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Original article

Association of Mini Nutritional Assessment with anthropometric measurements and muscle strength in elderly people: a neglected risk group

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Summary. *Aim:* Elderly individuals that are one of the neglected risk group are at a higher risk for health problems owing to inadequate and unbalanced nutrition. Nutritional status is also an important determinant of health in people over 65 years of age. Screening and diagnostic instruments are important in the recognition of the elderly people in evaluating the results of malnutrition. Unfortunately, there is no gold standard for the detection of malnutrition in elderly people. In this study, we aimed to assess the association of Mini Nutritional Assessment with anthropometric measurements and muscle strength in elderly people. *Materials and Methods:* A cross-sectional study included 210 elderly volunteers. Anthropometric measurements were taken, body mass index (BMI) values were calculated and muscle strength was evaluated by a hand dynamometer. Nutritional status was assessed using the Mini Nutritional Assessment (MNA) screening tool. The study was approved by Research Ethics Committee. *Results:* Elderly individuals with a BMI value of ≥ 30 kg/m^2 had significantly lower right and left hand grip strengths than BMI values of 18.5-24.9 kg/m^2 and 25-29.9 kg/m^2. However, elderly individuals with a BMI of ≥ 30 kg/m^2 had significantly higher waist/hip ratio, waist/height ratio, body fat percentage, waist, hip, calf, neck and mid-upper arm circumferences than BMI values of 18.5-24.9 kg/m^2 and 25-29.9 kg/m^2. Additionally, a positive and statistically significant correlation was determined between the right- and left-hand grip strengths and the MNA score in women. *Conclusion:* To improve the nutritional status, elderly people should be monitored at regular intervals by obtaining anthropometric and muscle strength measurements and performing nutritional status screening tests.

Key words: Mini Nutritional Assessment, elderly, muscle strength, anthropometric measurement

Introduction

Ageing is described as the deterioration of physiological functions and is an irreversible condition. It encompasses the period from the birth of the organism to the end of its life (1). It is characterised by a decrease in the basic biological capacities and is a process associated with physiological, psychological, economic and social aspects (2). It is stated that chronic diseases in the elderly cause dietary restrictions, decreased functional capacity and have a negative impact on their quality of life. Ensuring adequate and balanced nutrition during the old age provides elderly individuals with protection from diseases, improved health, regulation of lifestyle habits, increased life expectancy and improved quality of life (3). Thus, adequate and balanced nutrition is essential for better ageing (4). Malnutrition, covering both over and under nutrition, enhances health problems during the old age (5). Elderly individuals are at a higher risk for health problems owing to

inadequate and unbalanced nutrition and decreased appetite. Malnutrition can occur in elderly individuals along with loss of fat and lean body masses. Although malnutrition is common in the geriatric population, it is neglected in the diagnosis and treatment procedures. Causes of malnutrition in the elderly are; decreased food intake, gastrointestinal diseases, digestion-absorption disorders and hypermetabolism. Nutritional status is also an important determinant of health in people over 65 years of age. Screening and diagnostic instruments are important in the recognition of the elderly people in evaluating the results of malnutrition. For an early diagnosis of malnutrition, screening tests such as the MNA and anthropometric measurements are important to determine the nutritional status. Unfortunately, there is no gold standard for the detection of malnutrition in elderly people (6). Mardani et al. (7) revealed that the MNA-score was significantly correlated with BMI, body weight, calf and mid-arm circumferences in the elderly population. Furthermore, muscle health (muscle mass and muscle strength) is an important factor in process of healthy ageing. Muscle strength is affected by nutrition, which is one of the modifiable risk factors (8). According to a cross-sectional study was conducted in 234 elderly people in New Zealand; decreased muscle strength and BMI were shown as notable indicators of malnutrition risk in patients who were admitted to the hospital (9).

The aim of this study was to evaluate the association of Mini Nutritional Assessment with anthropometric measurements and muscle strength in individuals aged 65 years and older.

Materials and Methods

Procedures and Participants

This cross-sectional study was conducted to assess the anthropometric measurements, muscle strength and nutritional status of elderly individuals aged ≥ 65 years. It included 105 elderly men and 105 elderly women volunteers (total 210) registered in Cyprus, between November 2015 and February 2016. In addition, support was obtained from Famagusta Municipality regarding the address determination by obtaining permission through a petition. The questionnaire was applied to elderly people in their own homes through face-to-face interview method.

Ethics Committee approval was obtained for this study from the Başkent University Medicine and Health Sciences Research Committee (Decision No.: 15/98, dated 11/04/2015) and informed consent was obtained from all participants. Inclusion criteria were; elderly people who were volunteer, 65 years and over, enough co-operation and orientation. Exclusion criteria were; older people who were still fed parenterally or enterally, bed-dependent, difficulty in swallowing, neurological disease, cognitive dysfunction (such as Alzheimer's disease, dementia, delirium etc.), communication problems and severe hearing problems.

Content of Questionnaire

A questionnaire consisting of 52 questions was applied to determine the personal characteristics of individuals. The questionnaire included sociodemographic characteristics (age, gender, level of education, marital status and employment). The questionnaire was applied to elderly people by face-to-face interview method.

Anthropometric Measurements

Anthropometric measurements (body weight [kg], height [cm], waist and hip circumferences [cm], calf circumference (CC) [cm], mid-upper arm circumference (MUAC) [cm], neck circumference (NC) [cm] and body fat percentage [%]) were obtained and the BMI, waist/hip ratio and waist/height ratio were calculated. Body weight and body fat percentage were performed using TANITA BC-730 Inner Scan Body Composition Monitor. Height was measured by an inelastic tape measure without shoe and sock. Head was positioned in the Frankfort horizontal plane. The BMI was calculated by dividing the weight in kilograms by the square of the height in meters (weight/height^2) and classified according to the World Health Organization (WHO) Global Database on BMI: underweight [BMI < 18.50], normal [BMI 18.50-24.99], overweight [BMI 25.00-29.99] and obese [BMI ≥ 30.00] (10). The mid-upper arm, calf, neck, waist and hip

circumferences were measured using an inelastic tape measure (11,12). All anthropometric measurements were taken twice and the average was recorded.

Hand Grip Strength (HGS)

A hand dynamometer (Camry Hand Dynamometer) was used to measure muscle strength (kg) (13,14). Hand grip strength is a measure of the maximum strength of the hand and is described as the simplest method to evaluate muscle function and strength. Hand grip strength is an important indicator in defining the nutritional status of individuals with especially chronic malnutrition (13). While hand grip strength was measured; individuals must be standing, and the elbow and wrist were in full extension. For the dominant and non-dominant hand, the measurements were repeated three times with an interval of five seconds and average of three measurements was taken (15). The measured hand grip strengths of elderly individuals were compared with the reference values according to the age and gender that determined by Schlüssel et al (13).

Mini Nutritional Assessment

Malnutrition was evaluated through MNA that consists of two parts. When the total score is < 12 points in the short form, which is the first part (screening), proceed to the second part (assessment). The total score of the two parts; there is a normal nutritional status when > 23.5 points, there is a risk of malnutrition when 17-23.5 points and it means malnutrition when < 17 points (16). The nutritional status of the elderly individuals was evaluated using the MNA screening tool (16,17).

Statistical Analysis

Qualitative variables were expressed as numbers or sample size (n) and percentages (%); quantitative variables were expressed as mean, standard deviation and upper and lower values. For the statistical evaluation of the data, Spearman's correlation test, Pearson's chi-squared test, Fisher's exact test, One-sample t-test and One-way analysis of variance test were used. The significance level of all the hypothesis tests were evaluated at $p < 0.05$. The Statistical Package for Social Sciences (SPSS) 21.0 programme was used for the statistical evaluation of the data.

Results

A total of 210 elderly individuals, 105 men and 105 women were included in the study. The sociodemographic characteristics of the elderly individuals were shown in Table 1. 64.3% of all individuals were found to be in the 65-74 age group, 31.9% in the 75-84 age group and 3.8% in the 85 and over age group. The difference between the distribution of age groups by gender was not statistically significant ($p > 0.05$). The mean age of men was 72.26 ± 5.35 years, and the mean age of women was 73.66 ± 5.91 years. A statistically significant difference was found in education and marital status by gender ($p < 0.05$). Similarly, there was significant difference between men and women in terms of employment and occupational status ($p < 0.05$) (Table 1).

The mean value of the right-hand grip strength was 34.95 ± 7.08 kg in men and 19.91 ± 4.37 kg in women, whereas that of the left-hand grip strength was 32.70 ± 7.18 kg in men and 18.66 ± 4.11 kg in women (Data not shown). The left-hand grip strength in the group including individuals aged 65-74 years (for women) was found to be significantly lower than the reference value ($p < 0.05$) (Table 2). Furthermore, elderly individuals with a BMI value of ≥ 30.00 kg/m^2 had significantly lower right- and left-hand grip strengths than BMI values of 18.50-24.99 kg/m^2 and 25.00-29.99 kg/m^2 ($p < 0.05$). However, elderly individuals with a BMI of ≥ 30.00 kg/m^2 had significantly higher waist circumference (106.98 ± 9.10 cm), hip circumference (110.46 ± 9.39 cm), waist/hip ratio (0.97 ± 0.09), waist/height ratio (0.68 ± 0.06), calf circumference (37.76 ± 3.21 cm), mid-upper arm circumference (30.10 ± 2.80 cm), neck circumference (38.50 ± 3.58 cm) and body fat percentage (40.44 ± 6.25 %) than BMI values of 18.50-24.99 kg/m^2 and 25.00-29.99 kg/m^2 ($p < 0.05$) (Table 3). Furthermore, a positive and statistically significant correlation was found between the right- and left-hand grip strength values with the physical activity level in both gender ($p < 0.05$) (Data not shown).

Table 1. Distribution of individuals according to their sociodemographic characteristics

	Men (n = 105)		Women (n = 105)		Total		
	n	%	n	%	n	%	p
Age groups							0.226
65-74 years	72	68.6	63	60.0	135	64.3	
75-84 years	31	29.5	36	34.3	67	31.9	
85 and over years	2	1.9	6	5.7	8	3.8	
Age (years)							
$\bar{X}$±SD	72.26±5.35		73.66±5.91		72.96±5.67		
Educational status							0.000*
Illiterate	2	1.9	6	5.7	8	3.8	
Literate	1	1.0	13	12.4	14	6.7	
Primary school	33	31.4	62	59.0	95	45.2	
Secondary school	11	10.5	11	10.5	22	10.5	
High school	28	26.7	8	7.6	36	17.1	
University	30	28.6	5	4.8	35	16.7	
Marital status							0.000*
Married	93	88.6	61	58.1	154	73.3	
Divorced	3	2.9	2	1.9	5	2.4	
Widow/widower	9	8.6	42	40.0	51	24.3	
Employment							0.035*
Employed	8	7.6	1	1.0	9	4.3	
Non-employed	97	92.4	104	99.0	201	95.7	
Occupational status							0.000*
Retired	103	98.1	41	39.0	144	68.6	
Housewife	-	-	64	61.0	64	30.5	
Self-employment	2	1.9	-	-	2	1.0	

n: Sample Size; %: Percentage; $\bar{X}$: Mean; SD: Standard Deviation; *: $p < 0.05$

Table 2. Comparison of hand grip strength measurements with the reference values of individuals according to gender and age groups

Age Group (year)	Men (n = 105)				Women (n = 105)			
	$\bar{X}$	SD	Reference Value	p	$\bar{X}$	SD	Reference Value	p
65-74								
Right hand	36.42	6.83	36.8	0.640	21.43	4.03	22.1	0.189
Left hand	33.83	6.81	34.5	0.404	19.87	3.65	21.0	0.017*
≥ 75								
Right hand	31.74	6.62	31.8	0.956	17.63	3.88	17.2	0.477
Left hand	30.24	7.46	29.4	0.525	16.83	4.14	16.4	0.507

n: Sample Size; $\bar{X}$: Mean; SD: Standard Deviation; *: $p < 0.05$

Table 3. The distribution of anthropometric and hand grip strength measurements according to the BMI classification of individuals

BMI Classification	18.50-24.99 (n = 20)		25.00-29.99 (n = 84)		≥ 30.00 (n = 106)		
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	p
Waist circumference (cm)	83.98	7.38	95.10	7.83	106.98	9.10	0.000*
Hip circumference (cm)	91.10	3.84	99.07	4.76	110.46	9.39	0.000*
Waist/hip ratio	0.92	0.06	0.96	0.08	0.97	0.09	0.043*
Waist/height ratio	0.52	0.04	0.58	0.04	0.68	0.06	0.000*
Calf circumference (cm)	31.63	2.65	34.45	2.33	37.76	3.21	0.000*
Mid-upper arm circumference (cm)	23.83	1.55	27.49	2.19	30.10	2.80	0.000*
Neck circumference (cm)	34.93	2.21	37.26	3.12	38.50	3.58	0.000*
Body fat percentage (%)	22.95	5.71	32.45	6.36	40.44	6.25	0.000*
Hand grip strength (kg)							
Right hand (kg)	29.66	9.88	29.46	9.72	25.40	9.00	0.008*
Left hand (kg)	27.56	9.08	27.69	9.33	23.72	8.66	0.007*

$\bar{X}$: Mean; SD: Standard Deviation; cm: Centimeter; %: Percentage; kg: Kilogram; BMI: Body Mass Index; *: $p < 0.05$

Table 4. Distribution of MNA results and BMI classifications of individuals by gender

		Men (n = 105)		Women (n = 105)		Total (n = 210)		
		n	%	n	%	n	%	p
MNA Score								
Normal nutritional status	> 23.5	100	95.2	75	71.4	175	83.3	0.000*
At risk of malnutrition	17.0-23.5	5	4.8	30	28.6	35	16.7	
BMI Classification								
18.50-24.99 (n = 20)		14	13.3	6	5.7			0.013*
25.00-29.99 (n = 84)		48	45.7	36	34.3			
≥ 30.00 (n = 106)		43	41.0	63	60.0			

n: Sample Size; %: Percentage; MNA: Mini Nutritional Assessment; BMI: Body Mass Index; *: $p < 0.05$

According to MNA, malnutrition risk was detected in 4.8% of men and 28.6% of women. A statistically significant difference was found between genders according to MNA ($p < 0.05$). Furthermore, BMI classifications by gender were shown (Table 4). When analyzed distribution of MNA scores according to the age groups of elderly individuals in Table 5; malnutrition risk was found in 13.3% of individuals in the 65-74 age group, 17.9% of individuals in the 75-84 age group and 62.5% of individuals in the 85 and over age group. None of the age groups had malnourished individual. There was a statistically significant difference between MNA scores and age groups ($p < 0.05$).

As seen in Table 6, there was no statistically significant correlation among MNA with body weight, BMI, waist circumference, hip circumference, waist/hip ratio, waist/height ratio, calf circumference, mid-upper arm circumference, neck circumference and body fat percentage in both men and women ($p > 0.05$).

The mean value of the MNA total score was 24.03 ± 1.06 in men and 22.79 ± 1.58 in women (Data not shown). It was found that there was a statistically significant difference according to gender ($p < 0.05$). Table 7 presents the correlation between hand grip strength values with age and MNA score. A positive and statistically significant correlation was determined

Table 5. Distribution of MNA scores according to the age groups of individuals

	Age (year)								
MNA Score	**65-74**		**75-84**		**85 and over**		**Total**		**p**
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
Normal nutritional status (> 23.5)	117	86.7	55	82.1	3	37.5	175	83.3	0.001*
At risk of malnutrition (17.0-23.5)	18	13.3	12	17.9	5	62.5	35	16.7	

n: Sample Size; %: Percentage; MNA: Mini Nutritional Assessment; *: $p < 0.05$

Table 6. Correlation of anthropometric measurement values with MNA

Anthropometric Measurements	**Men (n = 105)**		**Women (n = 105)**	
	MNA		**MNA**	
	r	**p**	**r**	**p**
Body weight (kg)	-0.014	0.884	0.028	0.780
Body Mass Index (kg/m²)	-0.015	0.877	0.046	0.644
Waist circumference (cm)	0.028	0.779	0.056	0.573
Hip circumference (cm)	0.021	0.834	0.037	0.706
Waist/hip ratio	0.033	0.742	0.043	0.661
Waist/height ratio	0.022	0.823	0.063	0.522
Calf circumference (cm)	-0.048	0.627	0.042	0.672
Mid-upper arm circumference (cm)	-0.114	0.245	-0.041	0.678
Neck circumference (cm)	-0.054	0.584	-0.084	0.396
Body fat percentage (%)	-0.104	0.292	-0.033	0.738

n: Sample Size; MNA: Mini Nutritional Assessment; r: Correlation Coefficient; %: Percentage; kg: Kilogram; cm: Centimeter; m: Meter; $p > 0.05$

Table 7. Correlation between hand grip strength values with age and MNA score

Hand Grip Strength	**Age**		**MNA**	
	r	**p**	**r**	**p**
Right hand				
Men (n = 105)	-0.447	0.000*	0.112	0.256
Women (n = 105)	-0.465	0.000*	0.240	0.014*
Left hand				
Men (n = 105)	-0.411	0.000*	0.172	0.079
Women (n = 105)	-0.398	0.000*	0.198	0.043*

MNA: Mini Nutritional Assessment; r: Correlation Coefficient; n: Sample Size; *: $p < 0.05$

between the right- and left-hand grip strengths and the MNA score in women ($p < 0.05$). A negative and statistically significant correlation was found among right ($r = -0.447$, $p = 0.000$) and left ($r = -0.411$, $p = 0.000$) hand grip strengths and age in men. Similarly in women, a negative and statistically significant correlation was determined among right ($r = -0.465$, $p = 0.000$) and left ($r = -0.398$, $p = 0.000$) hand grip strengths and age. Right- and left-hand grip strengths decreased with increasing age in both men and women.

Discussion

In elderly individuals, reduction of muscle mass and muscle strength is associated with physical disability, deteriorated quality of life, prolonged hospital stay and an increased risk of mortality. Measuring the maximum hand grip strength can reflect the muscle strength (18). According to this study, the mean value of the right-hand grip strength was 34.95 ± 7.08 kg in men and 19.91 ± 4.37 kg in women ($p < 0.05$), whereas that of the left-hand grip strength was 32.70 ± 7.18 kg in men and 18.66 ± 4.11 kg in women ($p < 0.05$). Moreover, in the study conducted by Pieterse et al. (19) that included elderly individuals; the hand grip strength was significantly higher in men (30.3 ± 6.7 kg) than in women (22.3 ± 5.1 kg). Furthermore, it was found that the hand grip strength was positively related to BMI.

Malnutrition is an important determinant of hand grip strength. According to the European Working Group on sarcopenia in elderly individuals; hand grip strength values of < 30 kg in men and < 20 kg in women are described as weakness (20). Thus, hand grip strength should be determined as a part of nutritional assessment. Poor hand grip strength inversely affects the daily living activities (21). In a study on hand grip strength cut-off points in Bosnia and Herzegovina; hand grip strength cut-off points for malnutrition were 23.50 kg (65-74 age group) and 19.50 kg (≥ 75 age group) for men; 15.50 kg (65-74 age group) and 13.50 kg (≥ 75 age group) for women. For malnutrition risk cut-off points were 28.50 kg (65-74 age group) and 24.50 kg (≥ 75 age group) for men; 24.50 kg (65-74 age group) and 19.50 kg (≥ 75 age group) for women (22). In a cross-sectional study including individuals aged ≥ 65 years (2007-2008); a strong correlation was found between the MNA score and hand grip strength. The mean hand grip strength values were 18.9 ± 7.4 kg in individuals at a risk of malnutrition and 22.9 ± 6.8 kg in individuals with no nutritional problems (23). Similarly in this study, a positive and statistically significant correlation was found between the right- or left-hand grip strength and the MNA scores in women ($p < 0.05$). As the MNA scores increased in women, the right- and left-hand grip strengths also increased. Furthermore, Akbar and Setiati (24) revealed a significant correlation between the nutritional status and hand grip strength ($p < 0.05$).

In a cross-sectional study examining the relationship between the nutritional status and anthropometric measurements of elderly individuals; a significant and positive correlation of the body weight, BMI, mid-upper arm circumference and calf circumference with the MNA score was determined (25). In another study including 210 elderly individuals aged ≥ 60 years; there was a positive and significant correlation of the BMI, mid-upper arm circumference and calf circumference with the MNA score (26). However, in this study, no statistically significant correlation was found between the MNA score and the body weight, BMI, waist circumference, hip circumference, waist/hip ratio, waist/height ratio, calf circumference, mid-upper arm circumference, neck circumference and body fat percentage ($p > 0.05$).

One of the indispensable indicators for elderly people, grip strength is associated with overall strength, falls, fractures, bone mineral density, malnutrition, cognitive functions, depression and diabetes (27). Additionally, it has been supported by the European Society of Parenteral and Enteral Nutrition (ESPEN) that early routine nutrition screening is mandatory and MNA is eligible as a nutritional screening tool (28).

According to the cross-sectional study was conducted on elderly people (total 173); a significant and negative correlation was found between BMI and hand grip strength. The higher BMI resulted in lower hand grip strength in both gender (29). Similarly in this study, elderly individuals with a BMI value of ≥ 30.00 kg/m^2 had significantly lower right- and left-hand grip strengths than BMI values of 18.50-24.99 kg/m^2 and 25.00-29.99 kg/m^2.

Elderly people with a BMI of ≥ 30.00 kg/m^2 had significantly higher waist, hip, calf, mid-upper arm and neck circumferences, waist/hip and waist/height ratios and body fat percentage than BMI values of 18.50-24.99 kg/m^2 and 25.00-29.99 kg/m^2 in this study. Hand grip strength can identify risk of hip fracture in older people (30). Denk et al. (30) revealed that the hand grip strength was significantly reduced in people with a hip fracture than control groups. A positive relationship was also found among hand grip strength with mid-upper arm circumference,

arm-muscle area and BMI in older people in Malawi (31). Hand grip strength is a multifactorial indicator. Furthermore, hand grip strength was positively associated with body weight, height and mid-upper arm circumference in cancer patients (32).

According to this study, a positive and statistically significant correlation was found between the right- and left-hand grip strength values with the physical activity level in both genders. Similarly, it was found in a cross-sectional study that low physical activity was significantly associated with a decrease in muscle strength and muscle mass in community-dwelling older people (33).

In the study about home-living older Chinese people; while the mean age of individuals with normal nutritional status was 78.5, those with malnutrition risk or malnourished were 78.6. The difference between them was not statistically significant (34). On the contrary, there was a statistically significant difference between MNA scores and age groups in our study ($p < 0.05$). The risk of malnutrition increased with increasing age.

Conclusion

The right- and left-hand grip strength values were significantly higher in men than those in women. It was determined that values of other anthropometric measurements increased, and the hand grip strength decreased as BMI increased. In addition, as the MNA score increased, the right- and left-hand grip strengths increased in women. To improve the nutritional status of elderly people, nutritional education should be provided regularly, and these individuals should be monitored at regular intervals by obtaining anthropometric and muscle strength measurements and performing nutritional status screening tests.

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