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VALIDITY OF THE NUTRITIONAL RISK INDEX AS AN INDICATOR OF MALNUTRITION IN HOSPITALIZED PATIENTS

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ABSTRACT

Malnutrition is commonly seen in hospitals and is associated with increased morbidity and mortality. Objective was to validate the use of the Nutritional Risk Index (NRI) in combination with different methods of nutritional assessment in the identification of malnutrition in hospitalized patients. Cross-sectional study. The diagnosis of malnutrition was obtained from the NRI, anthropometric variables and the Subjective Global Assessment (SGA). To evaluate the efficacy of the methods in the detection of malnutrition compared to SGA, a ROC curve was constructed and its area (AUROC) estimated. The agreement between the NRI and the SGA was verified by the kappa coefficient. We evaluated 100 patients, with a mean age of 53.20 ± 14.80 years. Malnutrition was identified in 68 patients by the SGA and 63 by the NRI. Significant correlations were observed between the NRI and most of the analyzed anthropometric variables and serum albumin. Sensitivity and positive values were 77.0% and 78.0%, respectively, with an area under the ROC curve of 0.74. The NRI was able to identify patients at nutritional risk when compared to the SGA and anthropometric variables, supporting its use as a complementary tool in the evaluation of nutritional status in hospitalized patients.

INTRODUCTION

Malnutrition in hospitalized patients has been identified as a public health problem in several countries, regardless of their level of development (Waitzberg *et al.*, 2001; Correia *et al.*, 2016). Latin America has a higher diagnosis of malnutrition in inpatients than Asia, Europe, North America and Australia, with a rate of 50.2% found in more than 9,000 hospitalizations (Correia *et al.*, 2016; Oliveira and Fortes, 2015). In Brazil, malnutrition affects approximately 20% to 50% of patients, as shown by the 2001 Brazilian Nutrition Assessment Survey (IBRANUTRI) in which 48.1% of hospitalized patients were diagnosed with malnutrition (1).

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In a study carried out in a teaching hospital in Greater Vitória, 23.3% of hospitalized patients were classified as malnourished by the Subjective Global Assessment (SGA) (Calazans *et al.*, 2015). Malnutrition in a hospitalized patient interferes with processes such as healing, increases the incidence of infections and postoperative complications, and contributes to the increase in hospital costs as a consequence of the longer hospital stay, besides causing other complications that adversely affect the patient (Duarte *et al.*, 2016). Because of these factors, and the observation that malnutrition does not only affect patients with low weight, nutritional assessment of the hospitalized patient is essential for the early detection of malnutrition and assessment of its severity, in addition to identifying individuals at risk of developing complications arising from nutritional deficiencies and providing the opportunity to institute early individualized nutritional therapy (Kyle *et al.*, 2004).

The SGA, a subjective method of assessing nutritional status, is considered as a gold standard in the hospital setting as it includes clinical aspects and physical examinations (Prasad *et al*. 2016). Additional objective measurements, such as anthropometric variables and biochemical tests, complement the evaluation, although in some conditions they are insufficient. However, there is still no consensus on an single method that is more appropriate for assessing nutritional status, especially in hospitalized patients, since there are physical and metabolic changes caused by the associated disease. Thus, several methods were compared in order to develop a unique tool that combines different instruments and that is sensitive and specific to classifying nutritional status, which has not yet been possible (Ryu and Kim, 2010). The Nutritional Risk Index (NRI) has been tested as an instrument to evaluate nutritional status, based on anthropometric and biochemical parameters. The NRI was originally designed for the nutritional evaluation of surgical patients and has been used to identify the risk of postoperative complications and mortality (Thieme *et al*. 2013; Oluwayemisi *et al*. 2015).However, its use has been extended to other populations, such as inpatients (Galvan *et al*. 2004), and oncological (Faramarzi *et al*. 2013; Prado and Campos, 2015) and renal patients (Prasad *et al*. 2016), with the objective of validating it for the identification of nutritional status in a wider population. The nutritional status from this method is defined based on an equation that uses information on serum albumin concentration and the percentage of weight adequacy (Prasad *et al*. 2016). In view of the above, our hypothesis is that NRI is an efficient method of assessing nutritional status in hospitalized patients with different clinical conditions, making nutritional diagnosis simple and efficient. This study aimed to validate the use of the NRI in the diagnosis of malnutrition in hospitalized patients.

METHODS

STUDY DESIGN

This is a cross-sectional descriptive study, using convenience sampling, performed at a General and Reparatory Surgery and Medical Clinic Unit, from July 2014 to September 2016, at a teaching hospital in Greater Vitória-ES / Brazil. Adult (20 to 59.9 years) and elderly (≥ 60 years)patients were evaluated independently of their diagnosis. They had all received an evaluation of their nutritional status in the first 48 hours of hospital admission and had had a biochemical evaluation and confirmed clinical diagnosis. The exclusion criteria were: being nursed in isolation pregnant, or candidates for bariatric surgery. The respondents were informed about the aims of the research and signed an informed consent form. Clinical, biochemical and sociodemographic data were collected according to the information available in the medical records, followed by an anthropometric evaluation at the bedside and administration of the SGA questionnaire. The diagnosis of malnutrition obtained from the NRI was compared to the results obtained from the SGA, anthropometric variables and serum albumin level. This study is part of the project entitled "Malnutrition and associated factors in a university hospital of Greater Vitória-ES", approved by the Ethics and Research Committee of the Federal University of Espirito Santo, under the number CAAE 27954014.0.0000.5060.

NUTRITION ASSESSMENT

The anthropometric evaluation was performed by previously trained evaluators and consisted of body weight in kilograms, height, arm circumference (AC) and calf circumference (CC) in centimeters, triceps skinfold (TSF) in millimeters, thickness of the adductor pollicis muscle (TAPM) as well as the patient's own report on his or her habitual weight, in kilograms. To measure the weight, a portable digital scale Techine® Mod. BAL-180 BR with 100gr of graduation and maximum of 180kg was used. The height was measured by means of a Personal Caprice Sanny® Estadiometer with a maximum height of 210cm. The circumference measurements were performed with a tape measure of non-elastic material and length of up to 150cm. For TSF and TAPM measurements, a Cescorf® Traditional Scientific Adipometer with a precision and sensitivity of 0.1mm and reading width of 85mm was used. All measures were performed as recommended by Lohman *et al*.

Subsequently, the arm muscle circumference (ACM) in centimeters and corrected arm muscle area (CAMA) in square centimeters, were determined. For the classification of ACM and CAMA, the percentile values proposed by Frisancho, 1990 were used to evaluate the adequacy percentage. The SGA was used as the gold standard for the diagnosis of nutritional status. The SGA includes aspects of the clinical history, such as weight changes, changes in food intake, presence of gastrointestinal symptoms, changes in functional capacity, physical examination, loss of subcutaneous fat and muscle mass, presence of sacral and ankle edema, and ascites. The results are expressed in three categories: well-nourished patients (SGA "A"), suspected / moderate malnutrition ("B" SGA) or severely malnourished ("C" SGA) (Detsky *et al*. 1987). For the calculation of the NRI, serum albumin values were used, together with the values of the current weight adequacy percentage in relation to the usual weight using the equation, NRI = [1,519 × serum albumin (g / l)] + 0.417 × current / usual weight × 100). From the score obtained in the equation, patients were classified as having no risk (> 100), mild risk (100 - 97.5), moderate risk (97.5 - 83.5 -) and severe risk (<83.5) (The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991).

STATISTICAL ANALYSIS

Means and standard deviations were used to describe the continuous variables and percentages for the categorical variables. The Kolmogorov-Smirnov test was used to verify the normality of the quantitative variables. For the analysis of data, the categories of NRI were grouped into: no risk (> 100), mild / moderate risk (100-83.5) and severe risk (<83.5). To compare the means according to the SGA categories, we used the ANOVA parametric test, with the Tukey post hoc and the non-parametric Kruskal Wallis tests. The post hoc test was performed comparing the categories of each nutritional status. Values accompanied by different letters on the same line differed significantly ($p \leq 0.05$). The presence of correlations between the variables was analyzed using Pearson or Spearman correlations, according to the normality of the data. The correlation coefficients may vary from -1 to +1 and be categorized as weak ($r < 0.3$), moderate ($r = 0.3-0.7$) or strong ($r > 0.7$) (Willet, 1998). The kappa coefficient was calculated to verify agreement between the nutritional diagnosis obtained by NRI when compared to SGA. The categories proposed by Landis; Koch, 1977, according to the degree of agreement found, are as follows: <0 without agreement; 0 - 0.19 poor agreement; 0.20 - 0.39 sufficient agreement; 0.40-0.59 moderate agreement; 0.60-0.79, substantial agreement, and between 0.80-1.00 excellent agreement. For the concordance analysis, the categories of moderate and severe malnutrition of the SGA and NRI were grouped using only the 'malnutrition' and 'well-nourished' classifications. The ROC curve and its area (AUROC) were constructed to evaluate the efficacy of the different methods in the evaluation of the nutritional state, using the SGA as the standard reference. The data were analyzed using SPSS 21.0 software. The significance level of 5.0% was adopted for all tests.

RESULTS

We evaluated 100 patients. Of these, 70 (70.0%) were adults, mean age 53.20 ± 14.80 years.There was a homogeneous distribution of gender, with 50 (50.0%) male patients and 50 (50.0%) female patients. Regarding the clinical diagnosis, the neoplasias were highlighted, which affected 67 (67.0%) of the patients. Regarding the classification of nutritional status according to the SGA, 35 (35.0%) patients were well nourished, 31 (31.0%) moderately malnourished and 34 (34.0%) were severely malnourished. When using NRI as a reference, 37 (37.0%) patients were well nourished, 51 (51.0%) had mild or moderate malnutrition and 12 (12.0%) had severe malnutrition (Table 1).

Table 1. Sample distribution according to socio-demographic variables, clinical and state nutritional diagnosis

Variable	n = 100
Age (Mean+SD)	53.20 ± 14.80
Gender	n (%)
Male	50 (50.0)
Female	50 (50.0)
Stage of life	
Adult	70 (70.0)
Elderly	30 (30.0)
Clinical diagnosis	
Cancer	67 (67.0)
Hepatobiliary diseases	16 (16.0)
Gastrointestinal tract diseases	09 (9.0)
Others*	08 (8.0)
Subjective Global Assessment	
Well nourished (A)	35 (35.0)
Suspected/moderate malnutrition (B)	31 (31.0)
Severely malnourished (C)	34 (34.0)
Nutritional Risk Index	
No risk	37 (37.0)
Mild/moderate risk	51 (51.0)
Severe risk	12 (12.0)

SD: standard-deviation; *Cardiovascular surgery, myasthenia, Consumptive syndrome, unilateral inguinal hernia and pulmonary lobectomy

Table 2 presents the comparison of the means between the anthropometric variables, according to the SGA categories. Significant differences were observed in the variables BMI (p <0.001), AC (p = 0.001), CC (p = 0.016), TSF (p = 0.001) and NRI (p <0.001). In the variables, BMI, AC and CC, differences were found among the well-nourished and severely malnourished categories. Regarding TSF, differences were observed between the well-nourished category and those moderately and severely malnourished. Regarding the NRI, differences were found between the severely malnourished category and well-nourished and moderately malnourished categories. Correlations between the NRI, anthropometric variables and serum albumin levels are described in Table 3. Significant and weak correlations were observed between the NRI and TSF (p = 0.030) and TAPM (p = 0.027), and moderate and significant correlations between the NRI and BMI (P <0.001), AC (p <0.001), CC (p <0.001), ACM (p <0.001) and CAMA (p <0.001), and a strong and significant correlation with serum albumin (p <0.001).

Table 2. Nutritional indicators according to the nutritional status defined by the Subjective Global Assessment

	Subjective Global Assessment			
Variable (n=100)	Well nourished A	Suspected/ moderate malnutrition B	Severely malnourished C	p-value
	35 (35.0%)	31 (31.0%)	34 (34.0%)	
BMI	25.24 ± 4.51[a]	23.24 ± 4.19[a,b]	21.14 ± 3.75[b]	<0.001*
AC	28.95 ± 4.11[a]	27.53 ± 4.37[a,b]	25.06 ± 4.14[b]	0.001*
CC	34.85 ± 4.17[a]	35.57 ± 4.40[a,b]	31.55 ± 4.51[b]	0.016**
TSF	17.50 ± 8.18[a]	12.94 ± 6.31[b]	11.18 ± 5.30[b,c]	0.001*
AMC	23.45 ± 3.52	23.46 ± 3.83	21.55 ± 3.75	0.056*
CAMA	36.00 ± 10.80	35.97 ± 14.38	29.96 ± 11.80	0.074*
TAPM	14.52 ± 4.30	15.19 ± 4.50	13.51 ± 4.75	0.326*
Albumin	3.66 ± 0.66	3.66 ± 0.44	3.57 ± 0.50	0.758*
NRI	99.69 ± 9.92[a]	96.66 ± 7.27[a]	89.99 ± 8.90[b]	<0.001*

*Analysis of Variance (ANOVA), complemented by the Tukey test; **Kruskal Wallis Test. BMI: Body Mass Index (kg/m^2); AC: Arm circumference (cm); CC: Calf Circumference (cm); TSF: Triceps Skinfold (mm); AMC: Arm Muscle Circumference (cm); CAMA: Corrected Arm Muscle Area (cm^2);TAPM: thickness of the adductor pollicis muscle (mm)

Table 3. Correlation between nutritional risk index, anthropometric variables and serum albumin

Variable	r	
(n=100)		p-value
BMI	0.325[a]	0.001**
AC	0.481[a]	<0.001**
CC	0.354[b]	<0.001**
TSF	0.218[a]	0.030*
TAPM	0.221[a]	0.027*
AMC	0.440[a]	<0.001**
CAMA	0.423[a]	<0.001**
Albumin	0.867[a]	<0.001**

[a]Pearson correlation coefficient.; [b]Spearman's correlation coefficient; *p<0,05; **p<0,01; BMI: Body Mass Index (kg/m2); AC: Arm circumference (cm); CC: Calf Circumference (cm); TSF: Triceps Skinfold (mm); TAPM: thickness of the adductor pollicis muscle (mm); AMC: Arm Muscle Circumference (cm); CAMA: Corrected Arm Muscle Area (cm^2).

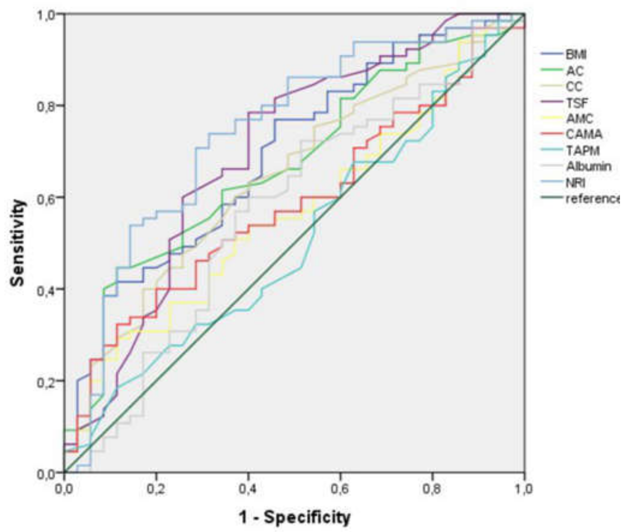
The ability of NRI as a tool to classify nutritional status is shown in Table 4. Of the total, 21/100 (21.0%) were correctly classified as well nourished by NRI (true negative), 50/100 (50.0%) were correctly classified as malnourished (true positive), 15/100 (15.0%) were classified as false negative and 14/100 (14.0%) were erroneously classified as malnourished (false positive). The NRI exhibited a high sensitivity of 77.0% and specificity of 60.0%. The positive predictive value (PPV) was 78.0% and the negative predictive value (NPV) was 58.0%. The accuracy of the test was 71.0%. The agreement between the instruments presented a kappa value of 0.37 and p <0.001.

Table 4. Validity of the Nutritional Risk Index as an indicator of nutritional risk compared to the Subjective Global Assessment.

		SGA		
		Nourished	Well nourished	Total
NRI	Nourished	50 (PPV)	14 (NPV)	64
	Well nourished	15 (FN)	21 (VN)	36

Kappa value: 0.37; p<0.001; NRI: Nutritional Risk Index; SGA: Subjective Global Assessment; PPV: positive predictive value; NPV: positive predictive value; FP: false positive; FN: false negative.

The ROC curve represents the different methods of nutritional evaluation in the detection of malnutrition when compared to the SGA. The methods that were able to diagnose malnutrition were the NRI, TSF, BMI, AC and CC.



AUROC: NRI: 0.74 (<0.001); TSF: 0.70 (0.001); BMI: 0.70 (0.002); AC: 0.67 (0.005); CC: 0.64 (0.018); AMC: 0.57 (0,277); CAMA: 0.58 (0.164); TAPM: 0.50 (0.908); Albumin: 0.57 (0.242).,

Figure 1. ROC curve for the different diagnostic methods for nutritional risk

DISCUSSION

The results obtained by the present study demonstrated that the NRI was able to classify nutritional status when compared to the SGA and anthropometric variables, indicating that it may be used as a complementary tool in the evaluation of nutritional status in hospitalized patients. The NRI was able to identify a greater number of patients in the initial stages of malnutrition when compared to the SGA. This finding suggests that nutritional interventions can be instituted in an early and preventive way to improve nutritional status. The NRI, comprising a simple score, can be applied easily and quickly in the nutritional screening of hospitalized patients with greater objectivity than the SGA (Prasad *et al*. 2016). Several studies have used the NRI to investigate hospital malnutrition, obtaining positive results (Prasad *et al*. 2016; Galvan *et al*. 2004; Faramarzi *et al*. 2013).

The use of classical methods in nutritional assessment, such as anthropometry, is common in the hospital environment (Prado and Campos, 2015). The findings of this study demonstrated a positive correlation between the NRI and the anthropometric variables evaluated, corroborating its relevance in clinical practice. Albumin values also showed strong correlations with the NRI, since it also composes its equation. Albumin is considered a parameter for the diagnosis of malnutrition and prognosis of the patient because it reflects the visceral protein reserves, making possible an early nutritional intervention. However, the use of this alone can generate failures, as it is influenced by the patient's underlying disease, state of hydration and inflammation, among other factors. Moreover, due to its long half-life, it does not faithfully reflect changes in nutritional status occurring in a short period of time (Fanali *et al*. 2012; Doyle *et al*. 2000; Schiesser *et al*. 2009). The nutritional diagnostic capacity of theNRIwas confirmed in our results by its significant sensitivity level, PPV, area of the ROC curve and accuracy of the test. These results are consistent with those of the previously mentioned studies, which confirms their efficiency when used in different diseases, however low specificity and NPV should be considered (Prasad *et al*. 2016; Galvan *et al*. 2004; Faramarzi *et al*. 2013).

Although there is a predominance of positive results in relation to the NRI, a study by Almeida *et al*. 2012, found less sensitivity and specificity in surgical patients, which shows the need for criteria in the diagnosis of the nutritional status of hospitalized patients, given their clinical specificities, state of hydration, underlying disease and previous nutritional status. Among the limitations of the study was the patient's report of his or her habitual weight, which depended on the patient's ability to accurately remember. Other limitations are that only one hospital was studied, and serum albumin concentrations may have been affected by the patient's state of hydration or the presence of inflammation.

Conclusion

The NRI was able to identify nutritional risk, as demonstrated by its significant sensitivity when compared to objective and subjective methods. However, given its low specificity, it should be used as a complementary method and in a judicious way in the diagnosis of malnutrition in hospitalized patients.

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