Relationship Between Malnutrition Inflammation Score and Dietary Fat Quality Indices with Cardiovascular Diseases in Hemodialysis Patients

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Introductions. Malnutrition-inflammation-atherosclerosis is an independent risk factor and the most significant cause of death in dialysis patients, accounting for about 50% of deaths in the population. Moreover, the high incidence of cardiovascular-induced mortality in patients with end-stage kidney disease cannot be fully attributed to cardiovascular (CVD) risk factors only. Studies suggest that risk factors such as oxidative stress, inflammation, bone disorders, vascular stiffness, and energy protein loss are closely related to CVD and its associated mortality in these patients. Moreover, dietary fat is a crucial factor in CVD. This study focused on determining the relationship between malnutrition-inflammation and fat quality indicators among CKD patients.

Methods. This study was conducted on 121 hemodialysis patients aged 20 to 80 years in a teaching hospital affiliated to Hashminejad kidney center in Tehran, Iran during 2020 to 2021. Data on general characteristics and anthropometric indices were collected. The malnutrition-inflammation score was assessed by using MIS and DMS questionnaires and dietary intake was measured by a 24-hour recall questionnaire.

Results. Out of 121 hemodialysis patients participating in the study, 57.3% were male and 42.7% were female. Anthropometric demographic characteristics showed no significant difference among diverse groups with heart disease ($P > .05$). There was no significant relationship between malnutrition-inflammation and heart disease indices in hemodialysis patients ($P > .05$). Furthermore, there was no correlation between the dietary fat quality index and heart disease ($P > .05$).

Conclusion. In this study, there was no significant relationship between the malnutrition-inflammation index and the dietary fat quality index with cardiac disease in hemodialysis patients. Further studies are needed to have a tangible conclusion.

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INTRODUCTION

Hemodialysis patients are more at risk of cardiovascular diseases. Cardiovascular (CVD) complications and mortality are higher than expected in this population and have been attributed to dyslipidemia, inflammation, malnutrition, and susceptibility to infection.[1] Maintenance hemodialysis (MHD) patients have

several cardiovascular complications and overall cardiovascular changes in chronic kidney disease (CKD) and end-stage kidney disease (ESKD) have been mentioned in many studies, most of which demonstrated that cardiovascular mortality increases significantly with elevated total cholesterol levels, when inflammation and malnutrition are absent, whereas it decreases in the presence of these conditions.[2] Chronic inflammation, which is associated with increased C-reactive protein, is a risk factor for CVD.[3] The collected data have shown that inflammation has an important and stimulating role in the creation of atherosclerosis, which leads to increased risk of CVD.[4]

Endothelial dysfunction, oxidative stress in vascular endothelial cells, macrophage accumulation, formation of inflammation, and production of tumor necrosis factor-alpha (TNF-α), interleukin-1 (IL-1), and IL-6 characterize the inflammatory process that leads to atherogenesis. This was the purpose of the studies focusing on the evaluation of the effect of prebiotics in the context of metabolic disorders. Specific dietary factors, such as dietary fats, may modulate inflammation, thereby reducing the risk of CVD in humans. In general, while saturated fatty acids (SFA) and trans-fatty acids (TFA) are considered pro-inflammatory, polyunsaturated fatty acids (PUFA) and especially n3 long-chain fatty acids (LC) are considered anti-inflammatory ones.[5]

The western diet is rich in refined grains, sugars, simple carbohydrates, red meat, and high-fat dairy products and increases the level of pro-inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6). In contrast, the traditional Mediterranean diet which consists of high consumption of fruits, vegetables, whole grains, legumes, fish, nuts, and olive oil is associated with lower levels of pro-inflammatory biomarkers such as CRP and TNF-α.[6] Inflammation and inflammatory factors play an important role in development of malnutrition in these patients.[7] Malnutrition including protein-energy malnutrition (PEM) is a complex, multifactorial and common problem in patients with end-stage kidney disease (ESKD) undergoing hemodialysis, and increases their mortality rate.[8] The causes of malnutrition in hemodialysis (HD) patients include low energy consumption due to anorexia, loss of nutrients during dialysis, restricted diet before starting dialysis, increased protein catabolism, change in sense of taste, emotional distress, improper diet, co-morbidities and increased metabolism due to inflammation.[9] Recent studies have shown that patients who suffer from malnutrition have a higher mortality rate than patients with appropriate nutritional state.[10] Since malnutrition is one of the most important conditions in hemodialysis patients, regular monitoring of nutritional status, adequate intake of food, maintenance of adequate dialysis dose, and therapeutic interventions are necessary.[11] Regular monitoring of food intake by hemodialysis patients, and understanding their eating habits, provide the possibility of improving the appropriate measures for planning the patients' diet, which is important in the prevention, treatment, and monitoring of inadequate nutrition, whether its deficiency or quantity. In order to provide guidance in a nutritional plan that is compatible with dialysis and includes restriction of some elements along with an increase in the consumption of others. Thus, it is necessary to learn about the food intake of these people, and taking into account the consumption of energy and nutrients and eating habits.

Along with the consumption of calories and protein, the intake of other nutrients such as carbohydrates, lipids, vitamins, and minerals and types of consumed minerals should also be evaluated.[12] Malnutrition-Inflammation syndrome (MIS), also known as Malnutrition-Inflammation-Cachexia Syndrome (MICS), is common in the world and is associated with hospitalization, morbidity, and mortality in chronic kidney disease.[13] The involved factors are diet, oxidative stress, acidemia, blood loss during dialysis and other sources of bleeding such as gastrointestinal bleeding, uremic environment, and the effect of anabolic hormones; therefore, dietary fat quality indicators are related to CVD.[13,14] It is believed that MICS is the main cause of increased blood pressure, high rate of cardiovascular atherosclerotic disease, reduced quality of life, and increased mortality and hospitalization in dialysis patients.[15,16]

Successful management of MICS may improve cardiovascular disease in hemodialysis patients.[16] As dietary fat quality indicators are related to CVD and no study has been conducted on the relationship between inflammation-malnutrition score and dietary fat quality indicators with cardiovascular disease in hemodialysis patients, this study aimed to investigate the issue.

MATERIALS AND METHODS

In a cross-sectional descriptive-analytic study on male and female adults of 20 to 80 years old, 120 volunteers (age: 57.29 ± 15.36) referring to dialysis ward of Hashminejad kidney center in Tehran during 2020 to 2021, were enrolled to the study. Information related to the basic characteristics of the study participants, including age, level of education, economic status, medical history (including a documented history of myocardial infarction or any coronary vascular disease based on angiographic reports), and smoking status were obtained by using a general questionnaire via interview. The anthropometric indices such as height, dry weight, and body mass index (BMI) were evaluated by using standard protocols.[17] Patients with active infections or a history of autoimmune diseases and cancers were excluded. Information related to inflammatory malnutrition was collected by using valid and reliable questionnaires (MIS, DMS, SGA)[18] and food intake was measured by using a valid and reliable 24-hour food recall questionnaire (Appendix 1-4). We estimated dietary fat quality indices by using the 24-dietary recall. For illiterate patients, a nutritionist helped to fill out the form. To estimate dietary fat quality indices, including atherogenic index (AI),[18] thrombogenic index (TI),[18] ratio of hypo and hypercholesterolemia,[19] and Cholesterol/saturated fat index (CSI)[20] were calculated by using validated formulas.

The Shapiro-Wilk test was used to find out the normality of the tested variables.[21] The Student's t-test was used to compare the mean of quantitative distributions (for parametric distributions), and the Mann–Whitney U test (for nonparametric distributions) was used to compare the median of outcomes between the two independent groups. The correlation model was used to compare the main variables of the study in case of a need to control the main variables of the study. Also, a multiple regression test was used to predict the effects of variables on Malnutrition Inflammation Score (MIS), Subjective Global Assessment (SGA), and Dialysis Malnutrition Score (DMS) as well. IBM SPSS Statistics for Windows version 27 (IBM Corp., Armonk, N.Y., USA) was used for data analyses, and a *P* value of .05 or less was considered to be significant with a confidence interval of 95%.

This study was approved by the Iran National Committee for Ethics in Biomedical Research under code IR.IAU.SRB.REC.1400.238. All the eligible volunteers were informed about the details of the study and their rights to sign a written consent. They were informed that all their information was secured.

RESULTS

As shown in Table 1, the incidence of cardiovascular disease was 39.3%, which indicates a higher rate of CVD among middle-aged and elderly people. Moreover, the incidence rate of CVD in hemodialysis patients who had a poor economic status, and moderate to good economic status was 52.8% and 47.2%, respectively. In the present study, educational status had no significant relationship with the rate of cardiovascular disease. No significant difference in BMI was seen among HD patients with various ranges of BMI and CVD. The dialysis frequency had no significant relationship with the rate of cardiovascular disease in hemodialysis patients either. It was found that 64.2% of hemodialysis patients had high blood pressure.

As shown in Table 2, 73% of HD patients have SGA in the moderate-severe range, and 77.5% have heart disease, while 56.2% of HD patients with heart disease have mild-moderate MIS and 43.8% have severe malnutrition. The results showed that 65% of HD patients with DMS scores were in the mild to moderate range, and 35% of them had severe scores, 62.9% of HD patients with heart disease had DMS scores in the mild-moderate range, and 37.3% of them had DMS in the severe range.

As shown in Table 3, there is no significant relationship between BMI and the rate of heart disease in HD patients. In this study, there was no significant relationship between systolic and diastolic blood pressure and heart disease in HD patients. Regarding the relationship between dietary fat quality indices and the rate of heart disease in HD patients, there was no significant difference between the AI, the ratio between hypercholesterolemia, and the ratio of unsaturated/saturated fatty acids Pn-3/Pn-6 with heart disease. Also, there was no significant relationship between TI and CSI with heart disease in HD patients. In the present study, there was no significant relationship between malnutrition-inflammation diagnosed by MIS index in hemodialysis patients

Table 1. Comparison of Demographic Variables and Hospital Characteristics in All Hemodialysis Patients and Separately Between Cardiac and Healthy Patients

Variable	The Entire Population	Coronary Heart Disease		*P**
		No	Yes	
Gender				
Man	74 (61.7)	23 (74.2)	51 (57.3)	> .05
Woman	46 (38.4)	8 (25.8)	38 (42.7)	
Age, y				
20 to 40	24 (20.0)	5 (16.1)	19 (21.3)	
41 to 60	44 (36.7)	9 (29)	35 (39.3)	> .05
> 61	52 (43.3)	17 (54.8)	35 (39.3)	
Economic Situation				
Good	8 (6.7)	1 (3.2)	7 (7.9)	
Average	48 (40.0)	13 (41.9)	35 (39.3)	> .05
Weak	64 (53.3)	17 (54.8)	47 (52.8)	
Educational Status				
High School	30 (25.0)	7 (22.6)	23 (25.8)	
Diploma	53 (44.2)	15 (48.4)	38 (42.7)	> .05
Bachelor's Degree and Above	37 (30.8)	9 (29)	28 (35.5)	
BMI, kg/m^2				
< 18.5	5 (4.2)	2 (6.5)	3 (3.4)	
18.5 to 24.9	60 (50.0)	17 (54.8)	43 (48.3)	> .05
25 to 30	35 (29.2)	10 (32.3)	25 (28.1)	
> 30	20 (16.7)	2 (6.5)	18 (20.2)	
3 times of Dialysis /week	115 (95.8)	31 (100)	84 (94.4)	> .05
High Blood Pressure				
Yes	77 (64.2)	20 (64.5)	57 (64)	> .05
No	43 (35.8)	11 (35.5)	32 (36)	
Congestive Heart Failure				
Yes	11 (9.2)	1 (3.2)	10 (11.2)	> .05
No	109 (90.8)	30 (96.8)	79 (88.8)	
COPD				
Yes	8 (6.7)	2 (6.5)	6 (6.7)	> .05
No	112 (93.3)	29 (93.5)	83 (93.3)	
Nervous Disorders				
Yes	8 (6.7)	1 (3.2)	7 (7.9)	> .05
No	112 (93.3)	30 (96.8)	82 (92.1)	
Gastrointestinal Disease				
Yes	12 (10.0)	2 (6.5)	10 (11.2)	> .05
No	108 (90.0)	29 (93.5)	79 (88.8)	
Liver Failure				
Yes	6 (5.0)	1 (3.2)	5 (5.6)	> .05
No	114 (95.0)	30 (96.8)	84 (94.4)	
Diabetes Mellitus				
Yes	43 (35.0)	8 (25.8)	32 (38.2)	> .05
No	78 (65.0)	23 (74.2)	55 (61.8)	
Infectious Disease				
Yes	15 (12.5)	4 (12.9)	11 (12.4)	> .05
No	105 (87.5)	27 (87.1)	78 (87.6)	
Kidney Transplant				
Yes	16 (13.3)	2 (6.5)	14 (15.7)	> .05
No	104 (86.7)	29 (93.5)	75 (84.3)	

*Analyzed by using Chi square.

and their heart disease.

As shown in Table 4, there is no significant relationship between MIS index and heart disease in HD patients, and malnutrition-inflammation

Table 2. Comparison of Indicators of Malnutrition-Inflammation in All Hemodialysis Patients and to Differentiate Between Cardiac Patients and Healthy Participants

Indicators of Malnutrition – Inflammation	The Entire Population	Cardiovascular Disease		*P**
		No	Yes	
SGA classification				
Mild Malnutrition	32 (26.7)	12 (38.7)	20 (22.5)	
Moderate Malnutrition	81 (67.5)	17 (54.8)	65 (71.9)	> .05
Severe Malnutrition	7 (5.8)	2 (6.5)	5 (5.6)	
Classification MIS				
Mild to Moderate	64 (53.3)	14 (45.2)	50 (56.2)	> .05
Severe	56 (46.7)	17 (54.8)	39 (43.8)	
DMS Classification				
Mild to Moderate	78 (65)	22 (71)	56 (62.9)	> .05
Severe	42 (35)	9 (29)	33 (37.1)	

*Analyzed by using Chi square.

Table 3. Comparison of Anthropometric Index, Blood Pressure, Fat Intake Quality Index, DMS, SGA, and MIS in Hemodialysis Subjects with Cardiovascular Disease and Healthy Participants

Variable	The Entire Population	Cardiovascular Disease		*P**
		No	Yes	
Weight	15.0 ± 69.3	14.0 ± 67.6	15.4 ± 69.9	> .05
Height	0.09 ± 1.65	0.90 ± 1.7	0.09 ± 1.6	> .05
BMI	4.8 ± 25.2	3.7 ± 24.0	5.0 ± 25.6	> .05
SBP	21.4 ± 117.2	20.5 ± 119.8	21.07 ± 116.3	> .05
DBP	11.9 ± 71.9	9.8 ± 72.7	12.6 ± 71.6	> .05
CSI	0.04 ± 0.13	0.04 ± 0.13	0.050 ± 0.133	> .05
SFA (%)	105 ± 383	121.3 ± 388.9	99.7 ± 382.1	> .05
USFA (%)	139 ± 561	149.9 ± 555.8	136.7 ± 563.4	> .05
AI	3.7 ± 11.1	4.4 ± 11.5	4.3 ± 11.0	> .05
TI	13.6 ± 39.9	15.4 ± 40.8	13.0 ± 39.7	> .05
Hh	9.8 ± 34.3	9.4 ± 32.5	9.9 ± 0.34	> .05
n3:n6	1.3 ± 4.2	1.3 ± 4.4	1.3 ± 4.2	> .05
Score SGA	2.5 ± 9.5	2.7 ± 9.2	2.4 ± 9.6	> .05
MIS Score	3.6 ± 18.8	3.6 ± 19.2	3.6 ± 18.6	> .05
Total DMS	2.9 ± 12.5	3.2 ± 12.5	2.9 ± 12.6	> .05

*Analyzed by using t-Test.

Table 4. Determining the Relationship Between MIS Index and Cardiovascular Disease in the Study Participants

Variable	OR	Interval Confidence	*P*
MIS			
Model 1	0.96	(0.86 to 1.06)	> .05
Model 2	0.99	(0.88 to 1.12)	> .05

Model 1: Raw Model
Model 2: Adjusted for age, gender, literacy level, smoking, economic status, BMI, and energy intake.
*Logistic regression

does not increase the chance of heart disease in HD patients.

There was no significant relationship between AI and TI and heart disease in hemodialysis patients and HD patients who had CVD (Table 5).

DISCUSSION

In this study, there was no significant relationship between comorbidities (blood pressure, diabetes, hyperlipidemia, etc.) and heart disease in HD patients. This finding is similar to some previous studies, for example, Kim and Jeong showed that only 40% of HD patients had heart disease.[22] In a retrospective cohort study, it was observed that the use of appropriate medication to control blood sugar in hemodialysis patients with diabetes mellitus could increase the patient's survival and reduce the mortality rate due to heart disease.[24] Also, in the study of Bansal *et al.*, a U-shaped relationship between high blood pressure and the mortality rate was observed in hemodialysis patients, while the relationship between high blood pressure and

Table 5. Correlation of AI and TI with the Studied Blood Markers

Marker	The Entire Population				Healthy People				People with Cardiovascular Disease			
	AI		TI		AI		TI		AI		TI	
	R	*P*	R	*P*	R	*P*	R	*P*	R	*P*	R	*P*
Creatinine	0.03	> .05	0.15	> .05	-0.10	> .05	0.13	> .05	0.15	> .05	0.17	> .05
Urea	-0.09	> .05	-0.003	> .05	-0.06	> .05	0.13	> .05	-0.11	> .05	-0.06	> .05
Na	0.02	> .05	0.04	> .05	0.02	> .05	0.12	> .05	0.03	> .05	0.04	> .05
K	-0.10	> .05	-0.02	> .05	-0.12	> .05	-0.13	> .05	-0.12	> .05	-0.03	> .05
P	-0.07	> .05	0.01	> .05	-0.11	> .05	0.34	< .05	-0.09	> .05	-0.006	> .05
Ca	-0.06	> .05	-0.09	> .05	-0.15	> .05	-0.23	> .05	0.07	> .05	-0.12	> .05
PTH	-0.11	> .05	-0.13	> .05	-0.26	> .05	-0.19	> .05	-0.02	> .05	-0.10	> .05
ALT	0.04	> .05	-0.01	> .05	0.23	> .05	-0.007	> .05	0.03	> .05	-0.02	> .05
ALP	-0.13	> .05	-0.11	> .05	-0.23	> .05	-0.13	> .05	-0.05	> .05	0.08	> .05
TC	0.07	> .05	0.07	> .05	0.04	> .05	0.08	> .05	0.08	> .05	0.07	> .05
TG	-0.08	> .05	-0.03	> .05	-0.25	> .05	-0.10	> .05	0.02	> .05	0.001	> .05
HDL	-0.03	> .05	-0.09	> .05	-0.02	> .05	0.03	> .05	-0.03	> .05	-0.13	> .05
LDL	0.10	> .05	0.06	> .05	0.06	> .05	0.10	> .05	0.11	> .05	0.06	> .05
FBS	0.03	> .05	-0.04	> .05	-0.08	> .05	-0.12	> .05	0.10	> .05	0.01	> .05
CRP	-0.07	> .05	0.66	> .05	-0.04	> .05	-0.03	> .05	-0.09	> .05	0.08	> .05
HDL/LDL	-0.002	> .05	0.01	> .05	-0.19	> .05	0.22	> .05	0.04	> .05	0.06	> .05
TC/HDL	0.10	> .05	0.1	> .05	0.14	> .05	0.13	> .05	0.11	> .05	0.11	> .05
Fe	-0.06	> .05	0.04	> .05	-0.33	> .05	-0.24	> .05	0.07	> .05	0.19	> .05
Ferritin	0.05	> .05	-0.03	> .05	-0.25	> .05	-0.26	> .05	0.20	> .05	0.10	> .05
TIBC	0.04	> .05	0.009	> .05	0.02	> .05	-0.11	> .05	0.05	> .05	0.05	> .05
Albumin	-0.07	> .05	-0.03	> .05	-0.06	> .05	0.04	> .05	-0.09	> .05	-0.05	> .05
D3	0.09	> .05	0.06	> .05	-0.007	> .05	0.17	> .05	0.28	< .05	-0.04	> .05
Hb	0.06	> .05	-0.13	> .05	-0.05	> .05	-0.03	> .05	0.12	> .05	-0.18	> .05

*It was analyzed with Pearson correlation.

heart disease in non-kidney patients was linear. While hypotension prevents heart disease in non-dialysis people, maintaining blood pressure in a high range can be effective in dialysis patients .[24]

Based on our findings, there was no significant relationship between the indicators of malnutrition and inflammation in HD patients with heart disease and healthy patients, while in the study of As'habi *et al.*, a significant relationship between the indicators of inflammatory malnutrition and related blood risk factors was reported. This difference might be due to the different methods used in these two studies.[26] As was seen in Table 2, there is no significant relationship between inflammatory-malnutrition indicators and heart disease in hemodialysis patients. Inflammation in HD patients has several reasons, one of which is the oxidative stress. The loss of some antioxidants, such as carnitine, during HD, may contribute to this disorder.[26] There is a clear interrelationship between inflammation and oxidative stress in HD.[28] Several components of current HD may cause inflammation in patients. During each hemodialysis session, the components of the dialysis membranes and febrile substances may cause oxidative stress. As a result, the guideline used to determine the nutritional pattern of these patients is similar, and in other words, all hemodialysis patients follow the same nutritional guideline.[28]

According to our findings, in hemodialysis patients, blood lipids including triglyceride (TG), total cholesterol (TC), low-density lipoprotein (LDL), and high-density lipoprotein (HDL) are related to heart diseases. One of the most important causes of hyperglycemia in ESKD patients is the deficiency and dysfunction of lipoprotein lipase (LPL). In normal conditions, LPL mediates the hydrolysis of triglycerides, very low-density lipoprotein (VLDL), and chylomicrons and allows the release and absorption of fatty acids by myocytes and fat cells. But in HD patients, due to the decrease in the expression of LPL in adipose tissue, skeletal muscle, and myocardium, and an increase in the serum concentration of the hormone Parathyroid (PTH), LPL levels decreased.[29] Also, decreasing the expression of the protein

gene related to the LDL Receptor-related Protein (LRP), which plays an important role in cleaning VLDL, chylomicrons, and intermediate-density lipoprotein (IDL) particles leads to an increase in the serum level of TG and lipoproteins rich in it.[31] CKD is associated with dyslipidemia consisting of high triglycerides and low HDL, while, LDL cholesterol (and therefore total cholesterol) levels do not usually increase. However, proteinuria is related to high cholesterol and high triglyceride levels. As mentioned, CKD leads to a decrease in lipoprotein lipase and LDL receptor, and the increase in serum triglycerides level in CKD is due to the delay in the catabolism of lipoproteins rich in triglycerides without any difference in the rate of TG production.[32] Due to several factors related to ESKD, including increased levels of urea (carbamylation), reactive oxygen species (oxidation), and systemic inflammation, HDL levels decrease in the blood. In addition, these changes in combination with the reduction of enzymes related to HDL, such as paraoxonase-1 and glutathione peroxidase, can significantly reduce the antioxidant and anti-inflammatory properties of HDL.[33,34] In the study of Kim *et al.*, a significant relationship was observed between the use of statins and the reduction in the incidence of heart disease in HD patients[22]. In another study, a significant relationship between the use of statins and the reduction of death was reported in HD patients[35]. Therefore, the causes of increase in blood lipids are different from the type of diet of HD patients.[36] According to the findings of the present study, there was no statistically significant difference between dietary fat quality indicators (AI, TI) and blood lipids. In a cohort study conducted by Nettleton *et al.*, there was no significant relationship between the type of dietary fat and consumption of saturated and unsaturated fat and the rate of heart disease.[37] Ewers *et al.* showed that unsaturated fat supplementation increased total dietary energy intake to recommended levels, with no adverse impact on blood lipids. To assess the improvement of nutritional status, dry body weight was assessed, and also reduced systemic inflammation assessed by C-reactive protein serum concentrations.[1] It seems that adding unsaturated fat to the diet is a safe and effective way to prevent and treat malnutrition in HD patients.[1] These results are not in line with the findings of the present study.

CONCLUSION

The findings of the present study show no significant relationship between the indicators of malnutrition-inflammation and the quality index of dietary fat with heart disease in hemodialysis patients. This finding is against the primary assumptions of the research and may be related to the small number of samples as one of the limitations of this study which mandates further studies.

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Dialysis Malnutrition Score
A. Patients-related medical history:

1. Weight change (overall change in past 6 months)				
1	2	3	4	5
no weight change or gain	minor weight loss (<5%)	weight loss 5 to 10%	weight loss 10 to 15%	weight loss >15%
2. Dietary intake				
1	2	3	4	5
no change	sub-optimal solid diet	full liquid diet or moderate overall decrease	hypo-caloric liquid	starvation
3. Gastrointestinal symptoms				
1	2	3	4	5
no symptoms	nausea	vomiting or moderate GI symptoms	diarrhea	severe anorexia
4. Functional capacity (nutritionally-related functional impairment)				
1	2	3	4	5
none (improved)	difficulty with ambulation	difficulty with normal activity	light activity	bed/chair-ridden with no or little activity
5. Co-morbidity				
1	2	3	4	5
dialysis <12 months and healthy otherwise	dialysis 1-2 years or mild co-morbidity	dialysis 2-4 years or age >75 or moderate co-morbidity	dialysis >4 years or severe co-morbidity	very severe multiple co-morbidity

B. Physical Exam:

1. Decreased fat stores or loss of subcutaneous fat (below eyes, triceps, biceps, chest)				
1	2	3	4	5
no change		moderate		severe
2. Signs of muscle wasting (temple, clavicle, scapula, ribs, quadriceps, knee, interosseous)				
1	2	3	4	5
no change		moderate		severe

C. Malnutrition Score: (sum of all numbers)

Appendix 1. Dialysis Malnutrition Score

MALNUTRITION INFLAMMATION SCORE (M.I.S.)			
(A) Patients' related medical history:			
1- Change in end dialysis dry weight (overall change in past 3-6 months):			
0	1	2	3
No decrease in dry weight or weight loss <0.5 kg	Minor weight loss (≥0.5 kg but <1 kg)	Weight loss more than one kg but <5%	Weight loss >5%
2- Dietary intake:			
0	1	2	3
Good appetite and no deterioration of the dietary intake pattern	Somewhat sub-optimal solid diet intake	Moderate overall decrease to full liquid diet	Hypo-caloric liquid to starvation
3- Gastrointestinal (GI) symptoms:			
0	1	2	3
No symptoms with good appetite	Mild symptoms, poor appetite or nauseated occasionally	Occasional vomiting or moderate GI symptoms	Frequent diarrhea or vomiting or severe anorexia
4- Functional capacity (nutritionally related functional impairment):			
0	1	2	3
Normal to improved functional capacity, feeling fine	Occasional difficulty with baseline ambulation, or feeling tired frequently	Difficulty with otherwise independent activities (e.g. going to bathroom)	Bed/chair-ridden, or little to no physical activity
5- Co-morbidity including number of years on Dialysis:			
0	1	2	3
On dialysis less than one year and healthy otherwise	Dialyzed for 1-4 years, or mild co-morbidity (excluding MCC*)	Dialyzed >4 years, or moderate co-morbidity (including one MCC*)	Any severe, multiple co-morbidity (2 or more MCC*)
(B) Physical Exam (according to SGA criteria):			
6- Decreased fat stores or loss of subcutaneous fat (below eyes, triceps, biceps, chest):			
0	1	2	3
Normal (no change)	mild	moderate	Severe
7- Signs of muscle wasting (temple, clavicle, scapula, ribs, quadriceps, knee, interosseous):			
0	1	2	3
Normal (no change)	mild	moderate	Severe
(C) Body mass index:			
8- Body mass index: BMI = Wt(kg) / Ht^2(m)			
0	1	2	3
BMI≥20 kg/m^2	BMI: 18-19.99 kg/m^2	BMI: 16-17.99 kg/m^2	BMI<16 kg/m^2
(D) Laboratory Parameters:			
9- Serum albumin:			
0	1	2	3
Albumin≥ 4.0 g/dL	Albumin: 3.5-3.9 g/dL	Albumin: 3.0-3.4 g/dL	Albumin: <3.0 g/dL
10- Serum TIBC (total Iron Binding Capacity): ♣			
0	1	2	3
TIBC≥ 250 mg/dL	TIBC: 200-249 mg/dL	TIBC: 150-199 mg/dL	TIBC: <150 mg/dL
Total Score = sum of above 10 components (0-30):			

Appendix 2. Malnutrition-Inflammation (M.I.S.) Questionnaire

SUBJECTIVE GLOBAL ASSESSMENT RATING FORM

Patient Name: **ID #:** **Date:**

HISTORY

WEIGHT/WEIGHT CHANGE: ***(Included in K/DOQI SGA)*** **Rate 1-7**

1. **Baseline Wt:** _____(Dry weight from 6 months ago)
   Current Wt: _____(Dry weight today)
   Actual Wt loss/past 6 mo: _____ **% loss:**_____(actual loss from baseline or last SGA)
2. **Weight change over past two weeks:** _____No change _____Increase _____Decrease

DIETARY INTAKE No Change_____(Adequate) No Change_____(Inadequate)

1. Change: Sub optimal Intake: _____ Protein _____ Kcal _____ Duration_____
   Full Liquid: _____ Hypocaloric Liquid _____ Starvation _____

GASTROINTESTINAL SYMPTOMS ***(Included in K/DOQI SGA-anorexia or causes of anorexia)***

Symptom:	**Frequency:***	**Duration:+**
_____ None	_____	_____
_____ Anorexia	_____	_____
_____ Nausea	_____	_____
_____ Vomiting	_____	_____
_____ Diarrhea	_____	_____

Never, daily, 2-3 times/wk, 1-2 times/wk > 2 weeks, < 2 weeks

FUNCTIONAL CAPACITY b

Description	**Duration:**
_____ No Dysfunction	_____
_____ Change in function	_____
_____ Difficulty with ambulation	_____
_____ Difficulty with activity (Patient specific "normal")	_____
_____ Light activity	_____
_____ Bed/chair ridden with little or no activity	_____
_____ Improvement in function	_____

DISEASE STATE/COMORBIDITIES AS RELATED TO NUTRITIONAL NEEDS

Primary Diagnosis_____Comorbidities_____

Normal requirements ____Increased requirements____ Decreased requirements _____

Acute Metabolic Stress: _____None _____Low _____Moderate _____High

PHYSICAL EXAM

_____ Loss of subcutaneous fat (Below eye, triceps, biceps, chest) ***(Included in K/DOQI SGA)*** ____Some areas _____All areas

_____ Muscle wasting (Temple, clavicle, scapula, ribs, quadriceps, calf, knee, interosseous ***(Included in K/DOQI SGA)*** ____Some areas _____All areas

_____ Edema (Related to undernutrition/use to evaluate weight change)

OVERALL SGA RATING

Very mild risk to well-nourished=6 or 7 most categories or significant, continued improvement.

Mild-moderate = 3, 4, or 5 ratings. No clear sign of normal status or severe malnutrition.

Severely Malnourished = 1 or 2 ratings in most categories/significant physical signs of malnutrition.

Appendix 3. Subjective Global Assessment (SGA) Questionnaire

Date	Time of meal	Rice	Chapatti	Dal	Vegetables		Tubers	Sugar	Tea/coffee	Milk and milk products	Fish/meat	Eggs	Fruits	Others
					Leafy	Others								
Day 1—24. 7. 20xx	Breakfast							50 g		1.0 L				
	Lunch	250 g	300g	100g	500 g		100 g			Curd 500 g				
	Evening							50 g		1.0 L				
	Dinner	300 g	300 g	75 g	500 g		50 g							
	TOTAL on day 1	550 g	600 g	175 g	1000 g		150 g	100 g		2500 mL				
Day 2—25. 7. 20xx	Breakfast													
	Lunch	250 g	300 g	100 g	500 g		150 g			Curd 500 g				
	Evening							50 g						
	Dinner	300 g	300 g	75 g										
	TOTAL on day 2	550 g	600 g	175 g	500 g		150 g	100 g		500 g				
Day 3—26. 7. 20xx	Breakfast							50g						
	Lunch	250 g	150 g	100 g	400 g		100 g			400 g				
	Evening							50 g		500 mL				
	Dinner	300 g	300 g	75 g	100 g	250 g								
	TOTAL on day 3	550 g	450 g	175 g	500 g	250 g	100 g			1900 mL				
Average intake per day														

Appendix 4. 24-hour Food Recall Questionnaire