



Associations between Handgrip Strength and Vitamin 25(OH)D Levels in Geriatric Patients

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Introduction: Thirty percent of the muscle mass is lost between the third and eighth decades of life. Vitamin D may have different roles in different aspects of the muscle cell function.

Aim: To assess the correlation between vitamin 25(OH)D levels, handgrip strength (HGS), and finger pinch strength (FPS) in elderly.

Materials and methods: This was a clinical observational study. It included a total of 92 patients of 65 years and over with good general health status and 66 young healthy volunteers. They all underwent HGS and FPS measurements. Study groups were further stratified into those with a serum 25(OH)D levels higher than 30 ng/dl and those with lower than 30 ng/dl.

Results: When geriatric patients were divided into two groups based on 25(OH)D levels, no statistically significant intergroup differences were found in FPS ($p > 0.05$) while statistically significant differences were found in HGS ($p < 0.05$). The analysis of the correlations between HGS and 25(OH)D concentrations revealed a positive, statistically significant correlation between these two parameters at $r = 0.330$ ($p < 0.05$).

Conclusions: This study demonstrated that serum vitamin 25(OH)D levels have an impact on HGS in both geriatric group and control group.

Key words:

vitamin D, hand grip strength, sarcopenia

INTRODUCTION

The percentage of the population aged 65 years and older is increasing due to recent technological advances and improved healthcare services. However, this increase has subsequently increased the prevalence of certain medical conditions such as decreased global performance, decreased motor coordination and dexterity.^{1,2} In addition to healthcare conditions, a reduced social and functional capability of these patients is associated with inability to perform activities of daily living.² Although the levels of physiological losses may vary from person to person, loss of whole body

skeletal muscle mass is a common finding among elderly.³ Loss of lean body mass and associated reduced musculoskeletal performance may lead to a frailty syndrome and disability and dependency, frequent falls and hospitalization which ultimately may result in a reduced quality of life.⁴ Thirty percent of muscle mass is lost between the third decade and eighth decade of life and muscle mass losses may reach up to 15% per decade until the age of 70.^{3,4} These alterations in the muscle mass may also impair hand functions, which have a significant role in our activities of daily living. This impairment may cause dependency in activities of daily living along with social and psychological problems.^{1,2} Muscle strength is a major determinant of

hand functions and is best measured by a dynamometer. Handgrip strength (HGS) reflects a maximum strength obtained from combined contraction of extrinsic and intrinsic hand muscles leading to the flexion of the finger joints.⁵ A weak handgrip represents a general weakness in humans and has been found to be associated with mortality in previous studies.^{6,7} Measurement of HGS is recommended as a measure of muscle strength and is the simplest modality to assess muscle functions in clinical practice.⁵ There are studies demonstrating that HGS and finger pinch strength (FPS) is decreasing with aging, notably after the age of 60, the grip strength measurements peaked in the age group 25-34 years for male and in the age group 35-44 years for female subjects.⁸

HGS measurements are increasingly used in clinical practice to assess sarcopenia, frailty and malnutrition.⁹ Puig-Domingo et al.¹⁰ defined HGS measurements as the best supplementary tool to assess muscle strength. HGS is a risk factor for mobility, functional status and mortality.¹¹ Moreover, another study has determined associations between HGS and functional performance.¹²

In recent years, vitamin D deficiency has become a global public health problem particularly in young children, pregnant women and older adults.¹³ Vitamin D has a crucial role in preventing osteomalacia and secondary hyperparathyroidism and in maintaining bone and mineral homeostasis, particularly in older adults.^{13,14} Vitamin D has been found to contribute bone health, independently from calcium regulation.¹³ The impacts of vitamin D levels on muscle mass have been investigated in several recent studies.¹⁴ Vitamin D status is assessed by serum 25-hydroxyvitamin D (25(OH)D) concentrations and low vitamin D levels have been linked to the loss of muscle strength and muscle volume. Vitamin D has been assumed to mediate the impacts on muscle mass by creating an increased mechanical stress that may increase bone mass.¹⁴ Furthermore, there are also studies indicating potential contribution of vitamin D intake to muscle mass building.¹⁵ Therefore, the way of vitamin D to affect muscle function has been extensively studied during the recent year.¹⁵ Thirty years ago, the nuclear vitamin D receptor (VDR) was first demonstrated in human and animal cells, although the presence of this receptor was confirmed 15 years later.^{15,16} Unlike previous studies, Wang and De Luca¹⁶ could not find VDRs in skeletal muscles in a recent study and this finding may be explained by the mediation of vitamin D in the transformation of myoblasts into mature muscle fibers as well as the effects of vitamin D on various aspects of muscle cell functioning such as proliferation and differentiation.¹⁷ Vitamin D may have different roles in different aspects of the muscle cell function. Vitamin D may rapidly induce changes in intracellular calcium concentrations probably by its actions on membrane-bound receptors rather than the genomic pathway.¹⁷ Histological evidence of muscle fiber atrophy, predominantly in type II muscle fibers has been defined in patients with vitamin D deficiency.¹⁷ Janssen et al.¹⁸ observed an association between total muscle mass and

vitamin D levels in a study in middle age men and women.

Possible associations between muscle strength and vitamin D are not clear, some studies claim that lower levels of vitamin D associated with muscle strength in elderly population, while others did not identify any such difference.^{19,20} In this study, we aimed at assessing associations between 25 (OH) D levels and rough HGS and FPS which may give us an opinion on actual functional state and future level of dependence in activities in daily living and mortality.

MATERIALS AND METHODS

Patients aged 65 years and over with knee osteoarthritis, lumbar spondylosis, attending Physical Therapy and Rehabilitation Outpatient Clinics of our hospital for routine follow-up visits were assessed in this observational, clinical study. The Turkish version of Mini Mental State Examination²¹ was used to assess cognitive functions of study subjects and those who scored 25 and more were included in this study. A control group of healthy volunteers (age range: 18-50 years) from hospital staff who agreed to participate in the study was also included in the study. The approval for this clinical study was obtained from the Institutional Review Board. All patients were informed about the study and a signed consent form was obtained from each patient.

Exclusion criteria were orthopedic or neurological diseases that may lead to weakness of the hand muscles, central and peripheral nervous system disorders, erosive osteoarthritis of finger joints, rheumatologic conditions affecting the hand, primary endocrine disorder leading to a secondary vitamin D deficiency, severe osteoporotic patients.

Out of a study sample of 172 subjects, 92 geriatric patients and 66 controls were included in the study (**Fig. 1**). Demographic characteristics of the subjects were recorded; every subject underwent HGS and FPS measurements and the results were noted. The body mass index (BMI) was calculated as kg/m². Serum concentrations of 25(OH)D of volunteers were determined by automated chemiluminescence immunoassay method (Siemens, Advia Centaur XP). Study groups were further stratified into those with serum 25(OH)D levels higher and equal to 30 ng/ml and lower than 30 ng/ml.

EVALUATION PARAMETERS

1) Hand Grip Strength (HGS): A standard hand dynamometer (Jamar® Plus+ Digital Hand Dynamometer from Patterson Medical by Sammons Preston) was used to measure grip strength. HGS was measured by an independent physical therapist. Since the reliability and validity of Jamar dynamometer is evaluated as high, it has been considered a gold standard in the assessment of grip strength.²² The test was performed in the sitting position with the shoulder of tested arm adducted, the elbow flexed at 90°, whereas the forearm and wrist were set in neutral position. Grip strength tests were performed three times with 1 minute intervals and the average of three measurements was cal-

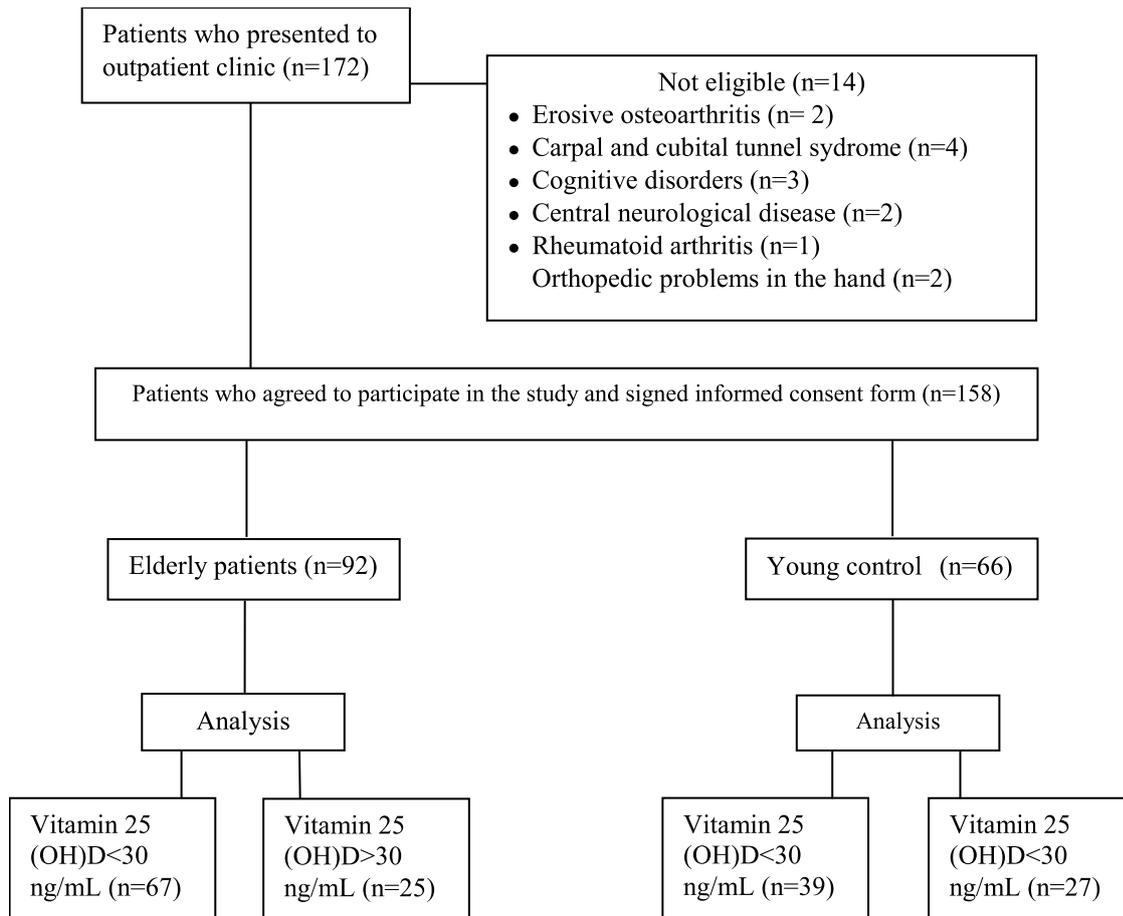


Figure 1. Flow diagram.

culated. For both measures the values between 0.2 and 0.5 indicated a low responsiveness, the values in the range of 0.51–0.8 were moderate and >0.8 showed a high level of responsiveness.²³

2) Finger Pinch strength (FPS): Patients' pinch strength was tested using a pinch meter (Jamar® Pinch Gauge, USA). Tip pinch was the type of pinch tested in the study. The pinch meter was pinched between the tip of the thumb and the tip of the index finger to measure the pinch strength. Patients were asked to pinch as hard as they could. The test was repeated three times and the average of three measurements was recorded in kilograms. The reliability and validity of the pinch strength test was shown by Mathiowetz et al.²⁴

STATISTICAL ANALYSIS

The data analysis was performed by IBM SPSS 23.0 statistics software package. Descriptive statistical methods (frequency, percentage, mean, standard deviation, median, min-max) were used to assess the study data. The Shapiro-Wilk test was used to check whether the data were normally distributed. The data showed no normal distribution. Mann-Whitney U test was used to make intergroup

comparisons. Chi-square test and Fisher test were used to compare categorical data. The relationships between variables were assessed using Spearman's rho correlation test. The results were evaluated in a confidence interval of 95% and statistical significance was set at $p < 0.05$.

RESULTS

Ninety-two geriatric patients (mean age \pm SD 69.34 \pm 5.19 yrs) and 66 healthy controls (mean age \pm SD 41.69 \pm 6.28 yrs) were included in this study. No statistically significant intergroup differences were found in sex and BMI ($p > 0.05$) (**Table 1**).

Serum 25(OH)D levels were compared between geriatric group and younger healthy controls. Serum vitamin D levels below 30 ng/ml were determined in 67 (72.8%) subjects from the geriatric group and in 39 (59.09%) subjects from the younger and healthy controls. The mean serum 25(OH)D concentration in elderly patients was lower (22.87 \pm 14.35 ng/ml) than that of the control subjects (25.59 \pm 13.68 ng/ml), however the difference was not statistically significant ($p > 0.05$) (**Table 1**).

HGS and FPS scores were found to be statistically significantly lower in the geriatric group than those in healthy controls ($p < 0.05$) (**Table 1**). In geriatric group, HGS and FPS scores were statistically significantly lower in women (female HGS 40.60 ± 11.37 , male HGS 52.90 ± 15.66 ; $p = 0.028$; female FPS 9.66 ± 2.54 ; male FPS 14.27 ± 3.43 ; $p = 0.001$). But in healthy control group no statistically significant difference were found between women and men (female HGS 46.09 ± 8.36 , male HGS 48.22 ± 9.75 ; $p = 0.451$; female FPS 11.23 ± 2.64 ; male FPS 12.00 ± 2.80 ; $p = 0.397$)

When geriatric patients were divided into two groups based on the 25(OH)D levels, no statistically significant intergroup differences were found in age, sex and BMI and FPS ($p > 0.05$) while statistically significant differences were found in HGS ($p = 0.009$) (**Table 2**).

When control subjects were divided into two groups based on the 25(OH)D levels, statistically significant intergroup differences were found regarding HGS ($p < 0.001$) and FPS ($p = 0.002$) (**Table 3**).

The analysis of the correlations between HGS and 25(OH)D concentrations revealed a positive for all participants, statistically significant correlation between these two parameters at Spearman's $\rho = 0.330$ ($p < 0.05$). Furthermore, the analysis of the correlations between FPS and 25(OH)D concentrations revealed a positive, statistically significant correlation between these two parameters at Spearman's $\rho = 0.167$ (**Table 4**). When we analyzed the correlation between HGS, FPS and 25(OH)D concentrations of geriatric and young groups, a positive statistically significant Spearman's ρ correlation between HGS and 25(OH) D vit for both groups ($p < 0.05$) was found, for FPS only in the young group has positive correlation with vitamin 25(OH) D ($p < 0.05$) (**Table 5**).

DISCUSSION

In our study, we found statistically significant reduction in HGS and FPS in geriatric patients compared to younger population (**Table 1**). Also we found lower HGS scores in

vitamin D deficient subjects both from geriatric and young adult groups (**Table 2,3**). We found negative correlation between FPS and HGS scores and serum 25(OH)D vitamin level in both groups (**Table 4**).

In a study assessing HGS and hand skills, Desrosiers et al.¹ reported that the functional capacity was reduced over the years, while baseline values played a major role in this result rather than the age. A number of factors may be involved in reductions in HGS, including diabetic neuropathy and cognitive impairment.² Neither patients with diabetic neuropathy nor patients with cognitive impairment were included in this study. In a study conducted by Giampaoli et al.² HGS readings were assessed in elderly male subjects who were independent in activities in daily living and these subjects were followed up for four years. A decline in the ability to perform activities of daily living occurred at a higher rate in subjects with lower HGS. In a study performed by Lenard et al.²⁵ HGS was found to be 64.3% lower in elderly and a negative correlation was reported between HGS and physical activities. The measurements revealed that the right hand possessed 10% greater grip strength than the left hand and HGS readings were two times higher in male subjects than that in female subjects. Ultimately, they found age related declines in the measurements used to assess HGS, physical activities and psychological state. They concluded that physical frailty rates increased as the HGS decreased in elderly. In our study, HGS and FPS were found to be significantly lower in elderly compared to healthy controls aged between 18 and 50 years.

Previous studies reported associations between vitamin D levels and muscle strength in elderly. Serum vitamin D concentration was defined as a risk factor for a weak hand-grip in elderly German patients,¹⁹ while another study did not reveal such associations in elderly female patients²⁰. In a study conducted by Janssen et al.¹⁸ total muscle mass, rough HGS, knee extension strength and physical performance were assessed in male and female patients aged between 40 and 80 years and they concluded that higher serum vitamin D levels were associated with an increased muscle mass, a greater rough HGS and higher physical performance. Viss-

Table 1. Comparison of intergroup demographic characteristics, HGS, FPS, vitamin 25(OH)D values of the subjects

	Elderly group (n=92)	Young controls (n=66)	p value
Age (years)	67 (65-85)	43 (24-50)	<0.001
Gender (Female/Male)	81/11 (%88/%12)	51/15 (%77/%23)	0.084
BMI (kg/m ²)	30.11 (18.67-77.0)	26.96 (20.07-40.0)	0.087
Vitamin 25(OH)D (ng/ml)	19.10 (5-70.50)	26.65 (3.70-65)	0.121
HGS (kg)	42 (16-67.00)	46 (32.60-70.10)	0.006
FPS (kg)	10 (5-20)	11 (6-20)	0.003

BMI: body mass index, HGS: hand grip strength, FPS: finger pinch strength, median (min-max) is used without normal distribution. Statistical significance at $p < 0.05$.

Table 2. Comparison of values in elderly subjects by level of vitamin 25(OH)D

Elderly Group	Vitamin 25(OH)D		p value
	Low (n=67)	Normal (n=25)	
Age (years)	68 (65-89)	66 (65-81)	0.057
Gender (Female/Male)	60/7 (%90/%10)	21/4 (%84/%16)	0.482
BMI(kg/m ²)	29.82 (18.67-37.66)	25.84 (21.30-39.06)	0.231
HGS (kg)	38.50 (16-67.00)	46.5 (17.60-67.00)	0.009
FPS (kg)	10 (5-20)	9 (5-17)	0.500

BMI: body mass index, HGS: hand grip strength, FPS: finger pinch strength, median (min-max) is used without normal distribution. Statistical significance at p<0.05.

Table 3. Comparison of values of participants in the control group by the level of vitamin 25(OH)D

Young control group	Vitamin 25(OH)D		p value
	Low (<30 ng/ml) (n=39)	Normal (≥30 ng/ml) (n=27)	
Age (years)	44 (24-50)	43 (30-49)	0.501
Gender (Female/Male)	33/6 (%85/%15)	18/9 (%67/%33)	0.135
BMI (kg/m ²)	27.51 (20.07-40.0)	26.17 (20.31-37.46)	0.502
HGS (kg)	40.10 (32.60-58.30)	52 (42-70.10)	<0.001
FPS (kg)	10 (6-15)	12 (9-20)	0.002

BMI: body mass index, HGS: hand grip strength, FPS: finger pinch strength, median (min-max) is used without normal distribution. Statistical significance at p<0.05.

er et al.¹⁹ found higher losses of appendicular skeletal muscle mass after three years of follow up in elderly patients with lower serum 25(OH)D levels. In another study lower vitamin D levels were not found to be associated with lesser muscle mass in a population under the age of 65.²⁶ Associations were also found between vitamin D levels and muscle mass, muscle strength and performance.³⁷ In our study, lower HGS readings were observed in vitamin D deficient subjects both from geriatric and young adult groups. The thumb makes a major contribution to the functional capacity and fine skills of the hand.²⁴ Therefore, lateral pinch between the thumb and index finger was also assessed in this study. A decline in these values was also more prominent in the elderly group compared to readings in younger controls. FPS was found to be reduced in control subjects with lower vitamin D levels while no significant reduction was observed in FPS in geriatric patients with lower vitamin D levels. A number of factors including sarcopenia and frailty may affect muscle strength and the presence of these factors may explain this observation in elderly. However, the lack of concomitant factors in the younger group might suggest that the reduction in FPS might be a reflection of vitamin D deficiency alone.

In a study investigating the impact of vitamin D levels on muscle strength and function (gait speed, balance dynamometer and muscle strength in lower limbs) in women over the age of 65, investigators underlined that readings above 20 ng/dl are required for a proper muscle function.²⁷ In a study conducted by Bunout et al.²⁸ elderly male subjects participated a 9-month exercise program and a subset of participants received supplementary vitamin D (4000 IU daily) concurrently with training; this study did not report any synergistic effects of vitamin D supplements on the muscle strength and function. Muscle strength did not improve despite vitamin D supplementation in healthy elderly with average serum vitamin D concentrations (60-65 nmol/L).¹⁸ The reference range for serum vitamin D concentrations is controversial in the literature. Serum 25(OH) D3 level is the best clinical indicator of vitamin D status since it reflects the sum of cutaneous synthesis and dietary intake of vitamin D. In our study, we chose a cut-off level of 30 ng/ml for vitamin 25(OH)D, which has been accepted as a lower limit for vitamin D concentrations in meta-analyses investigating serum vitamin D concentrations necessary to prevent falls and fractures in elderly.²⁹ Furthermore, Medical Guidelines for Clinical Practice of the Association of

Table 4. Correlation between vitamin 25(OH)D and HGS groups

		Vitamin 25(OH)D (ng/ml)
HGS (kg)	Spearman's rho	0.330
	p value	0.000
FPS (kg)	Spearman's rho	0.167
	p value	0.015

HGS: hand grip strength, FPS: finger pinch strength

Table 5. Correlation of HGS with vitamin 25(OH)D for elderly patients and control group

			Vitamin 25(OH) D (ng/ml)
HGS (kg)	Elderly group	Spearman's rho	0.305
		P value	0.003
	Young control group	Spearman's rho	0.665
		p value	0.000
FPS (kg)	Elderly group	Spearman's rho	0.007
		p value	0.948
	Young control group	Spearman's rho	0.431
		p value	0.000

HGS: hand grip strength, FPS: finger pinch strength

Endocrinology also recommend a cut-off value of 30 ng/dl for vitamin D (serum 25(OH)D levels from 20 to 29 ng/ml: vitamin D insufficiency, serum 25(OH)D levels <20 ng/ml: vitamin D deficiency, serum 25(OH)D levels \geq 30: recommended levels).³⁰

LIMITATIONS

The most important limitation of our study is using healthy younger control group. We think that the another limitation of the study was the relatively small sample size.

CONCLUSION AND CLINICAL IMPLICATIONS

This study showed that serum vitamin 25(OH)D levels had an impact on HGS in both geriatric group and young group. It should be kept in mind that lower vitamin D levels may have a negative impact on rough HGS and vitamin

D deficiency may present with muscle weakness in upper extremity in elderly. Further studies with larger samples are needed.

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Взаимосвязь между силой сжатия руки и уровнем витамина 25 (ОН) D у гериатрических пациентов

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Введение: Тридцать процентов мышечной массы теряется между третьим и восьмым десятилетиями жизни. Витамин D может играть разные роли в разных аспектах функции мышечных клеток.

Цель: Оценить корреляцию между уровнями витамина 25 (ОН) D, силой сжатия руки (ССР) и силой сжатия пальцев (ССП) у пожилых людей.

Материалы и методы: Мы провели клиническое исследование методом наблюдения. В него вошли 92 пациента в возрасте 65 лет и старше с хорошим общим состоянием здоровья и 66 молодых здоровых добровольцев. Все они прошли измерения ССР и ССП. Исследовательские группы были далее разделены на группы с уровнем сыворотки 25 (ОН) D более 30 ng/dl и группы с уровнем сыворотки 25 (ОН) D ниже 30 ng/dl.

Результаты: Когда пожилые пациенты были разделены на две группы на основе уровней 25 (ОН) D, статистически значимых различий при ССП не обнаружено ($p > 0,05$), но статистически значимые различия были установлены при ССР. Анализ корреляций между ССР и концентрациями 25 (ОН) D выявил положительную, статистически значимую корреляцию между этими двумя параметрами при $r = 0,330$ ($p < 0,05$).

Выводы: Это исследование продемонстрировало, что сывороточные уровни витамина 25 (ОН) D оказывают воздействие на ССР как в гериатрической, так и в контрольной группах.