

# Assessment of Nutritional Status of Nepalese Hemodialysis Patients by Anthropometric Examinations and Modified Quantitative Subjective Global Assessment

Arun Sedhain<sup>1</sup>, Rajani Hada<sup>1</sup>, Rajendra Kumar Agrawal<sup>1</sup>, Gandhi R. Bhattarai<sup>2</sup> and Anil Baral<sup>1</sup>

<sup>1</sup>Department of Nephrology, National Academy of Medical Sciences (NAMS), Bir Hospital, Kathmandu, Nepal. <sup>2</sup>Advanced Analytics, OptumInsight, Rocky Hill, CT, USA. Study location: Department of Nephrology, National Academy of Medical Sciences (NAMS), Bir Hospital, Kathmandu, Nepal.

## ABSTRACT:

**OBJECTIVE:** To assess the nutritional status of patients on maintenance hemodialysis by using modified quantitative subjective global assessment (MQSGA) and anthropometric measurements.

**METHOD:** We Conducted a cross sectional descriptive analytical study to assess the nutritional status of fifty four patients with chronic kidney disease undergoing maintenance hemodialysis by using MQSGA and different anthropometric and laboratory measurements like body mass index (BMI), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), triceps skin fold (TSF) and biceps skin fold (BSF), serum albumin, C-reactive protein (CRP) and lipid profile in a government tertiary hospital at Kathmandu, Nepal.

**RESULTS:** Based on MQSGA criteria, 66.7% of the patients suffered from mild to moderate malnutrition and 33.3% were well nourished. None of the patients were severely malnourished. CRP was positive in 56.3% patients. Serum albumin, MAC and BMI were (mean + SD) 4.0 + 0.3 mg/dl, 22 + 2.6 cm and 19.6 ± 3.2 kg/m<sup>2</sup> respectively. MQSGA showed negative correlation with MAC ( $r = -0.563$ ;  $P = <0.001$ ), BMI ( $r = -0.448$ ;  $P = <0.001$ ), MAMC ( $r = -0.506$ ;  $P = <0.0001$ ), TSF ( $r = -0.483$ ;  $P = <0.0002$ ), and BSF ( $r = -0.508$ ;  $P = <0.0001$ ). Negative correlation of MQSGA was also found with total cholesterol, triglyceride, LDL cholesterol and HDL cholesterol without any statistical significance.

**CONCLUSION:** Mild to moderate malnutrition was found to be present in two thirds of the patients undergoing hemodialysis. Anthropometric measurements like BMI, MAC, MAMC, BSF and TSF were negatively correlated with MQSGA. Anthropometric and laboratory assessment tools could be used for nutritional assessment as they are relatively easier, cheaper and practical markers of nutritional status.

**KEYWORDS:** nutritional status, CKD, MQSGA, anthropometric measuremen, hemodialysis

**CITATION:** Sedhain et al. Assessment of Nutritional Status of Nepalese Hemodialysis Patients by Anthropometric Examinations and Modified Quantitative Subjective Global Assessment. *Nutrition and Metabolic Insights* 2015:8 21–27 doi:10.4137/NMI.S27640.

**TYPE:** Original Research

**RECEIVED:** April 14, 2015. **RESUBMITTED:** June 25, 2015. **ACCEPTED FOR PUBLICATION:** July 5, 2015.

**ACADEMIC EDITOR:** Joseph Zhou, Editor in Chief

**PEER REVIEW:** Four peer reviewers contributed to the peer review report. Reviewers' reports totaled 585 words, excluding any confidential comments to the academic editor.

**FUNDING:** Authors disclose no funding sources.

**COMPETING INTERESTS:** Authors disclose no potential conflicts of interest.

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**CORRESPONDENCE:** arunsedhain@gmail.com

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## Introduction

Good nutritional status is a well-known marker of well-being in patients with chronic kidney disease (CKD). Protein energy malnutrition (PEM) develops during the course of CKD and is associated with adverse outcomes.<sup>1</sup> Although most of the overt symptoms of uremia diminish or disappear after commencement of maintenance hemodialysis (MHD), the dialysis procedure in itself may promote wasting by various mechanisms.<sup>2,3</sup> The pathogenesis of PEM in MHD patients is multifactorial in which acidosis and increased catabolism play important roles.<sup>1,4</sup> Nutritional status and dialysis adequacy index are considered major determinants of mortality and morbidity in patients undergoing MHD.<sup>5</sup>

Several methods are used to evaluate the nutritional status of hemodialysis patients. Among these nutritional assessment tools, the widely used are subjective global assessment (SGA), modified quantitative subjective global assessment (MQSGA), and malnutrition score (MS).<sup>6,7</sup> SGA tool was

developed by Detsky et al in 1984 that comprises subjective and objective aspects of nutritional status.<sup>8</sup> National Kidney Foundation Kidney Disease/Dialysis Outcomes and Quality Initiative (NKF/KDOQI) recommends assessing nutritional status of patients undergoing MHD by using SGA at least every six months.<sup>9</sup> Kalantar-Zadeh et al<sup>6</sup> developed a fully quantitative method to assess nutritional status in MHD patients in a practical and inexpensive way. This new tool relies on clinical judgment derived from grading scales calculated from a brief history and physical examination,<sup>10</sup> which aids in the prediction of nutrition-associated clinical outcomes in different conditions.<sup>11,12</sup> The tool has many strengths in the clinical and research settings because it is inexpensive, easy to conduct, and can be used effectively by providers from different disciplines.<sup>13</sup>

Generally, patients with end-stage renal disease (ESRD) in Nepal receive two four-hour sessions of hemodialysis per week. Malnutrition is common among Nepali population,



and it becomes more intense in the patients with CKD.<sup>14</sup> Nutritional status of these patients could be improved by regular evaluation and creating nutritional awareness in these patients. So far, there is no published study on nutritional assessment of Nepalese CKD patients using MQSGA score. This study aims to assess the nutritional status of ESRD patients undergoing MHD in a government hospital using anthropometric measurement, laboratory parameters, and MQSGA score.

## Methods

**Sampling frame.** This is a cross-sectional analysis of the patients with ESRD undergoing MHD in the Department of Nephrology, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal. The study was conducted after an approval from the institutional review board of National Academy of Medical Sciences and a written informed consent was obtained from each patient prior to enrollment in the study. The research complied with the principles of the Declaration of Helsinki.

Patients who were on MHD for more than six months were the population for this study. Fifty-eight of 60 patients undergoing MHD at the commencement of study agreed to participate (participation rate = 96%). Exclusions applied for patients with active infection at the time of study, history of admission to the hospital in the past three months, alcoholism, acute renal failure, cancer, major adverse cardiovascular events, severe gastrointestinal, and hepatic diseases. Four patients were excluded from the analysis leaving the final study sample at 54.

**Clinical and laboratory assessment.** Patient's medical history, demographics, and duration of hemodialysis were obtained from the hospital registry. On the day of evaluation, predialysis blood samples were collected to estimate complete blood count, serum urea, creatinine, calcium, phosphate, total protein and albumin, qualitative CRP, and lipid profile. Patients were interviewed during dialysis for their dietary habit, change in weight, gastrointestinal symptoms, and all other information relevant to the MQSGA tool.<sup>6</sup>

Anthropometric measurements were carried out 10–20 minutes after completion of hemodialysis. Height and body weight were measured with light clothing. Body mass index (BMI) was calculated as the ratio of end dialysis body weight in kilogram and the square of the height in meters ( $\text{kg}/\text{m}^2$ ). Patient's postdialysis dry weight six months prior to study date was collected from the hospital record. Measurements of skin fold in the areas of biceps (BSF) and triceps muscle (TSF) were done with Vernier's caliper to estimate body fat. Measurement of mid-arm circumference (MAC) was done with a measuring tape on the nonaccess arm to estimate muscle mass. MAC signifies the thickness of subcutaneous fat and muscle. Mid-arm muscle circumference (MAMC), which reflects the protein store in the body, was calculated using the following formula:  $\text{MAMC} = \text{MAC} - (3.1415 \times \text{TSF})$ .<sup>15</sup>

## Evaluation of nutritional status by MQSGA method.

Nutritional status was assessed by MQSGA that relied on seven components—weight change, dietary intake, gastrointestinal symptoms, functional capacity, comorbidity, subcutaneous fat, and signs of muscle wasting. Each component was given a score from 1 (normal) to 5 (very severe). Thus, the MS, sum of all components, ranged from 7 (normal) to 35 (severely malnourished).<sup>6</sup> Patients were categorized into three groups: normal nutrition (score of 7–10), mild-to-moderate malnutrition (score of 11–20), and severe malnutrition (score of 21–35).

**Statistical analysis.** Statistical analysis was done using SAS University Studio Edition software (SAS Institute). All categorical variables are expressed as percentages and compared across cohorts using the  $\chi^2$  test. Continuous variables are expressed as mean  $\pm$  standard deviation and the statistical significance of mean differences is compared using ANOVA and *t*-test across cohorts as appropriate. Pearson's correlation is used to assess the magnitude and direction of association between MQSGA scores and anthropometric measures. *P*-values  $<0.05$  are considered statistically significant. Sensitivity analysis regarding the use of individual anthropometric measure to predict the MQSGA categories are compared using the receiver operating characteristic (ROC) analysis in the logistic regression framework.

## Results

The final study sample included 54 patients, 38 males and 16 females with the mean age of  $45.4 \pm 12.3$  years. The duration of hemodialysis ranged from six months to 12 years with a mean duration of  $48.0 \pm 32.8$  months. Demographic and anthropometric parameters are shown in Table 1. Mean BMI was  $19.57 \pm 3.19$ . The bodily measurements such as height, weight, MAC, and MAMC were significantly higher in male, whereas measurements like BMI, BSF, and TSF did not differ by gender.

Mean serum protein, albumin calcium and phosphate were within normal range (Table 2). C-reactive protein was positive in 56.3% of patients. All laboratory measurements had no significant difference between male and female.

Overall MQSGA in the study population was  $12.2 \pm 3.2$ . One-third of the study population was classified as normal nutritional status, and two-thirds were classified as mild to moderately malnourished. Female patients had significantly higher mean MQSGA score than the males ( $13.8 \pm 3.4$  vs  $11.5 \pm 2.9$ ;  $P = 0.017$ ); suggesting a relatively worse nutritional status. However, a test of independence between gender and MQSGA categories showed no statistical significance ( $\chi^2 = 2.18$ ,  $P = 0.140$ ). All anthropometric parameters of patients with normal nutrition were significantly higher than patients with mild-to-moderate malnutrition (Table 3). Laboratory parameters between normal and malnourished patients were not statistically significant.

Relationship between MQSGA and selected anthropometric measures and laboratory parameters is shown in

**Table 1.** Demography and anthropometric measurement of study population.

VARIABLES	TOTAL (N = 54)	FEMALE (N = 16)	MALE (N = 38)	MALE VS FEMALE
	MEAN ± SD	MEAN ± SD	MEAN ± SD	P-VALUE
Age (years)	45.41 ± 12.31	44.69 ± 11.83	45.71 ± 12.64	0.783
Height (cm)	160.43 ± 6.03	154.8 ± 4.87	162.8 ± 4.8	<.0001*
Weight (kg)	50.64 ± 10.39	45.39 ± 7.99	52.84 ± 10.58	0.015*
BMI (kg/m <sup>2</sup> )	19.57 ± 3.19	18.86 ± 2.59	19.87 ± 3.4	0.296
BSF (mm)	5.37 ± 1.73	4.69 ± 1.35	5.66 ± 1.81	0.059
TSF (mm)	7.37 ± 2.37	6.63 ± 1.89	7.68 ± 2.49	0.134
MAC (cm)	22.57 ± 2.56	20.81 ± 1.97	23.32 ± 2.43	0.001*
MAMC (cm)	20.26 ± 2.15	18.73 ± 1.63	20.91 ± 2.03	0.000*
MQSGA	12.17 ± 3.21	13.75 ± 3.36	11.5 ± 2.94	0.017*
MHD (months)	48.03 ± 32.78	51.56 ± 32.99	46.55 ± 33.02	0.613

**Abbreviations:** BMI, body mass index; MQSGA, modified quantitative subjective global assessment; BSF, biceps skin fold; TSF, triceps skin fold; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference.

Table 4. There was no statistical evidence for the correlation of serum albumin with MQSGA ( $P = 0.930$ ). All assessed anthropometric measurements were negatively correlated with MQSGA and were statistically significant.

**Sensitivity analysis.** The adequacy of individual anthropometric measures to predict nutritional status was compared through the regression modeling. Simple linear regression models were run for MQSGA score as dependent variable with respect to each of the five anthropometric measures

(Fig. 1), and the goodness-of-fit of each model was compared. The MAC model ( $R^2 = 0.320$ ) had the strongest performance followed by BSF ( $R^2 = 0.259$ ) and MAMC ( $R^2 = 0.256$ ). Nearly all observation points fell within 95% prediction limits. BMI model performed the weakest among all measures in explaining the variation ( $R^2 = 0.201$ ). However, these  $R^2$  values are lower than the generally accepted range; these may not be as conclusive. Gender had no significant effect when included in the model, except for a weak relationship in the BMI model.

**Table 2.** Laboratory parameters of study population.

VARIABLES	TOTAL (N = 54)	NORMAL RANGE (FOR REFERENCE)
	MEAN ± SD	
Total leukocyte count (cell/mm <sup>3</sup> )	4961 ± 2281	4,000–11,000
Platelet counts (cells/mm <sup>3</sup> )	134128 ± 52798	150000–400000
Hemoglobin (gram%)	7.38 ± 1.12	12–14
Neutrophils (%)	65.94 ± 6.91	45–75
Lymphocytes (%)	28.19 ± 6.56	25–40
Blood sugar (mg/dL)	101.96 ± 35.05	70–110
Urea (mg/dL)	107.28 ± 33.04	7–20
Creatinine (mg/dL)	7.35 ± 2.52	135–145
Sodium (mmol/L)	138.72 ± 3.83	0.5–1.4
Potassium (mmol/L)	4.31 ± 0.79	3.5–5.5
Uric acid (mg/dL)	4.87 ± 1.8	3.4–7.2
Total protein (gm/dL)	7.24 ± 0.71	6.4–8.3
Albumin (gm/dL)	4.03 ± 0.3	3.5–4.5
Calcium (mg/dL)	8.53 ± 0.98	8.4–10.2
Phosphate (mg/dL)	5.13 ± 1.16	2.4–4.1
Total cholesterol (mg/dL)	138.65 ± 39.13	<200
HDL cholesterol (mg/dL)	41.69 ± 22.13	40–60
LDL cholesterol (mg/dL)	75.83 ± 27.75	<100
Triglycerides (mg/dL)	107.35 ± 44.91	<150

**Table 3.** Anthropometric, serum albumin, and lipid profile by MQSGA categories.

VARIABLES	NORMAL NUTRITION (n = 18)	MILD TO MODERATE MALNUTRITION (n = 36)	P-VALUE
	MEAN ± SD	MEAN ± SD	
Sex (female%)	16.7%	36.1%	0.146
Age (years)	43.61 ± 11.38	46.31 ± 12.81	0.453
Height (cm)	162.56 ± 5.58	159.36 ± 6.03	0.066
Weight (kg)	58.72 ± 10.66	46.59 ± 7.61	<.0001*
MQSGA	9.11 ± 1.23	13.69 ± 2.77	<.0001*
BMI (kg/m <sup>2</sup> )	22.12 ± 3.14	18.29 ± 2.37	<.0001*
BSF (mm)	6.61 ± 1.79	4.75 ± 1.34	<.0001*
TSF (mm)	8.94 ± 2.86	6.58 ± 1.61	0.004*
MAC (cm)	24.72 ± 2.47	21.50 ± 1.84	<.0001*
MAMC (cm)	21.93 ± 2.21	19.43 ± 1.58	<.0001*
Hemoglobin (gm/dL)	7.37 ± 0.96	7.38 ± 1.21	0.960
Total protein (gm/dL)	7.14 ± 0.72	7.28 ± 0.71	0.512
Albumin (gm/dL)	4.07 ± 0.26	4.01 ± 0.32	0.482
Total cholesterol (mg/dL)	150.94 ± 39.49	132.50 ± 38.02	0.103
HDL-cholesterol (mg/dL)	50.56 ± 35.61	37.25 ± 8.08	0.135
LDL-cholesterol (mg/dL)	81.00 ± 30.98	73.25 ± 26.06	0.338
Triglyceride (mg/dL)	126.39 ± 54.61	97.83 ± 36.41	0.056
MHD (months)	42.89 ± 28.90	50.61 ± 34.65	0.420
CRP (+ ve)	22.2%	44.4%	0.070

**Abbreviations:** MQSGA, modified quantitative subjective global assessment; BMI, body mass index; BSF, biceps skin fold; TSF, triceps skin fold; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; MHD, maintenance hemodialysis.

**Table 4.** Correlation of anthropometric assessments and lab parameters with MQSGA.

VARIABLES	MQSGA	
	r	P-VALUE
BMI (kg/m <sup>2</sup> )	-0.448	0.001*
BSF (mm)	-0.508	<.0001*
TSF (mm)	-0.483	0.0002*
MAC (cm)	-0.563	<.0001*
MAMC (cm)	-0.506	<.0001*
Hemoglobin (gm/dL)	0.243	0.077
Blood sugar (mg/dL)	-0.039	0.780
Urea (mg/dL)	-0.293	0.031*
Creatinine (mg/dL)	0.283	0.038*
Sodium (mmol/L)	-0.289	0.034*
Potassium (mmol/L)	-0.157	0.257
Uric acid (mg/dL)	-0.274	0.045*
Total protein (gm/dL)	0.275	0.044*
Albumin (mg/dL)	0.012	0.930
Calcium (mg/dL)	-0.033	0.813
Phosphate (mg/dL)	-0.316	0.020*
Total cholesterol (mg/dL)	-0.180	0.194
HDL-cholesterol (mg/dL)	-0.248	0.070
LDL-cholesterol (mg/dL)	-0.122	0.380
Triglyceride (mg/dL)	-0.197	0.153

**Note:** r for Pearson correlation coefficients (\*P < 0.05).

Each anthropometric measure was converted into binary categories and used in the classification table with MQSGA categories. The strength of individual model in correctly identifying true positive or true negative cases in a classification matrix is measured by the lift on the ROC curve from a logistic regression model. ROC curve is plotted as sensitivity against the 1-specificity (Fig. 2). Sensitivity indicates the relative strength of the model in accurately predicting positive cases as positive, and specificity refers to the relative strength in predictive negative cases as negative. The values of area under ROC curve indicate how best the model can discriminate those true positive and true negative cases. A value of 1.0 indicates perfect discrimination while a value of 0.5 indicates random outcomes.<sup>16</sup> Using this criteria, MAC was again the best performing in terms of prediction accuracy (AUC = 0.8773). Both MAMC (AUC = 0.8596) and BMI (AUC = 0.8519) performed very well. BSF (AUC = 0.7948) and TSF (AUC = 0.7855) had slightly lower but satisfactory lift.

## Discussion

Malnutrition is a common problem seen in patients with ESRD undergoing MHD. It has direct relationship with the quality of life and is associated with increased risk of mortality and morbidity in these groups of patients.<sup>17</sup> Multiple factors

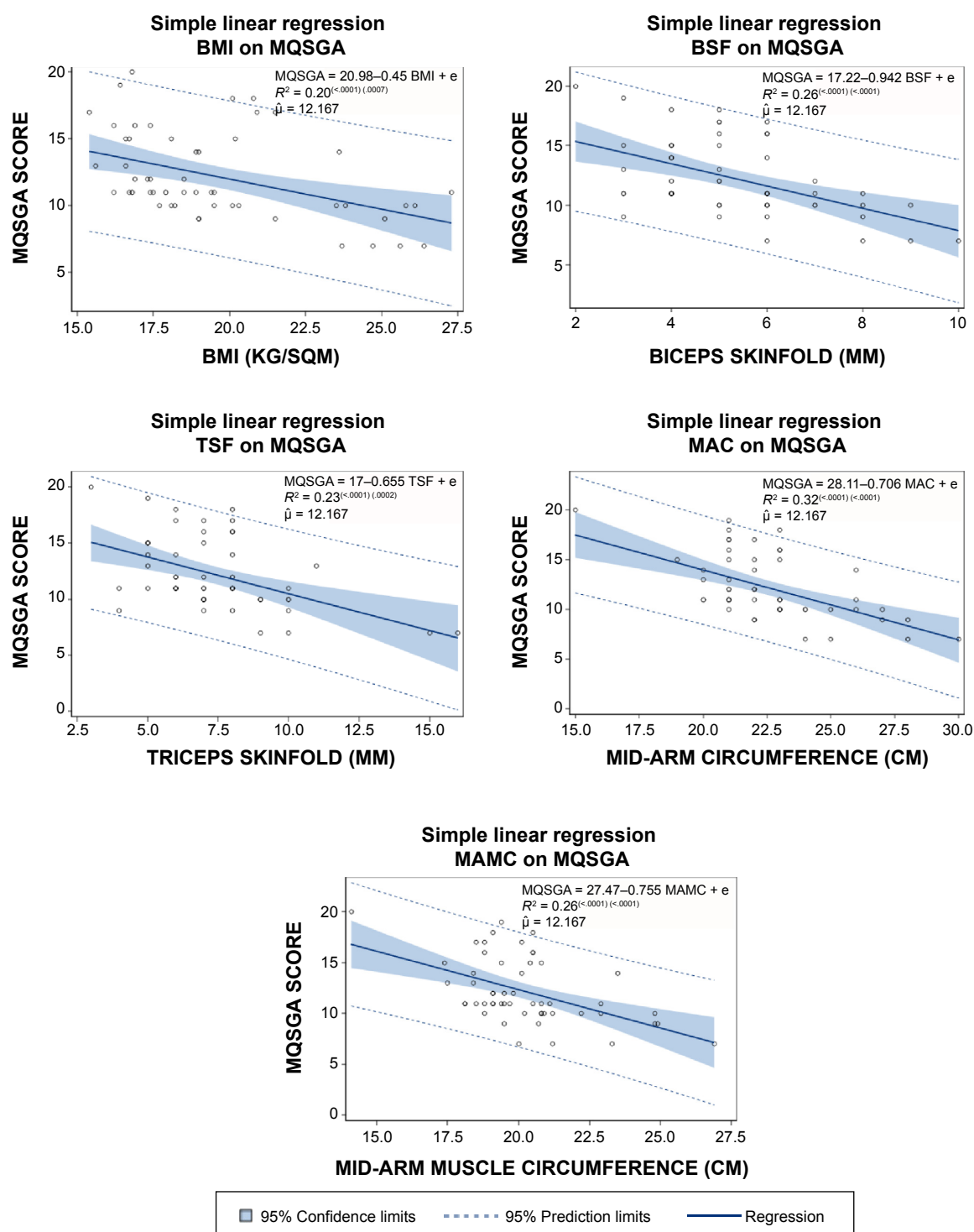
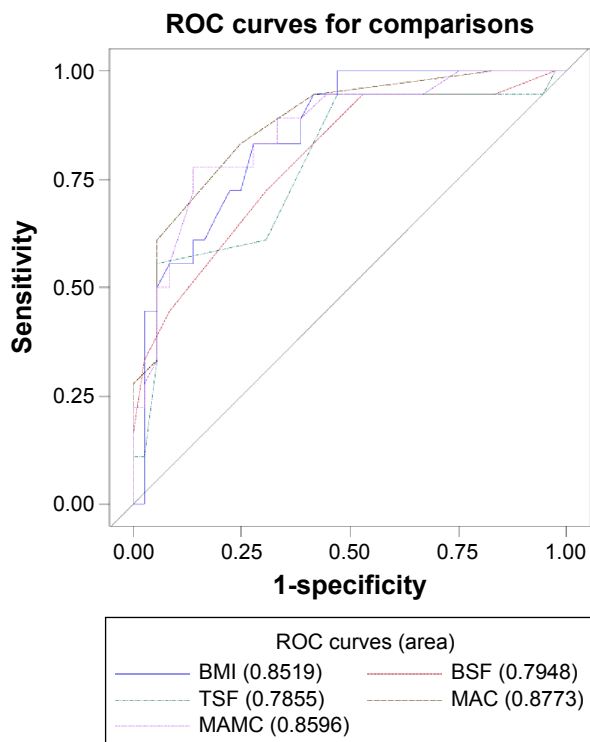


Figure 1. Regression lines for MQSGA scores with respect to anthropometric measures.

play a role in the occurrence of malnutrition in patients undergoing hemodialysis,<sup>18–20</sup> among which adequacy of dialysis, dietary intake, and recurrent infection are the important factors. Despite its immense clinical importance, evaluation of the nutritional status of dialysis patients is not considered as an important part in day-to-day practice.<sup>21</sup>

Several literatures show that the prevalence of PEM in dialysis patients is high<sup>22–24</sup> ranging from 23% to 94% being

malnourished.<sup>13,19,21,22,25,26</sup> Evaluation of nutritional status of patients on MHD in a private teaching hospital of Nepal revealed malnutrition in 84.6%.<sup>13</sup> In the present study, 66.7% of patients were mild to moderately malnourished. All the patients were receiving dialysis twice a week. As none of the patients with variable duration of dialysis were severely malnourished, poor dietary intake could have probably played a major role in mild-to-moderate malnutrition.



**Figure 2.** Comparison of area under ROC curve for all five anthropometric measures.

Strong negative correlation of MQSGA score with all anthropometric parameters like TSF, BSF, BMI, MAC, and MAMC in the current study was similar to previous studies<sup>13,27</sup> suggesting that decrease in anthropometric measurements is associated with increased MQSGA scores. So, combination of these anthropometric assessments may be as effective as MQSGA for evaluation of malnutrition of hemodialysis population.

Although age was significantly correlated with MQSGA score, the difference was not evident in the nutritional status categories. Similar finding was demonstrated by Kalantar-Zadeh et al.<sup>6</sup>

Serum albumin is considered as an indicator of malnutrition but is not considered as a reliable index. Hypoalbuminemia is a relatively late manifestation of malnutrition, since albumin has a long half-life and hepatic synthetic reserve is very large. Several studies have demonstrated a negative correlation between the plasma albumin concentration and mortality in patients undergoing MHD or peritoneal dialysis.<sup>25,28–30</sup> Overall MQSGA did not correlate with the serum albumin levels ( $r = 0.012$ ;  $P = 0.930$ ) and found similar across normal nutrition and malnutrition ( $P = 0.483$ ). This was probably because of the fact that serum albumin and creatinine increase during the first half year of hemodialysis<sup>30</sup> and a fall in serum albumin level lags much behind the onset of malnutrition. Similar findings were also reported in different studies from different parts of the world.<sup>24,31</sup>

Despite the higher risk of occurrence of dyslipidemia in ESRD<sup>32</sup> and a few studies demonstrating its relationship

with poor nutritional status,<sup>33,36</sup> this study found no statistically significant association between nutritional status and lipid levels. However, lower total cholesterol and triglyceride observed in mild to moderately malnourished patients could be because of poor dietary intake.

Anemia generally develops in patients with chronic renal insufficiency and is associated with a wide range of complications. Almost all patients in both normal nutrition and moderately malnourished groups had moderate-to-severe anemia ( $P = 0.060$ ) with overall mean hemoglobin level  $7.38 \pm 1.12$ . This particular finding differs from previous studies<sup>11,34</sup> that demonstrated a significant relationship between anemia and severity of malnutrition. However, anemia is multifactorial in patients with ESRD and a low level of hemoglobin may result from many causes in these patients. Estimation of hemoglobin may not be reasonable during assessment of nutritional status.

Average values of anthropometric measures, such as height, weight, MAC, and MAMC, differ significantly by gender.<sup>35</sup> Though significant differences were detected in these measures, gender did not have a significant interaction with these variables in predicting MQSGA. This shows that the anthropometric measures can be used independent of gender, at least in the studies of Nepalese hemodialysis patients. MQSGA scoring showed mild-to-moderate malnutrition in two-thirds of the patients on MHD with no cases of severe malnutrition. Anthropometric assessment tools like BMI, MAC, MAMC, TSF, and BSF are relatively easier, cheaper, and practical markers of nutritional status. The ROC curve analysis and its lift show that these indicators may be used independently with high degree of accuracy in assessing the nutritional status among the Nepali MHD patients. A joint study is recommended for future, including patients from all area hospitals with MHD services, which would increase the sample size and be more representative of the population.

### Limitation of the Study

Though the study recruited 96% of the available population from one hospital in the study, there was no sample at the severely malnourished level. Owing to the small sample size, it is not ascertained at this time whether MHD population in Nepal, in general, is not severely malnourished. Another limitation of the study is the use of Engineer's Vernier Caliper in place of skinfold caliper as the latter was not readily available in the local market. Engineer's Vernier Caliper is still being used in many studies as per the 2001 guidelines in International Standards for Anthropometric Assessment by International Society for the Advancement of Kinanthropometry. The authors followed the guidelines and believed that the study includes valid measure of anthropometric indicators.

### Acknowledgments

The authors would like to thank Dr. Dineshwori Shrestha for assisting in data collection, Abja Sapkota for compilation of data, all nursing staffs of the hemodialysis unit, Bir Hospital



for helping in blood sample collection, and also all patients with ESRD undergoing hemodialysis at Bir hospital for their participation in the study.

### Author Contributions

Conceived and designed the experiments: AS. Analyzed the data: GRB. Wrote the first draft of the manuscript: AS. Contributed to the writing of the manuscript: AS, GRB, RH and RKA. Agree with manuscript results and conclusions: AS, RH, RKA, GRB and AB. Jointly developed the structure and arguments for the paper: AS, RH, RKA and AB. Made critical revisions and approved final version: AS and GRB. All authors reviewed and approved of the final manuscript.

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