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Does Vitamin D Level Affect Grip Strength: A Cross-Sectional Descriptive Study

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ABSTRACT

Objective: Although there is increasing evidence about the role of vitamin D on muscle function, its relationship with grip strength is still a controversial issue. The aim of this cross-sectional clinical study was to evaluate the relationship between vitamin D and grip strength in premenopausal Turkish women.

Materials and Methods: A total of 127 women with an age range of 40–50 (44.7±4.3) years who were premenopausal and sedentary were included in this cross-sectional descriptive study. The mean body mass index (BMI) was 30.2±5.3 kg/m^2. Dominant and nondominant grip strengths were measured by digital hand dynamometer.

Results: The mean dominant and nondominant grip strengths were 24.2±5.9 kg and 22.5±5.7 kg, respectively. Mean serum 25-hydroxyvitamin D (25OHD) concentration was 16.4±9.7 ng/ml. Participants were divided into three groups as vitamin D deficiency (70.9%), insufficiency (18.1%), and sufficiency (11.0%). No statistically significant difference was found between the groups with respect to age, BMI, and dominant and nondominant grip strengths ($p>0.05$). Furthermore, no significant relationship was found between serum 25OHD concentration and dominant and nondominant grip strengths ($p>0.05$). In addition, BMI was not associated with dominant and nondominant grip strengths ($p>0.05$).

Conclusion: These results of this study provide evidence that vitamin D is not effective on grip strength at least in premenopausal Turkish women.

Keywords: Cross-sectional study, grip strength, serum 25OHD, vitamin D deficiency

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INTRODUCTION

Hand grip strength is a test, which is measured by a dynamometer, to evaluate the isometric muscle strength of the hand and forearm (1). It is also recommended as a predictor of general muscle strength (2). Grip strength is an important indicator about health, because low levels have been reported to be associated with various comorbidities; increased risk of falls, hospital stay, and mortality; and decreased quality of life (3). Therefore, in studies investigating the factors affecting muscle health, grip strength is very important.

Vitamin D has recently attracted great attention due to its beneficial roles on human health, such as positive calcium balance, immunomodulation, and protection from some systemic diseases, such as cancer (4). Many evidences, especially in animal experiments, indicate that vitamin D has an effect on muscle metabolism. The probability that vitamin D may play a significant role in muscle function has been increased by the demonstration of the vitamin D receptor (VDR) in human skeletal muscle (5). Vitamin D is thought to affect the muscle cell in two ways: (1) nongenomic effect on membrane receptors that affect intracellular and extracellular calcium concentrations and (2) genomic effect leading to calcium-binding protein formation by binding to nuclear receptors (6).

The relationship between vitamin D deficiency and proximal muscle weakness was first sighted in participants with osteomalacia, and then the relationship between vitamin D status and grip strength was shown in the elderly with vitamin D deficiency (7, 8). As there are studies showing that there is no relationship between serum 25-hydroxyvitamin D (25OHD) concentration and grip strength (9, 10), there are also studies showing that serum 25OHD is related to grip strength (11–13). In recent meta-analyses, it has been suggested that vitamin D plays a positive role on proximal muscle strength and balance, but there is insufficient evidence of the relationship between serum 25OHD level and grip strength (14, 15). Moreover, no significant correlation was found between 25OHD concentration and grip strength in women by Wang et al. (9) and Kim et al. (10). In a study showing the positive impact of vitamin D treatment on grip strength and lower extremity isokinetic muscle strength, it was indicated that the increase in isokinetic muscle strength was more in the young age group (12). However, studies to date investigating the relationship between vitamin D and grip strength have focused on postmenopausal women or older men (16, 17). To our knowledge, there are few studies investigating the effect of serum 25OHD concentration on grip strength in premenopausal women (11, 18). In addition, the differences in the study protocols and the fact that

the important clinical factors affecting muscle metabolism, such as immobility of the included participants, cannot be taken into consideration enough make it difficult to understand the effect of vitamin D level on grip strength.

To clarify these issues, the present study was planned to determine the effect of serum 25OHD concentration on the grip strength of premenopausal sedentary women in the 40–50 age range.

MATERIALS and METHODS

This cross-sectional descriptive study included 127 women who were admitted to the Physical Medicine and Rehabilitation Outpatient Clinic between January 2019 and February 2019. The mean age of the women was 44.7±4.3 years. Women with an age range of 40–50 years, who had not received vitamin D treatment in the last 6 months, and who were sedentary (not exercising at least 30 min/week) were included in the study. The study was approved by the ethics committee of Kafkas University, Faculty of Medicine (date: 11/28/2018, decision no.: 16) according to the principles of the Declaration of Helsinki. Participants were informed about the study. Written informed consent was obtained from the women.

The presence of comorbidities that could affect vitamin D levels and physical performance was defined as exclusion criteria: liver and kidney diseases; rheumatologic, endocrine, and neurological diseases; gastrointestinal malabsorption; pain in the neck and upper extremity; trauma; or surgery history associated with upper extremity muscle and joints. Age, weight, height, and body mass index (BMI) values of all participants were recorded.

Serum 25OHD measurements were performed by chemiluminescence immunoassay methods (UniCel DxI 600; Beckman Coulter, USA and Canada). Serum samples were centrifuged for 10 min at 3000 rpm, and the separated serum sections were stored at –80°C and then used to analyze 25OHD levels. Participants were divided into three groups according to serum 25OHD level: vitamin D deficiency 25OHD <20 ng/ml, vitamin D insufficiency 25OHD ≤30 ng/ml, and vitamin D sufficiency 25OHD ≥30 ng/ml (10).

Both dominant and nondominant hand grip strengths were measured by using a digital hand dynamometer (Baseline Digital Dynamometer/12-0288) (in kg units) by taking the average of three measurements of maximal contraction according to the recommendation of the American Society of Hand Therapist (19). The participants sat in a chair and gripped the dynamometer with elbow flexed at 90° and wrist at neutral position. The time between each measurement was approximately 60 s.

Statistical Analysis

SPSS 22.0 program (SPSS Inc., Chicago, IL, USA) was used for statistical analyses. Mean, standard deviation, median (minimum–maximum), number, and frequency values were used in the analyses. Kolmogorov–Smirnov test was used to measure the distribution of the variables. One-way analysis of variance and Kruskal–Wallis H test were used in the analysis of quantitative independent data. Levene test was used to measure variance homogeneity. Paired Wilcoxon test was used in the analysis of dependent quantitative data, Pearson chi-square test in the analysis of qualitative independent data, and Fisher's exact test was used when the Pearson chi-square test circumstances were not met. Spearman correlation test was used for correlation analysis. A p value of <0.05 was considered as statistically significant.

Table 1. Characteristics of the study population

	Min.-Max.	Med.	Avg.±SD
Age (years)	40.0–50.0	44.5	44.7±4.3
Height (cm)	145.0–172.0	160.0	159.5±5.7
Weight (kg)	50.0–115.0	75.0	76.6±12.3
BMI (kg/m^2)	20.0–44.9	29.4	30.2±5.3
BMI<30	69	54	
BMI≥30	58	46	
Educational status (n, %)			
Illiterate	31	24.4	
Primary school	11	8.7	
Secondary school	58	45.7	
High school	13	10.2	
University	14	11.0	
Dominant hand (n, %)			
Right	121	4.7	
Left	6	70.9	
Vitamin D status (n, %)			
Deficient	90	70.9	
Insufficient	23	18.1	
Sufficient	14	11.0	
Serum 25OHD (ng/mL)	2.1–49.8	14.4	16.4±9.7
Grip strength (kg)			
Dominant hand	10.1–39.9	24.3	24.2±5.9
Nondominant hand	8.8–36.5	22.2	22.5±5.7

Min.: Minimum; Max.: Maximum; Med.: Median; Avg.: Average; SD: Standart deviation; BMI: Body mass index; p<0.05 was considered as statistically significant

RESULTS

A total of 127 premenopausal sedentary women in the 40–50 age range were included in the present study. The descriptive characteristics of the participants are presented in Table 1 (mean age 44.7±4.3 years). The mean serum 25OHD concentration of all participants was 16.4±9.7 ng/ml (Table 1). Vitamin D deficiency, insufficiency, and sufficiency rates were 70.9%, 18.1%, and 11.0%, respectively (Table 2). The mean dominant hand grip strength was 24.2±5.9 kg, and the mean nondominant hand grip strength was 22.5±5.7 kg. The mean BMI of the included women was 30.2±5.3 kg/m^2. Of the 127 women, 54% had a BMI <30 kg/m^2, whereas 46% had a BMI ≥30 kg/m^2 (Table 1).

When the participants were divided into three groups as vitamin D deficiency, insufficiency, and sufficiency, a statistically significant difference was not found between the groups with respect to age, height, weight, BMI value, educational status, and dominant and nondominant grip strengths (p>0.05) (Table 2, Fig. 1). In women with BMIs <30 kg/m^2 and ≥30 kg/m^2, a statistically significant dif-

Table 2. Comparison of clinical characteristics according to vitamin D status groups

	Deficient		Insufficient		Sufficient		p
Age (years), Med. (Min.–Max.)	44.0 (34–51)		44.0 (35–50)		46.0 (40–50)		0.222[K]
Height (cm), Med. (Min.–Max.)	160.0 (145–170)		160.0 (150–172)		159.0 (150–170)		0.580[K]
Weight (kg), Med. (Min.–Max.)	77.5 (50.0–115.0)		72.0 (54.0–95.0)		72.0 (55–106)		0.583[K]
BMI (kg/m^2), Med. (Min.–Max.)	29.7 (20.0–44.9)		29.4 (21.1–42.2)		27.5 (21.5–39.4)		0.638[K]
	n	**%**	**n**	**%**	**n**	**%**	
Education status							
Illiterate	25	27.8	2	8.7	4	28.6	
Primary school	7	7.8	3	13.0	1	7.1	
Secondary school	43	47.8	12	52.2	3	21.4	0.069[XI]
High school	7	7.8	3	13.0	3	21.4	
University	8	8.9	3	13.0	3	21.4	
Dominant hand							
Right	88	97.8	20	87.0	13	92.9	0.083[XI]
Left	2	2.2	3	13.0	1	7.1	
Grip strength (kg), Avg.±SD							
Dominant hand	23.8±6.2		25.1±4.9		24.9±5.6		0.601[A]
Nondominant hand	22.0±6.0		23.7±4.8		23.8±5.2		0.320[A]

Med.: Median; Min.: Minimum; Max.: Maximum; BMI: Body mass index; Avg.: Average; SD: Standart deviation; A: ANOVA; K: Kruskal Wallis H test; XI: Chi-square (pearson) test; p<0.05 was considered as statistically significant

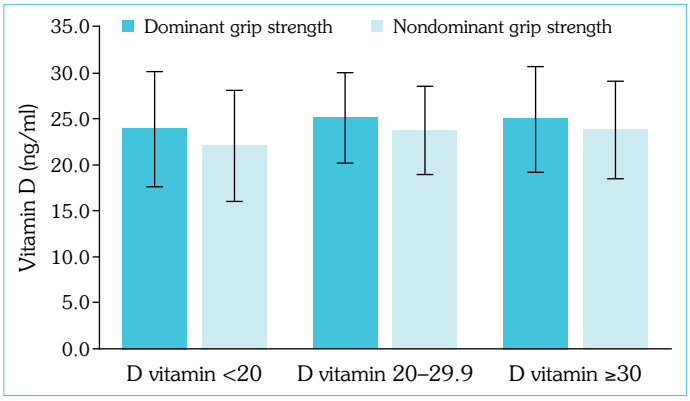

Figure 1. Comparison of grip strength according to vitamin D status

ference was not found with respect to dominant and nondominant grip strengths (p>0.05) (Table 3).

There was no statistically significant relationship between serum 25OHD concentration and dominant and nondominant grip strengths in Spearman correlation test (p>0.05). Additionally, BMI value was not significantly associated with dominant and nondominant grip strengths (p>0.05). The correlation coefficient is shown in Table 4.

DISCUSSION

Premenopausal sedentary women between the ages of 40 and 50 years were evaluated in the present study, and a significant difference was not found in the analyses between serum 25OHD concentration and grip strength (p>0.05). In addition, there was no significant difference between vitamin D status, defined as deficiency, insufficiency, and sufficiency, and grip strength (20). The results of the present study indicate that there was no distinct effect of vitamin D on the grip strength of premenopausal Turkish women. The effect of vitamin D on muscle function has been described in vitamin D deficient animal studies. In these studies, skeletal muscle abnormalities have been shown in animal models of vitamin D deficiency separately of other secondary metabolic status (21). Vitamin D can generate these effects with two mechanisms: genomic and nongenomic. In the first mechanism, vitamin D can induce the synthesis of myogenic transcription factors and contractile proteins that affect cell proliferation and differentiation by nuclear VDR-related gene transcription in myoblasts (22, 23). The effects on the nongenomic path may occur rapidly, and vitamin D may interact with the calcium system to increase signal transduction, affecting skeletal muscle contraction (24). Despite animal studies that clearly define the role of vitamin D on skeletal muscle, the effects of vitamin D on human muscle remain controversial due to inconsistent clinical outcomes (10, 16, 25).

Participants who had different vitamin D and/or muscle metabolism properties were evaluated in the previous studies investigating the relationship between serum 25OHD level and grip strength. This may be the cause of incompatible results. The results of the present study, in which both serum 25OHD concentration and vitamin D status were not found to be related with grip strength, were different from the study by Kalliokoski et al. (26) that defined the linear association between 25OHD concentration and grip strength. In addition, the results were also different from the study

Table 3. Comparison of grip strength according to body mass index

	BMI <30		BMI ≥30		
	Avg.±SD	Median	Avg.±SD	Median	p
Grip strength (kg)					
Dominant hand	24.0±5.7	24.2	24.4±6.3	24.7	0.745[t]
Nondominant hand	22.3±5.6	22.0	22.8±5.9	23.1	0.465[t]

BMI: Body mass index; Avg.: Average; SD: Standart deviation; t: t test; p<0.05 was considered as statistically significant

Table 4. Associations between grip strength, 25OHD concentration and body mass index

	Dominant hand grip strength		Nondominant hand grip strength	
	Rho	p	Rho	p
Serum 25OHD (ng/mL)	0.13	0.14	0.12	0.18
BMI (kg/m^2)	0.00	0.97	0.02	0.80

Spearman correlation; BMI: Body mass index; p<0.05 was considered as statistically significant

by Granlund et al. (11) which asserts the relationship between vitamin D deficiency and grip strength. In their study, unlike our study, postmenopausal women were considered, and vitamin D deficiency was described as serum 25OHD <10 ng/ml (11). In another study conducted on postmenopausal women who are older than 50 years, women with 25OHD <30 ng/ml were shown to have lower grip strength and lower extremity muscle strength than those with normal serum vitamin D levels (25). Moreover, Lee et al. (27) suggested that vitamin D levels in postmenopausal women with radius fracture are correlated with grip strength, and that grip strength increases with vitamin D supplementation. The results of another study evaluating women between the ages of 25 and 60 years reported that vitamin D is related with grip strength (18). Differences in definitions and patient characteristics may explain the difference in our results.

In a population-based study conducted by Kim et al. (10), no significant relationship was found between serum 25OHD concentration and grip strength in men who are older than 50 years and postmenopausal women. When subjects were separated into three groups as deficient, insufficient, and sufficient (25OHD <20 ng/ml, 63.8%; 25OHD ≤30 ng/ml, 30.0%; and 25OHD ≥30 ng/ml, 6.2%), a significant difference was not found in grip strength among these groups in this study (10). In a recent study, which included 5102 participants, Wang et al. (9) reported that there is a significant relationship between vitamin D concentration with grip strength in men aged ≥50 years, but no relationship was found in men aged <50 years and women of all age groups. In recent meta-analyses, it has been suggested that there is not enough evidence of the relationship between vitamin D and grip strength (14, 15). The results of this study are compatible with the studies indicating that there is no relationship between serum 25OHD concentration, vitamin D status, and grip strength.

Although the reason for the deficiency of the connection between vitamin D concentration and grip strength was not determined in the present study, the results differing from some other studies can be explained by differences in study designs, other factors that may affect grip strength, and/or the difference in grip strength measurement methods. The present study was planned considering age, gender, physical activity, menopause, and other disease states that could be effective on grip strength. However, distractive factors, such as sunlight exposure, protein intake, and other dietary habits, may have compensated for the roles of vitamin D on skeletal muscle metabolism. In the present study, the average of three grip strength measurements with dominant and nondominant hand power was recorded for analyses (10, 11, 19), although different measurement methods have also been used for both hands in other clinical practice and muscle research (28). At the end of this study, it was concluded that there was no statistically significant relationship between grip strength and BMI. Compatible with this result, any correlation between grip strength and BMI in young postmenopausal women has not been found in the study by Garcia et al. (29), but some studies have found a weak correlation (30).

The most important aspect of the present study was the evaluation of only premenopausal sedentary women in the 40–50 age range. The study was conducted considering many important factors, such as age, menopause, and physical activity, which may affect grip strength. In addition, all women were from the same region, and their evaluation in January–February was important with respect to grip strength and vitamin D level.

In addition, this study had some limitations. A small sample size was one of them. Since this was a cross-sectional study, a causal relationship was not determined between serum 25OHD status and grip strength. Moreover, it is known that cultural, environmental, and genetic factors can be effective on vitamin D metabolism and grip strength. Furthermore, we did not have specific knowledge of other factors, such as smoking, protein intake, and nutrient status.

In summary, there is no consensus on the correlation between serum vitamin D concentrations and muscle function in the literature due to differences in study designs and the heterogeneity of the cases involved. This study suggests that 25OHD concentration and vitamin D status were not related with dominant and nondominant grip strengths in premenopausal women in the 40–50 age range. Under favor of this study, clinical evidence was provided that the important function of vitamin D on human skeletal muscle metabolism may not be definite at least in premenopausal Turkish women. To explain the relationship between serum 25OHD concentration and grip strength, future studies are needed considering age and sex characteristics.

Ethics Committee Approval: The study was approved by the ethics committee of Kafkas University, Faculty of Medicine (date: 11/28/2018, decision no.: 16) according to the principles of the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors have no conflict of interest to declare.

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