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Research Article
Association of Malnutrition Screening Tools with Nutritional Assessment Parameters in Hospitalized Adult Patients

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Abstract

Background and Objective: The prevalence of malnutrition among hospitalized patients is quite high; therefore, the risk formal nutrition needs to be identified early. The objectives of this study were to determine the prevalence of malnutrition and to investigate the relationship between nutritional screening tools and nutritional status parameters. **Materials and Methods:** This study is an observational study with a cross-sectional design conducted in Waluyo Jati Regional Hospital Probolinggo, Indonesia. The subjects were 211 adult patients who were screened by the nutrition risk screening (NRS) 2002, simple nutrition screening tool (SNST)and malnutrition screening tool (MST) within 24 h of admission. Simple assessment tools, including body mass index (BMI), mid-upper arm circumference (MUAC), total body fat percentage of skeletal muscle, hemoglobin levels and TLC, were used to evaluate nutritional status. Differences in the mean nutritional assessment values between individuals at-risk and not at-risk of malnutrition were analyzed by t-tests. The relationships between the nutritional screening and nutritional assessment values were analyzed using chi-squared tests. **Results:** The results showed that 54.5% of the patients were at risk of malnutrition based on the NRS 2002 and SNST risk scores, while the MST showed that half of these patients were at risk (29.9%). A total of 47.4, 49.8, 70,6 and 62.6% of the patients were malnourished based on the BMI, MUAC, hemoglobin and TLC measures, respectively. The patients who were at risk of malnutrition had a lower average value of these nutritional parameters than did those not at risk. There were significant associations between all nutrition screening tools and all the nutritional status parameters ($p<0,05$), except for the TLC. **Conclusion:** The risk of malnutrition among hospitalized patients was high. The NRS 2002, SNST and MST have a strong correlation with the nutritional screening tools, indicating that lower nutrition screening values correspond to lower nutritional assessment values.

Key words: Hospitalized patient, Indonesian adults, malnutrition, nutritional assessment, nutritional screening

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Malnutrition is one of the issues of concern in both developed and developing countries. Malnutrition may be a problem that is largely unrecognized in hospitalized patients. Several studies have shown that the prevalence of malnutrition among hospitalized patients worldwide is quite high and it is estimated to be approximately 27-50%[1-3]. A study conducted in287 adult patients in Dr. Sardjito General Hospital in Indonesia reported that as many as 34.3% of the patients had malnutrition based on the Subjective Global Assessment (SGA) (categories B and C) when admitted to the hospital[4].

Malnutrition can be defined as a multifactorial syndrome that refers to the complex role between deficiency in dietary intake, increased requirements associated with disease-related metabolic alterations and reduced availability of nutrients due to processes such as poor absorption and excessive nutrient losses[5]. As a consequence, many adverse clinical outcomes may occur due to malnutrition, including impaired wound healing[6], a longer length of stay during hospitalization[7,8] and increased rates of hospital readmission, morbidity and mortality[5,7,9,10]. Hence, the risk of malnutrition should be identified early through nutritional screening.

Identifying malnutrition among hospitalized patients is important before implementing nutritional interventions. Nutrition screening refers to a quick and simple process to predict malnutrition risk for patients within the 24 first hours ofadmission[11,12]. Many screening tools have been developed in recent years to screen patients at risk of malnutrition. Each tool uses several indices that are associated with the characteristics of malnutrition, such as weight loss, body mass index (BMI) and appetite changes[13]. Some screening tools are valid for hospital settings and have been analyzed by several studies, such as the Nutrition Risk Screening (NRS) 2002 (ESPEN) and Malnutrition Screening Tool (MST)[14-16].

Currently, most people in Indonesia are rarely weighed regularly, so their weight history is unknown[4]. In addition, there is no nutrition screening tool that is considered the most appropriate and acceptable because some of them require mathematical calculations and can only be administered by skilled healthcare professionals[4]. Therefore, a new screening tool named the simple nutrition screening tool (SNST) has been developed; it consists of six questions and has been proven to be suitable in identifying patients at risk of malnutrition[4]. The validity of the SNST was compared with that of the Subjective Global Assessment (SGA), which was used as the gold standard (sensitivity 91.28%; specificity 79.8%). The SNST also has good reliability among dietitians (kappa 0.803), dietitians and nurses (kappa 0.653) and food service officers (kappa 0.718)[4].

Nutrition assessments are comprehensive nutritional evaluations that must be performed after nutrition screenings to determine the severity of malnutrition and its causes. Many types of nutrition assessments have been used to assess nutritional status, such as anthropometry assessments, functional tests, laboratory parameter assessments and dietary intake assessments. Additionally, nutritional assessments can be useful in evaluating nutritional status and identifying hospitalized patients at risk of malnutrition in the early stages of the disease.

This study aimed to (1) Determine the prevalence of malnutrition determined by nutrition screenings and assessments among hospitalized patients and (2) Investigate the relationship between nutritional screening tools and nutritional assessment parameters.

MATERIALS AND METHODS

Study design: This study was an observational study with a cross-sectional design. Approval for the study was provided by the Ethics Committee of The Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada Yogyakarta, Indonesia (KE/0261/03/2019).

Study population: The study included adult patients who were admitted to Waluyo Jati Hospital, Probolinggo from April to June 2019 and evaluated within the first 24 h of admission. The patients were eligible for study inclusion if they were compos mentis, able to communicate, willing to participate in the study and were inpatients in the internal medicine, nerve, or surgical ward. The exclusion criteria were patients who were pregnant or in the postpartum period and patients with ascites/edema conditions. The minimal sample size needed was 211 patients. All participants provided informed consent before enrolling in the study.

Data collection: Nutritional screenings and assessments were performed on all patients within 24 h of admission. The Nutritional Risk Screening (NRS) 2002 consisted of a nutritional score based on weight loss, food intake, body mass index, disease severity and an age adjustment for patients aged >70 years old. The Malnutrition Screening Tool (MST) consisted of questions about unintentional weight loss in the last six months and a decrease in food intake over a week. The Simple Nutrition Screening Tools (SNST) is a simple nutrition screening tool with six questions that do not require

anthropometric measurements and can be conducted in a short period of time for each patient[8]. The SNST questions were as follows: (1) Does the patient look thin? (2) Do your clothes feel looser? (3) Have you recently lost weight unintentionally (in the past 6 months)? (4) Have you decreased food intake during the past weeks? (5) Do you feel weak, sluggish and not powerful? (6) Do you suffer from a disease that results in a change in the amount or type of food you eat?[4]. Patients who were at risk of malnutrition were identified using the cut-off value for each nutrition screening tool: NRS 2002 ≥3; MST ≥2; SNST ≥3. Patients were classified as either at-risk or not at risk of malnutrition[17].

The anthropometric measurements were body mass index, percentage of body fat, skeletal muscle and mid-upper arm circumference (MUAC). Anthropometry data were obtained from direct measurements by using bioelectrical impedance analysis (BIA) . The body weight and height of the patients were obtained to calculate BMI (score of the body weight divided by the body height in meters squared). In this study, we used the cut-off values for body mass index (BMI) in adults according to the WHO criteria to generate eight categories[18]. A BMI <18.5 kg m^{-2} indicated underweight and undernutrition was be further subdivided into severity categories of <16 kg m^{-2} (severe malnutrition), 16-16.99 kg m^{-2} (moderate malnutrition) and 17-18.49 kg m^{-2} (mild malnutrition). The normal cut-off BMI ranged from 18-24.9 kg m^{-2}. Overweight was defined as having a BMI of 25-29.99 kg m^{-2} and the degree of obesity was defined as class I (BMI 30-24.99 kg m^{-2}), class II (BMI 35-39.99 kg m^{-2}) or class III (BMI ≥40 kg m^{-2})[18]. The normal range of the total body fat percentage and skeletal muscle were evaluated according to the instruction manual leaflet from the BIA tool. The normal range for the total body fat percentage was less than 25% in males and was less than 30% in females. The normal range for skeletal muscle ranged from 33-40% in males and from 24-30% in females. The normal ranges for both total body fat and skeletal muscle were classified by age. The mid-upper arm circumference (MUAC) was measured by using *metline* at the middle of the arm's length. When the measurement of MUA was <23.5 cm, the patient was categorized as malnourished[19].

Biochemical data, such as hemoglobin (Hb) levels and total lymphocyte count (TLC), were obtained from the patient's medical record. The value for TLC, which was less than 1500 cell/mm^3, indicated malnutrition for both genders[20]. The hemoglobin level was compared with the reference value for males (13 g dL^{-1}) and females (12 g dL^{-1})[21].

Data analysis: The characteristics and nutritional status of the patients are represented by descriptive statistics, such as frequencies and means±standard deviations. Differences in mean BMI, total body fat, skeletal muscle, hemoglobin levels and TLC between individuals at-risk and not at-risk of malnutrition were analyzed by independent samples t-tests. The relationships between the nutritional screening measures and nutritional assessment scores was analyzed using chi-squared tests. The level of significance was set at $p<0.05$.

RESULTS

In this study, we included 211 patients (107 males and 104 females), predominantly aged between41 and60 (60.2%), with an average age of 45±11.8. Half of the patients were diagnosed with a noninfectious disease (65.4%). The characteristics of the patients are presented in Table 1.

Upon admission, 54.5% of the patients were found to be at risk of malnutrition based on the NRS 2002 and SNST screening tools. The MST indicated that only 29.9% of the patients were at risk of malnutrition. The nutrition screening tools identified patients with nutritional risk differently and the results are presented in Fig. 1. Table 2 shows the characteristics of the patients based on the nutritional assessments. The results showed that 47.4% of the patients had a normal body mass index and 49.8% were malnourished by the MUAC measurement. The body composition measurements revealed that 45.5% of the patients had a normal total body fat percentage and that 92.4% of the patients had a low skeletal muscle percentage. The biochemical data showed that 70.6% of the patients had anemia and that almost half of the patients had normal total lymphocyte counts.

The associations between the nutrition screening tool subscales of the NRS 2002, SNST and MST with nutritional parameters such as age, BMI, MUAC, total body fat, skeletal muscle, hemoglobin (Hb) level and TLC are shown in Table 3. There were significant associations between all nutrition screening tool scores and all nutritional status parameters ($p<0,05$), except for skeletal muscle and TLC. Table 3 also shows that patients who were at risk of malnutrition had a

Table 1: Characteristic of participants (n = 211)

Characteristics	No.	Percentage	Mean±SD
Sex			
Males	107	50.7	
Females	104	49.3	
Age (years)			45±11.8
18-40 years	84	30.3	
41-60 years	127	60.2	
61-80 years	20	9.5	
Disease			
Infectious	73	34.6	
Non-infectious	138	65.4	

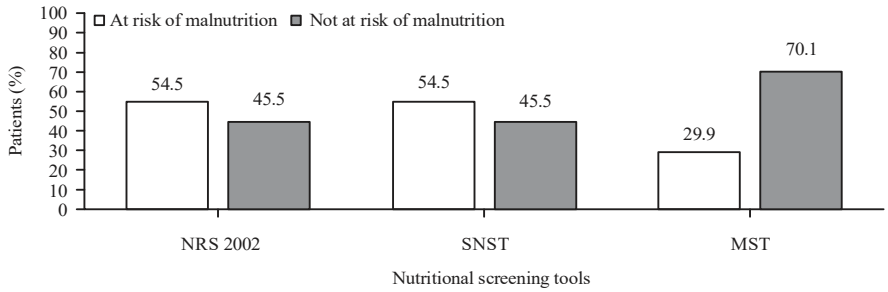

Fig. 1: Prevalence of risk of malnutrition based on different nutritional screening tool

Table 2: Prevalence of nutritional status based on nutritional assessment

Nutritional assessment	No.	Percentage	Mean±SD
Body mass index (kg m^{-2})			23.1±3.99
<16 (severe malnutrition)	3	1.4	
16-16.99 (moderate malnutrition)	4	1.9	
17-18.49 (mild malnutrition)	22	10.4	
18.5-24.99 (normal)	100	47.4	
25-29.99 (overweight)	77	36.5	
30-34.99 (obesity level 1)	5	2.4	
>35 (obesity level 2)	-	-	
Mid-Upper arm circumference (cm)			24.8±2.27
Well-malnourished	105	49.8	
Malnourished	106	50.2	
Total body fat (%)			23.2±5.74
Less	74	35.1	
Normal	96	45.5	
Over	41	19.4	
Skeletal muscle (%)			25.1±5.16
Less	195	92.4	
Normal	12	5.7	
Over	4	1.9	
Hemoglobin (g dL^{-1})			11.6±2.07
Low	149	70.6	
Normal	62	29.4	
Total lymphocyte count (cell/mm^3)			1,952±0.89
>1500 (normal)	132	62.6	
1200-1500 (mild malnutrition)	34	16.1	
800-1200 (moderate malnutrition)	40	19.0	
<800 (severe malnutrition)	5	2.4	

Table 3: Association between nutrition screening parameter by NRS 2002, SNST and MST with anthropometric and biochemical measurement

	NRS 2002		SNST		MST	
Nutritional parameters	At risk (n = 155)	Not at risk (n = 96)	At risk (n = 155)	Not at risk (n = 96)	At risk (n = 63)	Not at risk (n = 148)
Age (years)	47.0±10.63*	42.0±12.61*	47.0±10.17*	43.0±12.10*	46.0±10.23	45.0±12.38
BMI (kg m^{-2})	20.6±2.98*	26.1±2.47*	20.7±3.27*	25.9±2.46*	19.7±2.34*	24.6±3.49*
MUAC (cm)	23.6±2.11*	26.2±1.51*	23.7±2.36*	26.1±1.30*	22.9±1.89*	25.7±1.90*
Total body fat (%)	19.9±4.92*	27.2±3.78*	20.0±5.02*	27.0±3.84*	18.2±4.49*	25.3±4.85*
Skeletal muscle (%)	24.6±5.24	25.8±5.00	24.7±5.22	25.6±5.05	25.1±5.53	25.1±5.00
Hemoglobin (g dL^{-1})	10.9±2.15*	12.4±1.63*	10.9±2.18*	12.5±1.56*	10.6±2.47*	12.1±1.69*
TLC (cell/mm^3)	1843.0±0.99*	2083.0±0.73*	1833.0±0.98*	2092.0±0.74*	1763.0±0.86*	2033.0±0.89*

*p<0,05. BMI: Body mass index, MUAC: Mid upper arm circumference, TLC: Total lymphocyte count

lower average value for the objective parameters (BMI, MUAC, total body fat, skeletal muscle, hemoglobin level and TLC) than did patients not at risk of malnutrition. The average age of the patients who were at risk of malnutrition was higher than that of the patients who were not at risk of malnutrition.

DISCUSSION

The risk of malnutrition among hospitalized patients may arise from prior hospitalization due to illness or inadequate intake[8]. Hence, nutritional screening is an essential first step of

the nutrition care process during admission. Some nutrition screening tools have been developed and recommended for identifying the risk of malnutrition in hospitalized patients. These tools are the Nutrition Risk Screening (NRS) 2002, Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessment (MNA), Short Nutritional Assessment Questionnaire (SNAQ), Malnutrition Screening Tool (MST) and the Subjective Global Assessment (SGA)[8]. The NRS 2002 is a good nutrition screening tool with a grade of I; moreover, the MST is a fair nutritional screening tool with a grade of II[8,22,23]. Both of these screening tools have good validity, are simple and quick and have been combined with disease aspects, nutritional status and age[4].

Our study discovered that the prevalence of malnutrition among hospitalized patients at the time of admission ranged from 30-55%. This range is slightly higher than that of other studies, which is 27-50%[1-3,23] . The first step of the nutrition care process (NCP) is nutrition screening and it played an important role in detecting the presence of and the risk of malnutrition before the nutritional interventions were implemented[23]. Good screening tools with high clinical outcome predictive validity are positively correlated with clinical outcomes[23].

Currently, many screening tools have been developed to identify the most appropriate, valid, simple and reliable tool for screening patients at risk of malnutrition. Both the NRS 2002 and the MST have been recommended as nutritional screening tools for hospital settings because they have been analyzed in several studies and are widely used worldwide[14,15,24,25]. Even though the SNST is a newly developed nutritional screening tool, it had higher results in predicting patients at risk of malnutrition among hospitalized patients than did other international screening tools. A previous study showed that the SNST had higher validity (sensitivity 99%; specificity 84,5%; area under curve ROC 0,917) compared with the NRS 2002, MST and MUST in 287 hospitalized patients[11]. The SNST has also shown higher validity in identifying the risk of malnutrition in elderly patients and hemodialysis patients compared with existing nutritional screening tools[26,27].

Nutritional assessments are important clinical tools for determining the nutritional status of patients and the cause of malnutrition. The objective assessment of status requires objective data from various analyses, such as those from anthropometry measurements, bioimpedance analyses (BIAs), laboratory tests and functional tests[28].

From our study on newly admitted patients, we found that half of the patients were well nourished according to anthropometry measurements, such as BMI, MUAC and total body fat. Body mass index (BMI) is an important basic anthropometry parameter used to express nutritional status[29]. Anthropometric measurements of circumference such as the mid-upper arm circumference represent measurements of muscle tissue[29,30]. Although, these measurements seem to be relatively easy to perform, considerable skill is required to obtain reliable results and the results may also be inaccurate for patients with specific clinical conditions and elderly people[29].

In addition to anthropometry assessments, body composition assessments are also important for assessing nutritional status and under standing the changes that occur in body size, shape and composition due to clinical conditions. Recently, changes in body composition have been shown to occur independent of changes in body weight or BMI, so the measurement of body composition is fundamental for an evaluation of nutritional status[29]. In our study, we found that half of the patients with noninfectious diseases had a normal total body fat percentage. Furthermore, some previous studies demonstrated that total body fat percentage is associated with noncommunicable disease risk, such as diabetes mellitus, cardiovascular disease, hypertension, stroke and other metabolic syndrome[30-32].

Malnutrition is not only characterized by protein or energy depletion from inadequate food nutrient intake and disease-related malnutrition but also particularly in combination with physical in activity, which may accelerate the progression of sarcopenia[33]. In our study, we found that most patients had a lower percentage of skeletal muscle (92.4%). When a patient has sarcopenia, a decrease in the percentage of skeletal muscle may occur due to sarcopenia[34]. These results indicate that malnutrition can lead to a negative skeletal muscle protein balance following muscle loss[33].

The prevalence of anemia among hospitalized patients has been reported in several studies[8,11,25,35-38]. From our study, we also discovered that 70.6% of hospitalized patients had anemia. Several chronic diseases, such as infectious and inflammatory diseases, cancers and kidney dysfunction, can cause anemia[36]. The high prevalence of anemia in individuals with a chronic disease may be due to disease pathophysiology, inflammation, malnutrition and socioeconomic conditions of the patients[36]. Blood hemoglobin levels or other biochemical test results were found to be useful biochemical indicators of malnutrition, even in the presence of chronic inflammation[35,39]. Malnutrition maybe related to a decrease in immune function. Among all of the markers, TLC is more useful for evaluating immune competence in clinical practice[27]. In our study, we found that 62.6% of our patients had a normal total lymphocyte count (TLC) but a previous study found that patients who were at-risk of malnutrition and

screened with the NRS 2002 had a lower mean and median TLC than patients who were not at risk of malnutrition did[39,40].

Our study showed that there were significant associations between all nutrition screening tools and all nutritional assessments (p<0,05), except for between all the nutrition screening tools and TLC. The analysis showed that the patients who were at risk of malnutrition had a lower average score on the nutritional assessments than did the patients who were not at risk of malnutrition. Nutrition screening tools should be quicker than the assessments in determining the risk of malnutrition and nutritional assessments must cover variables that will not only lead to a nutritional status diagnosis but also lead to adequate follow-up nutrition therapy for patients[28]. Hence, both nutritional screening tools and assessments are two approaches that are essential in the nutrition care process. Most nutritional assessment tools have weaknesses; therefore, a combination of various parameters should be applied. All healthcare professionals need to understand the features of each method so that they can determine a favorable nutrition intervention for patients.

Malnutrition among hospitalized patients of ten involves a combination of cachexia (disease-related) and malnutrition (inadequate consumption of nutrients) rather than malnutrition alone[5]. Disease-associated malnutrition is caused in part by disease-activated biochemical and physiologic mechanisms, including systemic inflammatory responses that affect the individual's appetite and body composition and the ability of the metabolic system to metabolize energy and nutrients[41]. Appetite and food intake are also frequently affected by disease and objective measurements of daily energy and protein intake are two of the most useful parameters in assessing malnutrition[41,42]. We also examined whether nutritional assessments played the most important role in determining the nutritional status of hospitalized patients. Measurements of not only body size and shape through anthropometry but also of body composition and laboratory data were used to establish the diagnosis of malnutrition.

In our study, we aimed to present the prevalence of malnutrition among hospitalized patients. Our study has some limitations that should also be acknowledged. First, nutritional status was only evaluated within the 24 h of admission and the patients who had been previously hospitalized were not included in this study; therefore, the malnutrition rate reported in this study may not represent that of all hospitalized patients. Second, some factors that were not measured may be influenced by the presence of malnutrition. This study can be beneficial for health professionals to control the prevalence of malnutrition among hospitalized patients by implementing nutrition interventions. This study will help researchers understand the critical aspects of hospital-related malnutrition through nutritional screening tools and assessments that many researchers have not been able to explore. Thus, the theory of hospital-related malnutrition may be developed. Among all the existing nutrition screening tools, the SNST showed good performance in detecting the risk of malnutrition in newly admitted hospitalized patients.

CONCLUSION AND RECOMMENDATION

In conclusion, the prevalence of malnutrition was quite high among hospitalized patients based on nutritional screening tools and assessments. All of the nutrition screening tools were appropriate for predicting malnutrition among hospitalized patients in Indonesia. Our study suggests that nutritional status must be determined immediately after admission to a hospital so that malnutrition can be diagnosed early, appropriate nutritional interventions can be provided and better health outcomes can be achieved.

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