL (>75 nmol/L)) and ideal muscle function. They also reported that blood levels of 25-hydroxyvitamin D between 30 and 50 ng/mL (125 nmol/L) were associated with reduced inflammation, pain, and myopathy. These same blood concentrations of 25-hydroxyvitamin D resulted in increased muscle protein synthesis, adenosine triphosphate levels, strength, jump height, jump velocity, jump power, exercise capacity, and physical performance.

Shuler *et al.* (4) concluded that athletes who present with stress fractures, musculoskeletal pain, or frequent sickness should be evaluated for vitamin D deficiency. If an athlete, or any individual, is found to have a vitamin D deficiency, appropriate supplementation should be prescribed by a physician and registered dietitian.

In a prospective study, Close *et al.* (1) randomly assigned 30 club-level athletes into 1 of 3 supplementation groups, placebo, 20,000 IU of vitamin D₃, or

40,000 IU of vitamin D₃, to evaluate if there was a dose-response relationship to vitamin D supplementation. Their major outcome measures were serum 25-hydroxyvitamin D levels and muscle function, which they evaluated using 1-repetition maximum (1-RM) bench press, 1-RM leg press, and vertical jump height. The athletes were measured at baseline and 6 weeks and 12 weeks postsupplementation. They used less than 20 ng/mL (<50 nmol/L) as their criteria for vitamin D deficiency (there is a debate among scientists as to what the true vitamin D deficiency marker should be; some use <30 ng/mL as opposed to <20 ng/mL).

Close *et al.* (1) reported that more than half (57%) of their athletes were vitamin D deficient at baseline (20.4 ± 9.6 ng/mL (51 ± 24 nmol/L)). All of the athletes who were supplemented with vitamin D₃ significantly increased their blood levels of vitamin D at 6 and 12 weeks of supplementation, regardless of the level of supplementation, whereas blood levels in the placebo group decreased at both 6 and 12 weeks of supplementation. Despite the increased serum 25-hydroxyvitamin D levels, there were no significant changes on any of the performance measures. This absence of the improved muscle performance with supplementation could be caused by the short duration of the study.

SUMMARY

Vitamin D plays a major role in muscle function and thus can affect physical performance. Based on the aforementioned research and review article, it seems that vitamin D supplementation in athletes who are diagnosed as having vitamin D deficiency can improve vitamin D status and physical performance. Conversely, caution must be taken in that vitamin D supplementation in individuals who are not deficient will likely not result in improved exercise performance. In addition,

more studies are required before definitive conclusions can be made. In fact, as I was writing this article, I came across a synopsis of newly published research in *The Lancet Diabetes & Endocrinology*, stating that taking vitamin D supplements when one is not vitamin D deficient may be harmful to health. I placed the link to the Web MD synopsis of the article under “Recommended Resources.”

References

1. Close GL, Leckey J, Patterson M, Bradley W, Owens DJ, Fraser WD, Morton JP. The effects of vitamin D(3) supplementation on serum total 25[OH]D concentration and physical performance: a randomised dose-response study. *Br J Sports Med*. 2013;47(11):692–6.
2. Close GL, Russell J, Cobley JN, Owens DJ, Wilson G, Gregson W, Fraser WD, Morton JP. Assessment of vitamin D concentration in non-supplemented professional athletes and healthy adults during the winter months in the UK: implications for skeletal muscle function. *J Sports Sci*. 2013;31(4):344–53.

3. Food and Nutrition Board of the National Academies, Institute of Medicine. *Dietary Reference Intakes for Calcium and Vitamin D*. In: Ross AC, Taylor CL, Yaktine AL, Del Valle HB, editors. Washington (DC): National Academies Press; 2011.
4. Shuler FD, Wingate MK, Moore GH, Giangarra C. Sports health benefits of vitamin D. *Sports Health*. 2012;4(6):496–501.
5. Wyon MA, Koutedakis Y, Wolman R, Nevill AM, Allen N. The influence of winter vitamin D supplementation on muscle function and injury occurrence in elite ballet dancers: a controlled study. *J Sci Med Sport*. 2014;17(1):8–12.

Recommended Resources

Web MD

<http://www.webmd.com/vitamins-and-supplements/news/20140124/vitamin-d-supplements-dont-help-your-health-review>
Note – the above synopsis was written about a peer-reviewed article published in *The Lancet Diabetes & Endocrinology* on January 25, 2014, stating that taking vitamin D supplements do not improve health of people who are not vitamin D deficient and may even be harmful.

Office of Dietary Supplements

<http://ods.od.nih.gov/factsheets/VitaminD-QuickFacts/>

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