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Original

Nutritional assessment associated with length of inpatients' hospital stay

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Abstract

Objective: **To evaluate the nutritional status of patients on hospital admission, identify the length of hospital stay and identify the parameters of nutritional assessment that are most closely related with the length of stay (LOS).**

Methods: **A cross-sectional study of 278 hospitalized patients evaluated patients' nutritional status in the 48 hours after admission and their LOS after discharge. Anthropometric and biochemical parameters, related to nutrition status were analyzed, such as: weight, height, arm circumference (AC), waist circumference (WC), triceps skinfold thickness (TST), mild arm muscle circumference (MAMC), albumin (Alb) and hemoglobin (HB). Body mass index (BMI) was used to classify the nutritional status. All the nutritional factors except type of disease, gender and age were associated with LOS. The chi-square, Student-t, Mann-Whitney, Kruskal-Wallis and binary logistic multivariate tests were used in the statistical analyses.**

Results: **The majority of patients was male (53%), elderly (56%) and had neoplasm (19.4%). Undernutrition was higher in the elderly ($p < 0.05$) and neoplasm patients ($p < 0.05$), overweight or obese patients were more likely to suffer from cardiovascular diseases ($p = 0.001$). Average LOS was 14.7 days (± 12.5), longer in neoplasm patients ($p < 0.05$) and in elderly ones ($p < 0.05$), and also was 3 times longer in males ($p < 0.0001$). Among the nutritional parameters, patients with AC under 25 cm had higher LOS ($p < 0.05$), but only in women could it be considered a marker, increasing LOS 2.8 times. BMI less than 20 kg/m² increased LOS 2.1 times, and biochemical data (Alb and HB) do not contribute. In the multivariate analyses, male gender and TST depletion were the significant factors, which together best explained the lengths of hospital stay.**

Conclusion: **LOS was associated with disease, gender, age and nutritional status. We can highlight two anthropometric analyses: first, AC can be used in women as a marker of longer LOS and second TST is the best overall predictor of longer hospital stay.**

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Key words: *Nutrition status. Undernutrition. Length of hospital stay. Inpatients.*

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EVALUACIÓN NUTRICIONAL ASOCIADA CON LA ESTANCIA HOSPITALARIA

Resumen

Objetivo: **Evaluar el estado nutricional de los pacientes ingresados en el hospital, identificar la duración de la estancia hospitalaria e identificar los parámetros de la evaluación nutricional que se relacionen más estrechamente con la duración de la estancia (DE).**

Métodos: **Se evaluó en un estudio transversal con 278 pacientes hospitalizados el estado nutricional en las 48 horas siguientes al ingreso y su DE tras el alta. Se analizaron los parámetros antropométricos y bioquímicos en relación con el estado nutricional, tales como: peso, talla, circunferencia del brazo (CB), circunferencia de la cintura (CC), el grosor del pliegue cutáneo tricipital (GPT), la circunferencia de la musculatura del brazo (CMB), la albúmina (Alb) y la hemoglobina (HB). Se empleó el índice de masa corporal (IMC) para clasificar el estado nutricional. Todos los factores nutricionales salvo el tipo de enfermedad, el sexo y la edad se relacionaron con la DE. Se utilizaron las pruebas de chi cuadrado, *t* de Student, Mann-Whitney, Kruskal-Wallis tests multivariados logísticos binarios para los análisis estadísticos.**

Resultados: **La mayoría de los pacientes eran hombres (53%), ancianos (56%) y tenían neoplasias (19,4%). La desnutrición fue mayor en los ancianos ($p < 0,05$) y en los pacientes neoplásicos ($p < 0,05$); los pacientes con sobrepeso tenían una mayor probabilidad de padecer enfermedades cardiovasculares ($p = 0,001$). La DE promedio fue de 14,7 días (± 12,5), fue superior en pacientes con neoplasias ($p < 0,05$) y en los ancianos ($p < 0,05$), y también fue 3 veces superior en los hombres ($p < 0,0001$). De entre los parámetros nutricionales, los pacientes con CB menor de 25 cm tuvieron una mayor DE ($p < 0,05$), pero sólo en las mujeres se pudo considerar como un marcador, incrementando la DE 2,8 veces. Un IMC menor de 20 kg/m² aumentaba la DE en 2,1 veces, mientras que los datos bioquímicos (Alb y HB) no contribuyeron. En los análisis multivariados, el sexo masculino y la reducción del GPT fueron factores significativos que, combinados, explicaban la duración de la estancia hospitalaria.**

Conclusión: **la DE se asoció con la enfermedad, el sexo y el estado nutricional. Podemos destacar dos análisis antropométricos: primero, la CB puede usarse en mujeres como marcador de una DE prolongada y, segundo, el GPT es el mejor predictor global de una mayor estancia hospitalaria.**

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Palabras clave: *Estado nutricional. Desnutrición. Estancia hospitalaria. Pacientes ingresados.*

Abbreviations

LOS: Length of hospital stay.
AC: Arm circumference.
WC: Waist circumference.
TST: Triceps skinfold thickness.
BMI: Body mass index.
MAMC: Mild arm muscle circumference.
HB: Hemoglobin.
Alb: Albumin.
IDF: International Diabetes Foundation.

Introduction

Undernutrition is a health problem that involves not only high cost but also high mortality. Hospitalized patients should have their nutrition status evaluated on admission, to prevent complications, reduce hospital length of stay (LOS) and costs.[1-5]

The prevalence of malnutrition varies with the type of nutritional assessment and the region. Some degree of malnutrition has been reported in 30-50% of hospitalized patients.[6-10] In Switzerland, a developed country, the prevalence of undernutrition was around 10%.[11] In that study, the authors evaluated the nutritional status through a subjective mini nutritional assessment and two objective methods, anthropometric and bioelectrical impedance analysis

In Mexico, a developing country, a study of hospital in-patients found a high percentage (21.17% were malnourished).[12] In Portugal, the undernutrition prevalence was 22%, which increased to more than 50% when the researchers changed the criteria of BMI to weight loss.[13] A recent study in Brazil found that 2.9% of adults and 36.6% of elderly were malnourished on admission.[14]

Based on this evidence, we decided to diagnose the inpatient nutritional status on admission, identify the length of hospital stay and identify the parameters of nutritional assessment that are most closely related to LOS.

Subjects and methods

Patients

This was a cross-sectional study including 278 consecutive patients admitted to a university hospital in Rio de Janeiro, Brazil, during the second half of 2009. All the patients were evaluated (nutritional assessment) in the first 48 h after admission and had their LOS recorded upon discharge. The inclusion criteria were age > 20 years; both genders, nutrition assessment within the first 48 hours after admission; and LOS recorded in the medical records of the institution. The exclusion criteria were pregnancy, nutritional assessment not performed within the first 48 hours after admission and LOS not recorded. The study was approved by the hospital's research ethics committee (Protocol 1754/08).

Nutritional status evaluation

Anthropometry

The anthropometric indicators measured were: weight (W), height (H), arm circumference (AC), triceps skinfold thickness (TST) and waist circumference (WC). Based on these data, we calculated the Body Mass Index (BMI), dividing the weight by the square of the height (kg/m^2), and Mild Arm Muscle Circumference (MAMC) using the formula: MAMC = AC−(0.314 × TST).

Weight and height were determined with a mechanical scale with a maximum capacity of 150 kg and accuracy of 0.1 kg BMI (kg/m^2) was classified according to the World Health Organization criteria (WHO)[15] for adults, as follows: BMI < 18.5 = Undernutrition; 18.5 ≤ BMI ≤ 24.9 = Normal; 25 ≤ BMI ≤ 29.9 = Overweight; BMI ≥ 30 = Obese. The BMI for elderly patients (60 years or older) was classified according to Lipschitz:[16] BMI ≤ 22 = Undernutrition; 22 < BMI < 27 = Normal; BMI ≥ 27 = Overweight and BMI ≥ 30 = Obese.

WC *was* measured on the median line between the costal border and the iliac crest at the end of exhalation. WC was transformed into dichotomous variables: higher than 94 cm for men or 80 cm for women was considered at risk and under that no risk according to IDF.[17]

The skinfold caliper (Lange), with a measurement range of 0-60 mm and accuracy of ± 1.0 mm, was used to determine TST, and a 150-cm inelastic tape measure with accuracy of 0.1 cm was used for the other measures.

AC and TST were normalized,[18] since they represent different gender and age, as: data x 100, divided by data of 50th percentile. The data were transformed into dichotomous variables: TST < 70% (severe depletion) or TST > 70% (not severe depletion)[17] and AC < 25 cm (with depletion) or AC > 25 cm (without depletion), as previously defined and used by Powell-Tuck.[19]

Biochemical tests

Blood was collected through peripheral venipuncture after at least 12-hour fasting. Albumin (Alb) and hemoglobin (HB) were evaluated using the colorimetric method. The cut-off point for Alb was 3.5 mg/dl[20] and for HB it was 11 g/dl.[21] Lower than these points were considered at nutritional risk due to visceral protein depletion and anemia, respectively.

Factors associated with LOS

Gender, disease category, age and anthropometric and biochemical indicators were associated with LOS. Type of diseases was classified into cardiovascular,

Table I
Characteristics of the population according to the variables studied

Characteristics	*n*	*Mean ± SD*
Gender: Female. Male	129/149	
Age. Years	276	54.95 ± 17.52
LOS	278	14.69 ± 12.55
BMI	278	23.72 ± 5.74
WC	230	92.26 ± 13.85
AC	255	27.15 ± 5.08
MAMC	213	21.76 ± 3.67
TST	223	15.61 ± 8.12
G	256	121.17 ± 64.0
HB	272	10.45 ± 2.82
Alb	188	3.03 ± 0.72
Disease	*n*	*%*
Cardiovascular	39	14.0
Pulmonary	32	11.5
Gastrointestinal	37	13.3
Neoplasm	54	19.4
Rheumatology	20	7.2
Infectious	30	10.8
Others	66	23.7

SD = Std. Deviation; LOS = Length of Hospital Stay (days); BMI = Body Mass Index (kg/m^2); WC = Waist Circumference (cm); AC = Arm Circumference (cm); MAMC = Mid-Arm Muscle Circumference (mm); TST = Triceps Skinfold Thickness (mm); G = Glucose; HB = Hemoglobin; Alb = Albumin.
*Values (except for gender and disease) given as mean ± SD.

pulmonary, digestive, malignant neoplasm, rheumatologic, infectious or others. Age was stratified as adult (< 60y) and elderly (≥ 60y). The anthropometrical and biochemical measures were transformed into dichotomous variables: BMI < 20 kg/m^2 (risk) and BMI > 20 kg/m^2 (no risk), AC < 25 cm (with depletion) or AC > 25 cm (without depletion); TST < 70% (severe depletion) or TST > 70% (not severe depletion); WC > 94 cm for men or 80 cm for women (risk) or less than these thresholds (no risk); Alb < 3.5 mg/dl (visceral protein depletion) or > 3.5 (normal); and HB < 11 g/dl (anemia). Also, the LOS was categorized into two groups: < 12 days (short) and ≥12 days (long).

Statistical analysis

A descriptive analysis of the patients was done, calculating mean, standard deviation and proportion of the studied variables. Dichotomous variables were expressed as percentages. The chi-square test was used to compare the proportions. The Student t-test was used to compare the continuous and parametric variables; the Mann-Whitney test was used to compare the nonparametric continuous variables between two groups; and the Kruskal-Wallis test was used for > = 3 groups. Complementary investigation was done to verify whether risk factors influenced LOS.

The power of association between the variables was calculated as relative risk (RR) with a 95% confidence interval. Dichotomous variables considered to be risk factors for longer length (undernutrition, age, gender, anthropometric variables, hypoalbuminemia, and anemia) and length of hospital stay were analyzed using a logistic regression model. The level of significance for all the statistical tests was 5% ($P < 0.05$).

Results

A total of 278 patients were studied: 46% were females (n = 129) and 53% males (n = 149); 44% adults (n = 121) and 56% elderly (n = 157). The most common causes of hospitalization were neoplasm (19.4%, n = 54) followed by cardiovascular (14%, n = 39), gastrointestinal (13.3%, n = 37), pulmonary (11.5%, n = 32), infectious (10.8%, n = 30) and rheumatic disease (7.2%, n = 20). Other causes accounted for 23.7% (n = 66) of the hospitalizations.

Regarding the variables studied in the whole population, the mean values were: age = 54.9 ± 17.9 y; BMI = 23.7 ± 5.74 kg/m^2; WC = 92.3 ± 13.9 cm; AC = 27.2 ± 5.1 cm; TST = 15.6 ± 8.2 mm; MAMC = 217.6 ± 36.7 mm; HB = 10.4 ± 2.8 mg/dl; Alb = 3.0 ± 0.72. The mean LOS was 14.7 ± 12.6 days. The number of patients, age, gender, LOS, anthropometric and laboratory indicators as well as disease frequency is shown in table I.

When the BMI was stratified for age, 38.9% of adults were normal, 38.9% overweight or obese, and 22.2% undernourished. The elderly subjects were distributed as follows: 37.8% normal, 27.7% overweight or obese, and 34.5% undernourished. The data show a significant difference between adults and elderly for nutritional state, according to BMI ($p < 0.05$). The elderly had worse nutritional status than adults.

The nutritional status classified by BMI according to type of disease is shown in table II. A greater prevalence of being overweight/obese was found among patients with cardiovascular diseases compared to other patients ($p = 0.001$) and those with neoplasm were more likely to be underweight ($p = 0.006$).

Table III shows a comparison of average LOS according to gender, age, disease BMI, AC, TST and WC. Average LOS was 14.7 days (± 12.5), longer in neoplasm patients ($p < 0.05$) and elderly ones ($p < 0.05$), and men were 3 times more likely to stay longer in hospital than women ($p < 0.0001$) (table IV). These data show gender and age contributed significantly to the difference in LOS.

Among the nutritional parameters (table IV), BMI under 20 kg/m^2 increased LOS 2.1 times, TST under 70% increased it 2 times and WC < 80/94 increased in 2.2 times. HB and Alb did not contribute to longer LOS.

Table II
Nutritional status of the population classified by body mass index according to type of disease

Disease	Underweight		Normal weight		Overweight	
	number	%	number	%	number	%
Cardiovascular	8	20.5	11	28.2	20	51.3*
Pulmonary	9	28.1	11	34.4	12	37.5
Gastrointestinal	8	21.6	15	40.5	14	37.8
Neoplasm	20	37.7*	23	43.4	10	18.9
Rheumatology	7	35.0	8	40.0	5	25.0
Infectious	10	33.3	12	40.0	8	26.7
Others	14	21.5	26	40.0	25	38.5
Total	76	27.5	106	38.4	94	34.1

*$p < 0.05$, according to the chi-square test. Nutritional status × disease.

Interestingly, the patients with AC under 25 cm had higher LOS ($p < 0.05$) (table III), but this did not contribute to longer LOS (table IV). When stratified for gender, AC could only be considered a marker in women, increasing LOS 2.8 times (table V).

Table III
Comparison of averlage LOS according to gender, age, diseases, BMI, AC and WC

Variables	Length of Hospital Stay (days)		p
	number	Mean ± SD	
Gender			
Male	129	18.36 ± 13.88	
Female	149	11.51 ± 10.31	**< 0.0001**[b]
Age			
≥ 60 y	120	16.48 ± 14.56	
< 60 y	157	13.33 ± 10.66	**< 0.05**[a]
Disease			
Cardiovascular	39	14.74 ± 14.76	
Pulmonary	32	14.56 ± 10.90	
Gastrointestinal	37	13.35 ± 14.32	
Neoplasm	54	17.30 ± 9.83	
Rheumatology	20	9.50 ± 6.83	
Infectious	30	15.10 ± 11.67	
Others	66	14.71 ± 14.33	**< 0.05**[c]
BMI (kg/m²)			
Underweight	76	17.04 ± 13.94	
Normal weight	106	14.58 ± 11.87	
Overweight	94	13.07 ± 12.01	**0.067**[c]
STS (mm)			
< 70 (risk)	79	16.39 ± 1.34	
> 70 (no risk)	143	14.76 ± 1.07	**0.133**[b]
AC (cm)			
< 25 (risk)	83	17.29 ± 13.23	
> 25 (risk)	172	14.16 ± 12.52	**< 0.05**[b]
WC (cm)			
Low risk	83	17.73 ± 14.15	**< 0.05**[b]
High risk	147	13.16 ± 11.52	

BMI = Body Mass Index (kg/m²); WC = Waist Circumference (cm); AC = Arm Circumference (cm).
[a] = Student's t-test; [b] = Mann-Whitney test; [c] = Kruskal-Wallis test.

Table IV
Prolonged hospital stay (LOS > = 12 days) and risk factors. Univariate analysis (n = 278)

Risk factor	OR	CI
Male	3.0	1.9-4.9*
Elderly	0.7	0.5-1.2
BMI < 20 kg/²	2.1	1.2-3.7*
AC < 25 cm	1.6	0.9-2.7
TST < 70%	2.0	1.2-3.5*
WC < 80/94	2.2	1.3-3.8*
HB < 11 mg/dl	0.8	0.5-1.3
Alb < 3.5 mg/dl	0.7	0.4-1.3

BMI = Body Mass Index (kg/m²); AC = Arm Circumference (cm); TST = Triceps Skinfold Thickness (mm); WC = Waist Circumference; HB = Hemoglobin; Alb = Albumin; OR = Odds Ratio; CI = Confidence Interval.
*$p < 0.05$.

We analyzed a subgroup (180) to identify the parameters associated with LOS according to binary multiple regression models. The following variables were investigated to see if they influenced LOS: gender, disease, age and anthropometric and biochemical indicators. The multiple regression models showed that male and TST depletion were the variables which together best explained the lengths of hospital stay. The other variables together had no contribution, so they were excluded from the model (table VI).

Discussion

Undernutrition has previously been associated with high rates of complications, increased LOS[14] and high hospital costs.[1,2] Its prevalence ranges from 15% to 50%[3,22,23] depending on the population studied and diagnostic criteria. Our data showed 27.5% undernutrition

Table V
Odds ratio (95% CI) length of hospital stay by gender and AC < 25 cm upon hospital admission, for woman and AC > 25, respectively

Risk factors	*LOS < 12 days*		*LOS ≥ 12 days*		*OR (95% CI)*
	n	*%*	*n*	*%*	
Men					
Adult	27	39.1	42	60.9	2.14 (1.13-4.08)*
Elderly	18	31	40	69	3.43 (1.16-7.3)*
AC < 25 cm					
Men	15	33	30	67	0.98 (0.45-2.15)
Women	15	39	23	61	2.8 (1.3-6.1)*

OR = Odds Ratio; CI = Confidence Interval.
*p < 0.05.

Table VI
Significant risk factors for hospital stay greater than 12 days. Multivariate analysis (n = 180)

Risk factor	*OR*	*CI (95%)*
Male	3.2	1.7-6.03*
TST < 70%	3.1	1.6-6.24*

TST = Triceps Skinfold Thickness; Multivariate analysis; OR = Odds Ratio; CI = Confidence Interval.
*p < 0.001.

diagnosed using BMI. Besides some limitations, BMI is still one of the most cited nutritional assessments, especially in underdeveloped countries, due to it low cost and accessibility.

Undernutrition can be over or under evaluated depending of the nutrition assessment methods used. In a multicenter trial involving 13 Latin America countries, using a subjective overall assessment, undernutrition was diagnosed in 50.2% of patients.[9] Similar results were found in a British study, reaching 60% undernutrition of hospitalized patients.[24]

A recent Multidisciplinary consensus on the approach to hospital malnutrition in Spain, conducted by García de Lorenzo et al, recommended a screening in the first 24-48 hours of hospital admission, which included at least BMI evaluation, involuntary weight changes and modifications in regular food-intake in the previous month as important criteria.[25]

Considering age, we found undernutrition in 23.2% of adult patients, which increased to 34.5% in elderly ones, demonstrating higher prevalence of undernutrition in the elderly, as previously reported.[26-27]

The high prevalence of excessive BMI (34%) in hospital patients is a reflection of the increase in obesity worldwide and should prompt health care teams to pay closer attention to this group. This higher over-nutrition prevalence was observed in our cardiovascular disease group, where 50% were affected. They have a higher metabolic risk and possibility of complications besides longer hospital stay.[27]

Other studies have found similar result as ours both for under or overnutrition.[7,29]

The most common cause of hospitalization was malignant neoplasm followed by cardiovascular and gastrointestinal disease, as found in previous studies.[26-30] As expected, we found that malignant neoplasm patients had a higher prevalence of being underweight (37.7%). Similar results have been described,[24] and in one study this figure reached 65.6%.[8] Waitzberg et al. (2001) and Planas (2004) demonstrated that oncology patients have almost a three-fold undernutrition rate as other patients.[10,31]

In our study, malignant disease worsened the nutritional state and increased the LOS. Stratton et al. found a relationship between disease-related malnutrition, increased risk of mortality and longer hospital stay.[24,28]

Biochemical parameters such as HB and Alb have been used as nutritional markers, and studies show that low levels of albumin in hospital patients is correlated with increased length of stay.[12,31] Our data show low mean values compared to the reference range, demonstrating poor nutrition status, which might be explained by chronic disease and poor diet, although it did not increase the LOS risk.

Our data show gender (male) and age (elderly) contributed significantly to increase LOS. Correia et al., in a malnutrition prevalence study in Latin America, also found a correlation between age and LOS.[9] Many studies have already shown the influence of age and gender on LOS.[23,27,29,31,34,35] We justify higher LOS prevalence and risk for malnutritionin in male due to worse self-health care and a high length to look for medical and hospital support.

An important finding of this study was longer LOS in patients with arm circumference below 25 cm. Interestingly, AC did not contribute to longer hospital stay in the overall sample, but when the data were stratified by gender, in women lower AC was a marker of greater LOS, increasing it 2.8 times. We therefore recommend the use of AC to evaluate nutritional status and predict LOS, mainly in women. It requires no calculation, reduces the risk of error compared with derived measurements like arm muscle circumference; and does not need expensive equipment or patient deambulation. Others studies have shown the advantages of using AC. According to Leandro-Merhi et al. (2010), when AC increases, LOS decreases. They also suggested that in neoplasm patients, AC is an independent risk factor to assess LOS.[14] Powell-Tuck & Hennessy (2003) reported no advantage in stratifying AC according to age and gender. They suggested using a cut-off of 25 cm.[19] None of these studies showed a gender difference as found by us.

Gender and some anthropometric parameters are good markers of increased LOS. For the first time, our study showed that being male and TST depletion were variables which together best explain the lengths of hospital stay through a binary multiple regression model. TST was the anthropometric variable that best predicted longer LOS upon admission. Nutritional assessment results, such as BMI less than 20 kg/m^2, AC < 25 and STS < 70%, can be used routinely upon hospital admission to indicate to the health care team the presence of malnutrition and thus the need for nutritional therapy. These findings also should stimulate governmental policies to improve nutrition.

Conclusions

LOS was associated with disease, gender, age and nutritional status. We can highlight two anthropometric analyses: AC can be used in women as a marker of longer LOS and TST is the best predictor for longer hospital stay.

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