Athletes and COVID-19

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Contributor: William Grant

The COVID-19 pandemic is having major economic and personal consequences for collegiate and professional sportsThe COVID-19 pandemic is having major economic and personal consequences for collegiate and professional sports. It is proposed that vitamin D supplementation be included as a method by which to reduce the risk of SARS-CoV-2 infection and progression to and severity of COVID-19. Evidence supporting this suggestion includes approximately 30 observational studies from several countries finding that serum 25-hydroxyvitamin D [25(OH)D] concentrations are inversely correlated with SARS-CoV-2 infection and severity, progression and risk of death of COVID-19. In addition, “quasi-experimental” studies in France found that COVID-19 patients receiving high-dose vitamin D supplements before or shortly after development of COVID-19 had significantly reduced risk of death. A pilot randomized controlled trial in Spain using high-dose 25(OH)D3 on COVID-19 patients found significant reductions in progression to the intensive care unit and death. Sports teams are already aware of the better athletic performance associated with higher 25(OH)D concentrations and vitamin D supplementation. Thus, supplementing with vitamin D by athletes and associated staff could add an extra measure of protection against COVID-19 as well as help maintain peak athletic ability. This review provides guidelines for supplementation.

Keywords: athletic performance,COVID-19

1. Introduction

The COVID-19 pandemic has had and continues to have a major impact on life and economics globally. Among people affected are athletes and sports teams at all levels of play. The Summer Olympics originally scheduled for summer 2020 in Japan are now postponed until summer 2021. Professional sports organizations have experienced delays, interruptions, and cancelations despite practicing significant measures designed to reduce COVID-19 risk. Collegiate sports seasons have been delayed, canceled, or dramatically altered by the pandemic [1][2][3]. Some programs have even been eliminated in light of growing financial challenges [4]. High school sports, amateur races, and recreational sports have been put on hold. A Google Forms survey of 692 elite and semi-elite South African athletes conducted in April found that in response to COVID-19 reductions in sports events, many of the athletes consumed excessive amounts of carbohydrates, felt depressed, and required motivation to keep active. [5]. Thus, additional methods to reduce risk of COVID-19 for athletes would be useful, especially if they might also improve athletic performance.

2. Treating COVID-19 with Vitamin D

The results of the first vitamin D RCT to treat COVID-19 patients were reported in late August 2020 [6]. The mean age of patients was 53 ± 11 years, and 54% of treated patients were males. Fifty were randomized to be treated with calcifediol [25(OH)D] in addition to the standard of care, whereas 26 were treated only with the standard of care. The calcifediol treatment was 0.532 mg on the day of admission and then 0.266 mg on days 3 and 7 and then weekly until discharge or admission to the intensive care unit (ICU). The conversion from calcifediol to cholecalciferol (vitamin D_3) was given as 3.2 times the molecular weight of each; therefore, 0.532 mg of calcifediol is approximately 68,000 IU of vitamin D_3. Calcifediol has an advantage over vitamin D_3 in not having to go through the liver to be processed. However, as reported in the New York study, large doses of vitamin D were effective in treating COVID-19 patients [7]. Whereas only one treated patient had to enter the ICU, 13 of those given only the standard of care treatment had to do so. The univariate risk odds ratio for ICU for patients with calcifediol treatment was 0.02 (95% CI, 0.002 to 0.17).

A second vitamin D RCT to treat COVID-19 patients was reported from India [8]. COVID-19 patients admitted to a tertiary care hospital in north India were invited to the study. The criteria for participation included being mildly symptomatic or asymptomatic with or without comorbidities, that serum 25(OH)D was <20 ng/mL, and that participants were able to take oral vitamin D supplementation (e.g., not requiring invasive ventilation or with significant comorbidities). Forty patients were enrolled: 16 were randomized to receive 60,000 IU/day of vitamin D_3 for 7 days, whereas 24 served as controls. Members of the treatment group who did not achieve a 25(OH)D concentration >50 ng/mL in the 7 days were supplemented with 60,000 IU/day for another 7 days. The mean age was ~50 years (range, 36 to 51 years). Mean 25(OH)D was 9 ng/mL (range, 7 to 13 ng/mL) in the treatment group and 19 ng/mL (range, 8 to 13 ng/mL) in the control group. Serum 25(OH)D increased by 42 ng/mL (range, 39 to 49 ng/mL) in the treatment group and 5 ng/mL (range, 0 to 12 ng/mL) in the control group. Fibrinogen decreased from 4.1 g/L (range, 3.7 to 5.1 g/L) to 3.2 g/L (range, 1.7 to 4.1 g/L) in the treatment group but was essentially unchanged in the control group: 3.7 g/L (range, 3.4 to 4.3 g/L) vs. 3.7 g/L (range, 2.4 to 4.3 g/L) ($p = 0.001$). As a result, 10 (63%) participants in the intervention group and five (22%) participants in the control arm ($p < 0.02$) became SARS-CoV-2 RNA negative.

A recent "quasi-experimental" study of high-dose vitamin D supplementation in a French nursing home shows the benefit of maintaining high 25(OH)D concentrations [9]. Sixty-three of 96 elderly residents developed COVID-19. The residents had been receiving single oral doses of 80,000 IU of vitamin D_3 every 2–3 months. During 36 ± 17 days of follow up, 83% (57) residents who had received vitamin D within 1 month before to 1 week after diagnosis of COVID-19 compared to 44% of the nine who did not. The fully adjusted hazard ratio for survival with respect to vitamin D was 0.11 (95% CI, 0.03 to 0.48; $p = 0.003$). Those authors reported similar results for 77 consecutive COVID-19 patients in a geriatric hospital [10]. Of course, many athletes are larger than nursing home residents and so should take higher daily average vitamin D supplements. As of 9 November 2020, 30 observational studies report that COVID-19 or SARS-CoV-2 positivity was associated with lower serum 25(OH)D concentration [11]. In addition, two small-scale RCTs with vitamin D supplementation have been reported and at least 33 clinical trials have been registered [12].

3. Athletic Performance

For some time, sports teams have been aware of the benefits of vitamin D supplementation to improve athletic performance. A 2009 review by Cannell and colleagues increased the interest of vitamin D among athletes [13]. It reviewed the evidence that many athletes have vitamin D deficiency, that Russian and German investigators showed improved athletic performance though UVB irradiation starting in the 1930s, that athletic performance improves after solar or artificial UVB irradiation, and that vitamin D has been shown to improve athletic performance. Interestingly, after publication of that review, the Chicago Blackhawks ice hockey team was supplemented with 5000 IU/day of vitamin D_3 and improved from near the bottom rank in 2009 to win the Stanley Cup in 2010 [14]. Now many sports teams have their players supplement with vitamin D [15][16]. Table 1 presents selected findings related to those benefits.

Table 1. Benefits of higher vitamin D status for athletes.

Benefit	Population	Intervention	Results	Reference
Muscle strength	163 healthy athletes	Vitamin D_3 supplementation (5000 IU/day) in RCTs, meta-analysis	No significant effect *	[17]
Muscle strength	22 adult male white national-level judoka athletes	Bolus dose of 150,000 IU vitamin D_3	25(OH)D concentration increased from 13 to 17 ng/mL and muscle strength by 13% in 8 days	[18]
Muscle strength and power	25 Polish elite judoists	Observational study, 25(OH)D ranged from 8 to 30 ng/ml	Left hand grip, total work during extension of the right and left lower limb, and muscle power increased by 20–30% ($r = 0.22$ to 0.32)	[19]

Muscle repair	14 recreationally active adults	Intense leg exercise of one leg	Serum 25(OH)D concentrations inversely predicted ($p < 0.05$) muscular weakness (i.e., control leg vs. exercise leg peak isometric force) immediately and days (i.e., 48 and 72 hours)	[20]
Muscle repair	30 reportedly healthy and modestly active adult males (31 ± 5 years, 31 ± 8 ng/mL)	Randomly assigned to 4000 IU/day of vitamin D_3 or placebo for 28 days and then subjected to a one-legged exercise routine	Supplemental vitamin D increased serum 25(OH)D concentrations ($p < 0.05$; ≈70%) and enhanced recovery in peak isometric force after the damaging event ($p < 0.05$; ≈8% at 24 hours). Supplemental vitamin D attenuated ($p < 0.05$) immediate and delayed (48, 72, or 168 hours) increase in circulating biomarkers representative of muscle damage (ALT or AST) without ameliorating muscle soreness ($p > 0.05$)	[21]
Muscle repair	20 males with baseline 25(OH)D = 18 ± 10 ng/ml	Participants performed knee-damaging exercise, supplements with 4000 IU/day of vitamin D_3 or placebo	Supplemental vitamin D_3 increased serum 25(OH)D and improved recovery of peak torque at 48 hours and 7 days postexercise	[22]
Stress fractures	118 NCAA Division I athletes in South Carolina	Vitamin D supplementation in winter	Stress fracture rate dropped from 7.5% to 1.7% ($p = 0.009$)	[23]

Lung function	28 active college-age males, Gdansk, Poland	6000 IU/day of vitamin D_3 for 8 weeks or placebo, January to March; mean 25(OH)D increased from 20 to 60 ng/ml	Significant improvements in maximal aerobic and anaerobic power; VO_{2max} test, maximal lung minute ventilation (VE_{max} $mL \cdot min^{-1}$), maximal breath frequency (BF_{max} $1 \cdot min^{-1}$) improved significantly	[24]
Immune function	225 endurance athletes in winter, UK	Observational study	A significantly higher proportion of subjects presented with symptoms of URTI in the vitamin D-deficient status group (initial plasma 25(OH)D < 12 ng/mL) than in the optimal vitamin D group (>48 ng/mL); total number of URTI symptom days and median symptom-severity score in vitamin D-deficient group was significantly higher	[25]
Heart size	521 male national-level athletes in Qatari; 244 lightly exercising controls	Observational study with respect to serum 25(OH)D concentration	Severely 25(OH)D-deficient athletes (25(OH)D < 10 ng/mL) present significantly smaller cardiac structural parameters than insufficient and sufficient athletes; athletes had larger cardiac parameters than controls	[26]
Traumatic brain injury	Three patients, aged 17, 23, and 31 years	Case series treated with vitamin D, progesterone, omega-3 fatty acids, and glutamine	Reversed coma and improved clinical outcomes	[27]

Stress fractures	600 navy servicewomen diagnosed with stress fracture of the tibia or fibula and 600 controls matched by race, length of service, day of blood draw	Observational study with respect to serum 25(OH)D concentration	OR for stress fracture for high 25(OH)D quintile (mean = 50 ng/mL) vs. low quintile (mean = 14 ng/mL) = 0.51 (95% CI, 0.34 to 0.76, $p < 0.01$)	[28]

25(OH)D, 25-hydroxyvitamin D; 95% CI, 95% confidence interval; ALT, alanine aminotransferase; AST, aspartate aminotransferase; BF_{max}, maximal breath frequency; *r*, regression coefficient; OR, odds ratio; RCT, randomized controlled trial; URTI, upper respiratory tract infection; VE, maximum minute ventilation; VO_{2max}, maximal oxygen uptake. * Trial lasted only 4 weeks and got half the athletes to levels >31 ng—enough for strength to start to increase.

A review of the effects of vitamin D on muscles noted that vitamin D increases the number of type II, or fast-twitch, muscle cells, including type IIA fibers, which are associated with muscular high-power output [29].

A recent study confirmed the benefit of vitamin D supplementation in maintaining optimal serum 25(OH)D concentrations after the summer season. A 12 week intervention study was conducted in which 19 college swimmers in Virginia were given 5000 IU/day of vitamin D_3 or placebo from August to November [30]. Those in the treatment arm increased mean 25(OH)D concentration from 47 to 61 ng/mL, whereas those in the control arm had 25(OH)D decrease from 44 to 33 ng/mL. Fat-free mass increased in the treatment arm but not in the control arm. Those in the treatment arm performed better on dead-lift and vertical-jump tests than participants in the control arm.

Researchers at Virginia Tech sent questionnaires to all NCAA Division I head athletic trainers to learn about 25(OH)D testing, vitamin D supplementation, and vitamin D-related protocols and procedures [16]. Responses were received from 249 trainers (72% response rate). The 139 programs with a full-time registered dietitian or nutritionist were more likely to have a protocol in place ($p < 0.05$). A range of 25(OH)D concentration targets resulted: 20–30 ng/mL, 3%; 30–40 ng/mL, 6%; 40–50 ng/mL, 27%; >50 ng/mL, 13%; unsure, 51%. Programs that participated in the Football Bowl Subdivision were more likely to have 25(OH)D concentrations measured.

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