Original Article

COMPARISON OF BODY MASS INDEX WITH MODIFIED SUBJECTIVE GLOBAL ASSESSMENT FOR DETECTION OF MALNUTRITION AMONG PATIENTS UNDER MAINTENANCE HEMODIALYSIS: A MULTI-CENTER CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Patients under maintenance hemodialysis are at increased risk of malnutrition, causing from multitude of factors. Present study aims to assess the prevalence of malnutrition among maintenance hemodialysis patients using both modified subjective global assessment score and body mass index, compare them and assess the sensitivity and specificity of body mass index for detecting malnutrition, along with determining a new cutoff value for BMI that better represent the maintenance hemodialysis patient's nutritional status.

***Methods*:** This was a cross-sectional study conducted in the hemodialysis unit of Bangabandhu Sheikh Mujib Medical University, Sir Salimullah Medical College Mitford Hospital, BIRDEM General Hospital and National Institute of Kidney Diseases & Urology; among 80 adult CKD patients who were on regular (≥2 sessions per week) maintenance hemodialysis for more than 3 months without any acute infection, during the period of July 2016 to June 2017. Nutritional assessment was done for each patient using modified SGA score along with BMI. Sensitivity analysis of WHO recommended cutoff value for BMI was done among the study population using modified SGA score as gold standard test for detection of malnutrition among the respondents. ROC curve was used to estimate the best fitting cutoff value of BMI that showed highest sensitivity, specificity and accuracy for detracting malnutrition among maintenance hemodialysis patients.

***Results*:** The study participants were predominantly male (66.3%) and from age group 45 to 59 years (36.3%). Modified SGA score detected 90.0% of the study population as malnourished. WHO recommended 18.5 kg/m^2 cutoff value was also used to detect malnutrition among study population and 13.8% were found to be malnourished, with a sensitivity and specificity of 12.5% and 75.0% respectively. Accuracy was found to be 18.8%. Using ROC curve, 23.1 kg/m^2 was found to be the best fitting cutoff value of BMI for the study population to detect malnutrition. With a sensitivity of 47.2%, specificity of 37.5% and accuracy of 46.3%.

***Conclusion*:** BMI showed low sensitivity for detecting malnutrition among patients under maintenance hemodialysis, compared to modified SGA score and should be avoided as a screening tool, but 23.1 kg/m^2 cutoff value for BMI showed potential to be used as an easy to use and quick tool for detecting malnutrition among such patients. Further study with larger sample size could shed more light on this.

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Keywords: Sensitivity, Specificity, Accuracy, BMI, Modified SGA Score.

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INTRODUCTION

Patients under maintenance hemodialysis often suffer from malnutrition, leading to an increased incidence of mortality and morbidity[1,2]. The process of hemodialysis removes nutrients and promotes protein catabolism. It also induces anorexia caused by uremic state, altered taste sensation, concurrent illness, emotional distress, impaired ability to procure, prepare or mechanically digest foods, unpalatable prescribed diets and the catabolic response to superimposed illness [3]. Patients under maintenance hemodialysis are the most vulnerable to malnutrition and are in constant need of nutritional support. Maintaining proper nutritional status can drastically improve outcome of the treatment leading to reduced duration and cost of treatment [4–9]. While treatment outcome has been found to be directly dependent on the nutritional status of the patients, screening for malnutrition is often ignored and over looked in many dialysis centers[10–13].

There have been several different scales proven to be effective in screening for malnutrition, but not all are easily assessable in hospital environment. Among them subjective global assessment has shown the most accuracy for detecting malnutrition among end stage renal disease patients, specially patients under maintenance hemodialysis [14–16]. Subjective global assessment (SGA) score is a well-validated screening tool recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) for nutritional screening[17–20], determined by medical history on seven items and clinical findings on four items. Using components of conventional SGA, in 1999, Kalantar-Zadeh et al presented a version of the SGA that was originally referred to as modified quantitative SGA[1]. This fully quantitative version of SGA used the 7 original SGA components and created a quantitative 5-point scale with 1 as normal and 5 as very severe malnutrition. The final score was the total sum of all 7 components. Total range was from 7 (normal) to 35 (severely malnourished). SGA is mostly examiner dependent, fully quantitative, performed in few minutes, reproducible and definitely determines the nutritional status of hemodialysis patients. SGA gives a global score of protein energy nutritional status. Disadvantages of this method include the fact that visceral protein levels are not included in the assessment; it is focused on nutrient intake and body composition [18]. It seems that modified SGA is superior to conventional SGA and more suitable to detect the changing trend of nutritional status [21,22].

On the other hand, anthropometric parameter such as body mass index (BMI) has been widely in use as metrics for nutritional status[23]. Although, its practicality and accuracy in assessing malnutrition among hemodialysis patients have not been convincing [24]. In Bangladesh, there is a high prevalence of malnutrition among patients with end stage renal disease (ESRD) as the calorie and protein intake of these patients are poor[25]. Modified subjective global assessment (SGA) has been in use in Bangladesh as a simple and dynamic tool to assess malnutrition, but for faster screening in a hospital setup, BMI classification could be used.

This study was carried out to assess the prevalence of malnutrition among maintenance hemodialysis patients using both modified subjective global score and body mass index, compare them and assess the sensitivity and specificity of body mass index for detecting malnutrition, along with determining a new cutoff value for BMI that better represent the maintenance hemodialysis patient's nutritional status.

METHODS

This was a cross-sectional study conducted in the hemodialysis unit of Bangabandhu Sheikh Mujib Medical University (BSMMU), Sir Salimullah Medical College Mitford Hospital (SSMCMH), BIRDEM General Hospital and National Institute of Kidney Diseases & Urology (NIKDU); all situated in Dhaka, during the period of July 2016 to June 2017. Study was conducted among adult CKD patients who were on regular (≥2 sessions per week) maintenance hemodialysis for more than 3 months without any acute infection. As per selection criteria, 80 patients were enrolled for the study. Patients were fully briefed regarding the study before the enrollment and written consent were collected from every participant during enrollment. Ethical approval was collected from the local ethical committee of respective institute.

Data were collected through face-to-face interview using a pre-tested data collection sheet. The relevant socio-demographic data along with anthropometric and nutritional status data of the patients were collected and recorded. Computer based statistical analysis were carried out with appropriate techniques and systems. Quantitative data were expressed as mean and standard deviation and qualitative data were expressed as frequency distribution and percentage. Statistical analysis was performed by using Statistical Packages for Social Sciences (SPSS® version 22) for Windows®.

From the anthropometric data, body mass index (BMI) was calculated for all the respondents and were classified as per WHO guideline [26]. Researchers performed all anthropometric measurements

immediately after a dialysis session. All participants were considered normohydrated. If patients were overhydrated anthropometric measurements were postponed. Height and body weight were measured in light clothing using standard instruments. As per WHO guideline, BMI < 18.5 kg/m^2 was classified as malnourished and BMI ≥ 18.5 kg/m^2 was classified as without malnutrition. Nutritional status of the respondents was evaluated using modified SGA score. Modified SGA score was proposed in 1999 based on SGA score [1]. The SGA score was based on 5 components of a medical history (i.e., weight change, dietary intake, gastrointestinal symptoms, functional capacity, metabolic demands in view of underlying disease state) and 2 components of a brief physical examination (signs of fat and muscle wasting, nutrition-associated alterations in fluid balance). The patient is then assigned a rating of well nourished, moderately malnourished or severely malnourished [24]. In this study subjective global assessment was performed by using 7 point modified SGA scale.

For the purpose of this study, sensitivity analysis of BMA classification was done among the study population using modified SGA score as gold standard for detection of malnutrition among patients on maintenance hemodialysis. (Figure 1). Accuracy of the test was measured along with predictive values and likelihood ratios[27,28]. Predictive ratio were used to estimate trust ability of the test [29].

Test Parameters		**Nutritional status according to modified SGA score**	
		Positive	**Negative**
Test status	Positive	a	b
	Negative	c	d

Figure 1: Sensitivity analysis

Sensitivity and Specificity

According to Trevethan[27], sensitivity is the proportion of people with a condition who are correctly identified by a screening test as indeed having that condition and specificity is the proportion of people without a condition who are correctly identified by a screening test as indeed not having the condition. Sensitivity = a/(a+c). Specificity = d/(d+b).

Accuracy

Accuracy of a test is its ability to differentiate the patient and healthy cases correctly. It is the proportion of true positive and true negative in all evaluated cases [30]. Accuracy = (a+d)/(a+b+c+d)

Predictive Values

Positive predictive value (PPV) is the probability that people with a positive screening test result indeed do have the condition of interest and negative predictive value (NPV) is the probability that people with a negative screening test result indeed do not have the condition of interest [27].

Positive predictive value (PPV) = a/(a+b)
Negative predictive value (NPV) = d/(c+d)

RESULTS

Among the study population, 38.8% were from over 60 years aged, followed by 36.3% from 45 – 59 years of age group (Table I). Study population was predominantly male (66.3%).

Table I: Descriptive statistics of the study population

Criteria		**Frequency N = 80**	**Percentage (%)**
Age in years			
	18 – 29	8	10.0
	30 – 44	12	15.0
	45 – 59	29	36.3
	≥ 60	31	38.8
Sex			
	Male	53	66.3
	Female	27	33.8
Total		80	100%

Study population was classified based on their nutritional status using both modified SGA score and BMI (Table II). According to modified SGA score, 90% of the respondents were malnourished. According to BMI, 13.8% were malnourished. WHO recommended 18.5 kg/m^2 was used as cutoff for BMI [26].

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Table II: Results of modified SGA score and BMI

Test		Frequency (n = 80)	Percentage (%)
Modified SGA Score			
	Malnourished (≥ 8)	72	90.0
	Well-nourished (< 8)	8	10.0
BMI (Cutoff at 18.5 kg/m^2)			
	Malnourished (< 18.5 kg/m^2)	11	13.8
	Well-nourished (≥ 18.5 kg/m^2)	69	86.3
BMI (Cutoff at 23.1 kg/m^2)			
	Malnourished (< 23.1 kg/m^2)	39	48.8
	Well-nourished (≥ 23.1 kg/m^2)	41	51.2
Total		80	100%

Using modified SGA score as gold standard, sensitivity and specificity of BMI (18.5 kg/m^2 as cutoff value) for detecting malnutrition among patients under maintenance hemodialysis was calculated (Table III). Sensitivity was found to be 12.5% and specificity was found to be 75.0% for BMI (Table IV). Accuracy was found to be 18.8%. Positive predictive value (PPV) and Negative predictive value (NPV) were found to be 81.8% and 8.7% respectively.

Table III: Sensitivity Analysis of BMI compared to modified SGA score

		Nutritional status according to modified SGA score	
		Malnourished	**Without Malnutrition**
BMI using 18.5 kg/m^2 as cutoff value	Malnourished	9 (12.5%)	2 (25.0%)
	Well-nourished	63 (78.8%)	6 (75.0%)
BMI using 23.1 kg/m^2 as cutoff value	Malnourished	34 (42.5%)	5 (62.5%)
	Well-nourished	38 (47.5%)	3 (37.5%)
Total		**72**	**08**

ROC curve was done to determine the best fitting cutoff value of BMI for the study population against the gold standard, modified SGA score (Figure 2). Based on younder index, BMI 23.1 kg/m^2 was found to be the cutoff value with maximum accuracy. Using 23.1 kg/m^2 as cutoff value for BMI, 48.8% of the study population were found to be malnourished (Table II). Using modified SGA score as gold standard, sensitivity and specificity of BMI (23.1 kg/m^2 as cutoff value) for detecting malnutrition among patients under maintenance hemodialysis was calculated. Sensitivity was found to be 47.2% and specificity was found to be 37.5%, with an accuracy of 46.3%. Positive predictive value (PPV) and Negative predictive value (NPV) were found to be 87.2% and 7.3% respectively.

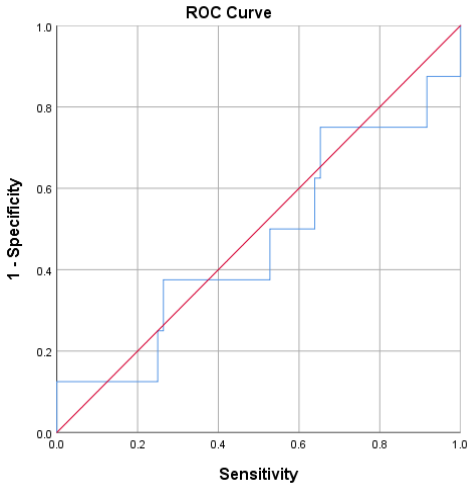

Figure 2: ROC Curve showing sensitivity and specificity of BMI to accurately identify malnutrition among study population, compared to modified SGA score used as gold standard.

Table IV: Estimated values of test parameters

Tests parameters	BMI using 18.5 kg/m^2 as cutoff value	BMI using 23.1 kg/m^2 as cutoff value
Sensitivity	12.5%	47.2%
Specificity	75.0%	37.5%
Accuracy	18.8%	46.3%
Positive predictive value (PPV)	81.8%	87.2%
Negative predictive value (NPV)	8.7%	7.3%

DISCUSSIONS

Respondents in present study was predominantly male (66.3%) and majority (38.8%) were from over 60 years of age. Similar findings have been shown in previous studies among patients under hemodialysis where male were 62.9% and 60.9% were above 60 years of age [31]. Respondents were classified into malnourished and well-nourished groups and according to modified SGA score, 90% of the respondents were malnourished. This finding is consistent with another study from India [32], where using modified SGA, malnutrition rate was 91% among 66 patients undergoing hemodialysis. Present study used modified SGA score as gold standard for assessing nutritional status, since modified SGA is a reliable prognostic indicator for malnutrition. Previous studies have shown that modified SGA not only determines the nutritional status, but also predicts the likelihood of complications from malnutrition [10,33–35]. In present study, using WHO recommended cutoff value of 18.5 kg/m^2 for BMI, 13.8% were classified as malnourished. This result is consistent with nutritional assessment conducted among elderly population, where >10% had malnutrition with a BMI of 18.5 kg/m^2 [36].

WHO recommended cutoff value for BMI was evaluated for sensitivity and specificity for detecting malnutrition among patients under maintenance hemodialysis. Sensitivity was found to be 12.5% and specificity was found to be 75.0%, with an accuracy of only 18.8%. This indicates the cutoff value of 18.5 kg/m^2 could accurately detect the nutritional status of only 18.8% of the respondents. These findings suggest that the WHO recommended cutoff value of 18.5 kg/m^2 is not suitable to detect malnutrition among patients under maintenance hemodialysis. This result is consistent with previous studies, where malnutrition and obesity prevalence in maintenance hemodialysis patients were simultaneously assessed [37,38]. These studies have shown an overlap between patients with malnutrition and those with obesity, indicating a problem with nutritional assessment methodologies, further supporting the fact that BMI may not be a reliable indicator for nutritional assessment among maintenance hemodialysis patients [39–45], but BMI is relatively easy, inexpensive and less time consuming to measure than modified SGA score [23,46].

So, in order to develop a new cutoff value for BMI that could detect malnutrition among patients under maintenance hemodialysis, ROC curve was used. A cutoff value of 23.1 kg/m^2 was found to have shown the maximum accuracy (46.3%) in detecting the nutritional status of the respondents with a sensitivity of 47.2% and specificity of 37.5%. This higher sensitivity means that at the cutoff value of 23.1 kg/m^2, BMI could detect more patients with malnutrition than WHO recommended 18.5 kg/m^2. Now if we have increased the cutoff value even more, it would have increased the sensitivity, but it would reduce the specificity even lower to the point that accuracy of the test becomes substantially lower.

STRENGTH

Modified SGA score was used as gold standard to identify the nutritional status of the respondents. Sensitivity, specificity, predictive values and accuracy of BMI were compared against modified SGA score, increasing the validity and precision of the study. Also, study was conducted among respondents from multiple centers, generating results more acceptable and accurate than studies conducted in one center.

CONCLUSION

Due to the design of the study, each sample was interviewed once, doings subsequent follow ups over an extended period of time would have given us more data on the predictive capabilities of BMI classification on developing malnutrition among patients under maintenance hemodialysis. But solely based on the findings of this study, BMI based nutritional assessment doesn't appear to be a reliable method for detecting malnutrition among patients under maintenance hemodialysis, although if needed, a BMI value of 23.1 kg/m^2 could be used as a easy to use marker for detecting malnutrition among maintenance hemodialysis patients, until proper assessment is possible. A small sample size of 80 was used for present study, future studies with bigger sample size is highly recommended for a more

accurate and reliable cutoff value of BMI for maintenance hemodialysis patients.

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