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Evaluation of nutritional status with different methods in geriatric hemodialysis patients: impact of gender

Tezcan Kaya · Savaş Sipahi · Cengiz Karacaer · Ahmet Nalbant · Ceyhun Varım · Hakan Cinemre · Ali Tamer

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Abstract
Purpose This study investigated the frequency of malnutrition in geriatric hemodialysis patients according to biochemical, anthropometric, bioelectrical impedance analysis (BIA), modified quantitative subjective global assessment (MQSGA), and geriatric nutritional risk index (GNRI) methods, and the effect of gender on these different parameters.
Methods A total of 160 chronic hemodialysis patients (older than 65 years old) were included in this study. There were 82 males (51.2 %) and mean age was 72.8 ± 6.1 years. Nutritional status of patients was evaluated by using serum albumin, body mass index (BMI), triceps skinfold (TSF), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), calf circumference (CC), BIA, MQSGA, and GNRI.
Results The prevalence of malnutrition according to the aforementioned methods were as following: MAC 62.5 %, MQSGA 60 %, MAMC 50 %, CC 43.1 %, TSF 39.4 %, body fat percentage 33.8 %, albumin 29.1 %, GNRI 15 %, and BMI 8 %. While malnutrition was found to be more prevalent among women according to MQSGA, TSF, and body fat percentage ($p = 0.008$, $p < 0.001$, $p = 0.042$, respectively), it was more frequent in men when we used MAC and MAMC ($p = 0.012$, $p < 0.001$, respectively).
Conclusions Our data indicated that while there was a difference in malnutrition prevalence between female and male geriatric hemodialysis patients according to MQSGA, TSF, MAC, and body fat percentage, there was no difference between genders in terms of malnutrition prevalence according to GNRI, albumin, BMI, and CC.

Keywords Geriatrics · Hemodialysis · Malnutrition · Nutritional assessment

T. Kaya (✉) · C. Varım · H. Cinemre · A. Tamer
Department of Internal Medicine, Sakarya University Faculty of Medicine, Sakarya, Turkey
e-mail: tezcan@sakarya.edu.tr

C. Varım
e-mail: ceyhunvarim@yahoo.com

H. Cinemre
e-mail: cinemreh@gmail.com

A. Tamer
e-mail: atamer2002@yahoo.com

S. Sipahi
Division of Nephrology, Department of Internal Medicine, Sakarya University Faculty of Medicine, Sakarya, Turkey
e-mail: savassipahi@yahoo.com

C. Karacaer · A. Nalbant
Department of Internal Medicine, Sakarya University Training and Research Hospital, 54100 Sakarya, Turkey
e-mail: karacaerc@yahoo.com

A. Nalbant
e-mail: drnalbant@hotmail.com

Introduction

There is recently a distinct increase in the geriatric patient population receiving the hemodialysis (HD) treatment due to the end-stage renal disease (ESRD) [1]. These patients are under the risk of malnutrition due to some reasons such as loss of appetite, diet restrictions, loss of nutrients during dialysis, additional diseases, and hormonal and gastrointestinal diseases [2]. The presence of protein-energy wasting (PEW) in maintenance HD patients is related to the increase in mortality and morbidity [3]. Besides, since advanced age also affects mortality and morbidity, the presence of malnutrition in geriatric HD patients is much more important [4].

Periodical evaluation of the nutritional status of dialysis patients is important in terms of diagnosis, prevention, and treatment of the malnutrition. There is no reference method indicating the PEW alone in ESRD patients [5]. Some of the methods used to evaluate the nutritional conditions of maintenance HD patients include dietary assessments, anthropometric measurements, laboratory parameters, dual energy X-ray absorptiometry, and bioelectrical impedance analysis (BIA) [5]. Besides, there have been reliable nutritional screening tools for HD patients which are indicated to be related to morbidity and mortality, such as modified quantitative subjective global assessment (MQSGA), malnutrition inflammation score (MIS), and geriatric nutritional risk index (GNRI) [5–7].

ESRD patients receiving renal replacement treatment have a high PEW prevalence. According to various nutritional evaluation methods, malnutrition is reported in 23 and 76 % of adult HD patients [8]. However, there is a lack of data concerning frequency of malnutrition with different methods in geriatric HD patients. There are apparently anthropometric and physiological differences between male and female patients [9, 10]. On the other hand, there are no certain data regarding the effect of gender on nutritional parameters especially in geriatric HD patients. This study investigated the frequency of malnutrition in geriatric HD patients according to biochemical, anthropometric, BIA, GNRI, and MQSGA methods, and the effect of gender on these different evaluation methods.

Patients and methods

Patients

This was a cross-sectional study conducted in three dialysis units in our city from October to November 2013. The population of the study involved 160 HD patients aged over 65 years who have been on HD for at least 3 months. All the patients were receiving HD thrice a week and for 4 ± 0.5 h per session. Patients at all three dialysis centers were receiving dialysis with a standard bicarbonate-containing dialysate bath using a biocompatible HD membrane (Polysulfone, FX series, Fresenius, Germany). Dialysate flow rates were 500 mL/min and blood flow rates were 250–350 mL/min. The following patients were excluded from the study: those who had lower limb amputation or paraplegia, those who had either a metal stent or a pacemaker in their bodies, patients with active underlying disease or infection, and patients who were hospitalized within the last 3 months prior the study. We also excluded patients if they had advanced senility or dementia interfering with application of the nutritional questionnaire or refused to cooperate with the study. All clinical data were obtained from patient's medical records. Ethics committee of our university approved the protocol. Written informed consent was obtained from all patients before the study.

Modified quantitative subjective global assessment

MQSGA that was accepted to be used in evaluating the nutritional status of HD patients involves seven features: weight change, gastrointestinal symptoms, dietary intake, functional capacity, co-morbidity, signs of subcutaneous fat, and muscle wasting [6]. Each component has a score from 1 (normal) to 5 (very severe). MQSGA score is a number between 7 (normal nutrition) and 35 (severely malnutrition). While lower scores show the normal nutritional condition, higher scores show the malnutrition [6]. MQSGA score of patients was calculated and those with a score of 11–35 were accepted as malnourished [6].

Geriatric nutritional risk index

It was demonstrated that GNRI was a valid screening method showing the nutritional status of not only the elderly patients, but also the HD patients [7]. GNRI was calculated by modifying the nutritional risk index for elderly subjects, as reported by Yamada et al. [7]. The GNRI formula is as follows: GNRI = [14.89 × albumin (g/dL)] + [41.7 × (weight/ideal body weight)] [7]. Body weight or ideal body weight was set to one when the patient's body weight exceeded the ideal body weight. Ideal body weight was calculated using height and a body mass index (BMI) of 22 as Yamada et al.'s study [7]. GNRI were calculated in all patients. The study of Yamada et al. [7] suggests GNRI below 91.2 as a clinical trigger for nutritional support. Thus, patients who had a GNRI lower than 91.2 were accepted as malnourished.

Anthropometric measurements

Anthropometric parameters are also used as a reliable means in depicting the nutritional status of HD patients [11]. Triceps skinfold (TSF), biceps skinfold (BSF), midarm circumference (MAC), and calf circumference (CC) were measured three times after the dialysis, and these three measurements were averaged. Arm measurements were performed on the non-access arm. While MAC and CC were measured with the metal tape measure, TSF and BSF were measured with the standard skinfold caliper. Anthropometric measurements were performed by the same researcher using standard techniques [11]. Mid-arm muscle circumference (MAMC) was calculated with the following formula: MAMC = MAC − (3.1415 × TSF)

[11]. TSF, MAC, MAMC below the 10th percentile are other indicators of poor nutritional status [12]. Thus, those with TSF, MAC, MAMC values below the 10th percentile according to age and gender were considered malnourished [12]. Besides, those with CC lower than 30.5 cm according to both genders were evaluated as malnourished, which was also suggested by Bonnefoy et al. [13] for elderly patients. Body mass index (BMI) was calculated as the rate of post-dialysis body weight (kg) to the square of height (meter) (kg/m^2). According to the suggestions of the World Health Organization (WHO), those with BMI lower than 18.5 kg/m^2 were accepted malnourished [7, 14].

Bioelectrical impedance analysis

Body compositions were analyzed by using the Body Composition Analyzer (Tanita SC 330S) 30 min after the end of the dialysis. The patient measurements were performed by making the patients stand on the metal side of the device barefoot and hold their arms free and parallel to the body. The measurements lasted for approximately 1–2 min for each patient, and the results were printed out of the device. BIA evaluated the body fat percentage, fat free mass (FFM), and total body water (TBW).

Laboratory evaluation

Morning blood samples were taken after an overnight fast for serum albumin, creatinine, hemoglobin, urea nitrogen, total cholesterol, triglyceride, parathyroid hormone (PTH), phosphorus, and C-reactive protein (CRP) before the dialysis session. Besides, post-dialysis blood samples were taken for urea nitrogen to determine urea kinetics by single-pool Kt/V [15]. CRP was assayed by using immunoturbidimetric method (normal range of CRP: 0–5 mg/L). Serum albumin levels were measured by using the quantitative colorimetric method. All the other laboratory measurements were performed by using automated and standardized methods. In accordance with the protocol of Blackburn et al., patients with albumin lower than 3.5 g/dL were accepted as malnourished [7, 16].

Statistical analyses

The results were expressed as mean ± standard deviation (SD). A comparison between the two groups was performed by using Student's *t* test for normally distributed variables, whereas the Mann–Whitney's *U* test was used for non-normal distributed variables. Nonparametric chi-square test was used to compare nominal variables among the different study groups. Pearson's test was used to assess the linear correlation between the malnutrition-related parameters. Statistical analysis was performed with the SPSS software, version 17.0, and a p value less than 0.05 was considered as statistically significant.

Results

Among 160 patients included in the study, 82 were males (51.2 %). Mean age was 72.8 ± 6.1 years, and mean HD duration was 49.3 ± 41.7 months. Table 1 illustrates clinical, biochemical, and nutritional parameters of patients. While weight, FFM, and TBW were found to be significantly higher in male patients ($p = 0.005$, $p < 0.001$, $p < 0.001$, respectively), body fat percentage, TSF, and BSF were found to be significantly higher in female patients ($p < 0.001$ in all three) (Table 1). While MQSGA was significantly higher in female patients compared to male patients ($p = 0.004$), there was no significant difference between female and male patients in terms of GNRI ($p = 0.467$) (Table 1).

Table 2 illustrates the prevalence of malnutrition in patients according to different evaluation methods. While malnutrition was higher in female patients according to MQSGA, TSF, and body fat percentage ($p = 0.008$, $p < 0.001$, $p = 0.042$, respectively), it was higher in male patients according to MAC and MAMC ($p = 0.012$, $p < 0.001$, respectively) (Table 2). No significant difference was observed between genders in the frequency of malnutrition according to albumin, GNRI, BMI, and CC (Table 2).

Table 3 shows the correlation of MQSGA, GNRI, and TSF with some clinical, laboratory, and anthropometric parameters concerning the nutritional status. While MQSGA was negatively correlated with both TSF and GNRI in female patients ($r = -0.381$, $p = 0.001$; $r = -0.328$, $p = 0.003$, respectively), it was negatively correlated with TSF and was not significantly correlated with GNRI in male patients ($r = -0.227$, $p = 0.040$; $r = -0.91$, $p = 0.414$, respectively). There was a significant negative correlation between MQSGA and MAC, MAMC, and CC; however, GNRI was not correlated with any of them (Table 3). Figure 1 shows the negative correlation between MQSGA and GNRI according to Pearson's simple correlation model ($r = -0.381$; $p = 0.001$) in geriatric female HD patients.

Discussion

PEW is a problem that affects approximately one-third of chronic HD patients, increases the hospitalization rate, and causes deterioration in the recovery of infection [2, 17]. In their study including 58 HD patients with mean age of 49.2 ± 14.8, Oliveira et al. [18] reported that malnutrition prevalence was between 12.1 and 94.8 % according to different methods. In our study, we found that the

Table 1 Clinical, biochemical, and nutritional parameters of geriatric hemodialysis patients

Parameters	All patients ($n = 160$)	Female ($n = 78$)	Male ($n = 82$)	p value
Age (year)	72.8 ± 6.1	73 ± 6	72.7 ± 6.1	0.719
Dialysis duration (month)	49.3 ± 41.7	54.7 ± 44.6	44.1 ± 38.4	0.198
Hemoglobin (g/dL)	10.5 ± 1.2	10.5 ± 1.1	10.5 ± 1.3	0.913
Albumin (g/dL)	3.7 ± 0.4	3.7 ± 0.4	3.8 ± 0.4	0.714
Creatinine (mg/dL)	6.7 ± 1.5	6.5 ± 1.6	6.9 ± 1.4	0.102
Kt/V	1.4 ± 0.1	1.5 ± 0.1	1.4 ± 0.1	0.358
Total cholesterol (mg/dL)	174.4 ± 46.8	178.7 ± 48.4	170.3 ± 45.2	0.269
Triglyceride (mg/dL)	147 ± 68.1	154.3 ± 79.1	139.9 ± 55.5	0.432
PTH (pg/mL)	316 ± 222	342 ± 253	292 ± 187	0.410
Phosphorus (mg/dL)	4.7 ± 1.4	4.6 ± 1.5	4.7 ± 1.2	0.836
CRP (mg/L)	10.1 ± 7.4	9.6 ± 7.3	10.7 ± 7.6	0.421
Weight (kg)	64.8 ± 13.7	61.7 ± 14	67.8 ± 12.8	0.005
BMI (kg/m2)	24.6 ± 4.6	25 ± 5	24.2 ± 4.2	0.269
Percentage body fat	27.2 ± 10	32.4 ± 10.4	23.4 ± 7.8	<0.05
Fat free mass (kg)	47.1 ± 8.7	40.7 ± 6.4	51.9 ± 7.1	<0.05
Total body water (kg)	34.5 ± 6.4	29.8 ± 4.7	38 ± 5.2	<0.05
TSF (mm)	11.8 ± 6	14.1 ± 6.7	9.6 ± 4.2	<0.05
BSF (mm)	11 ± 5.3	12.3 ± 6	9.8 ± 4.4	<0.05
MAC (cm)	25.4 ± 3.5	25.4 ± 4	25.3 ± 3.1	0.733
MAMC (cm)	21.9 ± 2.8	21.5 ± 3.1	22.2 ± 2.5	0.108
Calf circumference (cm)	31.7 ± 4.1	31.4 ± 4.5	32 ± 3.6	0.359
MQSGA	12.4 ± 4.1	13.4 ± 4.7	11.4 ± 3.2	0.004
GNRI	103.7 ± 11.9	104.4 ± 13.4	103 ± 10.3	0.467

PTH parathyroid hormone, *CRP* C-reactive protein, *BMI* body mass index, *TSF* triceps skinfold thickness, *BSF* biceps skinfold thickness, *MAC* mid-arm circumference, *MAMC* mid-arm muscle circumference, *cm* centimeter, *MQSGA* modified quantitative subjective global assessment, *GNRI* geriatric nutritional risk index

Table 2 Prevalence of malnutrition according to different methods in geriatric hemodialysis patients

Parameter of nutritional assessment	All patients (%) ($n = 160$)	Female (%) ($n = 78$)	Male (%) ($n = 82$)	p value
Albumin <3.5 gr/dl	29.1 (46)	29.5 (23)	42.7 (35)	0.919
MQSGA score = 11–35	60 (96)	57.3 (55)	42.7 (41)	0.008
GNRI <91.2	15 (24)	17.9 (14)	12.2 (10)	0.213
BMI <18.5 kg/m^2	8.1 (13)	11.5 (9)	4.9 (4)	0.124
Percentage body fat below normal	33.8 (54)	41 (32)	26.8 (22)	0.042
TSF (<10th percentile)	39.4 (63)	56.4 (44)	23.2 (19)	<0.001
MAC (<10th percentile)	62.5 (100)	52.6 (41)	72 (59)	0.012
MAMC (<10th percentile)	50 (80)	26.9 (21)	72 (59)	<0.001
Calf circumference (<30.5 cm)	43.1 (69)	43.6 (34)	42.7 (35)	0.908

Values of TSF, MAC, and MAMC were evaluated according to gender and age group percentile (12). *MQSGA* modified quantitative subjective global assessment, *GNRI* geriatric nutritional risk index, *BMI* body mass index, *TSF* triceps skinfold thickness, *MAC* mid-arm circumference, *MAMC* mid-arm muscle circumference

prevalence of malnutrition ranged from 8.1 to 62.5 % (Table 2). Our study results are important as there is no much data about different nutritional evaluation methods in the geriatric HD patient population. While the lowest malnutrition prevalence was found in the evaluation with BMI, the highest value was found in the evaluation with MAC in our study (Table 2). Besides, it was also found that the highest malnutrition prevalence was in the evaluation with MQSGA in 57.3 % of female patients and in the evaluation with MAC and MAMC in 72 % of male patients (Table 2). Our results showed that the frequency of malnutrition varied according to the evaluation method and gender in geriatric HD patients.

In our study, the mean MQSGA of geriatric HD patients was 12.4 ± 4.1, and according to MQSGA, 60 % of patients were malnourished. Besides, the malnutrition was significantly higher in female patients compared to male patients (Table 2). Kalantar-Zadeh et al. [6] found the

Table 3 Correlation coefficients between malnutrition-related parameters in geriatric hemodialysis patients

	MQSGA		GNRI		TSF (mm)	
	Female	Male	Female	Male	Female	Male
Dialysis duration (month)	0.299* ($p = 0.008$)	0.322* ($p = 0.003$)	−0.080 ($p = 0.485$)	0.073 ($p = 0.515$)	−0.388* ($p < 0.001$)	−0.108 ($p = 0.336$)
Albumin (gr/dL)	−0.350* ($p = 0.002$)	−0.317* ($p = 0.004$)	0.589* ($p < 0.001$)	0.594* ($p < 0.001$)	0.265* ($p = 0.019$)	0.256* ($p = 0.020$)
BMI (kg/m2)	−0.357* ($p = 0.001$)	−0.181 ($p = 0.104$)	0.114 ($p = 0.321$)	0.105 ($p = 0.350$)	0.630* ($p < 0.001$)	0.660* ($p < 0.001$)
Percentage body fat (%)	0.014 ($p = 0.934$)	0.185 ($p = 0.199$)	0.014 ($p = 0.934$)	0.000 ($p = 0.999$)	0.520* ($p = 0.001$)	0.526* ($p < 0.001$)
MAC (cm)	−0.440* ($p < 0.001$)	−0.327* ($p = 0.003$)	0.161 ($p = 0.159$	0.108 ($p = 0.335$)	0.776* ($p < 0.001$)	0.606* ($p < 0.001$)
MAMC (cm)	−0.343* ($p = 0.002$)	−0.246* ($p = 0.026$)	0.097 ($p = 0.397$	0.003 ($p = 0.976$)	0.530* ($p < 0.001$)	0.290* ($p = 0.008$)
CC (cm)	−0.521* ($p < 0.001$)	−0.426* ($p < 0.001$)	0.164 ($p = 0.152$)	0.053 ($p = 0.634$)	0.640* ($p < 0.001$)	0.574* ($p < 0.001$)

Pearson's correlation test was used to determine correlation between parameters. *p* values are shown in parentheses after each r value. *Statistically significant *r* values ($p < 0.05$)

MQSGA modified quantitative subjective global assessment, *GNRI* geriatric nutritional risk index, *TSF* triceps skinfold thickness, *BMI* body mass index, *MAC* mid-arm circumference, *MAMC* mid-arm muscle circumference, *CC* calf circumference

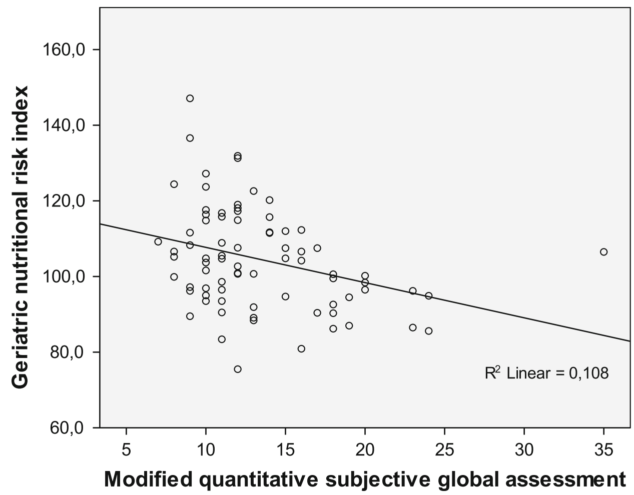

Fig. 1 Negative correlation between modified quantitative subjective global assessment and geriatric nutritional risk index according to Pearson's simple correlation model in geriatric female hemodialysis patients ($r = -0.381$; $p = 0.001$)

mean MQSGA as 10.9 ± 4 in 81 HD patients who had mean age of 57.2 ± 12.9 and stated that there was no difference between female and male patients in terms of MQSGA. Similarly, Houa et al. found that mean MQSGA was 9.8 ± 5 in 84 HD patients (mean age = 50.6 ± 16.3) and detected no difference between genders in terms of MQSGA [20]. Comparing our results with these studies, it seems that malnutrition is encountered more frequently in geriatric HD patients compared to younger adults. Besides, it could be asserted that female geriatric HD patients were under a higher risk of malnutrition compared to male patients.

GNRI is a screening tool that is proven to be reliable in determining the nutritional risk not only in geriatric patients, but also in adult HD patients [7]. In our study, malnutrition was found in 24 % of patients according to GNRI and no difference was observed between genders. Similarly, no difference was found between GNRI and gender by Yamada et al. in 422 patients who had a mean age of 63.8 ± 12.2 and by Ferng et al. in 179 patients who had a mean age of 64.7 ± 13.7 [7, 20]. Yamada et al. [7] reported that patients with lower GNRI (<91.2) had lower TSF, albumin, percentage body fat, and higher age. In our study, no correlation was found between GNRI and anthropometric parameters such as MAC, MAMC, and CC; however, a significant negative correlation was found between MQSGA and these parameters (Table 3). Thus, MQSGA could be more useful compared to GNRI, in evaluations including body fat amount and muscle mass of geriatric HD patients.

In our study, while the patients with TSF lower than 10th percentile and body fat percentage below normal were found to be higher in females, the patients with MAC lower than 10th percentile and MAMC lower than 10th percentile were found to be higher in males (Table 2). In a study among HD patients with a mean age 57.2 ± 12.9, Kalantar-Zadeh et al. [6] reported that TSF, BSF, MAC, and MAMC evaluations did not differ between genders. While the measurements of TSF and BSF give information about the body fat amount, MAC and MAMC give information about the muscle mass [21]. According to our results, it could be asserted that while female geriatric HD patients had more fatty tissue loss, male patients had more muscle mass loss. Thus, it could be accurate to evaluate the anthropometric measurements of geriatric HD patients differently from younger patients. Additionally, our study demonstrated that there were significant differences in the anthropometric evaluations of geriatric HD patients according to gender (Table 1).

Indicating the visceral protein stores, serum albumin is frequently used in evaluating the nutritional status of dialysis patients [22]. Albumin is closely related with morbidity and mortality in HD patients [23]. In our study, 29.1 % of patients had an albumin lower than 3.5 gr/dL and there was no difference between gender groups (Table 2). We also found a significant correlation between both genders in terms of albumin and all of MQSGA, GNRI, and TSF in our study (Table 3). Kalantar-Zadeh et al. [6] also reported a correlation between albumin and MQSGA.

BIA is an objective, reliable, non-invasive, cheap, and repeatable method that evaluates the hydration status and body components of HD patients [24]. It was recently reported that body composition monitor assessing malnutrition in the HD population independently predicts the mortality [25]. In our study, while FFM and TBW were significantly higher in male patients, the body fat percentage was higher in female patients (Table 1). However, the number of female patients whose body fat percentage was below normal was significantly higher than male patients (Table 2). In their study that was conducted with 748 HD patients, Rosenberger et al. [25] also found a relation between the low lean tissue index and the female gender. According to our findings, malnutrition was higher in female geriatric HD patients in evaluation with BIA compared to male patients.

BMI was accepted by WHO as the nutritional anthropometric reference marker [14]. In our study, we found that the mean BMI was similar in female and male patients (Table 1). Kalantar-Zadeh et al. [6] also found the BMI as almost equal in both genders. In our study, BMI was lower than 18.5 kg/m^2 in 8.1 % of patients and there was no difference between genders (Table 2). In their study that was performed with 84 HD patients who had an age average of 50.6 ± 16.3, Houa et al. [19] reported that BMI was lower than 18.5 kg/m^2 in 16.6 % of patients. BMI is directly correlated with the body fatness [26]. In our study, BMI was found to be significantly correlated with TSF in both genders, which supports this data (Table 3). On the other hand, the BMI cutoff point is controversial for malnutrition in dialysis patients [18].

In our opinion, this study has some limitations. Firstly, there are views suggesting different cutoff values especially for albumin, BMI, and anthropometric values for HD patients in methods that are used in the nutritional evaluation. Thus, it is possible to make evaluations according to different cutoff points. Secondly, the percentile values used for anthropometric measurements did not belong to our country.

In conclusion, our data indicate that while malnutrition were encountered at a higher rate in female geriatric HD patients according to MQSGA, TSF, and the percentage body fat compared to male patients, there was no difference between genders according to GNRI, albumin, BMI, and CC. While MQSGA, percentage body fat, FFM, and TSF had significant difference in the nutritional evaluation of geriatric HD patients according to gender, there was no difference in GNRI, albumin, BMI, MAC, and CC. Besides, our results show that while MQSGA is significantly and negatively correlated with TSF, MAC, MAMC, and CC in both genders in geriatric HD patients, there was no significant correlation between GNRI and these parameters.

Conflict of interest None.

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