Vitamin D Status in Athletes

Introduction

Vitamin D has many functions, ranging from optimal bone health to immune and muscle function (6,9). Little is known about vitamin D status and performance in athletes. However, it is accepted that athletes are at similar risk for low vitamin D status and that vitamin D insufficiency and deficiency can affect an athletes' health to a similar degree as is understood in the nonathletic population (10,9). In addition, several review articles and discussions have pointed to the importance of vitamin D for performance in athletes (5). Thus, it is the policy of the United States Olympic Committee to determine whether specific athletes may be at risk for vitamin D deficiency and subsequent screening and intervention is recommended in these populations.

Risk Factors for Vitamin D Deficiency in Athletes (9)

- Indoor sport
- Winter sport
- Ethnic background (e.g., Asian, African American, Native American)
- Living and training at Northern latitudes
- Sunscreen use
- Limited sun exposure
- Low dietary vitamin D intake
- Low or high body fat levels

Signs and Symptoms of Vitamin D Deficiency in Athletes (9)

- Low bone mass (Z score > -1 for spine or proximal femur)
- Stress fractures
- Fatigue
- Muscle and joint pain
- Frequent illness

Determining Vitamin D Status in Athletes

The best assessment for vitamin D status includes **25 hydroxy vitamin D3** or 25(OH) D. Serum 25(OH) D concentration is the best indicator to assess vitamin D status. Vitamin D status can be determined at any time of the day and does not have to be fasted. The most important source of error is the methodology used to analyze 25(OH) D among laboratories. Mean bias ranges between 2.9 – 5.2 $ng \cdot mL^{-1}$. The typical intra- and interassay variations for commercial vitamin D assays range from 8-15%. Thus, it is important for clinicians to know which type of assay (e.g., HPLC, radioimmuno assay etc.) is used and to consider this variability when comparing results from different laboratories (7). In addition, Vitamin D status varies seasonally. Thus, it is best to assess vitamin D status at the end of the summer and winter months, although baseline testing is justified at any time of the year, especially if low status may be expected. Table 1 shows reference ranges used for vitamin D.

Table 1 Reference Range for Vitamin D (6,7,8)

	ng·mL^{-1}	**nmol·mL^{-1}**
Vitamin D Toxicity	>150	375
Normal Vitamin D status	30-80	75-200
Vitamin D Insufficiency	<30	<75
Vitamin D Deficiency	<20	<40

*Conversion factor between units is 2.5

Recently, the Institute of Medicine (IOM) and the Food and Nutrition Board released the new Dietary Reference Intakes (DRIs) for both calcium and vitamin D (Table 2). The recommendations came as a surprise to many scientists and practitioners. While the IOM recommendation of an increase in vitamin D intake is supported by data from randomized clinical trials on fracture risk, a threshold of 20 ng·mL^{-1} for 25(OH) D does not appear in line with current research (4). Several meta-analyses exist that show a level of 20 ng·mL^{-1} does not prevent fracture or fall reduction in older populations (1,2) and that bone mass accretion requires levels well above 20 ng·mL^{-1} (2). Thus, previously published guidelines (6,7,9) are summarized below (Table 4 and 5). Despite some disagreement in the literature and the current criticism that vitamin D recommendations are too low, it is very important to monitor athletes for potential toxicity from vitamin D supplementation.

Table 2 Institute of Medicine 2010 DRIs for Calcium and Vitamin D, 2010

Life stage	**Calcium RDA (mg)**	**Calcium UL (mg)**	**Vitamin D RDA (IU)**	**Vitamin D UL (IU)**
9-13 yrs	1300	3000	600	4000
14-18 yrs	1300	3000	600	4000
19-50 yrs	1000	2500	600	4000

UL: Upper Tolerable Limit at or below which no negative side effects occur; Dietary Reference Intakes: Calcium and Vitamin D. Institute of Medicine and Food and Nutrition Board 2010 (8)

While dietary sources of vitamin D are important to support vitamin D status, vitamin D content in most foods is not high enough to meet daily requirements (see Table 3).

Table 3 Food Sources of Vitamin D

Food	**Serving Size**	**Vitamin D (IU)**
Wild salmon	3.5 oz	981
Sun dried mushrooms	1 oz	400-500
Canned sardines	3.5 oz	270
Farmed salmon	3.5 oz	249
Ahi Tuna	3.5 oz	164
Fortified milk	8 oz	100
Cod	3.5 oz	80

Partially adapted from Willis et al. 2008 (10)

<u>Sun Exposure</u>

Safe sun exposure, especially in the summer months may help athletes to build up their vitamin D stores as the skin can synthesize about 10,000-20,000 IU of vitamin D in less than 30 min. However, if sun screen is used (>SPF 15) nearly 98% of UVB rays from the sun are effectively blocked and so is vitamin D synthesis (9). While there are clear contraindications to sun exposure in individuals with a history of skin cancer and melanoma, most individuals can benefit from 5-30 minutes of sun exposure several times per week. Sunlight should reach arms, legs, and trunk for greatest benefits. For fair skinned athletes, sun exposure of as little as 5 minutes can help synthesize vitamin D. In addition, sun and day light exposure for indoor athletes may also positively affect wake and sleep cycles, and thus, recovery and performance. Athletes living, training and competing at a Northern Latitude greater than 35˚ - 37˚ such as Denver, CO will not be able to synthesize enough vitamin D in the winter months. Thus, it is expected that seasonal variations in status exist among sports.

Protocol of Vitamin D Supplementation in Athletes

Athletes at risk for low vitamin D status and those reporting signs and symptoms of vitamin D deficiency should be further investigated using a serum 25(OH) Vitamin D test. A combination of safe sun exposure, diet and supplementation should be considered in athletes with low vitamin D status. Vitamin D3 supplements are most effective, although vitamin D2 supplements (plant source) can also be recommended.

The dosage and duration of vitamin D supplementation depends on the season at which the deficiency or insufficiency was identified and the degree of deficiency. Vitamin D kinetics are nonlinear, meaning that the requirements for supplementation are higher the lower the status. Table 4 illustrates this point and provides general guidelines recently published by Larson-Meyer and Willis (9). The maintenance dose should target at least 1000-2000 IU/d, with the lower dose adequate for summer months and the higher dose adequate for winter months. Vitamin D supplementation may be discontinued if status is maintained optimally through increased sun exposure and dietary intake. However, considering the higher doses needed to remedy vitamin D deficiency, the lack of vitamin D synthesis in most winter environments, and the low amount of vitamin D found in food, it is best to maintain status also using supplementation.

Table 4 Supplementation protocol 1

Vitamin D Status	**Supplementation**	**Duration**	**Maintenance**
<20 ng·mL^{-1}	35,000-50,000 IU/wk*	8-16 weeks	1000-5000 IU/d
<30 ng·mL^{-1}	35,000 IU/wk*	3-4 weeks	1000-2000 IU/d
30 ng·mL^{-1}	1000-2000 IU/d	winter months	600-1000 IU/d

*Supplements can either be split into daily loads or consumed as weekly loads

Supplementation protocols can also be established based on adding 1000 IU/d for each 10 ng·mL^{-1} increase for a duration of 3-4 months. Table 5 illustrates this point.

Table 5 Supplementation protocol 2 (9)

Vitamin D Status	**Supplementation**	**Target Range**	**Maintenance**
10 ng·mL^{-1}	5000 IU/day for 3-4 months	> 30-80 (target 50)	1000-2000 IU/d
20 ng·mL^{-1}	4000 IU/day for 3-4 months	> 30-80 (target 50)	1000-2000 IU/d
30 ng·mL^{-1}	2000 IU/day for 3-4 months	> 30-80 (target 50)	1000-2000 IU/d

Summary

Maintaining a normal vitamin D status is important for both health and performance. All USOC athletes should be assessed for potential risk factors, signs and symptoms of low vitamin D status and should be referred to sports medicine for blood testing. Vitamin D supplementation should be initiated based on results and applying the protocols herein. Any high-dose supplementation should be supervised by sports medicine, and follow up with the athlete is critical to monitor supplementation compliance and re-assess status. When to re-assess status depends on the degree of deficiency and protocol used above. For high dose supplementation (Table 4), reassessment is encouraged after the first 3-4 weeks. Vitamin D assessment can be expensive (US $ 80-100 per test). Comparing fees among laboratories may assist in receiving a discounted (down to US $ 25 per test) cost for USOC athletes.

References:

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