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Is the Vitamin D Level Important on Isokinetic Muscle Strength in Adolescent Athletes?

Adolesan Sporcuların İzokinetik Kas Kuvvetinde Vitamin D Düzeyi Önemli Midir?

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ABSTRACT

Aim: To determine the relation between vitamin D levels and isokinetic muscular strength in athletes, and to compare the muscular strength between athletes with and without vitamin D deficiency.

Methods: The records in the sports medicine clinic were examined, where the general medical examinations and performance analyses of the athletes had been conducted. The data of the athletes were examined, whose serum 25-OH vitamin D levels had been determined and isokinetic knee flexion-extension muscular strength test had been conducted. Age, height, body weight, discipline of sports, the year of beginning to sports and training duration per week (hours/week) were recorded for each athlete. The athletes were separated into two groups as vitamin D levels below 20 ng/mL (Group 1) and above 20 ng/mL (Group 2).

Results: There was not any statistically significant difference between the demographic data and training data of the groups (p> 0.05). Vitamin D deficiency was found in 44% of all the athletes. The average vitamin D level was 13.8 ng/mL for Group 1, and 27.2 ng/mL for Group 2 (p:0.001). The serum calcium and serum phosphor levels were similar (p> 0.05). The isokinetic muscular strength test did not yield a difference between the two groups. It was found that vitamin D levels did not show any correlation with demographic data, training details and with any parameter of muscular strength (p> 0.05).

Conclusion: In this study, there are no difference in effect of vitamin D on muscle strength, but significant results could be obtained in other studies with large participants.

Keywords: Vitamin D, muscular strength, knee, athlete.

ÖZ

Amaç: Bu çalışmanın amacı, sporcularda D vitamini düzeyi ile izokinetik kas kuvveti arasındaki ilişkiyi belirlemek, D vitamini eksikliği olan ve olmayan sporcuların kas kuvvet değerlerini karşılaştırmaktır.

Yöntem: Spor Hekimliği kliniğinde genel tıbbi muayeneleri ve performans analizleri yapılan sporculara ait kayıtlar incelendi. Serum 25-OH vitamin D düzeyi belirlenen ve izokinetik diz fleksiyon-ekstansiyon kas kuvvet testi yapılan sporculardan çalışmaya dahil edilme kriterlerine sahip olanların verileri analiz edildi. Sporcuların; yaş, boy, vücut ağırlığı, spor branşı, spora katılma/başlama süresi (yıl) ve haftalık antrenman süresi (saat/hafta) kaydedildi. Sporcular, D vitamini düzeyine göre 20 ng/mL altında (Grup 1) olanlar ve üstünde (Grup 2) olanlar olmak üzere iki gruba ayrıldı.

Bulgular: Grupların, demografik veriler ve antrenman detayları arasında fark yoktu (p> 0.05). Tüm sporcuların %44'ünde D vitamini eksikliği belirlendi. Grup 1'in vitamin D düzeyi 13.8 ng/mL, Grup 2'nin ise 27.2 ng/mL idi (p:0.001). Grupların serum kalsiyum ve serum fosfor değerleri benzerdi (p> 0.05). İzokinetik kas kuvvet testi sonuçları, gruplar arasında istatistiksel anlamlı fark oluşturmadı (p> 0.05). Vitamin D düzeyinin; demografik veriler, antrenman detayları ve kas kuvvetine ait tüm parametreler ile korelasyon göstermediği saptandı (p> 0.05).

Sonuç: Bu çalışmada, D vitamininin kas kuvvetine olan etkisi açısından fark bulunmamıştır ancak geniş katılımcı kitleleri ile yapılacak başka çalışmalarda anlamlı sonuç elde edilebilir.

Anahtar kelimeler: D vitamini, kas kuvveti, diz, sporcu.

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INTRODUCTION

Vitamin D is a lipophilic prohormone that is synthesized through the skin with the activation of the ultraviolet radiation, and that can be absorbed in small quantities through diet [1]. The known function of vitamin D is related to calcium homeostasis and bone metabolism [2]. Serious vitamin D deficiencies cause rickets in children and osteomalacia in adults [3]. In addition, vitamin D receptors are found in some tissues such as the skeletal muscles [4]. It has been proved that, in some patients, muscle weakness may develop in addition to bone pathologies [5]. It is known that when the serum 25-(OH) vitamin D levels are elevated above 20 ng/mL, the symptoms recede in individuals diagnosed with vitamin D deficiency and myopathy [6].

It has not become clear how vitamin D affected on muscular strength [7]. However, it is though that it affected muscular strength in two ways, genomical and nongenomic. The genomic effect of vitamin D is realised by affecting the paths activating the proliferation and growth in the muscle cell. The nongenomic effect, on the other hand, appears by affecting the calcium-phosphor transport into the cell, ATP production and the amount of type 2 muscle fiber [4,7].

Today, vitamin D deficiency can be seen frequently in athletes, a population admitted healthy. Vitamin D deficiency is found in 32% of professional basketball players and insufficiency is found in 47% of them, while these values are found as 26% and 42-80% respectively in professional football players. It is known that vitamin D deficiency or insufficiency is found in the majority of athletes participating in dance, taekwondo, wheelchair sports, handball, athletics, weightlifting, swimming and volleyball. It is possible for vitamin D deficiency, which affects the musculoskeletal system, also affects the athletic performance of athletes [8].

Some studies conducted on athletes indicate that vitamin D deficiency negatively affects bone health, increase the injury risk for the musculoskeletal system and caused decreases in muscle strength and caused performance losses [6-10]. On the contrary to these findings, there are studies arguing that vitamin D does not have any relation to muscular strength or sportive performance [11,12].

Our hypothesis is that low vitamin D level will negatively affect muscle strength. This study aims at determining the relation between the vitamin D levels and isokinetic muscular strength in athletes, and comparing the muscular strength values of athletes with or without vitamin D deficiency.

METHODS

The digital archive records for athletes were analyzed, who had consulted to the Sports Medicine Clinic (Geographical localisation: 38º 28' and 38º 01' East; 36º 38' and 37º 32’ North) for performing general medical examination and performance analyses between 1 July 2017 and 1 July 2018. The athletes with inflammatory pathologies, back pain, lower extremity surgery history, tendon – muscle injuries, lower extremity fracture history, pregnancy, use of vitamin D supplements in the last six months, and with anemia diagnosis in the blood tests during the examination were excluded from the study. Athletes between 12 and 18 ages, who did not have active complaints and any pathologies during the general medical examination, who had been doing exercises regularly at least for one year (3 days a week, 1.5 hours/session) were included in the study.

Age, height, body weight, discipline of sports, the year of beginning to sports and training duration per week (hours/week), serum 25-(OH) vitamin D levels, blood calcium levels and blood phosphor levels were examined from the patient files. The isokinetic muscular strength tests were completed before the biochemical test results were recorder. The athletes were separated into two groups as vitamin D levels below 20 ng/mL (Group 1) and above 20 ng/mL (Group2), [6].

Biochemical test

Blood samples were taken from antecubital vein and centrifuged. Later, the 25 (OH) vitamin D, calcium and phosphor levels were analyzed. The radio immunoassay method was used to determine the 25-(OH) vitamin D levels [13].

Isokinetic test protocol

To determine the muscular strength, the isokinetic dynamometer (ISOMED 2000, D & R Ferstl GmbH, Germany) was used. The device was calibrated before each test. The athletes were informed about the procedure. After ten minutes' warm-up and extension exercises, the muscular strength measurement was conducted from the knee region. The knee muscular strength measurement for flexion-extension was conducted while the athlete was in a sitting position and by following the angle adjustments indicated in the manual of the dynamometer. Before the test, the athletes were ensured that they had two trials in both angular velocities for their adaptation to the device. The test was conducted in the concentric-concentric mode [14] and with the 60°/seconds (5 repetitions) - 240°/seconds (15 repetition) angular velocity [4,15]. During the test, the athletes were given oral and visual motivation. The maximum torque, maximum torque/body weight, maximum work, total work and hamstring/quadriceps muscle ratio were used in the analyses.

Ethics

The study was approved with the decision no 178, dated 1 August 2018, by the local ethics committee.

Statistical analysis

The SPSS v22.0 statistical software package was used for the analyses. The conformity of the data to normal distribution was evaluated using the Shapiro-Wilk test. The Mann-Whitney U test or the Independent t-test was used for comparing the data. Pearson or Spearman test was used for the correlation analysis. The data was presented as median ± standard error or average ± standard deviation. $p < 0.05$ value was accepted for statistical significance.

RESULTS

Five of the 19 athletes (15 male and 4 female) in Group 1 (25-(OH) vitamin D <20 ng/mL) were doing athletics, 4 doing wrestling, 1 weightlifting, 1 judo and 8 of them were doing taekwondo. Seven of the 24 athletes (23 male and 1 female) in Group 2 (25-(OH) vitamin D >20 ng/mL) were doing athletics, 2 playing football, 2 of them were doing wrestling, 3 weightlifting, 1 karate and 9 of them were doing taekwondo. There was not any statistically significant difference between the groups with regard to demographic data and training details (p> 0.05), (Table 1).

Table 1. Demographic and training data

	Group 1 (n:19)	Group 2 (n:24)	p value
Age (years)	16.7 ± 2.5	16.5 ± 1.8	0.8
Height (cm)	171.7 ± 9	172.7 ± 10.2	0.8
Body weight (kg)	60.8 ± 11	58.8 ± 8.6	0.5
Body Mass Index (kg/m2)	20.5 ± 2.4	19.7 ± 2	0.2
Training time (year)	4.2 ± 2.3	3.7 ± 2.9	0.2
Weekly training sessions (hour/week)	11.6 ± 2.9	12.1 ± 3.7	0.5

While the average serum 25-(OH) vitamin D level for the athletes in Group 1 was 13.8 ng/mL, this value was 27.2 ng/mL in the athletes in Group 2 (p:0.001). The serum calcium and phosphor levels of the groups were similar (p> 0.05), (Table 2).

Table 2. Biochemical tests results

	Group 1 (n:19)	Group 2 (n:24)	p value
Serum 25-(OH) vitamin D (ng/mL)	13.8 ± 4.2	27.2 ± 5.7	0.001*
Serum calcium (mg/dL)	9.4 ± 0.3	9.4 ±0.4	0.6
Serum phosphorus (mg/dL)	3.9 ± 0.6	4.2 ± 0.9	0.2

*: $p < 0.05$.

The isokinetic knee flexion-extension muscular strength test results did not show a statistically significant difference between the groups (p> 0.05), (Table 3). It was found that serum 25-(OH) vitamin D level did not show any correlation with the demographic data, training details and any of the parameters pertaining to muscular strength (p> 0.05).

DISCUSSION

In this study, any difference cannot be found between the isokinetic muscular strength of the athletes with and without vitamin D deficiency. The relation of vitamin D level with muscular strength could not be determined.

Athletic performance is a condition upon which genetic and environmental factors have an impact. Although the issues of how genetic and environmental factors operated and in which conditions the performance could be improved were studied frequently, there are some questions in this field which have not been clarified yet [16]. The effect of vitamin D levels on performance is one of these questions.

Table 3. İsokinetic muscle strength data

		Group 1 (n:38)	Group 2 (n:48)	p value
@ 60 °/sec	Flexion PT (Nm)	73.5 ± 21.5	72 ± 19.7	0.7
	Flexion PT/BW	1.2 ± 0.2	1.2 ± 0.3	0.7
	Flexion PW (J)	69 ± 3.8	70 ± 22	0.7
	Flexion TW (J)	334.3 ± 106.5	309.8 ± 93.8	0.3
	Extension PT (Nm)	156.3 ± 40.6	152.9 ± 43.6	0.7
	Extension PT/BW	2.6 ± 0.5	2.6 ± 0.6	0.8
	Extension PW (J)	130.8 ± 37.1	125.6 ± 33.6	0.5
	Extension TW (J)	610.7 ± 174.2	575.2 ± 166.8	0.3
	Ratio (F/E) TW (%)	60 ± 2	54 ± 2	0.5
@ 240 °/sec	Flexion PT (Nm)	70 ± 16.4	68.7 ± 21.3	0.7
	Flexion PT/BW	1.2 ± 0.2	1.2 ±0.3	0.8
	Flexion PW (J)	56.4 ± 13.8	57 ± 17.2	0.8
	Flexion TW (J)	722.4 ± 185.7	691.8 ± 230.7	0.5
	Extension PT (Nm)	110 ± 4	103 ± 3.8	0.7
	Extension PT/BW	1.8 ± 0.3	1.9 ± 0.3	0.6
	Extension PW (J)	92.5 ± 3.8	88.5 ± 3.3	0.6
	Extension TW (J)	1227.5 ± 50	1084.5 ± 47	0.4
		62.8 ± 2	59.8 ±2.4	0.6

PT: peak torque, PW: peak work, TW: total work, Nm: Newton meter, J: Joule, F/E: (Flexion/Extension), BW: body weigth.

Foo et al. reported that the vitamin D levels and isometric forearm muscular strength exhibit a positive correlation in healthy adolescent females with the average age of 15, who were not athletes. However, they found vitamin D deficiency (25-(OH) vitamin D < 50 nmol/L) in 57.8% of the healthy adolescents [3]. When the relation between the serum vitamin D levels of adolescent swimmers with an average age of 14, and the isometric handgrip strength, balance and swimming performances are examined, any correlation is not found between vitamin D levels and any of the parameters. The correlation of vitamin D levels to age is not found. However, vitamin D insufficiency is found in 66% of the athletes (25-(OH) vitamin D: 20-29 ng/mL), and vitamin D deficiency is found in 14% of them (25-(OH) vitamin D: <20 ng/mL) [17].

In a study conducted with children playing football as physical activity, a positive correlation between vitamin D level and isometric trunk strength, jumping ability, sprint and agility is found. It is found that plasma 25-(OH) vitamin D concentration is independent of age, maturity, body mass index, body fat, and the amount of protein and calcium taken with diet. Unfortunately, it is found that 47.2% of children have vitamin D deficiency and 32.8% have vitamin D insufficiency [7]. In our study, too, vitamin D insufficiency is found in 44% of the cases. We argue that it is essential to monitor vitamin D levels and to apply the required treatment/supplement in this special group, whose growing-development continue, not only for increasing athletic performance but also for the musculoskeletal system health.

It is reported that there is a positive correlation between the vitamin D levels and all performance parameters of athletes whose performance tests was conducted with the Vertical Jump Test, Shuttle Run Test, Triple Hop for Distance Test and the 1 Repetition Maximum (RM) Squat Test [18]. A positive correlation is also found when similar performance analyses are conducted with postmenarcheal adolescent females [19]. Carson et al. reported that the muscle strength of adolescents with vitamin D levels above 51 nmol/L is higher than the muscular strength of adolescents with vitamin D levels below 32 nmol/L. However, they emphasized that the correlation between the vitamin D levels, and muscular strength and cardiorespiratory fitness was not determined [20].

Grimaldi et al. evaluated the effect of vitamin D levels in healthy individuals to arm and leg strength with isokinetic and isometric test methods. While the researchers found that vitamin D level has a correlation to the isometric and isokinetic muscle strength of the upper extremities, they found the correlation with only isometric muscle strength in the lower extremities. The reason for vitamin D to have different effects on upper and lower extremities is explained with upper extremity muscles having more type 2 muscle fibers. Another possible reason may be that the androgenic effect is more salient in the upper extremities [21]. A positive correlation is found between the vitamin D levels and the left handgrip strength, vertical jump test, and the total work amount of the knee extensor at 60°/seconds angular velocity in Judo athletes [4]. Hamilton et al. reported that there is not any correlation between the vitamin D levels and the lower extremity isokinetic muscular strength of football players [11].

It is obvious that further studies are required to clarify the effect of vitamin D on muscular strength and after which level vitamin D could have an effect. It is possible to encounter studies that evaluate the prospective effect of vitamin D supplementation.

Close et al. applied vitamin D supplementation to athletes (rugby, football, jockey) with vitamin D levels of 29 nmol/L. After the supplement, the vitamin D levels reached to 103 nmol/L, their 10 meters sprint durations shortened, and their vertical jump height decreased. However, any difference could not be found in the '1-RM bench press and back squat test' performed to measure the upper and lower extremities muscular strength [1].

Wyon et al. found that the quadriceps isometric muscular strength increased by 18.7% and vertical jump improved by 7.1% in elite ballet dancers who had been given 2000 IU vitamin D supplement for 4 months. It is also reported that athletes taking vitamin D supplements experienced less injuries when compared to the control group [10]. In a study investigating the effect of vitamin D deficiency on the exercise related muscle damage, athletes of 16 years of age (football, basketball, baseball, athletics, weightlifting, tennis and lacrosse) were given D2 supplement (600 IU/day) for 6 weeks. The vitamin D supplement did not create any positive or negative difference in the biomarker levels in the serum indicating muscle damage. Any difference could not be found in the isometric leg-back strength and vertical jump height [22].

The effect of vitamin D supplementation (10.000 IU/day) in nonathlete healthy males was evaluated by Owen et al. using isokinetic dynamometer and percutaneous isometric electromyostimulation. At the end of the study, it is found that increasing the 25-(OH) vitamin D concentration above 120 nmol/L does not have any effect on musculoskeletal functions; however, serious vitamin D deficiencies (<12.5 nmol/L) may have effects on skeletal muscles [12].

Limitations: Inability to determine the body fat – muscle ratio, and the daily intake of protein, calcium, vitamin D and vitamin K by the athletes comprise the limitations of our study. Other limitations of our study are the lack of analyses in a single sports discipline with tests peculiar to that discipline, and the inability to determine the effect of the gender factor. Our other limitation is that the number of men and women in groups is not sufficiently homogenous.

Conclusion: Vitamin D is a vitamin required for the metabolism to function properly. The prevalence of vitamin D deficiency even in athletes, a group considered healthy, is an indicator that it is necessary to monitor closely this deficiency. The effect of this vitamin on muscular strength and sportive performance has not been clarified. In this study, there are no difference in effect of vitamin D on muscle strength, but significant results could be obtained in other studies with large participants.

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