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RELATION BETWEEN HANDGRIP STRENGTH AND VITAMIN D IN COMMUNITY-DWELLING ELDERLY

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Abstract: *Background:* Grip strength is a predictor of morbidity, mortality and disability. Vitamin D deficiency is common in elderly and causes weakness in the proximal muscles. *Objective:* To assess the relationship between grip strength and vitamin D level in community-dwelling elderly. *Design:* Cross-sectional study. *Setting:* Outpatient clinic of Ain Shams University Hospitals. *Participants:* Community dwelling elderly who are 60 years old or more were included. *Measurements:* Correlate serum 25(OH)D level to grip strength (using Baseline® pneumatic squeeze handheld dynamometer). *Results:* Low vitamin D level is associated with decreased grip strength independent of age, sex, type of occupation and body mass index. Vitamin D, age and sex all significantly affect grip strength. *Conclusion:* Low vitamin D, advancing age and female sex are all associated with lower grip strength.

Key words: Handgrip strength, vitamin D, dynamometer, elderly.

Introduction

With the growth of the older population comes a parallel expectation of growth in the burden of age-related physical disability; therefore, identifying modifiable risk factors that prevent or delay the onset of physical disability is a public health priority (1).

Handgrip strength (GS) is predictive of morbidity, mortality and disability. It has become suitable for use as a general objective health indicator in population-based surveys (2).

The measurement of GS is inexpensive and can easily be carried out by trained survey interviewers in non-clinical settings (2). The age-dependent decline in GS has mainly been explained by the age-related decline in muscle mass (3), and muscle strength (4).

Low 25(OH) vitamin D [25(OH)D] levels are common in older adults. Data from the National Health and Nutrition Examination Survey 2000–2004 show that approximately one-third of adults aged 70 and older were vitamin D deficient (i.e. 25(OH)D < 20 ng/mL) and three-fourths were vitamin D insufficient (i.e. 25(OH)D < 30 ng/mL) (5). Older adults are at risk for low 25(OH)D levels because of reduced exposure to ultraviolet B radiation, reduced efficiency of pre-vitamin D synthesis in the skin, and inadequate vitamin D intake (6).

Low 25(OH)D levels may affect physical function through its direct role on muscle function (7). Laboratory, epidemiologic, and clinical studies demonstrate a direct effect of vitamin D on muscle strength. 1,25(OH)2D3 receptors have been identified in human muscle tissue (8), and patients with osteomalacia have a reversible myopathy associated to low vitamin D levels (9). Cross-sectional studies show that elderly people with higher 25(OH)D serum levels have an increased muscle strength. In elderly people who have muscle weakness – particularly in proximal muscles – have an associated low vitamin D levels (10).

The aim of this study was to assess the relationship between grip strength and vitamin D level in community-dwelling elderly.

Methods

Design

Cross-sectional over a period of 1 year.

Setting

Outpatient clinic of Ain Shams University Hospitals.

The study was approved by the ethical committee of the Faculty of Medicine, Ain Shams University.

Informed written consent was obtained from all participants.

All consecutive patients attending the geriatric

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outpatient clinic of Ain Shams University Hospitals during the year between March 2011 and March 2012, on 3 days of the week were enrolled in the study; excluding those having any of the exclusion criteria or refusing to participate.

Before inclusion in the study, every subject was assessed by history and examination to ensure the absence of any of the exclusion criteria which are: subjects with anomalies or deformities in the hands, diseases that cause weakness or tremors in the hands, people with cognitive impairment or depression, those with history of admission to acute care in the past 3 months and patients already on vitamin D supplementation.

Handgrip strength was then measured in every participant using Baseline® pneumatic squeeze handheld dynamometer after being given instructions on how to use it and a trial before the assessment. All subjects were instructed to sit on a chair without armrest with a straight back, and with the feet flat on the floor, shoulder adducted and neutrally rotated, elbow flexed at 90˚, forearm in neutral position and wrist between 0˚-30˚of extension and between 0˚-15˚ of ulnar deviation, as given by the American Society of Hand Therapy (11). To get maximum reliability of data collected, every subject was asked to squeeze the dynamometer for three times by each hand with a rest period of 60 seconds given between trials to overcome fatigue and alternating attempts between right and left hands. And in order to counterbalance any order effect of the starting hand, every other subject was instructed to begin with the dominant hand. The mean GS of each hand and both hands were the measurements used in the study "The normative values of GS used for elderly (between 60 and 85 years) were (10.74-12.54 PSI) in males and, (9.45-11.12 PSI) in females" (12). Serum levels of 25(OH)D were measured using 25-OH Vitamin D ELISA kit, Eagle Biosciences, Inc. and levels below 20 ng/ml were categorized as vitamin D deficiency, those between 20-30 ng/ml were categorized as insufficiency and 30-50 ng/ml were categorized as normal (13).

Results

The study included 132 subjects. Their mean age was 67.55±4.81years with the minimum being 60 and a maximum of 78 years. Most of the participants were in the 60-69 age group (69.7%). Sixty six of the participants were males while 66 were females. Of the participants; 47.7% had jobs that mainly required physical effort. Mean GS of all participants was 9.66±2.86 and their mean vitamin D level was 22.75±8.07 and there was a highly significant correlation between them ($R=0.96$, $P<0.001$).

Females had significantly lower mean GS (Right, left, and mean of both hands) when compared to males ($P<0.001$ in all). Even after division of the sample to groups (cases and controls) according to their GS, a highly significant difference between genders was found and females scored significantly less in both right and left hands (Table 1).

Mean vitamin D level was lower in those with low GS (16.74±4.71 ng/ml) when compared to subjects with

Table 1

Mean values of GS among sample and gender difference

	Hand	Gender	Mean	SD	T	P
All Subjects	Right	Males	11.96	2.46	10.15	< 0.001
		Females	8.04	1.96		
	Left	Males	11.10	2.48	9.44	< 0.001
		Females	7.43	1.97		
	Mean	Males	11.53	2.41	10.23	< 0.001
		Females	7.73	1.82		
Low GS	Right	Both	7.53	1.47		
		Males	8.49	1.18	3.54	0.001
		Females	7.22	1.43		
	Left	Both	7.12	1.63	2.95	0.005
		Males	7.91	1.05		
		Females	6.86	1.71		
Normal GS						
	Right	Both	12.53	1.7	9.64	< 0.001
		Males	13.05	1.5		
		Females	10.75	0.34		
	Left	Both	11.47	2.15	5.73	< 0.001
		Males	12.1	1.88		
		Females	9.32	1.58		

normal GS (28.77±5.96 ng/ml) and a highly significant positive correlation between right, left and mean GS and vitamin D level was found (r 0.74 P <0.001, r 0.61 P <0.001, and r 0.96 P <0.001 respectively) (Table 2).

Table 2
Regression analysis of the predictors of mean grip strength of both hands

	Odds Ratio	SE	P value	95% Confidence Interval Lower	Upper
Sex	5.008	0.175	< 0.001*	1.225	0.531
Age	3.158	0.147	0.002*	0.754	0.173
BMI(1)	0.552	0.139	0.582	0.198	0.351
BMI(2)	1.195	0.195	0.234	0.618	0.153
Vitamin D	30.677	0.010	< 0.001*	0.286	0.326
Constant	8.632	0.544	< 0.001*	3.617	5.768

* Highly significant.

Regression analysis for the effect of the different variables on mean GS of the whole study sample revealed a highly significant effect for age, gender and vitamin D level (P 0.002, <0.001and <0.001respectively). Participants were then categorized according to their vitamin D status into normal, insufficient, and deficient groups. And comparison between the 3 groups revealed a significant difference between the 3 groups as regard gender, BMI, and type of occupation (P <0.001, 0.04, and 0.03 respectively) (Table 3). Post hoc analysis revealed that the occupation type difference was only significant between housewives who had lower GS than the other two types of occupation (occupations mainly requiring mental effort and occupations mainly requiring physical effort) (P is 0.009 in both).

Also a significant correlation was found between vitamin D categories and grip strength of the right and left hands and the mean GS of both hands (Table 4) and post hoc analysis also showed a highly significant difference between all the 3 categories being highest in those with normal vitamin D (13.94±0.18 PSI), lower in vitamin D insufficient group (10.03±0.17 PSI) and lowest in the vitamin D deficient group (6.69±0.12 PSI) (P is < 0.001in all).

Regression analysis for the effects of the different variables on vitamin D revealed that age, gender and mean GS all significantly influenced vitamin D level (P 0.031, 0.016, and < 0.001 respectively) and that BMI had an insignificant effect on vitamin D level (Table 5).

Table 3
Correlation of vitamin D categories to sex, occupation type, and BMI

			Vitamin D Category Normal	Insufficient	Deficient	Total	R	P
Sex	Males	N	26	35	6	67	51.5	< 0.001*
		% within sex	38.8%	52.2%	9%	100.0%		
		% within vitamin D category	100%	57.4%	13.3%	50.8%		
	Females	N	0	26	39	65		
		% within sex	0%	40%	60%	100.0%		
		% within vitamin D category	0%	42.6%	86.7%	49.2%		
BMI	Low	N	11	15	14	40	6.60	0.04†
		% within BMI	27.5%	37.5%	35%	100.0%		
		% within vitamin D category	42.3%	24.6%	31.1%	30.3%		
	Normal	N	15	33	27	75		
		% within BMI	20%	44%	36%	100.0%		
		% within vitamin D category	57.7%	54.1%	60%	56.8%		
	Obese	N	0	13	4	17		
		% within BMI	0%	76.5%	23.5%	100.0%		
		% within vitamin D category	0%	21.3%	8.9%	12.9%		
Occupation types	Mental	N	12	33	14	59	10.48	0.03†
		% within job	20.3%	55.9%	23.7%	100.0%		
		% within vitamin D category	46.2%	54.1%	31.1%	44.7%		
	Physical	N	14	25	24	63		
		% within job	22.2%	39.7%	38.1%	100.0%		
		% within vitamin D category	53.8%	41%	53.3%	47.7%		
	Housewife	N	0	3	7	10		
		% within job	0%	30%	70%	100.0%		
		% within vitamin D category	0%	4.9%	15.6%	7.6%		

* Highly significant, †Significant

Table 4
Correlation between vitamin D category and mean GS of right and left hands and the mean of both

Grip strength (GS)			Vitamin D Category: Deficient	Insufficient	Normal	Total	R	P
Left hand	Low	N	22	20	0	42	54.4	< 0.001
		% within left hand GS	52.4%	47.6%	0%	100%		
		% within vitamin D category	84.6%	32.8%	0%	31.8%		
	Normal	N	4	41	45	90		
		% within left hand GS	4.4%	45.6%	50%	100%		
		% within vitamin D category	15.4%	67.2%	100%	68.2%		
Right hand	Low	N	26	38	2	66	67.0	< 0.001
		% within right hand GS	39.4%	57.6%	3%	100%		
		% within vitamin D category	100%	62.3%	4.4%	50%		
	Normal	N	0	23	43	66		
		% within right hand GS	0%	34.8%	65.2%	100%		
		% within vitamin D category	0%	37.7%	95.6%	50%		
Mean of both	Low	N	45	33	0	78	69.3	< 0.001
		% within mean GS	57.7%	42.3%	0%	100%		
		% within vitamin D category	100%	54.1%	0%	59.1%		
	Normal	N	0	28	26	54		
		% within mean GS	0%	51.9%	48.1%	100%		
		% within vitamin D category	0%	45.9%	100%	40.9%		

* Highly significant, †Significant

Table 5
Regression analysis of the predictors of vitamin D

	Odds Ratio	SE	P value	95% Confidence Interval: Lower Bound	Upper Bound
Sex	2.181	0.579	0.031*	0.117	2.410
Age	2.445	0.458	0.016*	0.213	2.025
MEANHG	30.677	0.094	< 0.001†	2.700	3.072
BMI(1)	0.860	0.425	0.392	1.205	0.475
BMI(2)	1.115	0.598	0.267	0.517	1.852
Constant	4.382	1.965	< 0.001†	12.499	4.721

*Significant, †Highly significant.

Discussion

In the past two decades, it has become evident that the role of vitamin D extends beyond calcium homeostasis (14, 15). Many studies showed the direct effect of vitamin D on physical performance in the elderly. Yet, comparing studies and establishing a unified conclusion was difficult (16).

Due to the diversity of batteries testing physical performance, this work aimed to study the effect of vitamin D on GS using Baseline® pneumatic squeeze handheld dynamometer which is rather easy and handy in the clinical setting than others. The study was cross-sectional including 132 subjects.

It is debated what should be considered the normal level of vitamin D. Lips suggests cut-off points where levels below 20 ng/ml are considered vitamin D deficiency, those between 20-30 ng/ml are considered insufficiency and 30-50 ng/ml are considered normal (13). Using these cut-off values, the mean vitamin D level in the study sample (22.87±8.07 ng/ml) is considered rather low but studies in even sunnier areas of the Middle East also found high prevalence of vitamin D deficiency (17). The results were even lower in females than males with none of the females found in the normal vitamin D category and highest number being in the deficient category. This is not surprising as most literature show that elderly females have lower vitamin D levels than elderly males. That also applies to most age groups (18, 19).

The effects of vitamin D and sex on GS were studied extensively but the results show controversy. Still, there is a general agreement that vitamin D has some influence on GS. Examples include the Rancho Bernard Study which found that vitamin D status is associated with GS in elderly men, but not in older women (20), and Zamboni and colleagues who found 25(OH)D levels below 40 nmol/L (16 ng/ml) correlated with arm strength in women, but not in men (21). Also, the study by Mets in 1994 which found that a low serum 25(OH)D concentration (< 40 nmol/L) was associated with reduced GS in 63 community-dwelling elderly (22). Moreover, using univariate linear regression showed a significant association between serum 25(OH)D concentration and handgrip strength in the study of Annweiler and colleagues (23). Similarly, the InCHIANTI study showed that men and women with vitamin D deficiency had significantly lower GS than those with vitamin D levels of 50 nmol/L or above (P=0.01), even after the investigators controlled for factors such as body mass index, physical activity, seasonal variation, cognitive abilities, and anemia (24).

This study results showed a highly significant difference in the level of vitamin D between those with normal GS and those with low GS which was reflected by a highly significant positive correlation between GS and vitamin D level and also the significantly different GS among the 3 vitamin D categories and this difference remained after elimination of other confounding factors as age, sex, and BMI.

The gender difference observed in GS could be explained by the significantly lower vitamin D in the females of study sample and/or the difference in muscle power (4). Another explanation is that age-related decrease in muscle contraction velocity in the muscle groups related to handgrip movement may be greater in females than males (25).

Age as well has a strong effect on GS as stated by many researches (26, 27) and in this study, age did indeed have a statistically significant effect on GS of community-dwelling elderly and that effect was still seen even after elimination of other confounding factors.

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