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Title: Does Vitamin D Level Affect Grip Strength: a Cross-sectional Descriptive Study

Running Title: Does Vitamin D Level Affect Grip Strength

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Abstract

Although there is increasing evidence about the role of vitamin D on muscle function, its relationship with grip strength is still a controversial issue. In this cross-sectional clinical study, it was planned to evaluate the relationship between vitamin D and grip strength in premenopausal Turkish women. A total of 127 women with age range of 40-50 years (mean age: 44,7±4,3), premenopausal, sedentary, were included in this cross-sectional descriptive study. The mean BMI was 30.2 ± 5.3 kg/m2. Dominant and nondominant grip strength was measured by digital hand dynamometer. The mean dominant grip strength was 24.2 ± 5.9 kg and the mean nondominant grip strength was 22.5 ± 5.7 kg. Mean serum 25-hydroxyvitamin D (25OHD) concentrations were 16.4 ± 9.7 ng / ml. Participants were divided into 3 groups as vitamin D deficiency (70.9%), insufficiency (18.1%), sufficiency (11.0%). No statistically significant difference was found between the groups in terms of age and body mass index (BMI), dominant and nondominant grip strength ($p > 0.05$). Furthermore, no significant relationship was found between serum 25OHD concentration and dominant and nondominant grip strength ($p > 0.05$). In addition, BMI was not associated with dominant and nondominant grip strength ($p > 0.05$). 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

INTRODUCTION

Hand grip strength is a test, which is measured by a dynamometer, evaluates 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, quality of life, hospital stay and mortality (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 evidence, especially in animal experiments, indicates 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 demonstration of 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 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 relation 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-hidroxyvitamin D (25OHD) concentration and grip strength (9, 10), also there are studies showing that serum 25OHD is related to the grip strength (11-13). In recent meta-analyzes, it has been suggested that vitamin D has 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 the grip strength and the lower extremity isokinetic muscle strength, it was indicated that the increase in isokinetic muscle strength was more in the young age group (12). But studies to date investigating the relationship between vitamin D and grip strength have focused on postmenopausal women or older men (16, 17). As far as we know, 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, makes it difficult to understand the effect of vitamin D level on grip strength.

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In order to clarify these issues, this 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.

MATERIAL AND METHOD

This cross-sectional descriptive study included 127 women (mean age: 44.7±4.3) who were admitted to the Physical Medicine and Rehabilitation Outpatient Clinic between January and February 2019. Women with age range of 40-50 years, who had not received vitamin D treatment in the last 6 months and were sedentary (not exercising at least 30 minutes a week), were included in the study. The ethics committee of Kafkas University Faculty of Medicine approved this study (date: 28.11.2018/ decision no:16). Participants were informed about the study and their written informed consent was obtained. The principles of Declaration of Helsinki were complied with at all stages of the study.

The presence of comorbidities that could affect vitamin D levels and physical performance were 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 (Beckman coulter, UniCel DxI 600, US and Canada). Serum samples were centrifuged for 10 minutes at 3000 rpm and the separated serum sections were stored at -80 ° C and then

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used to analyze 25OHD levels. Participants were divided into 3 groups according to serum 25OHD level: vitamin D deficiency 25OHD < 20 ng/ml; vitamin D insufficiency 20 ≤ 25(OH)D < 30 ng/ml; or vitamin D sufficiency 25OHD ≥ 30 ng/ml (10).

Both dominant and nondominant hand grip strength was measured by using a digital hand dynamometer (Baseline Digital dynamometer / 12-0288) (in kg units) by taking the average of 3 measurements of maximal contraction according to the recommendation of American Society of Hand Therapist (19). The participants sat in a chair and gripped the dynamometer with elbow flexed at 90_0 and wrist at neutral position. The time between each measurement was approximately 60 second.

Statistical Method

In analyses; mean, standard deviation, median (minimum-maximum), number and frequency values were used. The distribution of the variables was measured by Kolmogorov Simirnov test. One-way analysis of variance (ANOVA) and Kruskal-Wallis H test was used in the analysis of quantitative independent data. The variance homogeneity was measured by Levene test. The paired Wilcoxon test was used in the analysis of dependent quantitative data, Pearson chi-square test in the analysis of qualitative independent data and the Fisher exact test was used when the Pearson chi-square test circumstances were not met. Spearman correlation test was used for correlation analysis. SPSS 22.0 program was used in the analyses. Statistical significance was defined as p values of <0.05.

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RESULTS

A total of 127 premenopausal sedentary women in the 40-50 age range were included in this study. Descriptive characteristics of participants presented in Table 1 (mean age 44.7 ± 4.3). The mean serum 25OHD concentration of all participants was 16.4±9.7 ng/ml (Table 1). Vitamin D deficiency, insufficiency and sufficiency rate 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 included women were 30.2 ± 5.3 kg/m2. 54 % of women were BMI <30 kg/m2, while 46% of women were BMI ≥30 kg/m2 (Table 1).

When the participants were divided into three groups as vitamin D deficiency, insufficiency and sufficiency, statistically significant difference was not found between the groups in terms of age, height, weight, BMI value, educational status, dominant and nondominant grip strength ($p > 0.05$) (Table 2, Figure 1). In women with BMI <30 kg/m2 and ≥ 30 kg/m2, the statistically significant difference was not found in terms of dominant and nondominant grip strength ($p> 0.05$) (Table 3).

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

DISCUSSION

Premenopausal sedentary women between the ages of 40-50 years were evaluated in this study and the significant difference was not found in the analyzes between the serum 25OHD concentration and grip strength ($p>0.05$). Also there was no significant difference between the vitamin D status, that defined as deficiency, insufficiency, sufficiency and grip strength (20). The results of this study indicate that there was no distinct affect of vitamin D on

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the grip strength of premenopausal Turkish women. The affect 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 affects 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). 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 this study, in which both serum 25OHD concentration and vitamin D status were not found related with grip strength, was different from the study of Kalliokoski et al. (26) that defining the linear association between 25OHD concentration and grip strength. In addition, this results also different from the study of Granlund et al. (11) which asserts the relation between vitamin D deficiency and grip strength. In this 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 which 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). Also, Lee et al. (27) suggested that vitamin D levels in postmenopausal women with radius fracture correlated with grip strength, and that grip strength increased with vitamin D supplementation. The results of another study evaluating women between the ages of 25 and 60 was in the way that vitamin D is related with the grip strength (18). Differences in definitions and patient characteristics may explain the difference in our results.

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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 which 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%; 20 ≤ 25(OH)D < 30 ng/mL, 30.0%; 25OHD ≥ 30 ng/mL, 6.2%), the 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 was significantly relation between vitamin D concentration with grip strength in men aged ≥ 50 years, but no relationship was found in men aged<50 and women of all age groups. In recent meta-analyzes, 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 connection between vitamin D concentration and grip strength was not determined in this study, the results differing from some other studies can be explained by differences in study designs, other factors that may affect the grip strength and/or the difference in grip strength measurement methods. This study was planned considering the 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 this 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 has 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 this result, any correlation between grip strength and BMI in the young postmenopausal women have not to be found in the study by Garcia et al. (29) but some studies have found a weak correlation (30).

The most strength aspect of this study was the evaluation of only premenopausal sedentary women in the 40-50 age range. The study was carried out considering the important factors such as age, menopause and physical activity which may affect the grip strength. In

addition, all women were from the same region and their evaluation in January-February was important in terms of grip strength and vitamin D level.

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

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

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Table 1. Characteristics of 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/m2)		20.0 - 44.9	29.4	30.2 ± 5.3
BMI<30				69 54%
BMI≥30				58 46%
Education status				
illiterate (n-%)				31 24.4%
primary school (n-%)				11 8.7%
secondary school (n-%)				58 45.7%
high school (n-%)				13 10.2%
university (n-%)				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

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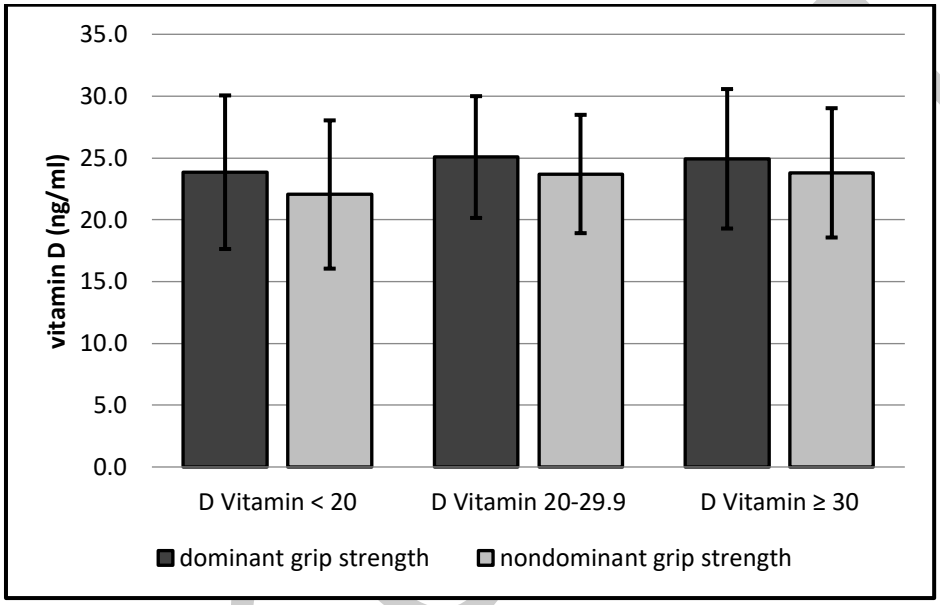
Figure 1. Comparison of grip strength according to vitamin D status



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