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Simple Nutritional Screening Tool (SNST) Has Good Validity to Identify Risk of Malnutrition on Hospitalized Elderly Patients

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Abstract: High prevalence of malnutrition related to adverse outcomes in elderly patients. A simple and inexpensive nutritional screening tool is required to detect malnutrition on the elderly in order to give a suitable intervention as early as possible. Mini Nutritional Assessment-Short Form (MNA-SF) is a screening tool developed specifically for elderly patient, however, it still requires anthropometric measurement and mathematic calculation. The new nutritional screening tool, SNST is a very easy, inexpensive and does not require mathematical calculation and anthropometric measurement. However, the validity of SNST to identify elderly patients who are at risk from malnutrition has not been tested yet. The aim of this study was to analyze the validity screening tool SNST compared with MNA-SF against anthropometry and biochemical of elderly patients in Dr. Sardjito Hospital. A cross sectional study was conducted to 268 elderly who were inpatient in RS Sardjito to test the validity of SNST compared with MNA-SF. Patients with mental disorders and oedema or ascites were excluded. BMI and MUAC data were obtained from direct measurements, whereas biochemical data such as albumin, haemoglobin and TLC obtained from patient's medical record. SNST screening tool had sensitivity 88.3%, specificity 95.2%, positive predictive value 98.4%, negative predictive value 77.1% and area under ROC curve 0.918. SNST was also as good as MNA-SF in distinguishing elderly patients at risk and not at risk of malnutrition. Subjects who were at risk for malnutrition according SNST screening tool had significantly lower values of BMI, MUAC, albumin, hemoglobin and TLC than subjects who were not at risk for malnutrition ($p<0.001$). SNST screening tool has good validity to identify risk of malnutrition on hospitalized elderly patients.

Key words: Malnutrition, nutritional screening tool, SNST, MNA-SF, anthropometry, biochemical

INTRODUCTION

The successful development of a nation indicated by several indicators, one of them is an increase in life expectancy. This brings some consequences, one of them is the changing structure of the population that makes the number and proportion of elderly population are increasing (Komisi Nasional Lanjut Usia, 2010). Based on data from the Population Census in 2010 showed that the number of elderly population in Indonesia increased by approximately 7.93% from 14.44 million in the year 2000 to 18.57 million in 2010 (BPS, 2010).

On the other hand, the increasing number of elderly population brings along various problems related to physical and physiological impairment of the elderly. This becomes a challenge to be resolved as the elderly susceptible to various health problems including protein energy malnutrition (Skates and Anthony, 2012).

Prevalence of malnutrition on admission to hospital is still quite high ranging from 20-60% (Correia and Campos, 2003; Imoberdorf *et al*., 2010; Kaiser *et al*., 2010). Malnutrition in elderly patients is common and can be associated with adverse clinical outcomes such as increased mortality, morbidity, length of hospital stay, cost, poor wound healing and decreased quality of life (Correia and Waitzberg, 2003; Stratton *et al*., 2006; Cereda *et al*., 2011; Flanagan *et al*., 2012).

A simple and inexpensive nutritional screening tool is required to identify malnutrition on elderly so that a suitable intervention can be given as early as possible to improve outcome and hospital resources utilization (Smith *et al*., 2009).

Based on systematic review on 83 studies which compared 32 screening tools showed that none of single screening tool or assessment instrument is capable of consistently assessing risk of malnutrition and predicting adverse nutrition related outcome. It still requires more study to assess different screening tool in different populations (Schueren *et al*., 2013).

Mini nutritional assessment (MNA) is a valid screening tool recommended by international organization ESPEN for the elderly in hospitals and community. The modified version of MNA-SF with calf circumference substituting BMI is a form of MNA that is easier and faster to be used

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for nutritional screening in the elderly (Kaiser *et al*., 2009; Skates and Anthony, 2012).

MNA-SF is a good substitute for the full MNA in the older hospitalized population (Schueren *et al*., 2013). However, MNA-SF still needs mathematical calculation and accurate anthropometric measurement by skilled personnel where not all hospitals such as in Indonesia and many other countries have sufficient anthropometry tools and dietitians. In addition it is difficult to perform anthropometric measurements in elderly patients related to acute condition when admitted to the hospital and changes in body structure and mobility problems due to aging process (Cape *et al*., 2007).

The new nutritional screening tool, SNST, which was developed to identify malnutrition risk in adult patients, is a very easy, inexpensive and does not require mathematical calculation and anthropometric measurement (Susetyowati *et al*., 2014). However, the validity of SNST to identify elderly patients who are at risk from malnutrition has not been tested yet.

The aims of this study were: to analyze the validity of SNST compared with MNA-SF on hospitalized elderly patients; to evaluate their comparison to objective nutritional assessment; to compare BMI, MUAC, albumin, hemoglobin and TLC values between elderly patients who are at risk and not at risk of malnutrition according to SNST.

MATERIALS AND METHODS

Participants and study design: A cross-sectional study was carried out at Dr. Sardjito Hospital from February to May 2014. The minimal sample size needed was 188 patients. The Patients were eligible for study inclusion if aged 60 years or older, compos mentis, able to communicate, willing to participate in the study and inpatient in five medical wards (i.e., surgery, ophthalmology, internal medicine, neurology and otolaryngology), identified by searching on the hospital information system. Exclusion criteria were patients with mental disorders and suffering from oedema or ascites. Approvals for the study were given by Medical and Health Research Ethics Committee Faculty of Medicine Gadjah Mada University-DR. Sardjito General Hospital.

Data collection: Nutritional screening and assessment were carried out within 48 h of admission. Nutritional screening and assessment for 1 patients obtained by a single investigator (dietitian). Independent variables were nutritional screening SNST and MNA-SF. Both screening tools were used to classify patient's malnutrition risk. Dependent variables were nutritional assessment i.e., anthropometry (BMI and MUAC) and biochemical parameters (albumin, haemoglobin and TLC).

Nutritional assessment: The anthropometric measurements were Body Mass Index (BMI) and Mid Upper Arm Circumference (MUAC). Anthropometry data were obtained from direct measurements, whereas biochemical data such as albumin, haemoglobin and total lymphocyte count obtained from patient's medical record.

Body weight and height of the patients were obtained to calculate BMI using the formula:

$$BMI = \text{weight (kg)}/\text{height}^2 \text{ (m)}$$

where, (Gibson, 2005). Patients were weighed in light clothing using a calibrated digital weight scales. Body weight was recorded to the nearest 0.1 kg. Meanwhile, patients' estimated height were obtained by knee height measurement using a sliding knee height caliper. Knee height was recorded to the nearest 0.1 cm with twice measurement in immediate succession and should agree within 0.5 cm. The average of these two measurements then used to calculate height by applying the formula (Cape *et al*., 2007):

$$\text{Height (male)} = (2.08 \times \text{knee height}) + 59.01$$

$$\text{Height (female)} = (1.91 \times \text{knee height}) - (0.17 \times \text{age}) + 75$$

where, Mid upper arm circumference was recorded to the nearest 0.1 cm. The MUAC was measured using flexible non stretch tape on non-dominant arm, the elbow at a right angle with the palm up. MUAC measurement is taken at the marked midpoint between the acromial surface of the scapula and the olecranon process of the elbow on the back of the arm (Gibson, 2005).

Malnutrition scores: Participants were categorized as being no risk of malnutrition if scored 0-2 and at risk of malnutrition if scored 2 or greater using SNST. The SNST comprises six questions i.e., does the patient look thin; does your clothes feel looser; have you recently lost weight unintentionally (6 months); have your food intake decreased during the first weeks; do you feel weak, sluggish and lethargic; do you suffer from a disease that results in a change in the amount or type of food you eat (Susetyowati *et al*., 2014).

Mini Nutritional Assessment-Short Form (MNA-SF) classifies elderly people as well nourished if the score is 12-14 points, at risk if the score 8-11 points and malnourished if score 0-7 points. The MNA-SF consists of 6 questions i.e., has food intake declined over the past three months due to loss of appetite, digestive problems, chewing or swallowing difficulties; involuntary weight loss during the last 3 months; mobility; has the patient suffered psychological stress or acute disease in the past three months; neuropsychological problems; BMI or if the BMI cannot be obtained, substitute calf circumference (Kaiser *et al*., 2009). In this study, MNA-SF score was grouped into 2 categories, 0-11 points in risk of malnutrition and 12-14 points in normal nutritional status.

Statistical analysis: Statistical analysis was performed using STATA 12. A contingency table was used to analyze the validity screening tool NST-UGM compared with MNA-SF. T-test was performed to compare mean result for BMI, MUAC, albumin, haemoglobin and TLC amongst participants who were at risk of malnutrition and who were not. Mann-whitney test was undertaken if data not normally distributed.

RESULTS

Total subjects were 268 patients with a median of age 68 years (60-96). There were 160 male and 108 female. Majority of subjects were admitted to the surgery ward (43.28%) with primary cause of admission to hospital was malignancy (25%). Educational background of the subjects were mostly elementary school (39.18%) as shown in Table 1.

SNST scores classified 69.03% of the subjects as being at risk of malnutrition while MNA-SF scores classified 76.87% of the subjects as being at risk of malnutrition and 41.42% malnutrition as shown in Table 1.

Validity of SNST: The validity is the ability of a screening test to accurately detect diseased and non-disease individuals (Kanchanaraksa, 2008). SNST validity test was compared with a gold standard. In this study, MNA-SF is the gold standard. A 2 x 2 table was used to compare the performance of the new test as shown in Table 2.

The 2 x 2 table shows the evaluation results of a screening test that was conducted in 268 subjects. The gold standard indicated that 206 patients were at risk of malnutrition and the other 62 subjects were not at risk of malnutrition. If we focus on the rows, we find that 185 subjects had a positive screening disease, i.e., the test results were abnormal and suggested at risk of malnutrition. However, only 182 of patients were found to be at risk of malnutrition, based on the gold standard test (true positive).

Also noted that 83 people had a negative screening test, suggesting that they were not at risk of malnutrition, but, in fact only 59 of those people were actually not at risk of malnutrition (true negative). The analysis shows that SNST had sensitivity at 88.3%, specificity at 95.2%, PPV at 98.4%, NPV at 71.1% and AUC at 0.918.

Comparison between SNST and MNA-SF against objective nutrition assessments: Comparison (T-test or Mann-Whitney test) of risk categories for both SNST and MNA-SF with anthropometry and biochemical parameters shown in Table 3 indicated that there were significant differences between the categories.

Subjects who were at risk for malnutrition according to SNST as well as MNA-SF had significantly lower values of IMT, LILA, albumin, hemoglobin and TLC than subjects who were not at risk for malnutrition (p-value<0.05).

Table 1: Patients characteristics

Variable	N	Percentage
Sex		
Male	160	59.7
Female	108	40.3
Age	*66	(66-96)
SNST		
Not at risk for malnutrition	83	30.97
At risk for malnutrition	185	69.03
MNA-SF		
Normal nutritional status	62	23.13
At risk for malnutrition	95	35.45
Malnutrition	111	41.42
Educational background		
No school	55	20.52
Elementary school	105	39.18
Junior high school	40	14.93
Senior high school	48	17.91
University	20	7.46
Ward		
Internal medicine	72	26.87
Surgery	116	43.28
Others	80	29.85
Primary cause of admission to hospital		
Infectious/ inflammatory	12	4.48
Cardiac disease	30	11.19
Cerebrovascular disease	10	3.73
Fall (including fracture)	25	9.33
Malignancy	67	25.00
Tumor	36	13.43
Eye disease	33	12.31
Others	55	20.52

Table 2: Cross-classification of malnutrition risk according to SNST and MNA-SF

	---------- MNA-SF ----------		
SNST	At risk	Normal	Row total
At risk	182	3	185
Not at risk	24	59	83
Column total	206	62	268

DISCUSSION

This is the first study to test validity of SNST compare with the MNA-SF in the over 60 age group. MNA-SF is a screening tool which comprises 6 questions including medical history, dietary history and anthropometric measurements.

Mini Nutritional Assessment (MNA) is a nutrition screening tool that has been recommended by international organizations ESPEN because this tool is very specific, reliable and has been validated as a screening tool to identify risk of malnutrition on the elderly, in the community and hospital. The newest version of MNA is MNA-SF version 3 which is a good substitute for the full MNA in the older hospitalized population (Skates and Anthony, 2012). But this screening tool is still using the anthropometric measurement and mathematical calculation which difficult to be applied in several hospital related to limited anthropometry tool and skilled personnel.

The result of this study shows that SNST had good validity (sensitivity at 88.3%, specificity at 95.2%, PPV at

Table 3: Comparability of SNST and MNA-SF and their relation to other nutritional assessments

Screening tool	Category	BMI (kg/m^2) n=204	MUAC (cm) n = 268	Alb (g/dL) n = 214	Hb (g/L) n = 264	TLC (cell/mm) n = 262
SNST	At risk	18.57 ± 3.13	23.95 (15.5 - 42.45)	3.56 (2.11 - 4.79	11.6 (3.8 - 20.8)	1456.54 ± 683.50
	Not at risk	23.10 ± 3.20	28 (21.9 - 35.5)	3.63 (2.11 - 4.79)	12.8 (3.2 - 17.5)	1861.61 ± 722.29
	p-value	< 0.001*	< 0.001**	<0.001**	<0.001**	<0.001*
MNA-SF	At risk	18.61 ± 3.00	24 (15.5 - 42.45)	4.12 (2.51 - 4.81)	11.7 (3.2 - 20.8)	1472.05 ± 694.95
	Normal	24.21 ± 2.61	28.63 (24 - 35.5)	4.24 (2.61 - 4.81)	13.2 (4.6 - 17.5)	1943.28 ± 683.46
	p-value	< 0.001*	<0.001**	<0.001**	<0.001**	<0.001*

Alb: albumin, Hb: hemoglobin. *t-test, data were presented as mean±SD, p-value<0.05. ** Mann-whitney test, data were presented as median (min-max), p-value<0.05

98.4%, NPV at 71.1% and AUC at 0.918) in identifying risk of malnutrition on hospitalized elderly patients. A good screening tool should has at least 80% of sensitivity and specificity to demonstrate the usefulness of screening tool (Azad *et al*., 1999). High sensitivity enable further diagnose to be done thus suitable clinical interventions can be given. On the other hand, high specificity can reduce possibility of providing further interventions for patients who do not need it, as such can minimize the cost (Shahar and Hussain, 2007).

SNST screening tool had AUC at 0.918 (91.8%). The value of AUC>0.9 shows incredible discriminating power (Jones, 2004). Nutritional screening using SNST requires only a short time, less than 5 min. SNST is also valid, not invasive and does not require anthropometric measurement. The weakness of the elderly in memorizing is not a problem if the family or care giver knows well the daily conditions of the elderly.

There are four types of measurements to assess nutritional status (Soeters *et al*., 2008) i.e., measurement of nutrient balance (dietary history, energy expenditure, nitrogen balance, etc), measurement of body composition or anthropometry (BMI, MAMC, MUAC, BIA, etc), measurement of inflammatory activity (albumin levels, Hb, CRP, etc) and measurements of function (muscle function, immune function and cognitive function).

Based on SNST, the mean of BMI of subjects who were at risk of malnutrition was 18.57 kg/m^2 and those who were not at risk of malnutrition was 23.10 kg/m^2 whereas, based on MNA-SF, the mean of those who were at risk of malnutrition was 18.61 kg/m^2 and those who were not was 24.21 kg/m^2. The study on 1052 patients when admitted to hospital showed that BMI <20 kg/m^2 had a high sensitivity of detecting severe malnutrition in the elderly (Campillo *et al*., 2004).

This is also in accordance to WHO guidelines, including risk of malnutrition if BMI at 18.5-20 kg/m^2 and in normal nutrition status if BMI>20 kg/m^2 (Slee *et al*., 2014). Measurement of height and weight is difficult to perform in patients newly admitted to hospital due to patients' acute conditions (Tuck and Hennesy, 2003). It is even more difficult in the elderly due to changes in the structure of the body due to aging process and majority of them have mobility problems (Hickson and Frost, 2003; Cape *et al*., 2007).

Subjects at risk of malnutrition had median value of MUAC 23.86 cm and subjects not at risk of malnutrition 28.17 cm. Meanwhile, based on MNA SF, the result of MUAC at 24 cm was found from subject who were at risk of malnutrition and those who were not at risk had MUAC at 28,3 cm. The value of MUAC less than 22 cm in women and less than 23 cm in men indicates loss of peripheral muscle mass (Ferro-Luzzi and James, 1996). Another study have shown that the value of MUAC 24 cm is simple and efficient cut off point to determine lack of chronic energy and mortality (Chakraborty *et al*., 2009).

Subjects who were at risk of malnutrition had lower median of albumin than not at risk of malnutrition, based on SNST ans MNA-SF. This is in accordance with the previous studies (Skates and Anthony, 2012; Rasheed and Woods, 2013; Sungurtekin *et al*., 2004; Kuzuya *et al*., 2005).

Albumin is a negative acute-phase reactant. Decreased plasma albumin levels and other negative acute phase protein that occurs during the acute phase are due to the down-regulation of gene expression and translation, increased catabolism, transport to the extravascular, decreased synthesis by inducing anorexia (Mahan and Escott-Stump, 2004; Fuhrman *et al*., 2004).

Based on SNST, the median of haemoglobin in patients at risk of malnutritions was lower than in patients that was not at risk based on SNST and MNA-SF. The results of this study are consistent with studies that have been done previously (Donini *et al*., 2013; Susetyowati *et al*., 2014).

In the elderly, the prevalence and incidence of anemia have risen sharply with the increase of age. National Congress of FADOI in 2012 showed that besides the increase level of anemia, lean body mass also decreases as the age increases. Therefore, it is proposed that anemia can be a sign of protein deficiency and should be considered when evaluating nutritional status of institutionalized elderly patients (Rondoni *et al*., 2013).

Subjects who were not at risk of malnutrition than subjects who were not at risk based on SNST had lower TLC i.e., 1.456, 54 cell/mm and 1.861,61 cell/mm, respectively. While based on MNA-SF reveals TLC in two groups was at 1472, 05 cell/ mm and 1943,28 cell/ mm, respectively. The value of TLC less than 1.500 cell/ mm indicates the presence of malnutrition (Gibson, 2005; Cereda *et al*., 2008). It is not clear that TLC decline as a consequence from acute stress or a part of progressive depletion in body nutrition stores. It is hypothesized that the process of illness may accelerate stress that can increase steroid level then lead to lymphopenia (Cereda *et al*., 2008).

Conclusion and recommendation: SNST is a nutritional screening tool having good validity value to identify risk of malnutrition on elderly patients with sensitivity of 88.3%, specificity 95.2%, PPV 98.4%, NPV 71.1% and AUC 0.918. SNST is also as good as MNA-SF in distinguishing elderly patients who are at risk and not at risk of malnutrition. The results of BMI, MUAC, albumin, haemoglobin and TLC in elderly patients at risk of malnutrition according to SNST are lower than those not at risk. Therefore, SNST may be considered as a nutritional screening tool for elderly patients. However, the use of nutritional screening SNST in elderly patients should be carried out along with families/care giver who know best their daily conditions.

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