High Prevalence of Vitamin D Insufficiency in Athletes and Dancers

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Objective: Vitamin D insufficiency is prevalent in various populations worldwide but with scarce data on physically active individuals. Vitamin D is important to athletes, affecting bone mass, immunity, and physical performance. This study evaluated the prevalence of vitamin D insufficiency and deficiency among young athletes and dancers.

Design: Cross-sectional study.

Setting: Sport medicine clinic.

Patients: Data on 98 athletes and dancers (age, 14.7 ± 3.0 years; range, 10-30 years; 53% men), who had undergone screening medical evaluations, were extracted from medical records.

Independent Variable: Serum 25(OH)D concentrations.

Main Outcome Measures: Serum 25(OH)D concentrations, age, sex, sport discipline, month of blood test, and serum ferritin. Vitamin D insufficiency was defined as serum 25(OH)D concentration <30 ng/mL.

Results: Mean serum 25(OH)D concentration was 25.3 ± 8.3 ng/mL. Seventy-three percent of participants were vitamin D insufficient. Prevalence of vitamin D insufficiency was higher among dancers (94%), basketball players (94%), and Tae Kwon Do fighters (67%) and among athletes from indoor versus outdoor sports (80% vs 48%; $P = 0.002$). 25(OH)D levels adjusted for age and sex correlated with serum ferritin and season.

Conclusions: In this study, conducted among young athletes and dancers from various disciplines in a sunny country, a high prevalence of vitamin D insufficiency was identified. A higher rate of vitamin D insufficiency was found among participants who practice indoors, during the winter months, and in the presence of iron depletion. Given the importance of vitamin D to athletes for several reasons, we suggest that athletes and dancers be screened for vitamin D insufficiency and treated as needed.

Key Words: cholecalciferol, vitamin D deficiency, sport

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INTRODUCTION

Low levels of serum vitamin D (25(OH)D) are considered a risk factor for many disease states. Low vitamin D levels are related to low bone mineral density, cancer, heart disease, autoimmunity, infections, and a higher risk of death.[1–5] Two additional effects are more specifically important to athletes: (1) the relationships between serum 25(OH)D levels and physical performance, and (2) between low serum 25(OH)D levels and the susceptibility to viral infections. Vitamin D levels were recently shown to correlate positively with muscle power, force, velocity, and jump height in female adolescents.[6] This may explain observations of better physical performance in athletes during the summer months and after vitamin D–producing ultraviolet B irradiation.[7] The second important relationship pertinent to athletes was recently identified in large-scale observational studies: low vitamin D levels are related to a higher risk of upper respiratory tract infections.[3] Such infections in athletes are highly prevalent[8] and might hinder performance. Therefore, beyond the well-known importance of vitamin D for bone health and that of additional organ systems, 2 important areas of concern to a young athlete would be its relationship with the preservation of muscle strength and performance and its effects in maintaining proper immune function. Therefore, maintaining proper vitamin D levels could be important to an athlete seeking maximal athletic ability year-round.

During the passing decades, an increasingly high prevalence of vitamin D insufficiency has evolved in both young and older populations.[1,3,9–13] Recent studies from the United States found vitamin D insufficiency in 61% of children and adolescents,[13] and in 77% of adults.[3] This high prevalence of vitamin D deficiency/insufficiency, with its possible adverse consequences listed above, could be highly relevant to athletes.[14] Yet very few studies examined the current prevalence of 25(OH)D deficiency in active populations, and there is scarce data on vitamin D intake and sun exposure in athletes. A study on 18 elite artistic gymnasts from Australia raised awareness to a possible high prevalence of vitamin D insufficiency among these highly active adolescent

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girls.[15] Additional studies from other athletic populations are clearly needed, mainly because of the probable effects of vitamin D on athletic function and health.

The aim of this study was therefore to determine the prevalence of vitamin D insufficiency among young Israeli dancers and athletes from various disciplines, identify groups with increased risk, and assess the role of sun exposure in vitamin D status.

METHODS

The study population included 98 trained athletes and dancers who had undergone a routine medical evaluation in a large sport medicine clinic in Israel. The routine medical screening in this clinic includes personal history; a complete physical examination; blood tests that include a complete blood count, serum chemistry, iron stores (ferritin), vitamin B12, and vitamin D (25(OH)D); and additional tests as needed on an individual basis. All particpants were healthy. Athletes from our clinic who were using vitamin D-containing supplements were a priori not included in the study (n = 2).

Data on 25(OH)D levels and month of blood test drawing were extracted from medical records. The month of blood testing was used to assess whether blood was drawn in winter or summer months as an indication for sun exposure. We defined the winter months in Israel as November to April and summer months as May to October. Vitamin D insufficiency was defined as a 25(OH)D serum level below 30 ng/mL.[16,17] Vitamin D deficiency was defined as below 15 ng/mL for adolescents[13,18] and 20 mg/dL for adults.[17] Serum 25(OH)D was measured by radioimmunoassay (DiaSorin, Stillwater, Minnesota; intra-assay coefficient of variation at this range, 10.5%-11.7%; inter-assay coefficient of variation, 8.2%-9.4%).

To characterize the athletes with low vitamin D status, the study group was divided into 4 subgroups by serum 25(OH)D levels: below 15, 15 to 19.9, 20 to 29.9, and ≥30 ng/mL. Clinical and laboratory parameters were compared among these 4 groups.

Sport disciplines were divided to indoor or outdoor sports, as a measure indicating sun exposure. Indoor sports were dancing, basketball, swimming, Tae Kwon Do, judo, gymnastics, and table tennis. Outdoor sports were tennis, soccer, running, triathlon, and sailing.

Iron status was used as a surrogate marker for sport nutrition quality, and iron depletion was defined as serum ferritin below 20 ng/mL.[19] Serum ferritin was measured by an electrochemiluminescence immunoassay (Roche Elecsys 2010; Roche Diagnostics GmbH, Mannheim, Germany). The study was approved by the Institutional Review Board of Hadassah Medical Center.

Statistical Analysis

Continuous variables were compared by analysis of variance. Categorical variables were compared by the χ^2 test. Differences in mean 25(OH)D level between months was compared using analysis of variance and Tukey post hoc test. Using multivariable linear regression models, with the measured plasma 25(OH)D level as the dependent variable, we examined the examined ferritin level, age (continuous), sex, and season of blood draw. A 2-tailed *P* value of less than 0.05 was considered statistically significant for all calculations.

RESULTS

Study participants' mean age was 14.7 ± 3.0 years, ranging from 10 to 30 years. Fifty-three percent were men (52 men and 46 women). Athletes came from a wide array of sport and exercise disciplines: dancing (n = 35), basketball (n = 16), swimming (n = 12), Tae Kwon Do (n = 9), tennis (n = 9), soccer (n = 8), running/triathlon (n = 3), judo (n = 2), gymnasts (n = 2), table tennis (n = 1), and sailing (n = 1). Blood samples were obtained throughout the year, and 49 (50%) were obtained during the summer months. Mean serum 25(OH)D concentration was 25.3 ± 8.3 ng/mL, ranging from 4 to 53 ng/mL. Levels were higher among men compared with women (27.2 ± 9.6 vs 23.3 ± 6.0 ng/mL; *P* = 0.02). When adjusted for age, sex, and ferritin levels, mean serum 25(OH)D concentration was highest during the months of May to October, as compared with the period of November to April (*P* = 0.02).

Examining the proportions of athletes in each vitamin D group, only 27% were vitamin D sufficient. Vitamin D level was between 20 and 29.9 ng/mL in 48% of participants and between 15 and 19.9 ng/mL in 19% of participants. Vitamin D deficiency was found among 33% of adults and 6% of the children and adolescents.

Table 1 presents the age, sex distribution, season of blood drawing, and ferritin levels in the 4 vitamin D groups.

TABLE 1. Clinical Data and Iron Status in Athletes Across Serum 25(OH)D Groups

	Vitamin D Group				
	<15 ng/mL	15-19.9 ng/mL	20-29.9 ng/mL	≥30 ng/mL	*P*
n	6	19	47	26	
Males, n (%)	3 (50)	8 (42)	24 (51)	17 (65)	0.47
Age, y	15.9 ± 7.1	14.6 ± 2.7	14.6 ± 2.8	14.6 ± 2.3	0.785
Sample taken in winter, n (%)*	5 (83)	15 (79)	26 (55)	7 (27)	0.002
Ferritin, ng/mL	16.5 ± 3.7	21.4 ± 10.9	25.4 ± 17.5	35.1 ± 19.0	0.014
Iron depletion, n (%)	5 (83)	10 (53)	18 (42)	4 (16)	0.006

Values are n (%) or mean ± SD as appropriate.
*November to April.

The proportion of summer sampling was higher across rising serum 25(OH)D levels (P = 0.004). Mean ferritin level was 26.6 ± 17.1 ng/mL, and 37 participants (38%) had iron depletion. The proportion of iron depletion was lower in the groups with higher serum 25(OH)D levels (P = 0.014). Factors significantly associated with serum 25(OH)D level from a multiple linear regression model, adjusted for age and sex, were serum ferritin (β = 0.127; P = 0.018) and blood drawn in winter months (β = −12.40, P = 0.022). The model R^2 was 30%. No statistically significant interactions were observed among the variables.

Vitamin D insufficiency was identified in 10 of 21 athletes (48%) engaged in outdoor sports compared with 62 of 77 athletes (80%) training in indoor sports (P = 0.02). In several sport disciplines, there were a large enough number of participants (≥9) to address the rates of vitamin D insufficiency. Serum 25(OH)D was below 30 ng/mL in 33 dancers [94%; 95% confidence interval (CI), 81%-99%], 15 basketball players (94%; 95% CI, 70%-100%), 6 Tae Kwon Do fighters (67%; 95% CI, 30%-92%), 4 tennis players (44%; 95% CI, 14%-79%), and 4 swimmers (33%; 95% CI, 10%-65%).

DISCUSSION

This study, conducted among young athletes and dancers from various disciplines, demonstrated a high prevalence of 73% of vitamin D insufficiency. Athletes from indoor-type sports had nearly twice the rate of vitamin D insufficiency compared with those from outdoor sports, who could be more exposed to the sun. Obtaining blood samples during winter months was also related to lower vitamin D levels, reinforcing the well-known effect of sun exposure in vitamin D status.[7,17]

The rate of vitamin D insufficiency found among the athletes in our study is in concert with the high prevalence found in the general population of similar countries, like the United States.[3,13] In a recent study performed among 203 children and adolescents from the same city of our study (Jerusalem, Israel), 88% of children were found to have serum levels of 25(OH)D below 30 ng/mL.[20] The seasonal variation found in serum 25(OH)D levels is well known[7] and was also previously demonstrated in a study from Israel.[21] Although sun exposure is the major source for active vitamin D in the body,[17] low dietary intake is also an established risk factor for vitamin D insufficiency and deficiency. Even with a seemingly adequate sun exposure, vitamin D deficiency can be found,[10,21] suggesting that a concomitant proper dietary intake is needed. Because vitamin D deficiency is successfully treated in clinical practice by oral supplementation alone, even with no sun exposure, it seems that pharmacological amounts of vitamin D can ensure its sufficiency. Yet with a normal and seemingly adequate dietary intake of vitamin D, sun exposure is still needed.[22]

Low vitamin D levels are related to numerous adverse health conditions in the general population, such as low bone mineral density, cancer, heart disease, autoimmune diseases, and respiratory infections, alongside a higher risk of death.[1–5] Most of these relationships were identified in both large observational studies and randomized supplementation trials. However, competitive athletes are a special population who differs markedly from the relatively sedentary general population in many aspects. To properly examine the anticipated role of vitamin D and health outcomes in athletes,[7,14] supplementation studies should be performed.

Another important finding of our study was the high rate of iron depletion among these young active individuals and the relationship between low ferritin and low 25(OH)D levels. This has 2 implications. First, we used ferritin levels as a surrogate marker for diet quality because iron is an extremely important factor in sports nutrition.[23] The higher prevalence of a low ferritin level among athletes with lower 25(OH)D levels suggests a suboptimal dietary support of these athletes in general, even though these nutrients are derived from different sources. Second, the well-known high prevalence of iron depletion among athletes,[23–26] with its negative effects on physical performance,[23,27] makes it an important cofactor together with vitamin D insufficiency in reducing athletic performance. The higher rate of iron depletion found among athletes with lower vitamin D levels and the high prevalence of these 2 insidious conditions make the periodic screening for deficiencies of iron and vitamin D very important to an active athlete.

Taken together, it is now evident that both sun and diet are important sources of vitamin D in the general population. The correlation of both ferritin levels and season/location of training with vitamin D levels in our study suggests that both inadequate sun exposure and low dietary vitamin D intake in these athletes and dancers could explain our findings.

Our study has several limitations. First, this was a chart review of medical records, so precise measurements of sun exposure or diet content were absent. We used surrogate markers of the 2 measurements, namely, winter and indoor training as markers of low sun exposure, and low ferritin levels as a marker of a proper sports nutrition. Our conclusions should therefore be confirmed in prospective studies in which data on food intake and sun exposure will be meticulously recorded. Second, our study population was young and came from several specific sport disciplines. Larger studies from additional countries and other sports types could reinforce our findings and identify additional athletic populations at risk for vitamin D insufficiency.

In this study, conducted among young athletes and dancers from various disciplines in a sunny country, an overall high prevalence of vitamin D insufficiency was identified, especially in athletes from indoor-type sports, during the winter months, and in those with low iron stores. In addition to the known deleterious effects of low vitamin D levels in many health aspects, competitive athletes might also be affected by lower physical functioning and a higher risk for infections that could hinder their performance. We therefore recommend that athletes and dancers be screened for vitamin D insufficiency, especially if engaged in indoor training or during the winter months and supplemented as needed.

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