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Research Article

Assessment of Relationship Between Nutritional Status and Handgrip Strength in Hemodialysis Patients

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Abstract

In hemodialysis patients, the prevalence of malnutrition is high; a decrease in muscle strength is observed.

The objective of the research was to evaluate the nutritional status of hemodialysis patients and the relationship between the nutritional status and muscle strength.

Materials and Methods. Sixty hemodialysis patients (38 males, 22 females) were chosen from among volunteers. Food consumption, biochemical values, anthropometric measurements, body composition, physical activity status, subjective global assessment, and handgrip strength in individuals were examined.

Results. According to subjective global assessment, 73.3% of patients were well-nourished, 26.7% of patients were moderately malnourished. In male patients, a moderate positive correlation was determined between handgrip strength and lean body mass (r=0.359, $p < 0.05$), albumin level (r=0.408, $p < 0.05$), energy intake (r=0.437, $p < 0.05$), protein intake (r=0.345, $p < 0.05$). In female patients, a moderate positive correlation was determined between handgrip strength and body weight (r=0.470, $p < 0.05$), body mass index (r=0.472, $p < 0.05$), triceps skinfold thickness (r=0.530, $p < 0.05$), mid-upper arm circumference (r=0.515, $p < 0.05$), mid-upper arm muscle circumference (r=0.557, $p < 0.05$), lean body mass (r=0.470, $p < 0.05$), body fat content (%) (r=0.588, $p < 0.05$), albumin level (r=0.565, $p < 0.05$).

Conclusions. Handgrip strength alongside with more than one method of food consumption, biochemical parameters, subjective global assessment, anthropometric measurements, and body composition should be used for assessing the nutritional status in hemodialysis patients.

Keywords

hemodialysis, nutritional status, anthropometric measurements, biochemical parameters, muscle strength

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Problem statement and analysis of the latest research

End-stage renal disease (ESRD) is a major public health problem due to increasing the incidence in the world and in our country, causing high morbidity and mortality rates, severely influencing quality of life, and high-cost need for renal replacement therapy and poor prognostic course [1]. Technological and surgical advances have facilitated the treatment of hemodialysis (HD) [2]. However, during the treatment of HD, complications may develop. Metabolic disorders, protein-energy malnutrition (PEM), infection, cardiovascular diseases, uremic complications, non-uremic complications, and malnutrition are observed [3]. The loss of muscle protein storage, decrease in muscle strength, and lack of physical activity are observed in malnutrition [4].

Handgrip strength (HGS) is a direct marker of body muscle mass. In HD patients, grip strength is used as a marker of the nutritional status. Low HGS was associated with inadequate nutrition [5].

The objective of the research was to assess malnutrition in HD patients, determine the nutritional status, and analyze the relationship between the nutritional status and anthropometric measurements, body composition, some blood parameters, and HGS.

1. Materials and Methods

Sixty volunteer HD patients (38 males, 22 females) at the age of 18-65 years, undergoing HD for more than 6 months were included in the study. A poll was taken to patients to collect the data about general information, nutrition habits, and physical activity status. Height, mid-upper arm circumference (MUAC), and triceps skinfold thickness (TSF) of patients were measured. Bodyweight measurements were taken after HD. The patients' body mass index (BMI) was calculated divided by the square of height and mid-upper arm muscle circumference (MUAMC) was calculated using equation "MUAMC = MUAC - ($\pi \times$ TSF)" [6]. Body fat mass, lean body mass (muscle mass), body water content, basal metabolic rate (BMR), and body fat content, were measured by bioelectrical impedance analysis (BIA) after hemodialysis.

HGS in the individuals who participated in the study was measured by using the JAMAR hydraulic hand dynamometer [7]. HGS was evaluated in both arms after HD sessions. HGS was repeated three times and the highest value was used in the analysis. Biochemical analysis of routinely collected blood samples was performed in the Biochemistry Laboratory of Erzincan State Hospital. The blood values for routine follow-up in HD patients were examined from the patient's file. Subjective global assessment (SGA) was applied as described by Detsky *et al.* [8].

Individual food consumption records were taken from patients within three consecutive days including one dialysis treatment day, a week day, and a weekend day [9]. The data from dietary recall forms were analyzed by a computer program the Nutrition Information System (BeBiS) [10]. The calculated values were compared with the values of recommended daily intake of dialysis patients; the levels of competence have been identified [11]. Twenty-four-hour physical activity record forms filled out during three days of food consumption were taken. Total energy expenditure was calculated by multiplying the time spent on activities by the minute to minute resting metabolic rate (RMR), and the physical activity ratio (PAR) values. The patients' physical activity level is total energy expenditure divided by basal metabolic rate value (PAL = total energy/BMR) [6].

Statistical Analyses

The data obtained from the study were evaluated using SPSS 21 software. There were used descriptive statistics according to data characteristics, the median values, and, at least, most of the range. The median and minimum-maximum values given did not show normal distribution; the Mann-Whitney U test and the Kruskal-Wallis tests were used. Pearson's correlation analysis was applied for examining the relationship between the values in the tables. For the analyses, p values less than 0.05 were considered significant [12].

Clinical Research Ethics Board of the Hacettepe University Faculty of Medicine approved this study. The informed consent was obtained from the patients before the study.

2. Results

Sixty HD patients participated in the study – 63.3% of males and 36.7% of females. The average age of male patients (n=38) was 51.3 $\pm$ 12.7 years and the average age of female patients (n=22) was 48.5 $\pm$ 13.3 years. The duration of undergoing HD was 52.9 $\pm$ 41.6 months in males and 43.9 $\pm$ 41.9 months in females.

The patient's classification according to SGA is shown in Table 1. According to SGA, 73.3% of patients were well-nourished.

The patients' average HGS according to some parameters was given. In male patients, there were statistically significant differences between choles-

Table 1. Distribution of patients according to the SGA.

SGA Classification	Males (n=38)		Females (n=22)		Total (n=60)	
	n	%	n	%	n	%
A (well-nourished)	31	81.6	13	59.1	44	73.3
B (moderately malnourished)	7	18.4	9	40.9	16	26.7
C (severely malnourished)	-	-	-	-	-	-
Total	38	100.0	22	100.0	60	100.0

terol levels and SGA regarding HGS ($p < 0.05$). In female patients, a statistically significant difference was observed between HGS and albumin, blood urea nitrogen (BUN) levels, BMI classification, and protein consumption (g/kg) ($p < 0.05$) (Table 2).

In male patients, a statistically significant moderate correlation was found between HGS and lean body mass, albumin level, energy intake and protein consumption; a negative power correlation was found between HGS and SGA ($p < 0.05$). In female patients, a statistically significant positive moderate correlation was found between HGS and body weight, BMI, TSF, MUAC, MUAMC, lean body mass, fat percentage, and albumin ($p < 0.05$) (Table 3).

3. Discussion

In this study, we conducted the assessment of the relationship between the nutritional status and muscle strength in patients undergoing HD; according to SGA, 73.3% of patients were well-nourished and 26.7% of patients were moderately malnourished. According to Kirushnan *et al.*, among 93 HD patients who participated in the study, 68% of patients were well-nourished and 32% of patients were undernourished (there were 29% of moderate and 3% of severe malnutrition cases) [13]. Koor *et al.* found that in a study that included 190 HD patients, according to SGA, 8.4% of patients were well-nourished, 47.4% of patients were mildly malnourished and 44.2% of patients were moderately malnourished [14]. In another study that comprised 73 HD patients, mild, moderate, and severe PEM were observed in 51.4%, 45.9%, and 1.4% of cases, respectively [15]. According to this study, the prevalence of malnutrition determined in our country was relatively lower than in other studies. A dialysis center was private and the presence of a dietitian in a public hospital was considered to be effective for these results. SGA determines the degree of malnutrition; however, it does not include anthropometric measurements and biochemical parameters. Therefore, especially in patients with renal failure, in the determination of the nutritional status, such data have to be evaluated.

PEM is common in patients with chronic renal failure and has been reported to be associated with increased morbidity and mortality [16]. According to the International Society of Renal Nutrition and Metabolism (ISNRM), if there was a decrease in albumin, transferrin and cholesterol levels, reduction in body weight and muscle mass (muscle loss or MUAC reduction), PEM can be diagnosed [16, 17]. Muscle mass or muscle loss is diagnosed using functional tests of HGS [18, 19]. The reference values are healthy individual data; there has not been observed a study classifying muscle loss according to HGS in patients undergoing HD. However, the effect of muscle strength on dialysis variables was evaluated in several studies. In the study involving 43 HD patients, HGS measured after HD in male patients was 30.9 ± 9.9 kg and in female patients, it was 14.5 ± 6.3 kg [20]. In another study, among 156 HD patients, HGS in male patients was 32.6 ± 8.4 kg and in female patients, it was 21.0 ± 6.9 kg [21]. In the study conducted in 34 HD patients, HGS measured in males and females were 21.9 ± 8.8 and 17.3 ± 5.3 kg, respectively [22]. Vogt *et al.* found that in 265 HD patients, HGS value in men was 24.0 ± 11.4 kg

Table 2. Handgrip strength of patients according to some parameters.

	Handgrip Strength (kg)							
	Males (n=38)				Females (n=22)			
	Median	Min	Max	p_1	Median	Min	Max	p_2
Sex	24.6	8.2	42.6	-	11.6	5.4	22.8	-
Duration of Dialysis (years)								
<5	19.9	12.3	42.6	0.767	10.9	8.7	22.8	0.507
≥5	18.8	8.2	34.6		13.0	5.4	17.8	
SGA Assessment								
A	21.7	12.3	42.6	**0.010***	13.4	8.7	22.8	0.095
B	9.7	8.2	34		8.7	5.4	15.8	
BMI (kg/m^2)**								
<18.5	-	-	-	0.219	6.0	5.4	11.2	**0.042****
18.5- 24.9	18.2	8.2	42.6		7.7	6.2	13.7	
25- 29.9	19.6	8.6	39.8		13.1	9.2	17.7	
>30	32.5	33.2	34.3		13.8	9	22.8	
BUN (mg/dL)								
<50	16.6	8.2	34.6	0.220	9.7	5.4	22.8	**0.021***
≥50	21.1	12.3	42.6		17.4	15.1	17.7	
Total Cholesterol (mg/dL)								
<200	18.1	8.2	38.7	**0.010***	12.9	8.7	22.8	0.216
≥200	35.3	33.2	42.6		9.4	5.4	17.7	
Total Protein (g/dL)								
<6.5	17.5	8.6	34.3	0.536	10.9	10	10.3	0.480
≥6.5	20.1	8.2	42.6		13.3	5.4	17.7	
Albumin (g/dL)								
<3.5	14.3	8.6	38.7	0.088	6.0	5.4	16.2	**0.017***
≥3.5	21.4	8.2	42.6		13.5	10	22.8	
Hemoglobin (g/dL)								
<10	19.0	13	42.6	0.603	11.2	9	15.8	0.867
≥10	21.6	8.2	39.8		11.6	5.4	22.8	
Energy Intake (kcal/kg)								
<35	18.6	8.2	42.6	0.254	11.4	8.7	22.8	0.117
≥35	35	35	35		8.5	5.4	12.1	
Protein Intake (g/kg)								
<1.2	20.3	8.2	39.8	0.454	12.0	9	22.8	**0.011***
≥1.2	21.6	8.6	42.6		8.9	5.4	15.1	

Notes: * - significance from basal values; $p<0.05$ Mann-Whitney U test, p_1 = males; p_2 = females;
** - Kruskal-Wallis test.

and in women, it was 12.5 ± 6.5 kg [23]. In this study, HGS in male and female patients were 24.6 (8.2-42.8) kg to 11.6 (5.4-22.8) kg, respectively (Table 2). Schlüssel *et al.* reached the reference value of HGS by studying healthy individuals and different ethnic groups [19]. Leal *et al.* reached HGS values by studying different ethnic groups of HD patients [20]. While assessing loss of mus-

Table 3. Correlation (r) between handgrip strength and some parameters.

	Handgrip Strength			
	Males (n=38)		Females (n=22)	
	r	p-value	r	p-value
Age	-0.250	0.129	0.124	0.582
Height	0.096	0.566	0.120	0.594
Body weight	0.265	0.108	0.470	**0.027***
BMI	0.256	0.121	0.472	**0.026***
TSF	0.219	0.187	0.530	**0.011***
MUAC	0.202	0.224	0.515	**0.014***
MUAMC	0.082	0.625	0.557	**0.007***
LBM	0.359	**0.027***	0.470	**0.027***
Fat Percentage (%)	-0.029	0.861	0.588	**0.004***
ALP	0.054	0.746	-0.463	**0.030***
Total Cholesterol	0.281	0.088	-0.204	0.363
Total Protein	0.033	0.845	-0.305	0.168
Albumin	0.408	**0.011***	0.565	**0.006***
Calcium	-0.155	0.354	-0.214	0.338
PTH	-0.140	0.401	-0.351	0.109
SGA	-0.424	**0.008***	-0.365	0.095
Duration of Dialysis	-0.047	0.779	0.043	0.848
Energy Intake	0.437	**0.006***	-0.042	0.853
Protein Consumption	0.345	**0.034***	-0.135	0.549

Note: * - significance from basal values $p<0.05$.

cle, Schlüssel *et al.* [19] and Leal *et al.* [20] have presented a cut-off point (10th percentile). According to Schlüssel *et al.* [19] and Leal *et al.* [20], these values ($<$ 10th percentile) were on average as follows: for males and females at the age of 20-29 years – 33.95 and 19.05 kg; for males and females at the age of 30-39 years – 35.65 and 20.04 kg; for males and females at the age of 40-49 years – 33.35 and 19.01 kg; for males and females at the age of 50-59 years – 29.90 and 16 kg; and for males and females at the age of 60-69 years – 26.45 and 15.8 kg. However, malnutrition or good nutrition defines a cut-off point that has not been established. In some studies of HD patients, HGS was reported to be lower in malnourished patients [24]. The study involving 330 HD patients, while assessing low muscle strength, has presented the cut-off point of $<$ 30 kg in men and $<$ 20 kg in women. Low muscle strength was found in 36% of patients. Low muscle strength was seen in 76% of patients with PEM [25]. In this study, 18.4% of males, 40.9% of females, and 26.7% of all patients undergoing HD were found to be diagnosed with PEM. PEM indicates the presence of muscle loss. In this study, in well-nourished and malnourished male patients, HGS was 21.7 (12.3-42.6) kg and 9.7 (8.2-34) kg, respectively, while in well-nourished and malnourished female patients, HGS was 13.4 (8.7-22.8) kg and 8.7 (5.4-15.8) kg, respectively. Malnourished patients with decreased muscle strength are the case of loss of muscle protein stores.

Dietary energy intake of about 30-35 kcal/kg/d and protein intake of about 1.2 g/kg/d is recommended for HD patients [26]. In this study, the recommended daily average protein intake was 1.2 ± 0.3 g/kg. The recommended daily average energy intake was 26.3 ± 6.6 kcal/kg/d. Consuming the recommended protein levels is important for HD patients for replacing amino acid loss that occurs during HD, lowering serum albumin and total protein levels and preventing PEM and negative nitrogen balance. There must be an appropriate dietary protein content per kilogram of the patient body; as the daily energy intake is low, the protein cannot be used for the purpose sufficiently and daily requirements have proved to be relatively more. Low energy and protein intake accompanied by catabolic results of dialysis therapy are known to lead to uremic malnutrition [27]. In addition, in HD patients, the decrease in muscle mass due to inadequate protein intake resulted from insufficient energy intake [28]. In this study, low values of grip strength were caused by inadequate protein intake due to insufficient energy intake that resulted from a decrease in muscle protein depot.

HGS is a simple indicator of skeletal muscle function and a functional indicator of the nutritional status [5]. HGS and MUAMC are suggested to be the best indicators of lean body mass [29]. According to the results of this study, in female patients, there was found a significant positive relationship between HGS and MUAC (r=0.515, $p < 0.05$) (Table 3).

The relationship between HGS and SGA were found in HD patients [22]. In this study, in male patients, there was found a negative relationship between SGA and HGS (r=-0.424, $p < 0.05$). A negative relationship between HGS and SGA in male patients might be due to the high proportion of well-nourished male patients (81.6%).

Considering the age, gender, and body weight, there is a a very strong relationship between hand force and lean body mass [30]. In this study, in both male and female patients, there was found a positive relationship between HGS and lean body mass (r=0.359 and r=0.370, $p < 0.05$). This result confirmed lean body mass to be a determinant of HGS.

4. Conclusions

According to the research results, when assessing the nutritional status in dialysis patients, it is important not to use a single method only; it is important to use a combination of different methods of nutritional status assessment. To evaluate the nutritional status, the parameters such as food consumption, biochemical parameters (serum albumin, BUN, cholesterol), anthropometric measurements (bodyweight, height, MUAC, TSF), body composition analysis, and HGS should be used. In HD patients, the determination of HGS is a valid method for determining the nutritional status as its application is a quick, easy, cheap, and effective method.

5. Prospects of Further Researches

In our country, there are no adequate data on HGS in both HD patients and healthy individuals. Therefore, the study of HGS values and its relationship with nutrition for different age and gender groups is promising.

Ethical Stnadarts

Clinical Research Ethics Board of the Hacettepe University Faculty of Medicine approved this study.

Informed Consent

Informed consent was obtained from the patients before the study.

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Conflict of Interest

The authors stated no conflict of interest.

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