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Assessment of Nutritional Status among Hemodialysis Patients by Three Different Tools

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A B S T R A C T

Background: Multiple factors contribute to the increased risk of malnutrition among patients on haemodialysis, which may lead to poor clinical outcomes and increased risk of morbidity and mortality. **Objective**: to assess the nutritional status among haemodialysis patients using different nutritional assessment tools and to assess their agreement. **Method:** A cross-sectional study was conducted among 125 patients on haemodialysis at Zagazig university hospital, in Egypt. Nutritional assessment tools included the Subjective Global Assessment (SGA), Mini Nutritional Assessment (MNA), and Malnutrition Inflammation Score (MIS). Nutritional assessment was done by the three tools**. Results:** The average age was 48.02±13.15 years and 49.6% of the patients were males. The average body mass index was 23.12±3.98 kg/m². The main reasons for haemodialysis were hypertension (40.0%) and diabetes mellitus (17.6%). Based on SGA, MNA, and MIS tools, 20.8%, 18.4%, and 20% were severely unnourished, respectively. Additionally, 47.2%, 48.0%, and 46.4% had mild to moderate malnutrition. There was statistically significant agreement among different methods (P<0.0001). The kappa values further support this agreement. Agreement between SGA and MNA was strong (κ=0.936, p<0.001). Agreement between SGA and MIS was very strong (κ=0.962, p<0.001). Agreement between MNA and MIS was also strong (κ=0.898, p<0.001). **Conclusions:** Malnutrition is very prevalent among haemodialysis patients using three different methods of nutritional assessment, affecting more than 65% of them, including about 20% severe malnutrition. The strong agreement between the three tools suggests that they can be used interchangeably.

INTRODUCTION

End Stage Renal Disease (ESRD) is a globally growing health problem, with hemodialysis (HD) being the most applied treatment. Nearly 1.7 million individuals had chronic kidney disease in Egypt, with a 5-10% increase between 1990 and 2017, and an estimated prevalence of dialysis of 0.61 per 1000 people .[1]

One of the most prevalent and devastating complications of ESRD is malnutrition.[2] Malnutrition is commonly encountered among HD patients and is estimated to globally affect between 28-54% of these patients, depending on the study population and the assessment method.[3] The relation between

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malnutrition and comorbidities of inflammation resulted in the emergence of a new definition of malnutrition, "malnutrition-inflammation-atherosclerosis syndrome," which places greater importance on the investigation of cardiovascular complications in patients with ESRD. With the progress of studies researchers have found that malnutrition in HD patients is a multifactorial process resulting from interaction of both iatrogenic and non-iatrogenic causes with subsequent impairment of quality of life and increased risk of frailty, infection and hospitalization and significant patient morbidity and mortality.[4] Inadequate dialysis with persistent metabolic acidosis and uremic milieu, dialysis-induced nutrients loss, especially amino acids and protein (around 7-8 gm protein loss with each dialysis session), dialyzer reuse, and dialysis-associated inflammation are identified as iatrogenic factors of malnutrition [5-6] while non-iatrogenic causes of malnutrition include suboptimal dietary intake due to altered taste sensation, decreased appetite, anorexia, decreased physical activity, psychological factors such as depression as well as financial factors and increased insulin resistance.[2]

In the early days, malnutrition was evaluated depending on anthropometric measures using electrical bioimpedance and dual-energy X-ray absorptiometry.[7] Currently, malnutrition diagnosis relies on several scoring systems, as there is no single measurement that provides a complete and reproducible assessment of nutritional status .[8-9] Any nutritional assessment tool should be accurate in the diagnosis of malnutrition, able to detect nutritional status changes, measure morbidity and mortality, and assess the impact of nutritional intervention.[10]

According to The Kidney Disease Outcome and Quality Initiative (KDOQI) of the National Kidney Foundation, the Subjective Global Assessment (SGA) is the recognized clinical nutrition evaluation instrument that has prognostic significance for patients with chronic kidney disease (CKD) and is associated with an assessment of the high-risk of nutritional death related to dialysis.[11] However, it is subjective and depends on the raters in the assessment, which makes it inaccurate for the detection of malnutrition among dialysis patients.[12]

The Mini Nutritional Assessment (MNA) is another assessment method used for the identification and early prediction of nutritional problems in dialysis patients and is strongly associated with mortality among those patients. The malnutrition-inflammation score (MIS) is another emerging scoring system for the diagnosis of the malnutrition-inflammation complex syndrome and one of the best predictors of mortality; however, in clinical practice, it is not easy to use as it requires physical examination to detect signs of muscle wasting and measure subcutaneous body fat and other biochemical measurements, including transferrin level, total iron binding capacity, and serum albumin.[13] Dialysis patients still have high rates of morbidity and mortality, despite the significant improvements in the quality of dialysis management.

Table (1): Distribution of the studied patients according to demographic and hemolysis related data

Variables	Values*
Age (years)	
Mean± SD	48.02 ± 13.15
Range	23-77
Dialysis Vintage	
Mean± SD	9.17 ± 5.15
Range	1-25
BMI (Kg/m²)	
Mean± SD	23.12 ± 3.98
Range	16-31
Sex	
Male	62 (49.6%)
Female	63 (50.4%)
Duration of Session	
4.5 hours	1 (0.8%)
4 hours	124 (99.2%)
Urine Output	
Yes	6 (4.8%)
No	119 (95.2%)
Cause of RF or CKD:	
Hypertension	50 (40.0%)
Diabetes	22 (17.6%)
Drug induced.	10 (8.0%)
Immune disorder	2 (1.6%)
Glomerulonephritis	8 (6.4%)
Renal stones	7 (5.6%)
Preeclampsia	3 (2.4%)
Congenital	6 (4.8%)
Polycystic kidney	5 (4.0%)
Familial mediterranean fever	1 (0.8%)
Unknown	11 (8.8%)

** Number and percentage, unless mentioned otherwise. SD: standard deviation*

Table 2: Distribution of the studied patients according to nutrition status:

Variables	Values*
Subjective Global Assessment	
A (well nourished)	40 (32%)
B (moderately unnourished)	59 (47.2%)
C (severely unnourished)	26 (20.8%)
Mini Nutritional Assessment	
Mean ± SD	21.13 ± 4.18
Normal Nutrition	42 (33.6%)
At risk of malnutrition	60 (48%)
Malnourished	23 (18.4%)
Malnutrition Inflammation Score	
Mean ± SD	7.02 ± 5.38
Normal	42 (33.6%)
Mild Abnormal	20 (16%)
Moderate Abnormal	38 (30.4%)
Severely Abnormal	25 (20%)

** Number and percentage, unless mentioned otherwise. SD: standard deviation*

Despite various tools for detecting malnutrition among hemodialysis patients, MIS was found to be more clinically effective in assessing inflammation and malnutrition among hemodialysis patients, regardless of their age.[14]

This study aimed to assess the nutritional status among the studied sample of HD patient attending a hospital dialysis unit in Egypt by using different nutritional assessment tools, including SGA, MIN and MIS and to assess if there a difference between them.

METHODS

A cross-sectional study was conducted on 125 patients with ESRD on regular hemodialysis at the hemodialysis unit in the internal medicine department at Zagazig University Hospitals over five months after receiving the approval of Zagazig University Institutional Review Board (IRB).

Assuming the prevalence of malnutrition among hemodialysis patients by the MNA tool was 42.75% according to Agboton et al. study [15] and the total number of patients with ESRD on regular hemodialysis at hemodialysis units in Zagazig University Hospitals was 162 patients, the required sample was 114 using OpenEPI software, with 80% power of study and 95% confidence level. To adjust for an expected 10% non-response, the sample size was increased to 125. The sample was selected from the patients list using a simple random method technique.

Population: Patients with ESRD on regular hemodialysis at the hemodialysis unit. Inclusion criteria included patients having at least six months of regular hemodialysis, older than18 years old, and full consciousness can communicate well and agree to participate in the study. Exclusion criteria included patients with cancer or active sepsis, primary hyperparathyroidism, or other metabolic bone conditions, and patients with a history of acute critical illness that required hospitalization in the last four weeks.

Data collection: A written informed consent was obtained before the beginning of the study from all patients. A detailed history was taken from them, including age, sex, cause of hemodialysis, dialysis vintage, duration of the session in hours, and a complete clinical examination of the patients. Additionally nutritional assessment, BMI, and laboratory examination were recorded.

Nutritional assessment: It was done by the three tools SGA, MNA, MIS. SGA is a validated nutrition assessment tool that predicts patient outcomes.[16] This tool comprises five clinically significant nutritional features, namely reduced food intake, unintentional loss of weight, symptoms that affect oral intake, functional capacity, and metabolic demand. Additionally, it involves a physical examination that concentrates on subcutaneous fat loss, muscle wasting, and fluid accumulation. The SGA categorizes people as either severely malnourished (SGA C), mildly or moderately malnourished (SGA B), or well-nourished (SGA A). The SGA has been tested and confirmed to be effective in various clinical conditions and disease states, such as chronic renal failure, cancer, geriatrics, critically ill patients, and hospitalized general medical patients. [17]

MIS is widely used validated tool to evaluate a patient's level of malnutrition and inflammation, each of ten components that make up the composite score has four levels of severity, ranging from zero (normal) to three (severely abnormal).[18] There are four parts on the scoring sheet: 1) The patient's medical history in relation to the condition, including any changes in oedema free post HD body weight within the previous six months; 2) A physical examination that looks for signs of muscle wasting and subcutaneous body fat using the SGA criteria; 3) Body Mass Index (BMI); and

Table 3: Demographic, clinical characteristics, and laboratory data by Subjective Global Assessment groups

	Well nourished (n= 40)	Moderately unnourished (n= 59)	Severely unnourished (n= 26)	p-value
Sex (n, %)				
Male	23 (57.5%)	31 (52.5%)	8 (30.8%)	0.087
Female	17 (42.5%)	28 (47.5%)	18 (69.2%)	
Age (years), *mean± SD*	47.90 ± 14.11	47.53 ± 12.00	49.35 ± 14.51	0.841
BMI, *mean± SD*	27.11 ± 2.16	22.78 ± 2.54	17.77 ± 0.86	<0.001**
WBCs, *mean± SD*	6.59 ± 1.57	7.13 ± 1.92	9.33 ± 5.01	<0.001**
Hb, *median (range)*	12.45 (9.8 – 15.2)	10.3 (6.8 – 15.6)	8 (5.8 – 15.1)	<0.001**
Platelet count, *median (range)*	218 (106 – 378)	227 (62 – 388)	212 (91 – 599)	0.928
Hematocrit, *mean± SD*	37.12 ± 5.09	33.67 ± 5.22	27.34 ± 8.55	<0.001**
S. ferritin, *median (range)*	111.5 (10 – 845)	88 (3 – 722)	117.5 (5 – 1034)	0.095
S. iron, *median (range)*	60 (20 – 263)	59 (10 – 170)	46 (15 – 170)	0.098
TIBC, *median (range)*	282.5 (210 – 720)	241 (163 – 680)	178 (148 – 365)	<0.001**
TSAT, *median (range)*	22.02 (2.5 – 111.4)	23.62 (2.94 – 75.8)	22.11 (5.48 – 86.3)	0.684
CRP, *median (range)*	2.1 (0.12 – 190)	5.6 (0.31 – 38.17)	13.4 (1 – 195)	<0.001**
Calcium, *mean± SD*	8.95 ± 0.86	8.63 ± 0.84	8.31 ± 0.88	0.013*
Phosphorus, *mean± SD*	4.62 ± 1.17	5.01 ± 1.55	4.18 ± 1.58	0.049*
PTH, *median (range)*	261 (6.3 – 1691)	314.6 (16.4 – 1617)	225 (6.8 – 1160)	0.265
S. creatinine, *median (range)*	9.64 (5.45 – 18.69)	10.07 (5.25 – 18.4)	8.55 (4.37 – 88)	0.452
BUN, *median (range)*	63.01 (33.9 – 91)	62.4 (38.7 – 102)	60.6 (38 – 586)	0.862
Serum albumin, *median (range)*	4.07 (3.4 – 5.29)	3.63 (2.66 – 4.26)	2.89 (2.22 – 3.67)	<0.001**
Total cholesterol, *mean± SD*	162.300± 32.65	166.186± 32.65	155.965± 23.24	0.374
Triglycerides, *mean± SD*	126.50± 29.272	129.58± 33.139	133.58± 32.099	0.676
LDL, *mean± SD*	103.63± 9.862	111.00± 13.384	116.88± 14.93	<0.001**
HDL, *mean± SD*	39.30± 7.59	36.93± 7.294	31.58± 4.159	<0.001**

*BMI, body mass index; WBCs, white blood cells; Hb, hemoglobin; S Ferritin, serum ferritin; S iron, serum iron; TIBC, total iron binding capacity; TSAT, transferrin saturation; CRP, c-reactive protein; PTH, parathyroid hormone; BUN, blood urea nitrogen; LDL, low density lipoprotein; HDL, high density lipoprotein. *Statistically significant, ** Highly statistically significant*

Laboratory parameters, such as serum albumin level and TIBC. All components added together fall between 0 (normal) and 30 (severely abnormal). An improved rating represents an increase in the severity of malnutrition and inflammation.[13] MNA is originally designed to assess the nutritional status of elderly individuals and is mostly utilized in research settings.[19] With its eighteen items, the MNA evaluated four district areas: general assessment (lifestyle, medication, mobility, and presence of manifestations of depression or dementia); the anthropometric assessment (body mass index (BMI), weight loss, and arm and calf circumferences); short dietary assessment (meals number, fluid and food intake, and autonomy of feeding); and the subjective assessment (self-perception of health and nutrition). Using threshold values of less than 17 for "malnourished," 17 to 23.5 for "at risk of malnutrition," and 24 or more for "normal nutritional status," people can be categorized into three categories by adding up their scores. [20]

The patients' weight after dialysis was measured twice using a scale with 0.1 kg precision. They were wearing minimal clothing during the measurement. Their height was measured while standing barefoot against a wall with their heels, buttocks, shoulders, and head back pressed against it. The height measurement had a precision of 0.5 cm. The patients were then categorized into one of three BMI categories: underweight (BMI<18.5 kg/m^2), normal weight (18.5 kg/m^2<BMI<25 kg/m^2), and overweight (BMI>25 kg/m^2).

Table 4: Demographic and clinical characteristics by Mini Nutritional Assessment groups

	Normal Nutrition (n= 42)	Mild Abnormal (n= 20)	Moderate Abnormal (n= 38)	Severe Abnormal (n= 25)	p-value
Age (Years)					
Mean± SD	47.88 ± 14.30	48.25 ± 11.51	47.16 ± 11.87	49.40 ± 14.81	0.932
Sex					
Male	23 (54.8%)	10 (50%)	22 (57.9%)	7 (28%)	0.104
Female	19 (45.2%)	10 (50%)	16 (42.1%)	18 (72%)	
BMI					
Mean± SD	26.88 ± 2.39	23.65 ± 1.69	22.29 ± 2.88	17.84 ± 0.89	<0.001**

**Statistically significant, ** Highly statistically significant*

Table 5: Correlations between Mini Nutritional Assessment score and laboratory data among the studied patients

	rho	p-value
White blood cells	0.233	0.009*
Hemoglobin	-0.585	0.0000*
Platelet count	-0.028	0.759
Hematocrit	-0.506	<0.001**
Serum ferritin	-0.131	0.146
Serum iron	-0.111	0.217
TIBC	-0.613	<0.001**
Transferrin saturation	0.063	0.485
C-reactive protein	0.457	<0.001**
Calcium	-0.245	0.006*
Phosphorus	-0.048	0.598
Parathyroid hormone	-0.010	0.909
Serum creatinine	-0.039	0.664
Blood urea nitrogen	-0.036	0.693
Serum albumin	-0.656	<0.001**
Total cholesterol	-0.087	0.337
Triglycerides	0.181	0.043*
LDL cholesterol	0.363	<0.001**
HDL cholesterol	-0.268	0.003*

TIBC, total iron binding capacity; LDL, low density lipoprotein; HDL, high density lipoprotein
*rho: Spearman's correlation *Statistically significant, ** Highly statistically significant*

Laboratory investigations were collected from hospital records including routine investigations (complete blood picture, liver function tests, kidney function tests including serum creatinine and serum urea, bone mineral status assessment including serum calcium, serum phosphorus and serum intact parathormone (assay), inflammatory status markers C-reactive protein (CRP), iron profile and complete lipid profile.

Statistical analysis: The Statistical Package of Social Science (SPSS) program for Windows (Standard version 20) was used to analyze this data. First, we used one-sample Kolmogorov-Smirnov test to determine if the data were normal. Numbers and percentages were used to describe the qualitative data. The Chi-square test was utilized to measure the relationship between the categorical variables. For parametric data, continuous variables were presented as mean ± SD (standard deviation), and for non-parametric variables. We used the Kruskal-Wallis Test for non-parametric data and one-way analysis of variance (ANOVA) for parametric data when comparing more than two groups. Our method of choice for correlating continuous non-parametric data was Spearman's correlation. Furthermore, the agreement between various nutritional evaluation tools was evaluated using the Cohen's kappa test, and McNemar's test was used to compare between them; $p \leq 0.05$ was considered to be statistically significant, and highly significant differences were evident if $p \leq 0.001$.

RESULTS

This study involved 125 patients who underwent regular hemodialysis, with ages ranging from 23 to 77 years and a mean of 48.02 ± 13.15 years. The demographic characteristics of the studied participants showed that the gender distribution was 49.6% male and 50.4% female; the mean± SD of BMI was 23.12±3.98 kg/m2, which is considered normal weight. The mean± SD dialysis vintage was 9.17 ± 5.15 and duration of session was mainly 4 hours.

Table 6: Demographic and clinical characteristics by Malnutrition Inflammation Score groups

	Normal nutrition status (n= 42)	At risk of malnutrition (n= 60)	Malnourished (n= 23)	p-value
Age (years)				
Mean± SD	47.19 ± 14.16	48.80 ± 12.06	47.52 ± 14.43	0.817
Sex				
Male	24 (57.1%)	31 (51.7%)	7 (30.4%)	0.109
Female	18 (42.9%)	29 (48.3%)	16 (69.6%)	
BMI				
Mean± SD	26.93 ± 2.31	22.57 ± 2.70	17.83 ± 0.88	<0.001**

**Statistically significant, ** Highly statistically significant*

Table (7): Correlation between Malnutrition Inflammation Score and laboratory data among the studied patients

	rho	p-value
White blood cells	-0.214	0.016*
Hemoglobin	0.61	<0.001**
Platelet count	0.019	0.833
Hematocrit	0.494	<0.001**
Serum ferritin	0.096	0.285
Serum iron	0.187	0.037*
TIBC	0.499	<0.001**
Transferrin saturation	0.050	0.582
C-reactive protein	-0.460	<0.001**
Calcium	0.308	0.0004**
Phosphorus	0.060	0.503
Parathyroid hormone	-0.017	0.855
Serum creatinine	0.108	0.230
Blood urea nitrogen	0.124	0.170
Serum albumin	0.660	<0.001**
Total cholesterol	0.066	0.464
Triglycerides	-0.118	0.189
LDL cholesterol	-0.338	<0.001**
HDL cholesterol	0.294	<0.001**

*TIBC, total iron binding capacity; LDL, low density lipoprotein; HDL, high density lipoprotein; rho: Spearman's correlation *Statistically significant, ** Highly statistically significant*

The main reasons for hemodialysis were hypertension and diabetes mellitus, accounting for 40% and 17.6% of the cases respectively (Table 1).

We evaluated the nutritional status using SGA, MIS and MNA scores. Based on SGA, 32% of the patients were well nourished, 47.2 % were moderately nourished and 20.8 % were severely unnourished. According to MNA, 33.6% were well-nourished, 48% were at risk of malnutrition, and 18.4% of the patients were malnourished. Based on MIS, 33.6% were normal, 16% were mild abnormal, 30.4% were moderate abnormal, and 20% were severely abnormal (Table 2).

By analyzing the demographic and clinical characteristics of SGA groups, we found a statistically significant difference between SGA subgroups in terms of BMI (p<0.001). In addition, there were statistically significant differences between SGA subgroups in terms of hematocrit (p<0.001), WBCS count (P=0.001), TIBC (p<0.001), CRP (P=0.00004), Calcium (P = 0.013), Phosphorus (P = 0.049), Serum albumin (P p<0.001), HDL (p<0.001) and LDL (p<0.001, Table 3)

We also examined the demographic and clinical characteristics of MIS groups, and found a statistically significant difference between MIS subgroups in terms of BMI (P p<0.001), as well as statistically significant negative correlations with hematocrit (rho= -0.506, P p<0.001), hemoglobin level (rho= -0.585, p<0.001), TIBC (rho= -0.613, P=0.000), Calcium (rho =-0.245, P= 0.006), Serum albumin (rho = -0.656, p<0.001) and HDL (rho = -0.268, P=0.003). On the other hand, there were statistically significant positive correlations with WBCS count (rho = 0.233, P=0.009), LDL (rho = 0.364, p<0.001), and CRP (rho = 0.457, p<0.001, Tables 4 and 5)

We also investigated the demographic and clinical characteristics of MNA groups and found a statistically significant difference between MNA subgroups in terms of BMI (p<0.001), as well as statistically significant negative correlations with WBCS count (rho =-0.214, P=0.016), CRP (rho =-0.460, p<0.001) and LDL (rho =-0.338, p<0.001).

Table 8: Agreement between the three Nutritional Assessment Methods

Variables	SGA	MNA	MIS	kappa	p-value
Well-nourished/ normal	40	42	42	K1= 0.936	P1 <0.001**
Mild to moderately malnourished	59	60	58	K2=0 .962	P2 <0.001**
Severely malnourished	26	23	25	K3= 0.898	P3 <0.001**

*SGA, Subjective Global Assessment; MNA, Mini Nutritional Assessment; MIS, Malnutrition-Inflammation Score; k, Cohen's kappa test; ** highly statistically significant; K1and p1 is between SGA & MNA; K2 and p2 is between SGA & MIS; K3 and p3 is between MNA & MIS.*

Table (9): Comparing MNA and MIS with SGA as a gold standard test for Nutritional Assessment among hemodialysis patients

Variables	SGA		P value*
	Well-nourished/ normal (No= 40)	At risk or malnourished (No= 85)	
MNA			
-Well-nourished/ normal (No= 42)	**40**	**2**	
- At risk or malnourished (No= 83)	**0**	**83**	**0.50**
Sensitivity	**100%**		
Specificity	**97.6%**		
MIS			
-Well-nourished/ normal (No= 42)	**40**	**2**	
-At risk or malnourished (No= 83)	**0**	**83**	**0.50**
Sensitivity	**100%**		
Specificity	**97.6%**		

** McNemar test; SGA, Subjective Global Assessment; MNA, Mini Nutritional Assessment; MIS, Malnutrition-Inflammation Score*

Conversely, there were statistically significant positive correlations with hematocrit (rho =0.494, p<0.001), hemoglobin level (rho =0.61, p<0.001), TIBC (rho =0.499, p<0.001) Calcium (rho =0.308, P=0.0004), Serum albumin (rho =`30.660, p<0.001) and HDL (rho =0.294, p<0.001, Tables 6 and 7)

There was statistically significant agreement among different methods. All p-values were (p<0.001), indicating highly significant agreement. The kappa values further support this good agreement: K1: Agreement between SGA and MNA was strong (κ=0.936). K2: Agreement between SGA and MIS was very strong (κ=0.962). K3: Agreement between MNA and MIS was also strong (κ=0.898, Table 8).

There was no statistically significant difference between MNA and Malnutrition-Inflammation Score (MIS) with SGA where (p=0.50) and the sensitivity = 100% and specificity = 97.6% for both tests (Table 9).

DISCUSSION

In Egypt, few studies have been published regarding the assessment of the nutritional status of maintenance hemodialysis patients (MHD); therefore, this study was conducted to measure the prevalence of malnutrition among MHD patients and to assess their nutritional status through the MNA, SGA, and MIS. These tools were found to be more feasible to implement in clinical practice than other traditional methods, which are time-consuming.[21]

A total 125 patients were included in this study with a mean age of 48.02 ± 13.15 years, which is near the mean age of the participants of other similar studies.[15&22] Their ages range from 23 to 77, which means that most of our MHD patients in this study were in the working group population, which indeed entails the health authorities giving more attention to them to decrease morbidity and mortality since protein energy wasting is one of the most common health concerns among patients on dialysis.[15]

We observed consistency between the three tools in the detection of malnourished patients, as both SGA and MNA scores agreed that 20.8% and 18.4% of

patients were severely malnourished, respectively, while 47.2% and 48% of patients were moderately malnourished, respectively. Both MNA and MIS scores agreed that 18.4% and 20% of patients have severe malnutrition, respectively. This is consistent with Senegal study reported consistency between the nutritional tools[23] While Agboton et al.[15] did not observe consistency between the three used tools and the clinical scores. However, it was reported that the MIS tool might be more clinically useful in the assessment of malnutrition than the other mentioned tools.[14]

Regarding SGA, 46.2% of the patients were reported to be moderately malnourished, and 20.8% were severely malnourished. Others reported a high prevalence (59.8%) of malnutrition when using the SGA 7-scale, which was adopted from the original SGA among hemodialysis patients in the Italian cohort study, while the lowest prevalence was observed (25.6%) in the other Brazilian cohort. They observed changes in the prevalence of malnutrition depending on the method used, with fair agreement between SGA and MIS.[24]

The BMI of our studied participants was 23.12 ± 3.98 kg/m², which is similar to what was reported in other study.[24] Lemrabott et al.[25] revealed a significant correlation between the risk of mortality and decreased BMI, which indicated that BMI is an independent protective factor among dialysis patients. Furthermore, we observed that about 20% of the studied participants were diagnosed by MIS to be severely abnormal (PEW). Many studies have reported that protein-energy malnutrition and poor clinical outcomes among hemodialysis patients are the determinants of morbidity and mortality.[26]

Regarding age and gender, we did not detect any significant difference between the three SGA groups, de Mutsert et al.[27] observed that severely malnourished patients seemed to be older. Others attributed the significant association between malnourishment and old age to the harder life they faced of living alone, loss of appetite, increased medical comorbidities, and reduced cognitive function.[28]

Measuring albumin levels is essential for the detection of malnutrition, especially in chronic clinical settings. Our results confirmed that WBCS count, calcium, serum albumin, and HDL were statistically reduced among malnourished patients diagnosed by the MNA tool, and similar results were obtained from malnutrition detected by MIS, in addition to a reduction in hemoglobin level and hematocrit. This is matched with other meta-analyses that reported a marked reduction in serum albumin, total protein, hemoglobin, and hematocrit levels among highly malnourished patients [29]. The change in positive and negative correlation between the two studied tools is due to the difference in the scaling score between them.

The prevalence of inflammation among dialysis patients is a remarkable cause of undernutrition, and we detected a significant correlation between malnutrition in MHD and inflammation, which indicates the development of MIA syndrome among patients and is characterized by the presentation of malnutrition, inflammation, and atherosclerosis.[30]

Although this study was one that measured the prevalence of malnutrition among MHD using recent nutritional assessment tools that were more feasible and inexpensive, it showed some limitations. First, the study design was cross-sectional, which cannot establish a cause-and-effect relationship between the study variables and no follow up was done. Second, a cross-sectional study needs a large sample size and a heterogeneous study population to allow the generalization of the results, as we conducted our study in one health center. In addition to the use of the MNA tool, which mainly assesses the nutritional status of the elderly, it is a subjective tool that depends on the examiner.

CONCLUSIONS

Malnutrition is very prevalent among hemodialysis patients using three different methods of nutritional assessment, affecting more than 65% of them, including about 20% severe malnutrition. The strong agreement between the three tools suggests that they can be used interchangeably.

Ethical Approval

The study obtained all required approvals from the Institutional Review Board of Zagazig University (ZU-IRB#2905).

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