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Can vitamin D supplementation influence the physical components and performance of athletes with deficiency? A systematic review

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Vijay Selvan[1,2], Arunachalam Ramachandran[1], Althaaf Mohamed[3], Mohammad Sidiq[1]

[1] Department of Physiotherapy, Madhav University, Abu Road, Pindwara, Sirohi, Rajasthan, India
[2] Department of Physiotherapy, KMCT College of Allied Health Sciences, Manassery, Kozhikode, Kerala, India
[3] ABC Orthopedics, Manjeri, Kerala, India

Abstract

Introduction. Vitamin D deficiency, which is on the rise, can put any athlete at an increased susceptibility to various musculoskeletal injuries and prolonged recovery. It was intended to determine whether vitamin D supplements can help athletes to enhance their performance and body composition, and to determine which physical components of the athlete correlates with vitamin D inadequacy and vitamin D supplementation.

Methods. Study eligibility criteria – randomized controlled trials (RCT) and quasi-experimental studies that examined the effect of vitamin D supplementation in athletes performed during 2015–2019. The participants were athletes aged 20–40, including both sexes. Study appraisal – Pedro score.

Results. A total number of 43 studies were analysed, out of which 10 studies were selected for the final review (8 were double-blinded RCT and 2 were non-blinded RCT) reports. All the trials used 25-hydroxy vitamin D (25(OH)D) as the primary outcome measure to analyse the vitamin D levels. Studies were performed on subjects belonging to a variety of sports like football, rowing, winter sports, taekwondo, rugby and swimming. Except for one study, all the other studies reported that there was a significant improvement in the vitamin D levels after supplementation irrespective of the mode of administration. Higher doses of vitamin D3 had resulted in better improvement over a short period.

Conclusions. This systematic review analysis concludes that vitamin D inadequacy, which results in many physical derangements and compromised performance levels of athletes, can be restored by supplementing with vitamin D.

Key words: vitamin D, 25-hydroxy vitamin D, athletes, vitamin D deficiency, vitamin D insufficiency, athletic performance

Introduction

Vitamin D deficiency is already a global problem, one which is not only present in aged and sedentary people but also among young, active, and healthy people like athletes. Vitamin D deficiency can put them at an increased risk of musculoskeletal injury and prolonged recovery [1]. Recurrent injuries and prolonged rehabilitation can hamper the sporting career of most of athletes by not only keeping them away from sports but also by reducing their strength, agility and skill levels. Vitamin D is essential for the performance of the musculoskeletal system, particularly in the athletic population. 25-hydroxy vitamin D (25(OH)D) in an insufficient amount is a mandatory factor for the prevention of musculoskeletal injury and satisfactory recovery [2, 3]. In a clinical setup, "serum 25(OH) D" is measured to assess the vitamin D status because it reflects both vitamin D intake from ultraviolet (UV) B radiation exposure and dietary sources [4].

It is assumed that athletes are no exceptions to vitamin D deficiency. The statistical figures of athletes with vitamin D deficiency are so surprising that they do not show much difference when compared to the general public. Several studies in the past have discussed the relationship between vitamin D status and musculoskeletal health in athletes. A recent study from New York City Hospital examined the vitamin D levels among 89 players of a National Football League team. They found that 30% of the football players were deficient and 51% had insufficient levels of vitamin D. Other studies examined those players with muscle injuries and found that there was a significantly lower level of vitamin D compared to the uninjured players. A study conducted in Australia on 18 elite gymnasts reported that 15 had insufficient levels of vitamin D, out of which 6 of those athletes were in the deficient category [5, 6].

A systematic review examined the relationship between vitamin D values, bone strength and injuries among healthy adults. The review reported four studies on athlete and military populations, and it was concluded that there were very few randomized controlled clinical trials that examined the relationship between the two factors when compared to the popularity of vitamin D testing. It was made clear that future trials were necessary to gain insight into the scenario and to clarify what effect vitamin D has on the musculoskeletal system of healthy adults [7]. There were no published systematic reviews or meta-analysis published until 2013, when a satisfactory review was given of the available literature that explained the current scenario of vitamin D among athletes [8]. There was a recent narrative that related vitamin D deficiency to skeletal muscle function and performance levels of athletes, which underlined the need for more systematic reviews in analysing the role of calcitriol in enhancing athletic performance [9].

This study aims to determine whether vitamin D supplements do help athletes in enhancing their performance and body composition.

Secondly, this study attempts to determine which physical component of the athlete correlated with vitamin D inadequacy and vitamin D supplementation.

Correspondence address: Vijay Selvan, Department of Physiotherapy, Madhav University, Madhav Hills Opp. Banas River Bridge Toll N.H.-27, P.O. Bharja, Abu Road, Pindwara, Rajasthan 307026, India, e-mail: vijnat@yahoo.com; https://orcid.org/0000-0002-8934-519X

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Subjects and methods

Design

This is a systematic review done on the articles published from January 2015 to November 2019, with a predefined protocol.

Study eligibility

This systematic review included randomized controlled trials and quasi-experimental studies [10–12] on studies that examined the effect of vitamin D supplementation in athletes. We considered studies that were performed on athletes aged 20–40 years, including both sexes. We did not restrict the study only to athletics but also included other sports, i.e. football, basketball and so on. We also included conference proceedings and abstracts that met the essential criteria. We included studies that were published between January 2015 and November 2019 in the English language. We excluded studies conducted with less than 20 subjects. We also excluded case reports, review articles, qualitative studies, and non-human studies.

Search strategy

A systematic search was performed with reference manager software on the following database for articles published from January 2015 to August 2019: "MEDLINE (Ovid and PubMed), SPORTDiscus, and CINAHL". The search was performed utilising the following key words "Vitamin D" AND "Athletes", "25-hydroxyvitamin" D AND "Athletes", "Vitamin D deficiency" AND "Athletes", "Vitamin D insufficiency" AND "Athletes", "Vitamin D inadequacy" AND "Athletes", "Vitamin D status" AND "Athletes", "Vitamin D" AND "sports", "25-hydroxyVitamin D" AND "sports", "Vitamin D deficiency" AND "sports", "Vitamin D insufficiency" AND "sports", "Vitamin D inadequacy" AND "sports" and "Vitamin D status" AND "sports". Articles from different searches were merged and duplicate articles were removed. A search of the reference from the selected articles was performed to identify relevant articles.

Study selection

To minimize the bias, an independent duplicate assessment technique was used for the selection of the study and quality analysis. Two reviewers independently applied the eligibility criteria to the titles and abstracts of the selected articles, and then to the full-text of the articles that passed the title and abstract review. Kappa statistics were used to assess the level of agreement between the reviewers. A third reviewer was used to solve the discrepancies and disagreements between the two primary reviewers and a consensus was reached between all three reviewers. Setting: inpatient or outpatient; supervised or self-lead; home-based or hospital-based. The calculation of the percent agreement using Kappa Statistics is displayed in Table 1.

Table 1. Calculation of percent agreement using Kappa statistics

Articles included in the study	Raters		Difference
	A	B	
Alimoradi et al. 2019 [13]	1	1	0
Skalska et al. 2019 [14]	1	0	1
Mielgo-Ayuso et al. 2018 [15]	1	1	0
Carswell et al. 2018 [16]	0	1	–1
Jung et al. 2018 [17]	1	1	0
Jung et al. 2018 [18]	0	0	0
Fairbairn et al. 2018 [19]	1	1	0
Todd et al. 2017 [20]	1	1	0
Jastrzębska et al. 2016 [21]	0	0	0
Dubnov-Raz et al. 2015 [22]	1	1	0
Number of zeros			8
Number of items			9
Percent agreement			80

A – 1st reviewer, B – 2nd reviewer

Quality assessment

Both the reviewers found the quality independently without the influence of the other. Each study quality was analysed using the Pedro score to know whether it was complete and also to know if there were any chances of bias. Table 2 displays the Pedro score for each selected study.

Table 2. Risk of Bias assessment using PEDro Scores for the included studies

Author	1	2	3	4	5	6	7	8	9	10	11	QS (2–11)	IVS (2–9)	Methodological quality
Alimoradi et al. 2019 [13]	1	1	1	1	1	1	1	0	1	1	0	8	7	Good
Skalska et al. 2019 [14]	1	1	1	0	0	0	1	1	1	1	1	7	5	Good
Mielgo-Ayuso et al. 2018 [15]	1	0	0	1	1	1	1	0	0	1	1	6	4	Good
Carswell et al. 2018 [16]	1	1	1	1	1	1	1	0	1	1	1	9	7	Excellent
Jung et al. 2018 [17]	1	1	1	1	1	1	1	0	1	1	0	8	7	Good
Jung et al. 2018 [18]	1	1	1	1	1	1	1	0	1	0	0	7	7	Good
Fairbairn et al. 2018 [19]	1	1	1	1	1	1	1	1	1	1	0	9	8	Good
Todd et al. 2017 [20]	1	1	1	1	1	1	1	1	0	1	0	8	7	Good
Jastrzębska et al. 2016 [21]	1	1	1	1	1	0	1	0	1	1	0	7	6	Good
Dubnov-Raz et al. 2015 [22]	1	1	1	1	1	1	1	0	1	1	1	9	7	Excellent

Studies scoring 9–10 on the PEDro scale were considered methodologically to be of 'excellent' quality. Scores ranging from 6 to 8 were considered to be of 'good' quality, while studies scoring 4 or 5 were of 'fair' quality and studies scoring below 4 were felt to be of 'poor' quality [11, 12]

QS – quality score, IVS – internal validity score

Data abstraction

The two reviewers independently extracted data to minimize the errors in data entry handling a separate form for data collection. The reviewers collected the "study design", country where the study was conducted, geographical characteristic (as an indicator of sunlight exposure), and demographic data. We contacted the first author via e-mail whenever more information was required about the study.

Definition of vitamin D inadequacy

The units of "serum 25(OH)D" measures were pronounced in either nmol/L or ng/mL. Few of the studies did not mention the mean or median for "serum 25(OH) D" but most of the studies classified the vitamin D status as sufficient, insufficient, and deficient. The term "Vitamin D inadequacy" was coined to record 'deficiency' and 'insufficiency', and called it for consistency because the articles frequently used more diverse cut-off values for vitamin D Deficiency, whereas for insufficiency more consistent cut-off values were preferred, as detailed in Table 3.

Ethical clearance

The study is a part of doctoral thesis of the first author. The ethical clearance was provided by the institutional ethical committee (IEC/PHY/3/2018) and study review board of Madhav University, Sirohi, Rajasthan, India.

Results

Selection of studies

There was a good volume of studies conducted in relation to the vitamin D inadequacy with athletic performance and physiology in the past decade. This was most probably due to the increased prevalence of vitamin D inadequacy in the last decade. There are only limited studies published in the last decade with double-blinded RCT finding the effect of vitamin D supplements in the athletic population. A total number of 43 studies were analysed, among which 10 studies eligible for the final review were selected. Out of the 10 studies, 8 were double-blinded randomized controlled trials and 2 were non-blinded randomized controlled trials. Table 4 summarises studies which passed the selection criteria. Figure 1 illustrates the flow chart of the procedure followed.

Table 3. Summary of vitamin D recommendations

	Endocrine society	Institute of medicine	Vitamin D council
Adequate	30–100 ng/mL	20–60 ng/mL	40–150 ng/mL
Insufficient	21–29 ng/mL	13–20 ng/mL	31–39 ng/mL
Deficient <	20 ng/mL	< 12 ng/mL	< 30 ng/mL
Toxicity	> 10,000 IU	> 50 ng/mL > 4,000 IU	> 150 ng/mL
Daily recommendation	1,500 IU	600 IU	5,000 IU
Treatment	50,000 IU weekly for 8 weeks		

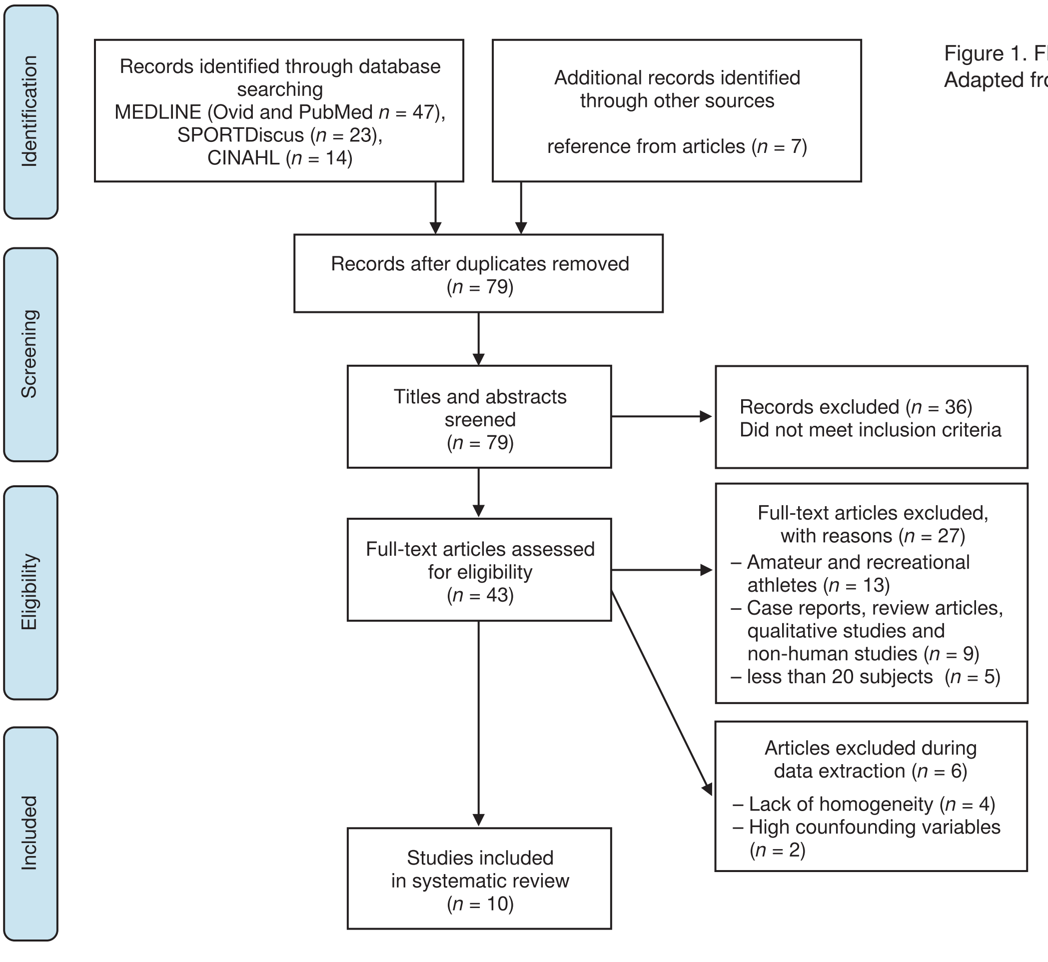

Figure 1. Flowchart of the procedure
Adapted from Moher et al. [23]

Table 4. Summary of Articles included in the study with their Pedro Scores (PS)

Author	Methods	Conclusion	Type	PS
Alimoradi et al. 2019 [13]	The study was a randomized controlled clinical trial. Seventy subjects were enrolled in the study. The athletes were randomly divided into two groups: vitamin D supplement (received 50,000 IU of vitamin D supplement weekly) and control (received a placebo dose weekly). Duration of the study was 8 weeks. Anthropometric, dietary, athletic performance, and biochemical evaluations were performed for all subjects at the beginning and at the end of the intervention period.	Weekly supplementation with 50,000 IU vitamin D resulted in nearly 17 ng/mL increment in circulating calcidiol. This increase was associated with significant improvement of power leg press and sprint tests in the vitamin D supplemented group.	Double-blind, randomized controlled trial	8
Skalska et al. 2019 [14]	The subjects were divided into two groups: the experimental one, which was supplemented with vitamin D (SG, *n* = 20), and the placebo group (*n* = 16), which was not supplemented with vitamin D. All the players were subjected to the same soccer training, described as High-Intensity Interval Training. The data of the vitamin D status, time motion parameters and heart rate were collected just before and after the intervention.	There were no statistically significant differences between the placebo and the supplemented groups; the effect size of the conducted experiment was trivial.	Randomized, double-blinded, and placebo-controlled	7
Mielgo-Ayuso et al. 2018 [15]	Thirty-six elite male rowers (27 ± 6 years) were assigned to one of the two groups randomly: (1) control group (*n* = 18, height: 181.05 ± 3.39 cm and body mass: 77.02 ± 7.55 kg), (2) group treated with daily dosage of 3,000 IU of vitamin D_3 (*n* = 18, height: 179.70 ± 9.07 cm and body mass: 76.19 ± 10.07 kg). The rowers were subjected to blood tests at the beginning of the study and after eight weeks of treatment, for the analysis of hematological and hormonal values. Repeated-measures ANOVA with group factor of group control and group vitamin D_3 (GC and GVD3) were used to examine if the interaction of the different values was the same or different between the groups throughout the study (time × group) after vitamin D_3 treatment. To analyze if 25(OH)D was a good predictor of testosterone, cortisol, and testosterone/cortisol ratio, the study used a stepwise regression model.	Oral daily supplementation with 3000 IU of vitamin D_3 during eight weeks was sufficient to prevent a decline in hematological levels of hemoglobin and hematocrit, and improve transferrin of 25(OH)D levels. However, although it was not sufficient to enhance muscle recovery observed by testosterone and cortisol responses, it was observed that serum 25(OH)D levels could be a predictor of anabolic and catabolic hormones	Double-blind, placebo-controlled design	6
Carswell et al. 2018 [16]	In study 1, we determined 25(OH)D relationship with exercise performance in 967 military recruits. In study 2, 137 men received either placebo, simulated sunlight (1.3 × standard erythemal dose in T-shirt and shorts, three times per week for 4 weeks and then once per week for 8 weeks) or oral vitamin D_3 (1000 IU daily dosage for 4 weeks and then 400 IU daily dosage for 8 weeks). We measured serum 25(OH)D by high-pressure liquid chromatography tandem mass spectrometry and endurance, strength and power by 1.5-mile run, maximum dynamic lift and vertical jump, respectively.	Vitamin D status was associated with endurance performance but not the strength or power in a prospective cohort study. Achieving vitamin D sufficiency via safe, simulated summer sunlight, or oral vitamin D_3 supplementation did not improve exercise performance in a randomized-controlled trial.	Double-blind, randomized, placebo-controlled trial	9
Jung et al. 2018 [17]	Thirty-five collegiate male and female taekwondo athletes, aged 19–22 years with low serum 25(OH)D concentration (28.8 ± 1.10 nmol/L), were randomly assigned to a vitamin D group (*n* = 20) or a placebo group (*n* = 15). Subjects received either a vitamin D_3 capsule (5,000 IU daily dosage) or a placebo during 4 weeks of winter training. Blood samples were collected for analyzing serum 25(OH)D concentration. Physical performance tests included a Wingate anaerobic test, isokinetic muscle strength and endurance, a countermovement jump test, sit-ups, agility test, and 20-m pacer.	This study suggests that 4 weeks of vitamin D supplementation elevates serum 25(OH)D concentration to sufficient levels. Correcting vitamin D insufficiency improves some but not all aspects of performance. Thus, efficacy of vitamin D supplementation to enhance performance remains unclear.	Double-blind, randomized, and placebo-controlled design	8
Jung et al. 2018 [18]	Twenty-five male taekwondo athletes, aged 19–22 years with vitamin D insufficiency [serum 25-hydroxyvitamin-D concentrations (25(OH)D, 31.3 ± 1.39 nmol/L)], participated in this study. They were randomized to receive 5000 IU daily dosage of vitamin D_3 (*n* = 13) or placebo capsule (*n* = 12) during 4 weeks of winter training. Blood samples were collected two times (pre- and post-tests) for analyzing serum 25(OH)D concentration while salivary samples were obtained three times (pre-, mid-, and post-tests) for secretory immunoglobulin A (SIgA) and lactoferrin analyses. The symptoms of URTI were reported daily during the intervention.	Vitamin D_3 supplementation may be effective in reducing the symptoms of URTI during winter training in vitamin D-insufficient taekwondo athletes.	Randomized, double-blinded, and placebo-controlled	7

Fairbairn et al. 2018 [19]	Serum 25(OH)D concentrations and physical performance were measured at baseline, weeks 5–6, and weeks 11–12. Mean (*SD*) serum 25(OH)D concentrations for all participants at baseline was 94 (18) nmol/L, with all players above 50 nmol/L. Vitamin D supplementation significantly increased serum 25(OH)D concentrations compared to placebo, with a 32 nmol/L difference between groups at 11–12 weeks (95% CI, 26–38; $p < 0.001$). Performance in five of the six tests at study completion, including the primary outcome variable of 30-m sprint time, did not differ between the vitamin D supplemented and placebo groups ($p > 0.05$).	Despite significantly improving vitamin D status in these professional rugby union players, vitamin D supplementation had little impact on physical performance outcomes. Thus, it is unlikely that vitamin D supplementation is an ergogenic aid in this group of athletes.	Prospective parallel group, double-blind, randomized, placebo-controlled intervention study	9
Todd et al. 2017 [20]	This randomized placebo-controlled trial in healthy male and female Gaelic footballers (n = 42) investigated the effect of vitamin D_3 supplementation [3000 IU (75 μg) daily for 12 weeks, via an oral spray solution] on VO_2max which was the primary outcome measure. Secondary outcomes included skeletal muscle and lung function.	Twelve-week daily supplementation with 3000 IU (75 μg) vitamin D_3 successfully resolved deficiency but did not have any significant effect on VO_2max, skeletal muscle or lung function.	12-week parallel group, double-blind, randomized, placebo-controlled trial	8
Jastrzębska et al. 2016 [21]	The subjects were divided into 2 groups: the placebo group and the experimental group (supplemented with vitamin D, 5,000 IU daily dosage). Both groups were subjected to High Intensity Interval Training Program. The selection to the groups was based on peak power results attained before the experiment and position on the field. Blood samples for vitamin D level were taken from the players. In addition, total work, 5, 10, 20, and 30 m running speed, squat jump, and countermovement jump height were determined.	An 8-week vitamin D supplementation in highly trained football players was not beneficial in terms of response to High Intensity Interval Training. Given the current level of evidence, the recommendation to use vitamin D supplements in all athletes to improve performance or training gains would be premature. To avoid a seasonal decrease in 25(OH)D level or to obtain optimal vitamin D levels, the combination of higher dietary intake and vitamin D supplementation may be necessary.	Double-blind, placebo-controlled study	7
Dubnov-Raz et al. 2015 [22]	Fifty-five competitive adolescent swimmers with vitamin D insufficiency were randomized to receive vitamin D_3 (2,000 IU daily dosage) or placebo for 12 winter weeks. A upper respiratory infection (URI) symptom questionnaire was completed weekly. Serum 25(OH)D concentrations were measured by radio-immuno-assay before and after supplementation. We used linear regression to examine the relation between the change in 25(OH)D concentrations during the trial, and the duration and severity of URIs.	Vitamin D_3 supplementation in adolescent swimmers with vitamin D insufficiency did not reduce the URI burden. However, larger decreases in serum 25(OH)D concentrations were associated with significantly longer and more severe URI episodes.	Randomized, placebo-controlled, double-blind intervention study	9

Table 5. Number and percentage of the studies meeting each PEDro criteria

Criteria	Number meeting criterion	Percentage meeting PEDro criteria
Eligibility criteria specified (yes/no)	10	100
Subjects randomly allocated to groups (yes/no)	9	90
Allocation was concealed (yes/no)	9	90
Groups similar at baseline (yes/no)	9	90
Subjects were blinded to group allocation	9	90
Therapists who administered therapy were blinded (yes/no)	8	80
Assessors were blinded (yes/no)	10	100
Minimum 85% follow-up (yes/no)	3	30
Intent to treat analysis for at least 1 key variable (yes/no)	8	80
Results of statistical analysis between groups reported (yes/no)	9	90
Point measurements and variability reported (yes/no)	4	40

Methodological quality

Individual papers were reviewed for methodological quality and were displayed by IVS as shown in Table 2. Out of the 10 studies, 8 of them were double-blinded randomized controlled trials. Randomization was not done in 1 study and blinding was not done in 1 study. 3 studies did not prefer the placebo group apart from the control and experimental group. The number and percentage of the studies meeting each PEDro criteria is detailed in Table 5.

Study characteristics

All the studies were conducted on elite athletes. Studies were performed on subjects belonging to a variety of sports including football, rowing, winter sports, taekwondo, rugby and swimming. All the studies used vitamin D supplements either through predominantly oral supplements or in the form of a spray. Most of the study used control, placebo and experimental groups. The studies were performed with a minimum of 20 subjects to a maximum of 137 subjects (mean number of subjects per trial 50.27).

Outcome measures

All the trials used "25(OH)D" as the primary outcome measure to analyse the vitamin D levels. Apart from the direct measure of vitamin D, other physical components and performances were also assessed. A few studies tried to determine whether vitamin D inadequacy resulted in poor physical performance and a few examined the influence of vitamin D supplements on the physical components.

Discussion

This systematic review was performed by two reviewers. Despite the fact that there was a third reviewer available, they did not play a role as there was no difference in agreement between the primary reviewers. This review was performed to find out whether vitamin D supplements were effective in managing vitamin inadequacy among elite athletes. The review was also aimed at determining whether components like muscle power, strength and endurance had any direct correlation with vitamin D deficiency and to determine whether there was a change in these components when vitamin D was supplemented. This systematic review selected experimental designs and quasi-experimental studies [13–22] which were performed in the last 5 years using at least 20 sample sizes, performed on a human, and published in the English language. We did not consider studies published before the last 5 years because the evidence for vitamin D supplementation continues to change rapidly. Five of the studies included in the systematic review used only male subjects whereas the remaining used both male and female subjects. We did not restrict the study criteria to a specific season or geographical location.

None of the studies reported any drawbacks or side effects following administration of the supplement. A variety of supplementation routines were used by the study selected for the review, these ranged from daily supplements to weekly supplements to bi-weekly supplements. Two different methods of administration of the supplements were also used, such as oral capsule and oral spray [20] supplementation. The minimum daily dosage that was used was 400 IU [16] and the maximum was 5000 IU [17]. Athletes were provided with supplements for a minimum of 6 up to a maximum of 12 weeks with an average duration time of 8 weeks. The predominant outcome measure which was measured in all the studies to reflect vitamin D level was "25(OH)D". There were also other outcome measures which were used, such as anaerobic test, isokinetic muscle strength, VO_2max, endurance testing, agility testing, lung function testing, sprint test, sit-up test, squatting, etc. The symptoms of upper respiratory tract infection were also analysed in two studies [18, 22]. Most of the studies which examined the physical component of the athletes with vitamin D inadequacy reported that there was a direct correlation between vitamin D inadequacy and the physical performance of the athletes. Particularly during the winter season, when the vitamin D inadequacy was at its worst, the physical performance and health components of the athletes were heavily compromised [22].

Except for one [16], all the other studies reported a significant improvement in the vitamin D levels after supplementation irrespective of the mode of administration. Higher doses of vitamin D_3 had resulted in better improvements over a shorter period. All the studies performed a pre and post-test analysis of vitamin D_3 level and have proved that the groups were similar at the start of the intervention program. One of the studies reported that endurance was enhanced by vitamin D supplementation; however, the strength and power of the athletes was not [16]. On the contrary another recent study proved that the power of the leg muscles and the sprint test improved significantly with vitamin D supplementation [13]. Studies were done on the analysis of the upper respiratory tract infection and its correlation with vitamin D demonstrated that vitamin D inadequacy resulted in upper respiratory tract infection symptoms compared to subjects with normal vitamin D levels. This fact was a supporter when the symptoms faded away following vitamin D supplementation to the athletes during the winter season [18, 22].

Many athletes resort to alternate methods, for example curve sprinting, linear sprinting and vertical jumps, to improve the athletic performance [24] rather than addressing their vitamin D deficiency or insufficiency. Hence it is suggested that the vitamin D levels are evaluated in all the athletes.

Recent studies stated that Circannual rhythm was noted for vitamin D but not for testosterone concentration; no correlations between them were found either in strength or endurance athletes or between 25(OH)D and body composition [25]. Vitamin D deficiency is associated with impaired myocardial global longitudinal strain (GLS). Another study demonstrated that vitamin D deficiency may be the cause of subclinical myocardial dysfunction in patients with or without diabetes mellitus and no history of significant coronary artery disease [26].

In the future, systematic reviews can concentrate on reporting studies from limited geographical areas and during particular seasons. The limitations of the study are as follows: the maximum follow period for vitamin D supplementation in this review was 12 weeks which is considered to be a very short period to learn whether supplementation has resulted in a sustained benefit and whether there are any sort of complications, hence we recommend analysing studies with a long-term follow-up. This can also analyse the long-term benefits of supplemented vitamin D.

Conclusions

This systematic analysis concludes that vitamin D inadequacy, which results in many physical derangements and compromised performance levels of athletes, can be restored by supplementing vitamin D and thereby enhancing the athletic performance and body composition. Secondly this review also concludes that the evidence is not very conclusive to predict and determine which specific physical components of the athlete were compromised with vitamin D inadequacy and which physical components were improved as a result of vitamin D supplementation. This review recommends clinical trials that use a large sample to examine the effect of vitamin D supplementation on physical components and their long term follow up.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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Reference

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