Prevalence of Vitamin D Insufficiency in Professional Hockey Players

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Background: Vitamin D is a fat-soluble hormone that plays a role in bone health, muscle function, and athletic performance. Studies have shown that low levels of vitamin D can lead to slower muscle recovery and function, increased rates of stress fractures, and even poorer athletic performance. Insufficient vitamin D levels have been demonstrated in professional basketball and football players, however, there have been no studies to date reviewing vitamin D insufficiency in professional hockey players.

Purpose/Hypothesis: The purpose of this study was to perform a cross-sectional review to determine the prevalence of vitamin D deficiency and insufficiency in professional hockey players. The hypothesis was that there would be a high percentage of players with vitamin D insufficiency.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: The preseason serum 25-hydroxy (OH) vitamin D laboratory test results of 105 professional hockey players were retrospectively reviewed. All players on 3 National Hockey League (NHL) teams were included. Player parameters evaluated included age, height, weight, body mass index, and 25(OH) vitamin D level. Players were divided into 4 groups based on serum vitamin D levels: deficient (<20 ng/mL), insufficient (20-31.9 ng/mL), sufficient (≥32 ng/mL), and ideal (≥40 ng/mL). Descriptive statistics were performed, in addition to 2-group and 3-group comparisons.

Results: The average 25(OH) vitamin D level of 105 players was 45.8 ± 13.7 ng/mL (range, 24-108 ng/mL). No players in the study were considered deficient. A total of 14 players (13.3%) were considered insufficient, while 91 players (86.7%) were considered sufficient. However, only 68 players (64.8%) were considered ideal. When comparing groups, athletes with sufficient vitamin D levels were older than athletes with insufficient vitamin D levels (25.9 vs 23.1 years; $P = .018$). All other player parameters demonstrated no significant difference between groups.

Conclusion: Despite playing a winter sport and spending a great deal of time training indoors, professional hockey players have low levels of vitamin D insufficiency.

Keywords: vitamin D; insufficiency; National Hockey League; professional; NHL

Natural sunlight is the major source of vitamin D in humans.[8] The sun emits ultraviolet B (UVB) light (wavelength, 290-315 nm) converting 7-dehydrocholesterol to previtamin D3 in the skin. Once previtamin D3 is isomerized into vitamin D3 (cholecalciferol) and bound by vitamin D binding protein it is transferred to the liver.[9] Once in the liver, the cholecalciferol is hydroxylated to 25-hydroxyvitamin D (25(OH)D3; calcifediol), which is the major circulating metabolite of the body. The 25(OH)D3 is then further metabolized into its active form, 1,25-dihydroxyvitamin D (1,25(OH)D3; calcitriol).[10-12]

The importance of adequate vitamin D levels to an athlete's overall health and performance has become a trending topic of interest. Vitamin D is a fat-soluble hormone that is vital for immune function, inflammatory modulation, bone health, muscle function, and performance.[3] Risk factors for vitamin D deficiency have been identified as living in northern latitudes (>35°N), inadequate sun exposure, consistent use of sunscreen lotion, inadequate dietary intake, and dark skin color.[3]

Despite correlations between adequate vitamin D serum levels and improved athletic performance,[3,4,17] multiple recent studies have demonstrated a high incidence of vitamin D deficiency in elite athletes. These rates of deficiency have ranged from 60% to 83% in athletes such as

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professional soccer players, professional football players, and elite level gymnasts.[5,13,14] Moreover, this deficiency has also been correlated to a risk of bony stress injuries[13] and upper respiratory tract infections.[7] Therefore, improved understanding of risk factors of vitamin D deficiency may provide performance and health benefits to competitive athletes across multiple sports and, in particular, those who train and compete indoors. Athletes at risk for vitamin D deficiency can then be treated with easily administered oral supplementation with limited risks.

The goal of this study was to determine the baseline levels of vitamin D deficiency in professional hockey players. Given their extensive time spent training and competing in indoor facilities, we hypothesized that a majority of athletes will have deficient serum levels of vitamin D.

METHODS

After institutional review board approval was obtained, the preseason laboratory values for serum 25-hydroxy(OH) vitamin D (ng/mL) of the rosters of 3 professional hockey teams (from the West, South, and Northeast geographical regions) in the National Hockey League (NHL) were retrospectively reviewed. Every eligible player had a routine preseason physical examination and laboratory work performed in September 2015. All players on these 3 NHL teams were included. Player age (years), height (inches), weight (pounds), body mass index (BMI, kg/m^2), and race were also tabulated and included in our analysis.

All data were subject to release after approval from the NHL and deidentified to protect the identity and confidentiality of the athletes. Based on previously published data, serum vitamin D levels were defined as deficient (<20 ng/mL), insufficient (20-31.9 ng/mL), and sufficient ($\geq$32 ng/mL).[1,14,16] We included a fourth category, "ideal" ($\geq$40 ng/mL), since there has been evidence in previous studies that athletes with vitamin D levels greater than 40 ng/mL may have a decreased risk of developing stress fractures.[2] Three different laboratories were used to measure the vitamin D levels; however, all 3 laboratories used a form of enzyme linked assays to make the measurement.

Statistical Analysis

All data are described using means, standard deviations, medians, and ranges. Two-group comparisons were performed using Wilcoxon rank-sum tests, while 3-group comparisons were performed using Kruskal-Wallis tests. In the case of pairwise comparisons, a Benjamini-Hochberg adjustment was applied to the *P* value to control the type I error rate. Statistical significance was set at $P < .05$. All analyses were performed using SAS 9.4 software (SAS Institute Inc).

RESULTS

A total of 105 players from 3 different professional hockey teams were included in the study. All data were from September of 2015, which corresponded to before the start of the 2015-2016 NHL season. An overwhelming majority of the athletes were white (n = 101; 96%). The average player age was 25.5 ± 4.4 years (range, 18-39 years). The average player height was 73.4 ± 1.8 inches (range, 69-79 inches). The average player weight was 202 ± 15.4 lbs (range, 170-260 lbs). The average player BMI was 26.5 ± 1.7 kg/m^2 (range, 23.1-30.8 kg/m^2).

The average 25(OH) vitamin D level was 45.8 ± 13.7 ng/mL (range, 24-108 ng/mL) (Table 1, Figure 1). No players in the study were considered vitamin D deficient. A total of 14 players (13.3%) were considered insufficient, while 91 players were considered sufficient. However, only 68 players (64.8%) were considered as having ideal vitamin D levels.

Spearman correlation coefficients were used to determine if there was a correlation between vitamin D levels and player demographics. Table 2 demonstrates that there

TABLE 1
Descriptive Statistics of All Variables in the Dataset for All 105 Observations

Variable	Mean ± SD	Median (Range)
Age, y	25.5 ± 4.4	25 (18-39)
Height, in	73.4 ± 1.8	73 (69-79)
Weight, lb	202.7 ± 15.4	200 (170-260)
Body mass index, kg/m^2	26.5 ± 1.7	26.3 (23.1-30.8)
Vitamin D level, ng/mL	45.8 ± 13.7	43.2 (24.0-108.0)

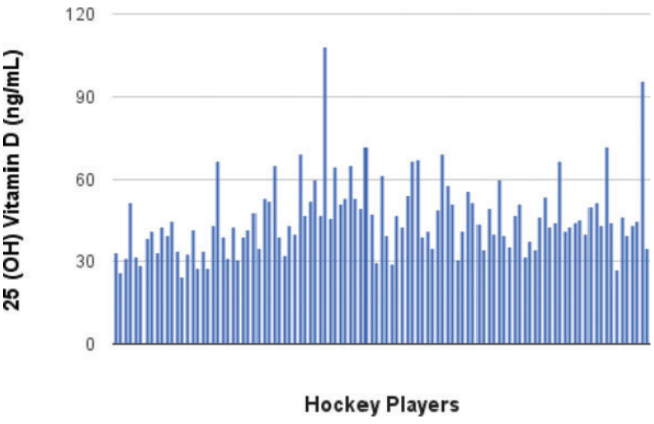

Figure 1. Range of vitamin D levels for the study cohort of professional hockey players.

TABLE 2
Spearman Correlation Coefficients for Each Variable

Variable	Correlation With Vitamin D Level	*P* Value[a]
Age, y	0.181	.064
Height, in	0.106	.281
Weight, lb	0.080	.417
Body mass index, kg/m^2	–0.009	.928

[a]There were no statistically significant correlations.

TABLE 3
Descriptive Statistics of Each Variable by Players With Insufficient and Sufficient Vitamin D Levels

	Insufficient (<32 ng/mL; n = 14)		Sufficient (≥32 ng/mL; n = 91)		
	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)	*P* Value
Age, y	23.1 ± 4.3	21 (18-32)	25.9 ± 4.3	25 (19-39)	.018[a]
Height, in	72.7 ± 1.7	72.5 (70-76)	73.5 ± 1.8	73 (69-79)	.141
Weight, lb	199.2 ± 18.2	200 (170-231)	203.3 ± 15.0	202 (170-260)	.414
Body mass index, kg/m^2	26.5 ± 2.2	26.3 (23.1-29.7)	26.5 ± 1.6	26.3 (23.1-30.8)	.977

[a]Age was statistically significantly higher in the sufficient group than in the insufficient group.

TABLE 4
Descriptive Statistics of Each Variable by Players With Insufficient, Sufficient, and Ideal Vitamin D Levels

	Insufficient (<32 ng/mL; n = 14)		Sufficient (≥32-39.9 ng/mL; n = 23)		Ideal (≥40 ng/mL; n = 68)		
	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)	*P* Value
Age, y	23.1 ± 4.3	21 (18-32)	25.0 ± 4.0	23 (20-32)	26.2 ± 4.4	25 (19-39)	.030[a]
Height, in	72.7 ± 1.7	72.5 (70-76)	73.1 ± 1.9	73 (69-76)	73.6 ± 1.8	73.5 (70-79)	.249
Weight, lb	199.2 ± 18.2	200 (170-231)	201.2 ± 16.6	200 (170-229)	204.0 ± 14.5	205 (180-260)	.577
Body mass index, kg/m^2	26.5 ± 2.2	26.3 (23.1-29.7)	26.5 ± 1.6	26.2 (23.1-30.1)	26.5 ± 1.6	26.4 (23.1-30.8)	.999

[a]Age was statistically significantly different overall between the 3 groups.

TABLE 5
Adjusted *P* Values for Age Compared Between Each Pair of Vitamin D groups

Pair	Adjusted *P* Value
Insufficient vs sufficient	.189
Insufficient vs ideal	.044[a]
Sufficient vs ideal	.213

[a]Patients with ideal vitamin D were significantly older than patients with insufficient vitamin D (26.2 ± 4.4 vs 23.1 ± 4.3 years). The other pairs were not statistically significantly different.

were no statistically significant correlations between vitamin D level and any player parameter. When considering player age, those with vitamin D insufficiency were younger than those who were vitamin D sufficient (23.1 vs 25.9 years; *P* = .018). However, no other player parameter was significantly different between the 2 groups (Table 3). This trend continued when player parameters were compared after dividing the players into 3 groups based on vitamin D levels: insufficient, sufficient, and ideal (Table 4). Age was again the only player parameter that was significantly different between the groups. Finally, we performed an age comparison between each pair of vitamin D groups. Athletes with ideal vitamin D were significantly older than athletes with insufficient vitamin D (26.2 ± 4.4 vs 23.1 ± 4.3 years). The other pairs were not statistically significantly different (Table 5).

DISCUSSION

This is the first study to evaluate vitamin D levels in professional hockey players, noting a low prevalence of deficiency or insufficiency despite the indoor nature of the sport. Villacis et al[16] performed a cohort study of college athletes and demonstrated that black race (odds ratio [OR] = 19.1; *P* < .0001) and dark skin tone (OR = 15.2; *P* < .0001) were the greatest predictors of abnormal vitamin D levels, even greater than season of sport, location of sport, male sex, or other races. When analyzing our cohort compared with other studies evaluating vitamin D deficiency in elite athletes, we determined that a major differentiating factor was race. Maroon et al[14] showed an average vitamin D level of 27.4 ng/mL in 80 National Football League (NFL) players, compared with 45.8 ng/mL in our cohort of 105 NHL players. A major differentiating factor between the 2 cohorts is racial composition. In their cohort, 84% of the athletes were black (compared with 3.8% in this study) and all athletes who were vitamin D deficient were black. More than two-thirds of black athletes had a vitamin D level that was either deficient or insufficient, while 23.1% of white athletes had a vitamin D level that was insufficient, and no white athletes were deficient.[14] In our cohort, 96.2% of the athletes were white, thus subgroup analysis was not feasible. However, 13.3% of the athletes were insufficient and no athlete was deficient, which is similar to the subgroup analysis of the white NFL cohort.

Although there has been limited data on vitamin D deficiency in professional hockey players, Fitzgerald et al[6] established that 37.7% of junior and collegiate hockey players (mean age, 20.1 years) in Minneapolis, Minnesota (latitude, 44.9°N) had insufficient vitamin D levels. Similar to our cohort (96% white athletes), they consisted of 93% white players and had no players with vitamin D deficiency. However, the blood draw of the athletes occurred in May to June, while in our study the blood draws occurred at the end of the summer in September. Seasonal variations in serum vitamin D testing should be considered when reviewing an athlete's level. One study demonstrated that the prevalence of serum vitamin D levels decreased by greater than 50% from August to December ($P < .001$).[15] Thus, it is possible that our results have a smaller percent of insufficient players because our athletes had serum levels obtained after summer months in which sunlight exposure would likely have been maximal.

In this study, vitamin D sufficient players were nearly 3 years older than vitamin D insufficient players. A possible explanation for this would include improved performance, fewer injuries, and increased career longevity in vitamin D sufficient players. In other words, age self-selects for athletes with greater vitamin D levels, as athletes with lower levels may have shorter careers due to a greater number of injuries or poorer performance. This trend has previously been suggested in the literature; for example, in one NFL team, players who did not make the roster had lower vitamin D levels compared with players who did, again suggesting a link between vitamin D deficiency and suboptimal athletic performance.[14] An alternative explanation is that older players have been in the NHL longer, have undergone more medical examinations, and may have been treated with prior supplementation or are simply more aware or vigilant of their metabolic status and its changes over time.

This investigation had several limitations. A cross-sectional study of a single time point might be affected if blood draws were performed at a different time intervals (end of the season, winter months, etc). Athletes' dietary supplementation behaviors were not assessable, nor were the location they spent their summers prior to the blood draw. The study group is predominantly white and not generalizable to other professional sports whose racial composition or age distribution may differ from the current cohort. However, the low prevalence of vitamin D insufficiency in a predominantly white athletic population is consistent with the subgroup analyses of studies of other professional athletic organizations (eg, NFL). Blood draw techniques can be different in other studies and could affect the comparison of serum vitamin D levels across studies. We also set an arbitrary number as ideal (>40 ng/mL) and currently no such number exists in the literature. Finally, vitamin D levels were not correlated to performance or injury data so no such conclusions can be drawn from this investigation.

This is the first study to evaluate the incidence of vitamin D deficiency and insufficiency in professional hockey players in North America. Our study demonstrates that our cohort of professional hockey players has much lower levels of deficiency and insufficiency than elite level athletes in other sports despite predominantly playing an indoor, winter sport. However, one must take into account that 96% of our cohort is white and the blood draws were performed at the end of the summer when athletes are off season and may have a greater degree of direct sunlight than during the winter season. Future studies should evaluate vitamin D prior to and on the completion of the season and compare the levels to injuries and playing time missed.

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