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Original Article

Evaluation of the impacts of nutritional support in maintenance Hemodialysis patients using anthropometric measurements, biochemical parameters, and the modified quantitative subjective global assessment (MQSGA)

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Abstract: Malnutrition is common in hemodialysis patients and is linked to increased morbidity and mortality. Anthropometric measurements, biochemical parameters, and the modified quantitative subjective global assessment (MQSGA) were used in this study to assess the effects of nutritional support in maintenance hemodialysis patients. This prospective cohort study included 62 patients (32 males, 30 females; mean age: 49.81±13.86 years) who were randomly divided into two groups according to full nutritional assistance (group 1) and partial nutritional assistance (group 2) that were followed from September 2020 to September 2021. The patient's anthropometric measurements, MQSGA score, and biochemical parameters were assessed at the 1st and 12th months of hemodialysis. After a year of maintenance hemodialysis with full nutritional support and partial nutritional support; Body mass index (BMI), triceps skinfold thickness (TSFT), mid-arm circumference (MAC), and handgrip strength (HGS) were all measured, and the mid-arm muscle circumference (MAMC) was determined. Several biochemical parameters were assessed, including Serum albumin (ALB), serum calcium, serum phosphorus, parathyroid hormone (iPTH), hemoglobin (HGB), triglycerides (TG), serum iron (Fe), and low-density lipoprotein (LDL). The MQSGA score correlated positively with MIS ($r = 0.618$, P: 0.001) whereas albumin ($r = -0.282$, P: 0.027), grip strength ($r = -0.376$, P: 0.003), dry weight ($r = -0.275$, P: 0.030) all had negative correlations with the MQSGA score. After one year of treatment, In group 1, iPTH, BMI, MQSGA Score, and MIS decreased whereas handgrip strength, dry body weight, albumin, Kt/Vurea, MAMC, TC, and Hb increased, The difference ($P<0.05$) was statistically significant. After treatment in group 2, MAMC, MAC, Hb, and Grip strength all decreased, while TC increased; the difference was statistically significant ($P<0.05$). The findings suggest that providing complete nutritional assistance can significantly improve overall nutritional status, reducing malnutrition in hemodialysis patients. Thus, nutritional status in hemodialysis patients can be assessed using the MQSGA score and anthropometric measurements.

Keywords: Nutritional assessment, anthropometric measurements, MQSGA, malnutrition, hemodialysis

Introduction

Chronic kidney disease (CKD) contributes to global morbidity and mortality [1]. Malnutrition is common in hemodialysis patients due to a lack of protein and energy reserves PEW (Protein Energy Wasting), which is linked to increased morbidity and mortality [2]. Patients on maintenance hemodialysis have their nutritional status assessed as part of their routine care. PEW is caused by a variety of factors in patients with MHD, which includes inadequate dialysis, accumulation of metabolic waste, metabolic acidosis, secondary hyperparathyroidism, gastric dysfunction, loss of appetite, protein loss, insufficient intake of dietary calorie and protein, hypercatabolism, inflammation, polypharmacy, and infection [3, 4]. Patients undergoing hemodialysis (HD) have a worse quality of life (QoL) than the general population [5]. Hence, nutritional intervention such as nutritional support counseling and proper clinical care in advance become indispensable for the benefit and QoL improvement in HD Patients. The purpose of this randomized controlled trial was to see if providing individual nutritional assistance follow-up improved nutritional status and quality of life when compared to partial nutritional assistance. In clinical practice, determining a patient's nutritional status using a single method is difficult. The MQSGA (Modified Quantitative Subjective Global Assessment) [6] is a superior tool to the SGA (Subjective Global Assessment) for assessing PEW in MHD patients.

Materials and methods

General information and methods

This is a prospective observational study in which 62 patients (of either gender) with ESKD who had been on hemodialysis for at least three months were recruited and followed up for 12 months at the Hemodialysis Center of Kunming Medical University's First Affiliated Hospital, where a total of 150 patients were undergoing hemodialysis treatment. From September 2020 to September 2021, a group of patients was randomly assigned to receive maintenance hemodialysis treatment for a year. Hemodialysis for at least three months and being over the age of 18 were the main inclusion criteria. Patients with a history of cancer, alcohol or drug abuse, kidney-transplanted patient, actual or intended pregnancy, breastfeeding, mental illness, advanced liver disease, and liver transplantation and those who refused to sign an informed consent form were not allowed to participate in the study. A total of 88 patients were excluded from the initial 150 patients, after which the remaining 62 patients were enrolled for the study. Each participant in this study gave informed consent to use their hemodialysis biochemical lab data. The Ethics Committee of the First Affiliated Hospital of Kunming Medical University approved this study. Mean, standard deviation, median, chi-square, "t"-Student test, and Pearson's correlation were used in the statistical analysis. P<0.05 was considered significant. All patients were randomly assigned to one of two groups: full nutritional support (group 1 = 40) or partial or partial nutritional support (group 2 = 22). The presence of a dietitian during hemodialysis sessions in the dialysis center was classified as full nutritional assistance. The necessity for an appointment for partial nutritional support was defined by the nutritionist not being present throughout HD sessions. All 62 patients completed the study with minor or no comorbidities. The patient's anthropometric measurements, MQSGA score, and biochemical parameters were assessed at the 1st and 12th months of hemodialysis. Patients in each group were treated with regular hemodialysis three times a week for around 3.5-4 hours per session with different hemodialysis modalities for a year of maintenance hemodialysis therapy with complete nutritional support (group 1) and partial nutritional support (group 2). Medical records were used to acquire demographic and clinical data and also by history taking and interviews. **Table 1** shows the demographics of the patients who took part in the study.

Observation indicators

In September 2020 and September 2021, fasting blood venous was obtained on the first day of dialysis to measure the important biochemical markers. General demographic information, main illness, dialysis modality, and duration were all obtained before and after therapy. Body mass index (BMI), triceps skinfold thickness (TSFT), mid-arm circumference (MAC), and handgrip strength (HGS) were all assessed, with the mid-arm muscle circumference (MAMC) being computed; MQSGA score (normal nutrition and malnutrition mild-to-moderate, severe malnutrition); biochemical parameters such as Serum albumin (ALB), serum calcium, serum phosphorus, parathyroid hormone (iPTH), hemoglobin (HGB), triglycerides (TG), serum iron (Fe), total iron-binding capacity (TIBC), and low-density lipoprotein (LDL) were evaluated. Instruments: anthropometric measurements, Biochemical tests, MQSGA score, malnutrition-inflammation score. Two physicians independently analyzed each participant's nutritional status.

Anthropometric measurements

After 10-15 minutes of HD therapy, height, weight, and anthropometric measures were

Table 1. Demographic data of the participating patients

Variables n (%)	Group 1 n = 40 (64.5)	Group 2 n = 22 (35.4)	*P*-value
Age (years) (Total Patients 49.81±13.86)	51.25±14.4	47.182±12.71	0.272
X ± sd			
Median *M*	50	48.5	
Variation	27-78	23-71	
Sex			
Male (32)	14 (35)	18 (81.81)	
Female (30)	26 (65)	4 (18.19)	
The primary cause of renal failure			
Diabetes	5 (12.5)	9 (40.9)	
Hypertension	8 (20)	4 (18.18)	
Glomerulonephritis	15 (37.5)	8 (36.4)	
Lupus nephritis	5 (12.5)	0	
Kidney stone	1 (2.5)	0	
IgA	1 (2.5)	0	
Renal cyst	1 (2.5)	0	
Others	4 (10)	1 (4.5)	
Comorbidities			
No of Comorbidities	0	0	

taken. The thickness of the Triceps skinfold (TSF) was measured using standard techniques and a skinfold caliper. A plastic tape was used to measure the circumference of the mid-arm. The formula for calculating the mid-arm muscle circumference (MAMC) was: MAMC = MAC-(3.1415xTSF). The non-access arm was used for all anthropometric measures. The ratio of post-HD body weight in kilograms to the square of height in meters (kg/m^2) was used to compute the body mass index (BMI).

Modified quantitative subjective global assessment MQSGA

Weight change, nutritional intake, gastrointestinal symptoms, functional capacity, comorbidities, evidence of subcutaneous fat, and muscle wasting are the seven components of MQSGA [6]. A score was assigned to each component ranging from 1 (normal) to 5 (very severe). The overall MQSGA score ranged from 7 (Normal) to 35 (severely malnourished). Normal nutrition (scores of 7-10), mild-to-moderate malnutrition (scores of 11-20), and severe malnutrition (scores of 20-30) were the three categories of patients. Whereas, in this study, there were no severe malnutrition patients. So, we divided the MQSGA score of patients into Normal nutrition (below 10) and mild-moderate Malnutrition (above 10).

Statistical analysis

The data was analyzed using the Statistical Package for Social Science (SPSS) version 23. The mean and standard error of the mean (mean ± SEM), median, chi-square, independent sample t-test and paired sample t-test, and Pearson's correlation coefficient are used to represent the measurement data. Using the χ^2 test, the counting data is reported in terms of rate (%). A *P*-value of less than 0.05 was considered statistically significant.

Results

Demographics

There were 62 patients in our research, 32 males and 30 females, with a mean age of 49.81±13.86 years, range 23-78 years. All 62 patients completed the study. **Table 1** shows the demographic data of the participating patients in the study. Full-time nutritional support (group 1 = 30 patients) and partial nutritional support (group 2 = 22 patients) were divided randomly. With a median age of 51 years, Group 1 was much older (range: 27-78

Table 2. Comparison of Anthropometric measurements, biochemical and clinical parameters of group 1 was evaluated on the 1st and 12th month of hemodialysis by analysis of variance with two factors of variation: group and time

Variables N (%)	Group 1 M1 n = 40 Mean (SD) Full-time nutritional assistance	Group1 M12	*P* value
Phosphorus (mg/dL)	2.423±0.96	2.212±0.74	0.148
Total Calcium (mmol/L)	2.36±0.28	2.31±0.211	0.261
iPTH (pg/mL)	459.49±402.02	363.508±287.10	0.044*
Albumin (g/dL)	41.59±4.2	43.44±3.78	0.003*
Triglycerides (mmol/L)	2.164±1.81	2.125±2.08	0.874
Kt/Vurea	1.5±0.25	1.7±0.46	0.020*
BMI	21.34±3.05	20.70±2.18	0.030*
Dry Body weight	54.86±7.8	55.15±7.9	0.371
Grip strength	22.1140±8.67	23.273±8.81	0.237
TSF	12.20±3.56	12.25±3.74	0.944
MAC	24.65±1.74	25.40±2.86	0.114
MAMC	21.60±2.29	22.75±3.38	0.025*
TC	2.22±0.93	3.65±0.68	0.001*
SCR	355.47±137.13	329.90±127.25	0.185
MQSGA Score	13.73±2.92	12.35±2.88	0.003*
MIS	6.73±3.14	5.75±2.83	0.015*
Nourished group	10 (25%)	20 (50%)	
Malnourished group	30 (75%)	20 (50%)	
Hb	101.25±19.78	113.32±13.60	0.001*
Serum Iron mmol/l	15.56±6.3	10.98±5.1	0.125

Statistical analysis methods: mean (mean ± SEM), median, chi-square, t-test. Note: All the values are expressed as mean ± SEM. *P<0.05; M1: 1st month; M12: 12th month; BMI: body mass index; MAC: mid-arm circumference; MAMC: Mid arm muscle circumference; MIS: malnutrition-inflammation score; TSF: triceps skinfold thickness; Albumin: ALB; MQSGA: modified quantitative subjective global assessment; parathyroid hormone: PTH; Dialysis Adequacy: Kt/V; Statistical analysis methods: mean (mean ± SEM), median, chi-square, independent sample t-test and paired sample t-test.

years). The median age in group 2 was 47 years (range: 23-71 years). In terms of gender, patients in groups 1 and 2 were 35% and 81.8% male, respectively. The most common causes of renal failure in MHD patients in group 1 were: Glomerulonephritis (37.5%), hypertension (20%), diabetic nephropathy and lupus nephritis (12.5%) each, kidney stone, IgA, Renal Cyst (12.5%) each and other causes (10%). The main cause of renal failure CKD among MHD patients in group 2 (partial nutritional support) were: diabetic nephropathy (40.9%), Glomerulonephritis (36.4%), hypertension (18.18%), and other causes (4.5%). 19 patients (30.6%) had normal nutritional status, while 43 patients (69.4%) had mild-to-moderate malnutrition, according to the MQSGA score.

Tables 1-3 show the study population's demographic characteristics, baseline data, anthropometric measures, and laboratory parameters.

The efficacy of full nutritional support in group 1: According to **Table 2**, After treatment for one year, In group 1, iPTH, BMI, MQSGA Score, and MIS decreased whereas albumin, Kt/Vurea, MAMC, TC, and Hb increased, P<0.05 indicated that the difference was statistically significant. While, Phosphorus, Dry body weight, serum calcium, Grip strength, TSF, MAC, SCr, and TG levels did not differ significantly. **Table 2** displays the results. MAMC, MAC, Hb, and Grip strength reduced in group 2 following treatment, but TC raised; there was a statistically significant difference (P<0.05).

Table 3. Comparison of Anthropometric measurements

Variables N (%)	Group 2 M1 n = 22 Partial nutritional assistance	Group 2 M12	*P*-value
Phosphorus (mg/dL)	2.72±1.19	2.47±0.63	0.301
Total Calcium (mmol/L)	2.32±0.164	2.26±0.199	0.061
iPTH (pg/mL)	437.76±458.69	421.46±457.76	0.742
Albumin (g/dL)	44.22±3.19	42.50±7.00	0.312
Triglycerides (mmol/L)	1.635±0.77	1.505±0.55	0.505
Kt/Vurea	1.1±0.29	1.0±0.11	0.083
BMI	24.50±3.5	24.30±3.8	0.463
Dry Body weight	54.91±8.5	54.91±8.5	0.807
Grip strength	27.94±10.1	25.91±10.4	0.001*
TSF	12.22±4.17	11.65±4.05	0.352
MAC	26.73±3.06	25.38±3.16	0.001*
MAMC	22.81±2.77	21.48±2.97	0.001*
TC	2.55±1.22	3.54±1.21	0.006*
SCR	512.59±154.24	531.0±161.48	0.547
MQSGA Score	11.0±2.3	11.7±2.4	0.152
MIS	5.32±2.27	5.18±2.48	0.642
Nourished group	9 (40.90%)	8 (36.4%)	
Malnourished group	13 (59.09%)	14 (63.6%)	
Hb	112.86±22.56	100.68±14.81	0.009*
Serum Iron mmol/l	14.31±8.4	13.12±7.6	0.298

Biochemical and clinical parameters of group 2 was evaluated on the 1st and 12th month of hemodialysis by analysis of variance with two factors of variation: group and time. Note: All the values are expressed as mean ± SEM. *P<0.05; M1: 1st month; M12: 12th month; BMI: body mass index; MAC: mid-arm circumference; MAMC: Mid arm muscle circumference; MIS: malnutrition-inflammation score; TSF: triceps skinfold thickness; Albumin: ALB; MQSGA: modified quantitative subjective global assessment; parathyroid hormone: PTH; Dialysis Adequacy: Kt/V; Statistical analysis methods: mean (mean ± SEM), median, chi-square, independent sample t-test and paired sample t-test.

The efficacy of Partial Nutritional Support in group 2: According to **Table 3**, after one year of treatment, MAMC, MAC, Hb, and Grip strength in group 2 declined, while TC raised, and the difference was statistically significant (P<0.05). Phosphorus, iPTH, albumin, Dry body weight, serum calcium, TSF, SCr, MQSGA Score, MIS, and TG did not change significantly (P>0.05). **Table 3** displays the results.

Table 4 shows that MQSGA score correlated negatively with Albumin (r = -0.282, P: 0.027), Grip strength (r = -0.376, P: 0.003), Dry weight (r = -0.275, P: 0.030) whereas, positively with MIS (r = 0.618, P: 0.000).

Figure 1 shows a receiver operating characteristic (ROC) curve study of nutritional status assessments using the MQSGA. Sensitivity is displayed versus 100 specificity for each parameter. A perfect test would have 100 percent sensitivity and specificity and be located in the top left corner of the graph. In contrast, a test with no diagnostic value would be located on the diagonal between the lower left and upper right corners. Handgrip strength, dry body weight, serum albumin, and MIS were all shown to be excellent indicators of nutritional status. As a result, we utilized ROC curve analysis to see if these metrics could be used to predict nutritional status clinically, using MQSGA as the reference standard (**Figure 1**). Albumin had an AUC of 0.548 (95% CI. 0.385-0.712), handgrip strength had an AUC of 0.712 (95% CI. 0.572-0.853), and dry body weight had an AUC of 0.687 (95% CI. 0.541-0.832). Dry body weight, albumin concentration, and handgrip strength were all shown to be good indicators of good nutritional status (P<0.05). For the prediction of malnutrition, a threshold handgrip strength value of 18 provided 84% sensitivity and 69%

Table 4. Pearson's correlation between malnutrition-inflammation score (MIS), biochemical and clinical variables

Variables	MQSGA	
	R	*P*
Albumin	0.618	0.001*
MIS	0.062	0.538
Age	-0.004	0.977
Phosphorus	0.017	0.893
BMI	-0.106	0.411
TSF	-0.120	0.351
Hb	0.058	0.656
Calcium	0.080	0.537
iPTH	0.096	0.456
Triglycerides	-0.120	0.354
BUN	-0.074	0.567
Dry weight	-0.275	0.030*
MAC	0.001	0.995
MAMC	-0.108	0.405
TC	0.102	0.430
Grip strength	-0.376	0.003*
Serum Iron	0.010	0.938
Scr	-0.033	0.799

Note: All the values are expressed as mean ± SEM. *P<0.05 Statistically significant *p*-value; r: Pearson's coefficient; BMI: body mass index; MAC: mid-arm circumference; MAMC: Mid arm muscle circumference; MIS: malnutrition-inflammation score; TSF: triceps skinfold thickness; Albumin: ALB; MQSGA: modified quantitative subjective global assessment; parathyroid hormone: PTH; Dialysis Adequacy: Kt/V; AUC: area under the curve; Statistical analysis methods: Pearson's correlation analysis.

specificity; a threshold albumin concentration of 40.2 g/l provided 69% sensitivity and 65% specificity; and a threshold dry body weight value of 52 kg provided 84% sensitivity and 72% specificity. According to the ROC curve analysis, MIS and MQSGA are both the best tools for assessing the nutritional status of MHD patients. Albumin (r = -0.282, P: 0.027), Grip strength (r = -0.376, P: 0.003), and Dry weight (r = -0.275, P: 0.030) all had negative correlations with MQSGA score whereas positively with MIS (r = 0.618, P: 0.000).

According to MQSGA, majority of the individuals maintained their baseline nutrition level during the course of the one-year treatment period. In group 1, all of the formerly malnourished participants improved their nutritional condition. The proportion of people in group 1 who were nourished increased from 25% at month 1 to 50% at month 12 (**Table 5**). However, the proportion of people in group 2 who were malnourished (mild to moderate) increased from 59.09% at month 1 to 63.6% at month 12. (There were no cases of severe malnutrition).

Discussion

Malnutrition is a serious problem among hemodialysis patients all over the world. In hemodialysis patients, protein-energy wasting is the leading cause of mortality [7], accounting for 18.0% to 75.0% of deaths [8]. Uremia's micro-inflammatory condition can cause anorexia and catabolism, resulting in malnutrition [9, 10]. Increased resistance to the action of anabolic hormones such as growth hormone (GH), insulin growth factor (IGF-1), and testosterone may have an indirect effect on increased muscle breakdown. Dialysis reduces plasma amino acids and intracellular muscle protein synthesis, which impacts energy and protein metabolism [11-13]. Some other factors, such as Protein-energy malnutrition, are caused by a combination of factors, including metabolic acidosis, dialysis-induced amino acid loss (On average, 4-8 grams every HD session are consumed, with high-flux dialyzers up to 20 grams), and insufficient dietary intake [14, 15]. HD patients have a poor quality of life (QoL) compared to the general population, as previously stated [16]. Nutritional monitoring during a dialysis treatment is essential for ensuring adequate fluid intake and dietary calcium, sodium, potassium, calcium, and phosphorus intake, resulting in significant changes in water and mineral metabolism with long-term consequences. MHD patients should have frequent nutrition screening, which includes laboratory tests (e.g., albumin), body weight, and food consumption, as well as recurrent screening for malnutrition every six months, according to KDOQI [17]. Nutritional status assessment is commonly disregarded in routine clinical practice, and specific assessment metrics are inaccurate. Non-nutritional variables such as edema, liver disease, and chronic inflammation can impact nutritional status, and malnutrition appears to worsen over time. Serum albumin is a valuable indicator of visceral protein storage that can be used to identify if a patient is malnourished.

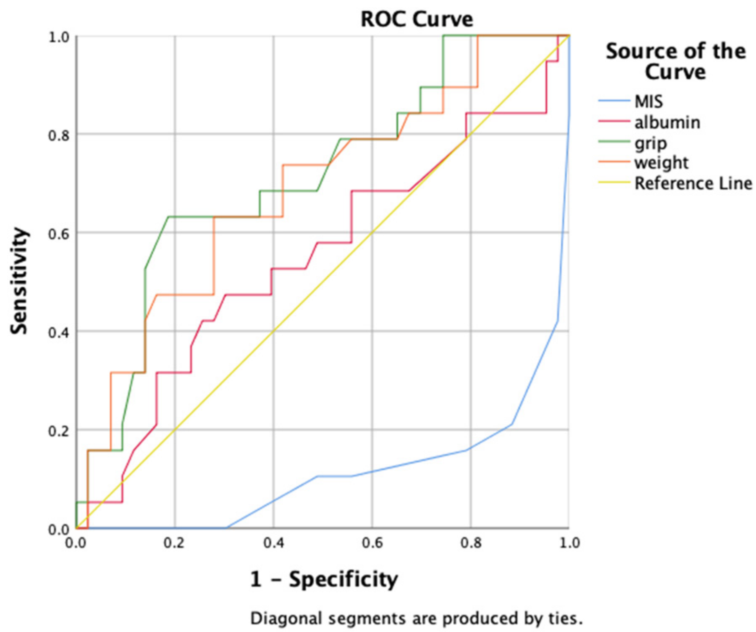

Figure 1. ROC curve; receiver operating characteristic (ROC). Sensitivity is displayed versus 100 specificity for each parameter.

Table 5. Change in MQSGA score for Group 1 and Group 2 over the 12 month treatment period

Change in MQSGA	Group 1 n (%)	Group 2 n (%)
Deteriorated	(0)	1 (4.6)
No change	20 (50)	21 (95.4)
Improved	20 (50)	0 (0)

In this study, After one year of treatment, in the full nutritional assistance group, iPTH, BMI, MQSGA Score, and MIS decreased whereas handgrip strength, dry body weight, albumin, Kt/Vurea, MAMC, TC and Hb increased, the difference was statistically significant as well (P<0.05). However, after one year of treatment in the partial nutritional assistance group, MAMC, MAC, Hb, and Grip strength decreased, and TC increased after treatment; the difference was statistically significant (P<0.05). These findings suggest that full nutritional assistance during maintenance hemodialysis is effective and can positively influence patients' overall nutritional status than patients with partial nutritional assistance, who are more prone to occur mild to moderate malnutrition due to lack of proper nutrition counseling.

Lower MQSGA results indicated improved nutritional status and albumin levels, resulting in less comorbidity. Malnutrition and comorbidities were seen in patients with higher MQSGA scores and lower blood albumin levels.

The MQSGA approach for measuring nutritional status in hemodialysis patients is both reliable and practical. MQSGA is generally well-validated measure for measuring nutritional status that was substantially associated with anthropometric factors [6]. In our research, handgrip strength, dry body weight, and serum albumin were strongly linked with the MQSGA (**Table 4**). Despite the fact that albumin is not a sensitive diagnostic of malnutrition, it is still used to evaluate nutritional status in clinical settings [18]. As a result, researchers are looking for more precise and simple assessment methods. Serum albumin concentration had a rather good sensitivity (69%) and specificity (65%) for predicting malnutrition in this study, using a threshold of 40.2 g/l. Handgrip strength and dry body weight, in particular, were shown to have a stronger relationship with nutritional status and a greater predictive value for nutritional status evaluation than the other anthropometric measurements as shown in **Tables 2-4**. Handgrip strength was shown to have a higher sensitivity in our investigation (84%). HGS is a quick and accurate approach to assess muscle function which is commonly employed in the general population's nutritional evaluation as a function of skeletal muscle strength and function. The degree of HGS is frequently linked to total muscular strength and function [19]. MIS and MQSGA can be the best tool for evaluating nutritional status in MHD patients [20].

We used numerous anthropometric parameters, MQSGA, and serum albumin to assess the nutritional status of hemodialysis patients in this study. In fact, there are a variety of approaches for assessing hemodialysis patients' nutritional status, including MIS. Each approach, however, has its own set of disadvantages [21].

It's also worth noting that we didn't find a link between diabetes and malnutrition in this study, which should be investigated further. According to a prior study, patients with diabetes who were on hemodialysis had a greater frequency of malnutrition and a lower survival rate than those without diabetes [22].

We also discovered no significant difference in Kt/V between participants on full nutritional assistance and those on partial nutritional assistance. It has been shown that for every 0.1 increase in Kt/V, the mortality rate lowers by 2%, and it has been hypothesized that increasing the frequency of hemodialysis will enhance the efficiency of the dialysis regimen, improving nutritional status and decreasing the patients' death rate [23].

The most significant issue affecting anthropometric measurements in dialysis patients appears to be inaccuracies caused by excessive hydration. Despite taking several precautions to avoid this flaw (e.g., strictly regulating measurement duration, estimating different manufacturers, etc.), we cannot completely ignore the problem. More research is needed to develop better indicators of malnutrition in hemodialysis patients. Furthermore, our investigation is constrained with insufficient dataset, mainly because the number of severe malnutrition patients was none, and albumin had low sensitivity for detecting malnutrition. As a result, more large-scale research is required to confirm our findings. While the sample size was mentioned as a study constraint, statistical differences were evident and adequate to support the study's aims. This study highlights the need for larger-scale research to determine the influence of nutritional support in the form of dietary counseling with regular monitoring on patient-centered outcomes like malnutrition and other comorbidities.

Conclusion

The findings suggest that providing complete nutritional support can have a significant positive impact on overall nutritional status and morbidity. The MQSGA score and anthropometric measures can be used to determine the nutritional status of hemodialysis patients. Nonetheless, significant flaws in this study remain, such as a limited number of patients, a lack of long-term clinical treatment feasibility monitoring, necessitating a larger sample size, a multi-center study, and a longer observation period for additional research.

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We confirm that all methods were carried out in compliance with the ethical standards outlined in the Declarations of Helsinki. The Department of Nephrology at KMU's first affiliated hospital approved all experimental procedures. All participants and/or their legal guardians gave their informed consent.

Disclosure of conflict of interest

None.

Abbreviations

BMI, body mass index; MAC, mid-arm circumference; MAMC, Mid arm muscle circumference; MIS, malnutrition-inflammation score; TSF, triceps skinfold thickness; ALB, Albumin; MQSGA, modified quantitative subjective global assessment; CKD, Chronic kidney disease; PTH, parathyroid hormone; Kt/V, Dialysis Adequacy; AUC, area under the curve.

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