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VITAMIN D AND INJURIES IN DANCERS: A SYSTEMATIC REVIEW

Marija Rakovac[1] and Dubravka Sajković[2]

[1]University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia;
[2]Sestre milosrdnice University Hospital Center, Zagreb, Croatia

SUMMARY – Vitamin D is involved in many different functions in the human body. Despite the well-known benefits of vitamin D and increasing trends of testing and supplementation, there is still a high prevalence of vitamin D deficiency worldwide, present in the general but also in the highly-active population such as athletes and dancers. Dancers are at a higher risk of vitamin D deficiency due to their long working hours spent indoors, without exposure to sunlight. The high level of workload and physical demands also put dancers at a high risk of injuries. The aim of this review was to systematically analyze the existing evidence on the association of vitamin D (serum level and supplementation) and injuries in dancers. Medline, Scopus, SportDiscus and Web of Science were searched to identify the available peer-reviewed articles. Five articles met the inclusion criteria (two interventional and three observational studies), three of which additionally investigated the relationship between vitamin D and muscle function. The reported results on positive influence of vitamin D serum level or vitamin D supplementation effect on reduced injury occurrence and enhanced muscular function in adolescent and elite professional ballet dancers are promising but the evidence is limited due to a low number of studies, small samples, and methodological limitations.

Key words: *Dance; Ballet; Injury; 25-Hydroxyvitamin D2; Muscle strength; Physical fitness; Supplementation*

Introduction

Vitamin D is a multifunctional prohormone involved in numerous processes in the human body[1]. Its production begins in skin by ultraviolet irradiation of 7-dehydrocholesterol, but in order to become biologically active it is further metabolized, first in the liver to 25-hydroxyvitamin D (25(OH)D, calcidiol) and then in the kidney to 1α,25-dihydroxyvitamin D ($1,25(OH)_2D$, calcitriol)[2]. The role of vitamin D in calcium and phosphate intestinal absorption, maintenance of calcium concentration in blood and its renal reabsorption is long known, and its indispensable role in bone health and prevention of diseases such as rickets, osteomalacia, and osteoporosis is undisputed[2,3]. In addition to its bone-related function, a growing body of evidence for the role of vitamin D in the function of the cardiovascular and endocrine systems, respiratory function, immunity, mental health, prevention of metabolic disorders and malignant diseases has been accumulating in the last couple of decades[1,3]. Another important studied role of vitamin D is its influence on the function of skeletal muscles, particularly mitochondrial function and regenerative capacity, and the influence of vitamin D deficiency on the development of muscle atrophy[4,5].

Correspondence to: *Assoc. Prof. Marija Rakovac, MD, PhD*, University of Zagreb, Faculty of Kinesiology, Horvaćanski zavoj 15, HR-10000 Zagreb
E-mail: marija.rakovac@kif.unizg.hr

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Despite the well-known health benefits of vitamin D and an increasing trend of vitamin D testing and supplementation, there is a high global prevalence of vitamin D deficiency[6]. In Europe, vitamin D deficiency (defined as serum 25(OH)D) concentration <50 nmol/L) is present in 30%-60% of the Western, Southern and Eastern European population, and <20% of people in Northern Europe, while >10% of the European population suffer from severe deficiency (serum 25(OH)D <30 nmol/L)[7]. Except for the general population, vitamin D deficiency has also been documented in athletes in whom it can have serious repercussions on both athletic performance and injury occurrence due to the mentioned influence on skeletal muscle function[8-10].

Although dietary intake and supplements are an important source of vitamin D, up to 90% of total vitamin D is estimated to be endogenously produced after adequate sun exposure[11]. Further, sunlight exposure and, consequently, vitamin D level can be influenced by a number of factors such as geographical latitude, seasonal variations and culturally determined clothing habits, but also by characteristics of occupation; it has been demonstrated that people who predominantly work indoors, as well as shift workers are at a higher risk of developing vitamin D deficiency[11].

Professional and pre-professional dancers can easily be considered as athletes predominantly training indoors. Physical demands of dance activities require of these artists a high level of muscular and aerobic fitness[12,13]. Their professional work is characterized by long working hours, usually six days a week, mainly in indoor conditions of studios and stages[14]. The high level of workload, tight schedule of classes, rehearsals and performances put dancers at a high risk of injuries[15], with a reported incidence of 0.97 and 1.24 injuries *per* 1000 dance hours in amateurs and professional ballet dancers, respectively[16]. Although injury occurrence is multifactorial and its many risk factors have been put forward and examined[17-20], vitamin D deficiency has gained interest in this context in parallel with research on its role as injury risk factor in other sports[21-23] and reports on its deficiency in dancers[24-26]. The available evidence on vitamin D and dance injuries has not yet been reviewed, so the aim of this review was to systematically analyze the existing evidence on vitamin D (serum level and supplementation) and injuries in dancers.

Methods

Search strategy and study selection

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were followed in design, analysis and result reporting in this review[27]. In January 2023, the Medline, Scopus, SportDiscus and Web of Science databases were searched to identify articles describing vitamin D and injuries in dancers. The following keywords were used in search: vitamin D AND (injury or injuries) AND (dance OR ballet OR hip hop OR jazz) (Medline and SportDiscus); vitamin D AND injuries OR injury AND dance OR ballet OR hip AND hop OR jazz (Scopus); and vitamin D AND (Injuries [MeSH Terms] or Injury) AND (Dance* OR Ballet OR "Hip Hop" OR Jazz) (Web of Science). Inclusion criteria included peer-reviewed publications presenting results on either vitamin D level or effect of vitamin D supplementation on injury incidence in dancers. No restrictions on the participant age, publication date or study design were applied. Non peer-reviewed publications were excluded from analysis. Each author independently searched article titles to exclude publications indexed in more than one database and abstracts to exclude the articles that did not comply with the inclusion criteria. The references of the articles included in final analysis were hand-searched by each author independently to identify the possible additional publications of interest. Disagreements were resolved by consensus.

Quality assessment

National Heart, Lung, and Blood Institute's Study Quality Assessment Tools were used to perform Quality Assessment of Controlled Interventional Studies, and Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, separately by authors[28]. Quality assessment tool for controlled interventional studies allows rating the study quality as good, fair, or poor, based on 14 items assessing randomization, blinding procedure, group baseline characteristics, drop-out rate and adherence, other interventions, outcome measurement, sample-size calculation, and intention-to-treat analysis[28]. Quality assessment tool for observational cohort and cross-sectional studies also allows for rating the study quality as good, fair, or poor, based on 14 items assessing research questions, characteristics of study population, sample size justification, timeframe and exposure measures, outcome measures, loss to follow-up, and controlling for confounding variables[28]. Each author assessed each study independently. Disagreements were resolved by consensus.

Results

Medline search yielded 11 articles, Scopus search 10 articles, SportDiscus search 12 articles, and Web of Science search yielded 26 articles, yielding a total of 59 initially identified records (Fig. 1). Seventeen duplicate records were removed before screening and 35 records were removed for not being related to the topic. Out of the remaining seven records, one was removed because it did not present data on injuries[29], and another one was a narrative review of a broader topic[30]. The references of both excluded articles were hand-searched to identify additional publications before exclusion.

Five studies met the inclusion criteria and were included in final analysis, out of which only two were interventional studies that examined the effect of vitamin D supplementation on injury incidence in classical dancers[31,32], while three studies were observational[25,26,33]. As three of the studies investigated the relationship of vitamin D and muscle function in addition to injury occurrence[31-33], this aspect was also included in further analysis and discussion, in the context of its potential association with injuries. Characteristics of the interventional studies are shown in Table 1, while characteristics of cross-sectional and cohort studies are illustrated in Table 2.

One of the interventional studies was a randomized, double-blind controlled trial performed on 67 preprofessional adolescent elite dancers of both sexes[31], while the other was a non-randomized controlled trial including 24 elite ballet dancers on full contract[32]. In both studies, the intervention groups received a vitamin D_3 supplementation (120 tablets of 1000 International Units (IU)[31] and daily tablets of 2000 IU[32]) during four months comprising winter and spring months on northern hemisphere (latitudes 51.5 °N[31] and 52 °29'N[32]). Besides the possible effect on injury

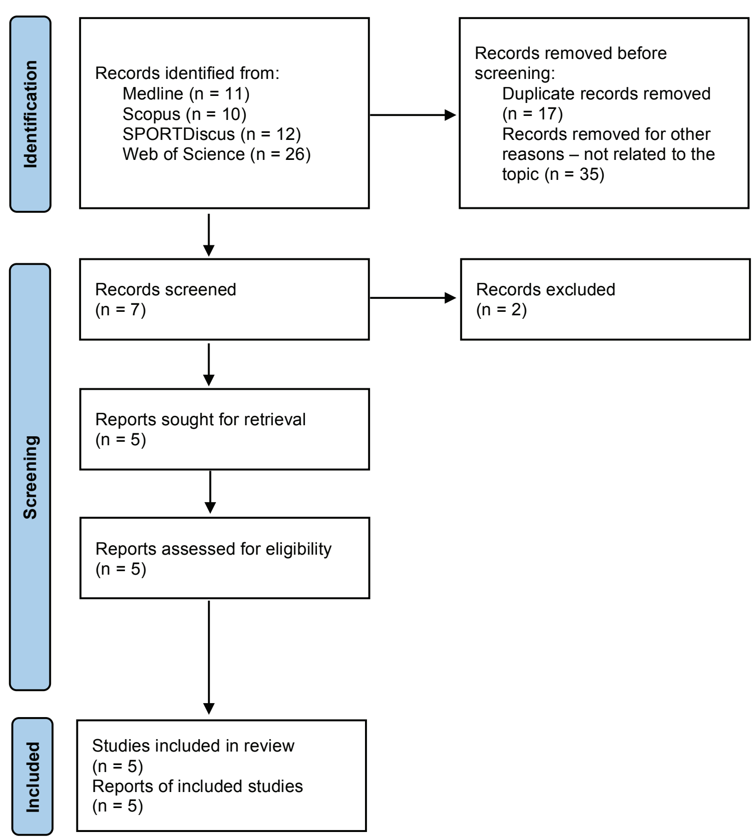

Fig. 1. Flow diagram of identification of studies via databases27.

Table 1. Characteristics of interventional studies

<table>
<tr><td>Study</td><td colspan="2">Wyon et al., 2019[31]</td><td colspan="2">Wyon et al., 2014[32]</td></tr>
<tr><td>Design</td><td colspan="2">Randomized, double-blind</td><td colspan="2">Non-randomized, controlled</td></tr>
<tr><td>Participants
Genre
Level

Age
Sex
Number</td><td colspan="2">
Classical ballet
Preprofessional, adolescent elite dancers
17-19 yrs
29F, 38M
n=67; Intervention (IG, n=45), Control (CG, n=22)</td><td colspan="2">
Classical ballet
Elite dancers (full-time contracts)

28±4.98 yrs
13F, 11M
N=24; Intervention (n=17), Control (n= 7)</td></tr>
<tr><td>Location</td><td colspan="2">Latitude 51.5°N</td><td colspan="2">Latitude 52°29'N</td></tr>
<tr><td>Time of the year</td><td colspan="2">January-April</td><td colspan="2">January-May</td></tr>
<tr><td>Intervention</td><td colspan="2">Duration: 4 months
IG: 120,000 IU of vitamin D_3 (120 tablets);
CG: 120 inert tablets</td><td colspan="2">Duration: 4 months
Daily tablet of 2000 IU of vitamin D_3</td></tr>
<tr><td>Muscle function</td><td colspan="2">Muscle strength: 3x5s isometric midthigh pulls (IMTP)
Muscle power: countermovement jumps (CMJ), reactive strength index</td><td colspan="2">Muscle strength: 3x5s isometric dominant quadricep contraction
Muscle power: standing vertical jump in the 1st position, from a demi-plié</td></tr>
<tr><td>Injury monitoring</td><td colspan="2">Time-loss definition*
Reported by in-house physiotherapists during 4-month intervention period</td><td colspan="2">Time-loss definition*
Reported by in-house physiotherapists during 4-month intervention period</td></tr>
<tr><td rowspan="5">Results (postintervention changes)</td><td colspan="2">Serum 25(OH)D_3 levels:
IG: 57% increase in serum 25(OH)D_3
CG: 18% increase in serum 25(OH)D_3</td><td colspan="2">/</td></tr>
<tr><td colspan="2">Muscle function:</td><td colspan="2">Muscle function:</td></tr>
<tr><td>IMTP:
IG: significant increase in force (7.8%, p=0.022)
CG: 1% decrease in force</td><td>CMJ:
No significant changes</td><td>Isometric strength:
IG: significant increase (18.7%, p<0.01)
CG: no significant changes</td><td>Vertical jump:
IG: significant increase (7.1%, p<0.01)
CG: no significant changes</td></tr>
<tr><td colspan="2">Injuries in the 4-month period</td><td colspan="2">Injury incidence in the 4-month period</td></tr>
<tr><td>Percentage of dancers with no injuries:
IG: 40.0%
CG: 36.4%</td><td>Percentage of dancers with no traumatic injuries:
IG: 88.9%
CG: 68.2%</td><td colspan="2">0.55/1000 h (IG) vs 1.87/1000 h (CG) (p=0.005)
Number of dancers with no reported injuries:
IG: 12 dancers vs CG: 1 dancer</td></tr>
<tr><td>Conclusions</td><td colspan="2">Supplementation significantly decreased the proportion of dancers with vitamin D deficiency and insufficiency.
IG: statistically significant, although clinically small increase in muscle strength
IG: negative association of muscle strength increase with incidence of traumatic injuries</td><td colspan="2">Supplementation during winter time improved muscular fitness and reduced injury incidence in the intervention group</td></tr>
<tr><td>Limitations</td><td colspan="2">Limited participant number
Participants from one vocational dance school
Limited intervention time</td><td colspan="2">Low participant number
No randomization
Participants from one dance company</td></tr>
</table>

*"any injury that prevented a dancer from taking full part in all dance-related activities that would normally be required of them for a period equal to or greater than 24 h after the injury was sustained"[34]

Table 2. Characteristics of cross-sectional and cohort studies

Study	Design	Participants		Location and time of the year	Outcome measures	Results	Conclusions	Limitations
		Genre and level	Age, sex, number					
De Rezende Araújo *et al*., 2020[33]	Cross-sectional	Ballet, pre-professional adolescent dancers	17±4.44 y; 37F, 5M; N=42 NG: normal group (>30 ng/mL vitamin D $(25(OH)D_3)$ (N=26) IG: insufficient/ deficient group (<30 ng/mL $(25(OH)D_3)$ (N=16)	Goiania, Latitude -16.6799 Longitude -49.255 October	Vitamin D $(25(OH)D_3)$ level Muscle function: 3x5 repetitions of knee concentric flexion/extension at $60°s^{-1}$ and $300°s^{-1}$ Injury history (previous 6 months, self-reported)	NG significantly lower fatigue rates *vs.* IG (p<0.05) Lower fatigue percentage in IG group No effect of vitamin D status on injury incidence Injured dancers (57%) had lower peak torque (extension and flexion) at $60°s^{-1}$ (p<0.05)	No effect of vitamin D serum level and muscle function Dancers with higher muscle strength less prone to injury	Age range (potential influence of diverse adolescent development rate) Imbalance in the number of F/M participants Self-reported injury data Cross-sectional design
Wolman *et al*., 2013[25]	Cohort	Ballet, elite dancers, full-time contract	26±8.86 y; 13F, 6M; N=19	Latitude 52°29'N February and August	Bone turnover markers (CTX, P1NP, PTH) and vitamin D (25(OH) D) Injury monitoring: Time-loss definition* Reported by in-house physiotherapists during two 4-month periods: December-March and August-November	Winter *vs.* summer measurements of 25(OH)D: 14.9 ng/mL *vs.* 23.9 ng/ mL (p<0.001) Significant positive effect of oral contraceptive on serum 25(OH)D Lower incidence of soft tissue injuries in summer *vs.* winter (24 *vs.* 13, p<0.05) No significant association between serum 25(OH)D and injuries	High incidence of 25(OH)D insufficiency /deficiency; improvement in summer months Increased winter incidence of injuries, not linked to serum 25(OH) D	Small sample of participants
Ducher *et al*., 2011[26]	Cross-sectional	Ballet, pre-professional adolescent dancers	10-19 y; N=16M	Melbourne Latitude 37°S July (winter)	Pubertal status (Tanner's criteria, self-assessed) Serum vitamin D (25(OH)D) PTH Calcium and vitamin D intakes – food frequency questionnaire Body composition (DXA) Injury history questionnaire	Nine dancers had 25(OH) D deficiency/ insufficiency (serum level <50 nmol/L) No relationship between 25(OH) D level and % body fat No difference in reported injuries between dancers with normal 25(OH)D level (1.4±0.6 injuries) and dancers with 25(OH) D deficiency/ insufficiency (2.1±0.6 injuries)	More than half of participants had low 25(OH)D level during winter No link to injury history	Age range (potential influence of diverse adolescent development rate) Small sample size Cross-sectional design No control group Only six participants provided food intake data Food questionnaire not validated for children/ adolescents

CTX = carboxy-terminal collagen crosslinks; P1NP = procollagen 1 N-terminal peptide; PTH = parathyroid hormone;
*"any injury that prevented a dancer from taking full part in all dance related activities that would normally be required of them for a period equal to or greater than 24 h after the injury was sustained"[34]

occurrence in the monitored four-month period, the effect of supplementation on muscle function, presumably also related to injury occurrence, was also measured in both studies (lower limb muscle strength and power)[31,32]. Time-loss definition of injuries[34] was used and injuries were reported by in-house physiotherapists[31,32]. Both studies found an increase in isometric strength in the intervention groups, a significant increase in muscle power was found only in the elite professional dancers, and a decrease in injury incidence in the monitored period was observed in both intervention groups[31,32].

Out of the remaining three observational studies, two were cross-sectional studies performed on a sample of preprofessional adolescent dancers[26,33] and one cohort study included elite ballet dancers on full-time contract[25]. One of the cross-sectional studies was performed in Brazil in the month of October[33], while the other one was performed in Melbourne during the winter month of July[26]. Both mentioned studies collected self-reported injury history data and serum 25(OH)D level, based on which the samples of dancers were divided into two groups: normal 25(OH)D serum level and deficient/insufficient 25(OH)D level[26,33]. De Rezende Araújo *et al.*[33] additionally measured muscle strength but found no effect of vitamin D status on the occurrence of injuries or on muscle function, while dancers with higher muscle strength were less prone to injuries. Ducher *et al.*[26] noted a high prevalence of low 25(OH)D serum level during winter, but also no link to self-reported injury incidence.

The remaining cohort study on elite professional ballet dancers, performed in England (Birmingham), measured 25(OH)D serum levels in winter (February) and summer (August)[25]. There was an expected improvement in 25(OH)D serum level during summer, and an increased incidence of injuries during winter, although seemingly not linked to vitamin D serum level[25].

Discussion

This systematic review aimed to analyze published evidence on the relationship between vitamin D and injuries in dancers. Two interventional and three observational studies were found through database search. The two interventional studies found a decrease in injury incidence during a four-month period in which dancers received vitamin D_3 supplementation[31,32]. This was confirmed in both elite professional dancers and preprofessional adolescent dancers, although only the result for the latter group was obtained in a randomized controlled trial[31,32]. In the two cross-sectional studies on adolescent dancers, no link between vitamin D level and self-reported occurrence of injures was found[26,33]. In the cohort study on professional ballet dancers, no direct link between vitamin D serum level and injury incidence was found, although vitamin D serum level was expectedly lower during winter, which coincided with a higher injury incidence in that part of the year[25].

The potential role of vitamin D in injury prevention and/or a relationship with lower injury occurrence have also been demonstrated in athletic population and military population exposed to high physical strain[35-37]. A three-week vitamin D_3 supplementation in ultramarathon runners decreased post-exercise skeletal muscle biomarkers, such as lactic dehydrogenase, creatine kinase, myoglobin, and troponin, showing a potential role in injury prevention, especially after eccentric muscle contractions[35]. Results of a longer, six-month vitamin D supplementation in swimmers and divers showed that although recorded injuries were not related to 25(OH)D, 77% of them did coincide with decreases in vitamin D level[36]. An 8-week calcium and vitamin D supplementation in female navy recruits was related to a 20% lower incidence of stress fractures in the intervention group compared to control[37].

The potential role of vitamin D in injury prevention is ascribed, besides its role in bone health, to its influence on muscle function. Studies show a decrease in multiple muscle functions in vitamin D deficient people of different ages, e.g., strength, power, and work in young athletes, and everything from muscle weakness, atrophy, decrease in mitochondrial function to increased oxidative stress with related risks in older people[38].

At the cellular level, the active form of vitamin D acts in a genomic and non-genomic way *via* its receptor present in skeletal muscles and various other tissues[4,39]. Expression of vitamin D receptors is crucial for the uptake and multiple functions of vitamin D in muscle cells[4,39]. Vitamin D plays a role in the regulation of muscle contraction and energy metabolism, so that insufficient vitamin D level may compromise the uptake of calcium by sarcoplasmic reticulum and mitochondria, with a negative effect on the kinetics of contraction and energy metabolism of muscle cells[4]. Vitamin D deficiency has also been related to reactive oxygen species generation inducing increased oxidative stress and its deleterious effects, including prolonged injury recovery. Positive effect of vitamin D in muscle repair includes lowered oxidative stress, modulation of cytokine and inflammatory mediator level (interleukin (IL)-10, IL-13, tumor necrosis factor alpha, interferon-gamma, etc.), increased satellite cell activity, proliferation, and differentiation of myoblasts[39-41].

Vitamin D receptors are predominantly expressed on the fast-twitch fibers (characterized by high force production and contraction velocity), explaining the influence of vitamin D on muscle strength, power and coordination[4,9]. It has been shown that vitamin D increases the number of fast-twitch type IIA fibers and thus enhances the muscular power output[42]. In this light, some studies found a relationship between serum vitamin D level and athletic performance, e.g., an association with better results in tests assessing muscular strength and power (squat jump and countermovement jump), sprinting and even aerobic capacity was found in professional soccer players[42], and a moderate correlation of vitamin D levels with time to peak torque in knee extension was found in adolescent female soccer players[43]. In the study on pre-professional ballet dancers, de Rezende Araújo *et al*. found no link between vitamin D level and muscle function[33]. Several other studies also failed to detect a correlation of vitamin D level and physical performance in athletes[42,44,45], or at best presumed a small effect size of such a relationship[46], so it remains to be elucidated in further research[47].

On the other hand, there is a larger body of evidence on ergogenic effects of vitamin D supplementation in athletes. To begin with, there is a high prevalence of vitamin D insufficiency in athletes. A recent systematic review and meta-analysis found that approximately one-third of adult and more than one-third of adolescent elite athletes had vitamin D insufficiency[48]. Comparing vitamin D concentration measured in different studies is rather complicated because the definition of deficiency, insufficiency, and even the variable measured to define vitamin D concentration is not standardized[4,47,48]. Serum calcidiol (25(OH)D) is considered an appropriate concentration indicator, due to its longer half-life of 15 days[38], and advised by the European Calcified Tissue Society to be a standardized measurement, with its concentrations of <50 nmol/L or 20 ng/mL indicating vitamin D deficiency[7]. In the mentioned meta-analysis on elite athletes[48], serum 25(OH)D of ≤50 nmol/L was a cut-off value to define vitamin insufficiency.

In a previous study on young dancers, a high prevalence of vitamin D insufficiency (defined as serum 25(OH)D concentration <30 ng/mL) was found (94% of investigated dancers)[24]. The studies analyzed in this review used comparable cut-off criteria for serum 25(OH)D concentration and revealed a high prevalence of vitamin D deficiency; the percentage of adolescent dancers with vitamin D deficiency/insufficiency was 38%[33], 56%[26], and 87%[31]. Wyon *et al*.[32] and Wolman *et al*.[25] found that all examined elite ballet dancers had deficient/insufficient vitamin D level during winter, while only 15% attained normal level after the summer break. This difference underpins the risk of vitamin D deficiency/insufficiency in people spending a lot of working hours indoors, already identified in shift workers and other athletes[11,49], although the notion on the difference between indoor and outdoor athletes has recently been challenged by a finding of it being influenced by different confounders[50]. Leanness is a proposed confounding factor related to the risk of low vitamin D level in dancers that should be explored in future studies[26].

A four-month (winter/spring) vitamin D_3 supplementation in the two interventional studies analyzed in this review (120 tablets of 1000 IU[31] and daily tablets of 2000 IU[32]) yielded positive effects on dancer muscle function. An increase in lower limb muscle isometric strength was found in both adolescent and adult dancers, while the latter group also demonstrated an increase in muscle power[31,32]. However, in the study on elite dancers, it was not reported to which extent the supplementation increased serum 25(OH)D concentration, which limits the conclusion on the effect of the intervention on muscle function[32].

Positive results of vitamin D supplementation on muscle function were confirmed in other athlete groups, e.g., a significant 13% increase in muscle strength in one week after a single bolus of 150 000 IU vitamin D_3 was previously demonstrated in adult male judokas, also indoor athletes[51].

Chiang *et al*.[8] reviewed randomized controlled trials that investigated the effects of vitamin D supplementation in athletes on their muscle strength. Supplementation period ranged from 4 weeks to 6 months while dosages varied from 600 to 5,000 IU/day[8]. An interesting finding was difference in the effectiveness of vitamin D_2 and D_3 supplementation. While vitamin D_2 had no significant impact on muscle strength, vitamin D_3 elicited a positive effect on muscle strength, with improvements ranging from 1.37% to 18.75%[8]. However, the results are based on a low number of studies and need further confirmation in future studies.

Due to its role in muscle repair and regeneration, vitamin D supplementation could arguably elicit clinical benefits in post-exercise recovery and sports- and dance-related injuries[23,52]. However, a sufficient number of well-designed clinical trials is lacking to confirm this hypothesis at present[23,52].

Although the studies analyzed in this review were rated fair or even good in some of the quality aspects, the low total number of studies, only one randomized controlled trial, and several significant limitations of the studies do not allow strong conclusions on either the relationship of serum vitamin D level or vitamin D supplementation on injury incidence or muscle function in dancers. Only two were interventional studies investigating the effect of vitamin D supplementation on muscle function and injury[31,32]. In one of them, the authors were not able to randomize participants and there was no reported effect of supplementation on serum 25(OH)D level[32]. All the studies had a relatively low number of participants, and the generalizability of their findings is compromised by the fact they include dancers from a single school or professional company[25,26,31-33]. In the studies by de Rezende Araújo *et al.*[33] and Ducher *et al.*[26], there is a potential influence of diverse adolescent development rate, since the participant age range was rather large (17±4.44 years and 10-19 years, respectively). In both studies, injury incidence was self-reported, and de Rezende Araújo *et al.* also report a potential limitation of a pronounced imbalance in the number of female *versus* male dancers (37 *vs.* 5, respectively)[26,33].

Conclusion

The studies analyzed show promising results on positive influence of vitamin D serum level or vitamin D supplementation effect on reduced injury occurrence and enhanced muscular function in pre-professional adolescent and elite professional ballet dancers. However, the low number of studies, small samples and methodological limitations do not permit drawing valid conclusions. More well-designed randomized controlled studies are required to provide stronger evidence.

However, based on the finding of the high prevalence of vitamin D deficiency and seasonal variation in vitamin D level in dancers, reported in the described studies and also recognized in studies on other indoor athletes, there is a case for monitoring serum 25(OH) D concentration in dancers throughout the year, with controlled supplementation, if indicated.

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Sažetak

VITAMIN D I OZLJEDE KOD PLESAČA: SUSTAVNI PREGLED

M. Rakovac i *D. Sajković*

Vitamin D je uključen u mnogo različitih funkcija u ljudskome tijelu. Usprkos dobro poznatim pozitivnim učincima vitamina D i rastućem trendu testiranja i suplementacije u svijetu se i dalje bilježi visoka učestalost nedostatka vitamina D prisutna u općoj, ali i u vrlo aktivnoj populaciji poput sportaša i plesača. Plesači su u visokom riziku od nedostatka vitamina D zbog dugotrajnih radnih sati koje provode u zatvorenom prostoru, bez izlaganja Sunčevoj svjetlosti. Visoka razina radnog opterećenja i fizički zahtjevi plesače dovode i u visok rizik od ozljeđivanja. Cilj ovoga preglednog rada bio je sustavno analizirati postojeće dokaze o povezanosti vitamina D (serumske razine i suplementacije) i ozljeda u plesača. Baze podataka Medline, Scopus, SportDiscus i Web of Science su pretražene radi identificiranja dostupnih recenziranih publikacija. Pet članaka je zadovoljilo uključne kriterije (dva intervencijska i tri opservacijska istraživanja), a u tri od njih dodatno je istražen i odnos između vitamina D i mišićne funkcije. Prikazani rezultati o pozitivnom utjecaju serumske razine vitamina D ili učinku suplementacije vitaminom D na smanjenu pojavnost ozljeda i poboljšanu mišićnu funkciju u adolescentnih i vrhunskih profesionalnih plesača baleta su obećavajući, no dokazi su ograničeni zbog malog broja istraživanja, malih uzoraka ispitanika i metodoloških ograničenja.

Ključne riječi: *Ples, Balet, Ozljeda, 25-Hidroksi vitamin* D_2*, Mišićna jakost, Tjelesna kondicija; Suplementacija*