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Comparison of a Simple Nutrition Screening Tool (SNST) Compared with Subjective Global Assessment (SGA) in Body Mass Index (BMI) Assessments of Type 2 Diabetic Patients Validation of SNST Versus BMI in T2 Diabetes

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Abstract: Diabetes is a major health problem and has become a burden to the health care system worldwide. Malnutrition is common among patients with diabetes, both in hospitalized and outpatient clinic settings. Therefore, nutrition screening is needed to detect malnutrition risk. Recently, a new nutrition-screening tool for adult populations has been developed, termed the Simple Nutrition Screening Tool (SNST). SNST has been validated for use in adult hospitalized patients. This study aimed to determine the validity (sensitivity, specificity, Maximum Sum Sensitivity and Specificity [MSSS] and Area Under Curve [AUC]) of SNST and SGA in calculating the body mass index in type 2 diabetic patients. This observational study employed a cross sectional design. A total of 153 type 2 diabetic outpatients from an internal medicine clinic at Dr Moewardi Hospital were recruited using a purposive sampling technique. The independent variables included nutrition-screening interpretation using SNST and SGA, while the dependent variable was body mass index (BMI). Contingency tables and the ROC curve were used to determine the validity of SNST and SGA compared with standards for nutrition and body mass index. There ware significant associations between SNST and BMI ($p<0.001$) and SGA and BMI ($p<0.001$). Validation of SNST vs. SGA revealed the following: sensitivity, 88.89% vs. 77.78%; specificity, 81.25% vs. 81.94%; MSSS, 170.14% vs. 159.72% and AUC, 0.851 vs. 0.799. SNST exhibited better validity than SGA predicting the body mass index of type 2 diabetic patients.

Key words: SNST, subjective global assessment, body mass index, validity, type 2 DM

INTRODUCTION

Diabetes mellitus (DM) is a major public health problem. Its prevalence worldwide in 2014 was ~9% and in Indonesia it has increased from 1.1% in 2007 to 2.4% in 2013. DM has contributed to the cause 82% of deaths worldwide among all non-communicable diseases (NCDs), along with heart disease, cancer and chronic obstructive pulmonary disease (Riskesdas, 2013; WHO, 2014a, b).

Hyperglycemia resulting from insulin resistance in patients with DM has lead to classic symptoms that can increase the risk of infection and unintentional weight loss (Rochette *et al*., 2014; Donath and Shoelson, 2011; Sherwood, 2007). When not handled properly, it can increase the risk of malnutrition in patients with diabetes.

Malnutrition often occurs in hospitalized diabetic patients, in both inpatient and outpatient settings. In hospitalized patients, 7.4% of diabetic patients have a body mass index (BMI) <18.5 (Sujanitha *et al*., 2015) and 4.3% of diabetic patients have a BMI <20 (Zekry *et al*., 2013). Furthermore, approximately 41% of diabetic patients are treated in the ICU because they suffer from malnutrition (Chakravarty *et al*., 2013) and 55.4% of diabetic patients are elderly women who are malnourished (Sanz Paris *et al*., 2013). Malnutrition status based on BMI in diabetes mellitus outpatients can reach 2% (Sugiani, 2011) to 2.7% (Adnan *et al*., 2013).

Malnutrition reduces immune function and affects physiological responses to medications and treatments that can inhibit healing, increase pain response, raise

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the risk of complications and death in acute illness, induce chronic delays in the processes of healing and recovery, increase the length of hospital stay and increase the treatment cost (Debruyne *et al*., 2008; Gupta *et al*., 2011; Valente da Silva *et al*., 2012; Almeida *et al*., 2013).

Nutritional screening that uses validated screening tools is needed both in inpatient and outpatient settings. Patients at risk of malnutrition should receive optimal nutritional intervention by providing early adequate nutrition support to prevent the negative impacts of malnutrition, improve nutritional status and minimize overall costs (Mueller *et al*., 2011; Gomez-Candela *et al*., 2013; Lee *et al*., 2013).

Susetyowati (2014) developed new nutritional screening tools for adult patients, termed the Simple Nutrition Screening Tool (SNST) that consisted of 6 questions designed to detect the risk of malnutrition. Individuals were classified as “Not at Risk of Malnutrition” for a score of 0-2 and “At Risk of Malnutrition” for a score of greater than 2. The SNST is an easy, simple, fast and inexpensive method. It does not require any mathematical calculations or anthropometric measurements and has been validated by a sensitivity and specificity score of 79.78 compared with 91.28 for the Subjective Global Assessment (SGA). Thus, it is suitable for implementation at hospitals in Indonesia. SNST nutritional screening tools have been used in some previous studies, including in assessments of hospitalized adult patients by Andini (2014) and Susetyowati (2014) and of hospitalized elderly patients by Mayasari *et al*. (2014); however, studies of the effectiveness of this screening tool have not yet been carried out in patients with diabetes.

A commonly used nutritional assessment tool is the Subjective Global Assessment (SGA). SGA is a method for describing nutritional status changes that include subjective assessments based on medical histories and general physical examinations (Gibson, 2005). SGA shows a high correlation with anthropometric parameters (Moriana *et al*., 2014). However, compared with nutritional screening SNST, it still has some weaknesses as it, requires mathematical calculations and detailed data collection that can only be performed by skilled personnel or nutritionists; not all hospitals in Indonesia have adequate nutrition experts and anthropometric equipment. The time required to carry out SGA checklists is longer than the time required by SNST nutritional screening, as it 15 vs. 3-5 min per patient, respectively (Susetyowati, 2014).

Body Mass Index (BMI) is an anthropometric measurement that is often used to assess the nutritional status of a patient. It is sensitive for determining the status of malnutrition, as it can indicate whether an individual is normal, overweight, or obese. BMI is also used to monitor nutritional status in adult patients (Gibson, 2005; Hartono, 2006).

This study aimed to analyze the sensitivity, specificity, maximum sum sensitivity and specificity [MSSS] and Area Under the Curve [AUC] to validate the nutritional screening SNST and SGA to assess BMI in patients type 2 diabetes.

MATERIALS AND METHODS

Participants and study design: The observational study had a cross sectional design. A total of 153 type 2 diabetic patients who underwent outpatient treatment at the Internal Medicine Department of Dr. Moewardi Hospital were enrolled as the patient cohort by using purposive sampling. Patients were selected to fulfill the following inclusion criteria: willing to participate in the study, providing written informed consent, greater than 18 years old, compos mentis, able to communicate and willing to have their height and weight measured. Additionally, patient exclusion criteria were as follows: mental disorder, pregnant, currently breast feeding, renal failure, heart failure, liver cirrhosis with edema/ascites, or obese (BMI>25). The study was approved by the ethics of health research ethics committee at the Dr. Moewardi Hospital, Faculty of Medicine, Sebelas Maret University (No: 813/XI/HREC/ 2015).

Data collection techniques: Collection of data for patient characteristics, nutritional screening, SGA assessments and BMI appraisals were carried out at a single visit in type 2 diabetic patients who underwent outpatient treatment at Dr Moewardi Hospital. Independent variables included SNST and SGA and the dependent variable was BMI, which was divided into malnutrition and good nutritional status. Data for patient characteristics (age, gender, education, employment, long suffering from diabetes and complications of disease) were obtained from interviews and medical record assessments. Malnutrition risk and nutritional assessments for each patient was performed by one dietician.

BMI nutritional assessment: Weight measurements ware performed in patients who were wearing minimal clothes and without shoes using a digital body weight scale with accuracy of 0.1 kg. Height measurements was carried out in patients who were standing upright and without shoes using a microtoise with an accuracy of 0.1 cm. Body weight and height data were used to calculate the BMI-based nutritional status using the following formula: weight (kg)/[height (m)]^2 (Gibson, 2005).

SGA nutritional assessments: Assessments were carried out by surveying medical records to confirm a diagnosis of disease and by interviewing the patients directly using a SGA form. Data taken from the SGA from were as follows: weight loss in the previous 6 months and the prior 2 weeks; food intake; gastrointestinal symptoms; functional capacity; physical examination data in the form of loss of subcutaneous fat, muscle mass loss, edema and ascites and anthropometric measurements. The percentage of weight loss was calculated using the following formula: (normal weight-current weight) x 100%/normal weight.

Scoring of malnutrition: Assessments of the malnutrition risk were conducted using SNST by directly interviewing samples and filling out a SNST form. Samples were categorized as 'not at risk of malnutrition' if the score was 0-2 or 'at risk of malnutrition' if the score was >2. SNST consisted of six questions that represented four nutritional components. Score were indicative of patients current condition, which described whether or not a patient looked thin or not, exhibited weight loss, had reduced food intake, or presented a variable history of the disease, as formulated by Rasmussen *et al.* (2010) study conducted in Denmark (Susetyowati, 2014).

Statistical analysis: Data were processed and analyzed using software. Descriptive data analysis was carried out to assess patient characteristics, the proportion of screening and nutritional assessments. The χ^2 test was to evaluate the relationship between patient characteristics and the findings of BMI nutritional status assessments. Additionally, the χ^2 test was performed to test for associations between nutritional screening, SNST nutritional assessments and SGA nutritional assessments with BMI nutritional status assessments. Assessments of nutritional screening validity for SNST and SGA and assessments of BMI were performed using 2 x 2 calculation tables. T-test was used to determine the average BMI per sample in each category of SNST and SGA. ROC curve analysis was conducted to determine the AUC. A performance nutritional screening method was determined based on the value of the AUC and MSSS.

RESULTS

A total of 153 subjects with an average age of 56±7.13 years were enrolled (38-68). Most subjects were adults (60.8%), female (57.5%), had a low educational level (58.2%), were unemployed (50.3%), had diabetes for an average duration of 6±6.08 years (0.08 to 32), suffered from diabetes $\geq$5 years (50.3%) and exhibited disease complications (63.4%; Table 1). Most study subjects in the malnutrition and good nutritional status groups were adult (18-59 years old), female, had a low educational level or never had any formal education (i.e., graduated from elementary school or more commonly junior high school [SMP] and suffered from complications. In the characteristic of type the occupation and the long-suffering DM. There were differences between malnutrition status group and good nutritional status. On the malnutrition status group, patients were mostly working and have been long-suffering short DM (<5 years) while in good nutritional status group; patients were mostly not working and have been long-suffering long term DM (>5 years).

For the detection of risk of malnutrition, SNST (22.9%) detected more cases than did SGA (21.6%; Table 2).

Subjects at risk of malnutrition based on SNST had a lower mean BMI (20.84±2.71 kg/m^2) than based on SGA (21.11±2.76 kg/m^2). Subjects who were not at risk of malnutrition based on SNST had higher mean BMI (23.05±1.67 kg/m^2) compared with patients with a good nutritional status based on SGA (22.94±1.78 kg/m^2).

There was a association between nutrition assessments based on SNST and nutritional status based on BMI. Based on the OR, subjects who were at risk of malnutrition based on screening SNST were found to have a 34.67% chance to have malnutrition status based on BMI. There was a relationship between nutritional assessments based on SGA and nutritional status based on BMI. Based on the OR, we recognized that subjects with an SGA-based malnutrition status had 15.885-fold increased chance of having a BMI-based malnutrition status (Table 3).

Validity of the simple nutritional screening tool (SNST): The SNST had a greater MSSS value (170.14%) compared with SGA (159.72%). The SNST also had higher positive predictive value (22.86%) and lower negative predictive value (99.15%) compared with SGA (Table 4).

The SNST exhibited a greater AUC value (0.851) than SGA (0.799). Finally, the SNST could describe the BMI of 85.1% of individuals, while the SGA could describe the BMI of 79.9% of cases (Table 4).

DISCUSSION

This study assessed the validity of nutritional screening SNST versus SGA compared with BMI assessments for type 2 diabetic patients. Previous studies have been conducted in hospitalized adult patients by Andini (2014) and Susetyowati *et al.* (2014) as well as in elderly hospitalized patients by Mayasari *et al.* (2014).

SGA is a nutritional assessment method that can describe changes in nutritional status, including subjective assessments based on medical history and general physical examinations (Gibson, 2005). SGA could identify malnutrition and had a high correlation with nutritional status based on BMI (Moriana *et al.*, 2014). This was in accord with our present result, which indicated that SGA had a significant association with nutritional status based on BMI. However, SGA required skilled health officers to carry out anthropometric measurements and mathematical calculations and also required a considerable time to complete (15 min), so that it was difficult to use in hospitals in Indonesia (Susetyowati, 2014).

Table 1: Associations of patient characteristics with nutrition status assessment BMI

	BMI					
	Malnutrition (n = 9)		Good nutrition (n = 144)		Total (n = 153)	
Characteristic	n	%	n	%	n	%
Age						
Adult	6	6.5	87	93.5	93	100
Elderly	3	5.0	57	95.0	60	100
Gender						
Male	4	6.2	61	93.8	65	100
Female	5	5.7	83	94.3	88	100
Education						
High	3	4.7	61	95.3	64	100
Low	6	6.7	83	93.3	89	100
Employment						
Working	5	6.6	71	93.4	76	100
Jobless	4	5.2	73	94.8	77	100
Period in suffering DM						
Short	5	6.6	71	93.4	76	100
Long	4	5.2	73	94.8	77	100
Disease complication						
None	2	3.6	54	96.4	56	100
With complication	7	7.2	90	92.8	97	100

Sources: Primary data

Table 2: Screening nutrition results: SNST, SGA and BMI Assessments

SNST, SGA and BMI results	n	%
SNST		
Not at malnutrition risk	118	77.1
At malnutrition risk	35	22.9
SGA		
Good nutrition status	120	78.4
Malnutrition status	33	21.6
BMI		
Good nutrition status	144	94.1
Malnutrition status	9	5.9

Sources: Primary data

The Simple Nutrition Screening Tool (SNST) is a nutritional screening tool that is simple and easy to use. It involved a direct interview of a patient using 6 questions without requiring nutritional calculations. It only required 3-5 min to complete, so it could feasibly to be applied in hospitals in Indonesia (Susetyowati, 2014). Subjects at risk of malnutrition based on SNST had a lower average BMI than subjects who had malnutrition based on SGA. SNST also revealed a significant association with nutritional status based on BMI. When considering an ideal screening tool, ease and accuracy in assessments of nutritional status should be favored (Young *et al.*, 2013).

Subjects at risk of malnutrition based on SNST had a lower average BMI than did subjects who were at risk based on SGA (20.84 vs. 21.11 kg/m^2). This finding indicated that the value of the average BMI of patients at risk of malnutrition and under nutrition-based SNST and SGA criteria was less than 22 (Campillo *et al.*, 2006).

Body Mass Index (BMI) is an anthropometric measurement that has been used to monitor imbalances between energy and protein intake and can be divided into two categories, “less” for BMI <18.5 kg/m^2 and “good” for BMI $\geq$18.5 and <25 kg/m^2 (Depkes, 2003). BMI was used as a measurement standard in this present study because its measurement was simple, safe, could be used in a large number of subjects, cheap, portable, precise, accurate, able to detect a past history of nutrition, could to evaluate changes in nutritional status over certain periods and could be used for nutrition screening in vulnerable groups. However, BMI had several weaknesses that could make this method difficult to perform in a hospital or other health care facilities that had the following conditions: BMI measurements could only be carried on subject that could stand upright, so it could not be performed on all patients in the hospital; it required mathematical calculations and it was insensitive to changes in nutritional status within a short time, including changes in body composition, biochemical changes, changes in energy expenditure and changes the function of body systems (Gibson, 2005; Hartono, 2006; Platek *et al.*, 2011).

Patients who are at risk of malnutrition, which initially can be caused by insufficient nutrition, did not reveal any changes in patient anthropometry measurements, so this risk could not be detected using BMI. In chronic malnutrition, tissue stores of energy would be used to meet the energy insufficiency. There would be a further reduction of tissue characterized by weight loss if nutrient insufficiency occurred for a long period of time. At this stage, it could only be detected using BMI by analyzing changes in a patient’s nutritional status (Gibson, 2005).

This present study showed that the nutritional status of patients who were malnourished based on BMI would indicate that they were at risk of malnutrition based on

Table 3: Associations between SNST and SGA and measurements of BMI

	BMI							
	Malnutrition (n = 9)		Good nutrition (n = 144)		Total (n = 153)			
SNST and SGA result	n	%	n	%	n	%	OR (95% CI)	p-value
SNST								
At malnutrition risk	8	22.8	27	77.2	35	100	34.67 (4.16-288.97)	<0.001
Not at malnutrition risk	1	0.8	117	99.2	118	100	Ref	
SGA								
Malnutrition	7	21.2	26	78.8	33	100	15.89 (3.119-80.897)	<0.001
Good Nutrition	2	1.67	118	98.3	120	100	Ref	

Sources: Primary data

Table 4: Comparative validation of nutrition screening SNST and SGA results with BMI assessments

	Analysis result								
SNST and SGA result	Sensitifity (%)	Specificity (%)	MSSS (%)	Value of positive prediction (%)	Value of negative production (%)	Visible positive (%)	Visible negative (%)	AUC value	p-value (95% CI)
SNST	88.89	81.25	170.14	22.86	99.15	77.14	0.85	0.851	<0.001 (0.725-0.976)
SGA	77.78	81.94	159.72	21.21	98.33	78.79	1.67	0.799	0.003 (0.637-0.960)

Sources: Primary data

SNST. This condition could be caused by hyperglycemia and would impair B and T cell functions, which increased the risk of infection in patients with diabetes mellitus (Atreja and Kalra, 2015; Knapp, 2013; Casqueiro *et al*., 2012). Infectious conditions could increase the risk of reduced appetite (Solmi *et al*., 2015), which could increase the risk of weight loss and malnutrition when not handled properly. Nutritional screening was a rapid and simple process to identify whether there was a risk of malnutrition in each new patient (Susetyowati, 2014).

This study showed that the validity of SNST was better than SGA (sensitivity: 88.89% vs. 77.78%; specificity: 81.25% vs. 81.94%; MSSS: 170.14% vs. 159.72%; value of positive prediction: 22.86% vs. 21.21%; value of negative prediction: 99.15% vs. 98.33% and AUC: 0.851 vs. 0.799) on assessments of BMI in type 2 diabetic patients. A screening tool needs to have a sensitivity of at least 60% and a specificity of at least 70% (Budiarto, 2012). Screening tools that have high sensitivity values could identify people who might suffer from malnutrition status based on BMI. Therefore, the implementation of optimal nutrition could occur earlier to avoid disease complications (Depkes, 2013).

The sum of sensitivity and specificity or MSSS value should be considered when choosing an assessment tool (Sastroasmoro and Ismael, 2011). This present study indicated that SNST would be better than SGA for BMI assessments in type 2 diabetic patients.

The SNST AUC 0.851 (85.1%) indicated that SNST could classify subjects who were at malnutrition risk in a population using BMI assessment in type 2 diabetic patients (Hajian-Tilaki, 2013).

From our analysis of the sensitivity, specificity, MSSS and AUC described above, it could be concluded that SNST was superior to SGA in BMI assessments, so SNST was established to have a better ability than SGA to predict the risk of malnutrition based on BMI in type 2 diabetic patients.

Research limitations:

1: It was difficult to test the reliability of the instrument using test-retest reliability to implement data collection at the outpatient unit because of the limited period of data collection
2: The gold standard BMI (Depkes, 2003) used the BMI Category that categorized BMI without age classification (BMI/U), which differed from the BMI category "WHO BMI Category"

Conclusions and recommendations: Values indicating the validity (sensitivity, specificity, MSSS and AUC) of SNST were better than SGA for BMI assessments of type 2 diabetic patients. SNST may be used as a screening tool in type 2 diabetic patients.

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