Original Article

Agreement between phase angle and nutritional and biochemical markers in hospitalized patients

Concordância entre ângulo de fase e marcadores nutricionais e bioquímicos em pacientes hospitalizados

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Anny Caroliny Hora Vasconcelos[1]
Carolina Cunha de Oliveira[2]

ABSTRACT

Introduction: Malnutrition is characterized by weight loss resulting from reduced food intake or poor nutrient absorption, leading to changes in body composition. In this context, phase angle (PhA) and standardized phase angle (SPhA), obtained by electrical bioimpedance, have been proposed as noninvasive markers of nutritional and functional status. In this study, the agreement and relationship between PhA and SPhA with nutritional and biochemical markers were investigated among hospitalized patients. **Methods:** This was a cross-sectional study conducted with hospitalized patients. Clinical and nutritional data were collected through anthropometric and biochemical data collection and electrical bioimpedance. **Results:** The PhA correlated positively with the thickness of the adductor pollicis muscle, appendicular muscle mass, appendicular muscle mass index, and hematocrit. The SPhA showed a positive correlation with age and hemoglobin levels. Significant agreement was observed between PhA and body mass index and thumb adductor muscle thickness ($p<0.05$), while SPhA showed significant and moderate agreement with arm muscle circumference and appendicular muscle mass index ($p<0.05$). **Conclusion:** The PhA and SPhA showed correlation and agreement with nutritional markers in hospitalized patients. We suggest the use of the PhA or SPhA as a complementary tool in the nutritional assessment of hospitalized patients.

RESUMO

Introdução: Desnutrição é descrita por uma perda ponderal decorrente da redução da ingestão alimentar ou má absorção de nutrientes, gerando mudanças na composição corporal. Nesse contexto, o ângulo de fase (AF) e o ângulo de fase padronizado (AFP), obtidos por bioimpedância elétrica, têm sido propostos como marcadores não invasivos do estado nutricional e funcional. Dessa forma, nesse artigo foram investigadas a concordância e a relação entre o AF e AFP com marcadores nutricionais e bioquímicos em pacientes hospitalizados. **Método:** Esse foi um estudo transversal, realizado com pacientes hospitalizados. Foram coletados dados clínicos e nutricionais, através de coleta de dados antropométricos, bioquímicos e realização da bioimpedância elétrica. **Resultados:** O AF correlacionou-se positivamente com a espessura do musculo adutor do polegar, com a massa muscular apendicular, com o índice de massa muscular apendicular e com o hematócrito. O AFP apresentou correlação positiva com a idade e com os níveis de hemoglobina. Observou-se concordância significativa entre o AF e o índice de massa corporal e com a espessura do musculo adutor do polegar ($p<0,05$), enquanto que o AFP apresentou concordância significativa e moderada com a circunferência muscular do braço e com o índice de massa muscular apendicular ($p<0,05$). **Conclusão:** O AF e o AFP apresentaram correlação e concordância com marcadores nutricionais em pacientes hospitalizados. Sugere-se a utilização do AF ou AFP de forma complementar na avaliação nutricional de pacientes hospitalizados.

Keywords:
Nutritional assessment. Malnutrition. Electrical bioimpedance.

Unitermos:
Avaliação nutricional. Desnutrição. Bioimpedância elétrica.

Address for correspondence
Anny Caroliny Hora Vasconcelos
Departamento de Nutrição, Universidade Federal de Sergipe – Av. Gov. Marcelo Déda, 13 - São José, Lagarto - SE, Brazil – CEP: 49400-000
E-mail: anny07vasconcelos@gmail.com

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1. Universidade Federal de Sergipe, Lagarto, SE, Brasil.
2. Departamento de Nutrição, Universidade Federal de Sergipe, Lagarto, SE, Brasil.

INTRODUCTION

Malnutrition is described as weight loss resulting from reduced food intake or poor nutrient absorption, causing changes in body composition and affecting the individual's physical and mental state[1]. Considered a public health problem, malnutrition drastically affects an individual's nutritional status, causing biochemical and anthropometric imbalances, making early diagnosis essential for a better prognosis[2].

In this regard, the systematization of nutritional care reports the stages of nutritional care in a linear manner, standardizing and using nutritional screening as a starting point, which has several scientifically recognized tools prepared to assess the risk of malnutrition in individuals in the first 72 hours of hospitalization[3].

There are several methods for nutritional screening and diagnosis in hospitalized patients. Among them, there is the Nutritional Risk Screening 2002 (NRS-2002), the Subjective Global Assessment (SGA), the GLIM (Global Leadership Initiative on Malnutrition) consensus, and anthropometry and bioelectrical impedance analysis (BIA)[4,5]. Therefore, the diversity of methods and instruments available for assessment aims to ensure good screening, diagnosis, and efficient nutritional intervention.

In this context, BIA is an effective, relatively inexpensive, non-invasive, and quick method, universally recognized as a method for assessing an individual's nutrition and health. BIA can estimate body composition and the distribution of intracellular and extracellular fluids and can be applied to healthy individuals and those with different pathological conditions[6]. This method is based on the passage of alternating electric current and its interaction with tissues, cells, and body fluids to provide results for resistance (R), reactance (Xc), and phase angle (PhA). PhA is related to cellular health and cell membrane integrity[7].

PhA is obtained through the tangent arc ratio between R and Xc and is not yet fully understood, but it is interpreted as a nutritional indicator. Reduced values of PhA are associated with nutritional risk[8], morbidity, and mortality in renal patients[9], cancer patients[10], and patients infected with human immunodeficiency virus[11], demonstrating that it is an indicator of poor functional status as well as a prognostic indicator[12].

In addition, PhA can be standardized and adjusted for sex and age. Standardized phase angle (SPhA) allows comparison of individual values with a reference population with similar characteristics, assisting in the prediction of nutritional status and clinical outcome[13].

Considering the hospital setting and the prevalence of malnutrition in this environment, PhA and SPhA have been related to other nutritional indicators and are considered good markers for early detection of nutritional risk[14]. In this regard, a study[15] conducted with cancer patients demonstrated that low PhA values are associated with reduced arm circumference and body mass index (BMI) values, negatively impacting the length of hospital stay. On the other hand, it has also been found that serum albumin levels were positively correlated with PhA, as well as with the nutritional profile of the patients evaluated[16].

Thus, there is interest in analyzing PhA and SPhA as nutritional indicators in hospitalized patients, since the use of these indicators is not common in hospital routine. Furthermore, there are few studies evaluating these indicators in the hospital setting in Brazil. Such a study could provide evidence on the use of this tool as a nutritional and clinical prognostic indicator. Therefore, this study aimed to investigate the agreement and relationship between PhA and SPhA with nutritional and biochemical markers in hospitalized patients.

METHODS

Study design and sample

This was a cross-sectional study conducted with a convenience sample at the Lagarto University Hospital (HUL) in the municipality of Lagarto, SE, Brazil.

The inclusion criteria were individuals aged 19 years or older, of both sexes, with different clinical conditions and who met the recommendations for BIA. For individuals aged 60 years or older who were not lucid and oriented in time and space, with impaired comprehension and consent regarding their participation in the study, authorization was requested from their legal guardian.

The exclusion criteria were children, adolescents, pregnant women, individuals with ascites or visceromegaly, individuals with edema, individuals with pacemakers or any physical-postural problems that would prevent anthropometric assessment, patients who failed to access the consent form and those under palliative care.

Collection instruments and procedures

The study was conducted in two stages: 1) patient screening according to the inclusion and exclusion parameters mentioned above and 2) nutritional assessment and BIA. The study was conducted by a team consisting of nutrition undergraduates, hospital nutrition residents, and monitored by the research coordinator. A standardized and pre-coded questionnaire was used for data collection, containing clinical, health (presence of morbidities, clinical conditions, and laboratory tests), and nutritional data (nutritional risk screening, anthropometric assessment, and BIA).

Nutritional screening was performed using the NRS-2002 tool, consisting of an initial screening stage (which assesses parameters such as BMI, weight loss in the last three months, reduction in dietary intake, and the presence of a serious clinical condition) and a final stage (severity of underlying disease and degree of nutritional impairment), with an additional point added for those aged ≥70 years. The final score ranges from 0 to 7 points, and individuals were classified as being at nutritional risk when the score was ≥3 points[17].

Nutritional assessment was performed within 72 hours of admission, obtaining data on weight, height, knee height (KH), arm muscle circumference (AMC), calf circumference (CC), triceps skinfold thickness (TSFT), and thumb adductor pollicis muscle thickness (APMT). The technique proposed by Lameu et al.[18] was used to assess APMT, and the techniques proposed by Lohman et al.[19] were used for the other measurements.

A digital electronic scale with a maximum capacity of 150 kg and an accuracy of 100 g was used to collect current weight, and a portable stadiometer (Sanny®) with a surface area of 220 cm was used to measure height. Furthermore, when it was not possible to measure weight and height, these were estimated using the equations proposed by Chumlea et al.[20].

Using the weight and height data, the body mass index (BMI) was calculated and classified as proposed by the World Health Organization[21] for individuals aged 19 to 59 years and by the Pan American Health Organization[22] for people over 60 years of age.

AMC and CC were measured using a non-elastic, adjustable tape measure. The AMC was calculated using the AMC and TSFT data. After that, the AMC was adjusted to classify the percentage of measurement adequacy by comparing the result obtained in the equation for AMC with the NHANES reference values, shown in percentile tables by Frisancho[23] for adults and the elderly. Next, the percentage of AMC adequacy was classified according to Blackburn & Thornton[23], with 89.9% or less considered malnutrition.

The reference values for classifying APMT as an indicator of malnutrition were cut-off points of 9.5 mm and 8.0 mm for men and women, respectively[25].

Laboratory parameters were collected from medical records, following hospital standards, and collected within the same week as the anthropometric assessment. They were classified as reduced when: albumin <3.5 g/dl[26], creatinine <0.7 mg/dl for men and <0.6 mg/dl for women, hemoglobin <13.0 g/dl for men and <12.0 g/dl for women[27], hematocrit <40% for men and <35% for women[27].

The BIA test was performed using the Biodynamics model 310 and TBW® device, with an electrical current frequency of 50 kHz (kilohertz), resistance accuracy of 0.1%, reactance accuracy of 0.2%, and electrical current intensity of 800 μA (microamperes). To perform the test, patients were instructed according to the manufacturer's handling methodology and based on ESPEN[28].

PhA was obtained using the equation: $Xc/R \times 180°/\pi$.

SPhA was obtained using the equation: SPhA = measured PhA – average PhA (for age and sex)/standard deviation of the population for age and sex, using the reference data from Barbosa-Silva et al.[29] for the Brazilian population.

In addition, appendicular skeletal muscle mass (ASMM) was obtained from the equation proposed[27]. Classified as reduced ASMM when less than 20 kg for men and 15 kg for women, according to Studenski et al.[30]. The appendicular skeletal muscle mass index (ASMM= ASMM/height^2), as described by Gould et al.[31], was classified as reduced ASMM when <7.0 kg/m^2 for men and <5.5 kg/m^2 for women.

Ethical aspects

The study was approved by the Research Ethics Committee of the Federal University of Sergipe, Lagarto campus, under process No. 4386020, in accordance with Resolution No. 466/12 and NHC Resolution n° 510/16. Participants were informed and explained about the purposes and procedures carried out in the research, as well as the benefits and possible harms, emphasizing that individuals signed the Free and Informed Consent Form knowingly and at their first contact with the research team.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 20.0 was used for data analysis. The Kolmogorov-Smirnov test was performed to verify the normality of the variables. Descriptive analysis was performed using measures of central tendency, dispersion, and simple and relative frequency of the variables. The Student's t-test was used to compare mean PhA and SPhA between the variable classifications.

The correlation between continuous variables was assessed using Pearson's correlation test. The agreement between PhA and SPhA with other nutritional indicators for the diagnosis of malnutrition was determined by the k coefficient, according to the following interpretation: k ≤0.20 (weak agreement), 0.21≤ k ≤0.40 (moderate agreement), 0.41≤ k ≤0.60 (moderate agreement), 0.61≤ k ≤0.80 (good agreement), and k> 0.80 (very good agreement)[32]. For all tests, the level of significance adopted will be 5%.

RESULTS

The sample consisted of 52 patients. Table 1 summarizes the sociodemographic, nutritional, and morbidity profiles of the patients. There was an equal distribution between genders, and most individuals were elderly (59.6%). Regarding the causes of hospitalization, the most frequent reasons were cardiovascular disorders (22.0%), followed by pulmonary (18.0%) and gastrointestinal (16.0%) conditions.

Table 1 – Descriptive table of sociodemographic, nutritional, biochemical, and morbidity profiles of hospitalized patients.

Variables	n (%)
Sex	
Male	26 (50.0)
Female	26 (50.0)
Age group	
Adult	21 (40,4)
Older adult	31 (59,6)
Reasons for hospitalization	
Cardiovascular	11 (22.0)
Pulmonary	9 (18.0)
Gastrointestinal	8 (16.0)
Metabolic/Renal	7 (14.0)
Infectious	5 (10.0)
Neurological	4 (8.0)
Others	6 (12.0)
Nutritional and biochemical markers	
BMI: underweight	40 (76.9)
CC[a]: deficit	31 (66.0)
AMC: deficit	26 (50.0)
APMT: deficit	15 (28.8)
NRS-2002[b]: nutritional risk	16 (36.4)
ASMM: deficit	27 (51.9)
ASMM/H^2: deficit	25 (48.1)
Reduced Albumin[c]	9 (81.8)
Reduced Creatinine	5 (9.6)
Reduced Hemoglobin[d]	43 (84.3)
Reduced Hematocrit[d]	43 (84.3)

n = sample size; BMI = body mass index; CC = calf circumference; AMC = arm muscle circumference; APMT = adductor pollicis muscle thickness; NRS-2002 = Nutritional Risk Screening 2002; ASMM = appendicular skeletal muscle mass; ASMM/H^2 = appendicular skeletal muscle mass/height^2. [a]n= 44; [b]n=47; [c]n=11; [d]n=51.

Regarding the nutritional profile, a high prevalence of low weight (76.9%) was identified, as well as nutritional deficiency through the indicators CC (66.0%), AMC (50.0%), ASMM (51.9%), and ASMM/H (48.1%). In the NRS-2002 assessment, 36.4% of patients presented nutritional risk. Most patients presented reduced laboratory parameters, with 81.8% for albumin, 84.3% for hemoglobin, and 84.3% for hematocrit.

Table 2 shows the mean values and standard deviation of PhA and SPhA according to age group and nutritional marker classification. A statistically significant difference was observed in the mean PhA value between age groups, BMI classification, and APMT classification, with lower PhA values in the elderly ($p=0.001$), those with low BMI ($p=0.018$), and those with APMT deficiency ($p=0.002$). In turn, SPhA showed a statistically significant difference when compared to age group ($p=0.004$) and ASMM/H classification ($p=0.009$). No statistically significant differences were found in the other parameters evaluated.

A significant inverse correlation was observed between PhA and age ($r=-0.42$; $p=0.002$). In addition, PhA correlated positively with APMT ($r=0.39$; $p=0.005$), ASMM ($r=0.33$; $p=0.016$), ASMM/H ($r=0.31$; $p=0.025$), and hematocrit ($r=0.29$; $p=0.038$). In turn, SPhA showed a positive correlation with age ($r=0.57$; $p<0.001$) and hemoglobin levels ($r=0.29$; $p=0.039$) (Table 3).

In the analysis of agreement between the nutritional deficit diagnosis by PhA and SPhA with nutritional and biochemical markers (Table 4), significant agreement was observed between PhA and BMI ($k=0.23$; $p=0.048$), with an agreement percentage of 61.5%, as well as moderate agreement between PhA and APMT ($k=0.42$; $p=0.001$), with an agreement percentage of 61.5% ($p=0.048$). There also was a moderate agreement between PhA and APMT ($k=0.42$; $p=0.001$), with an agreement of 71.2%. On the other hand, SPhA showed significant and moderate agreement with AMC ($k=0.35$; $p=0.012$) and ASMM ($k=0.31$; $p=0.028$). There was no statistical significance in the other markers.

DISCUSSION

The results of this study demonstrated that PhA was related to nutritional and hematological markers associated with nutritional deficiency, with moderate agreement between methods. In turn, SPhA showed less efficient results.

Variations in PhA A indicate changes in body composition, cell membrane function, or health status[15]. Thus, reduced PhA values may be associated with the presence or worsening of diseases, cell death, or changes in selective membrane permeability. On the other hand, higher values may reflect a greater number of intact cell membranes, greater body cell mass and a more adequate state of health[33].

Table 2 – Mean values and standard deviation of the PhA and SPhA according to age group and classification of nutritional markers.

Variables	AF	p-value	AFP	p-value
	Mean (SD)		Mean (SD)	
Age group				
Adult	6.1 (1.3)	0.001	-2.6 (1.8)	0.004
Older adult	4.9 (0.9)		-1.3 (0.9)	
BMI classification				
Adequate	6.1 (1.1)	0.018	-1.5 (1.0)	0.366
Malnutrition	5.1 (1.3)		-1.9 (1.6)	
CC classification[a]				
Adequate	5.6 (1.3)	0.412	-1.3 (1.1)	0.137
Deficit	5.3 (1.3)		-1.9 (1.4)	
AMC				
Adequate	5.4 (1.3)	0.993	-1.3 (1.0)	0.014
Deficit	5.4 (1.2)		-2.3 (1.7)	
APMT				
Adequate	5.6 (1.4)	0.002	-1.7 (1.5)	0.450
Deficit	4.7 (0.7)		-2.1 (1.4)	
NRS-2002[b]				
No nutritional risk	5.9 (1.3)	0.080	-2.0 (1.7)	0.586
Nutritional risk	5.1 (1.3)		-1.7 (1.4)	
ASMM				
Adequate	5.6 (1.2)	0.187	-1.7 (1.2)	0.505
Deficit	5.1 (1.3)		-1.9 (1.7)	
ASMM/H^2				
Adequate	5.5 (1.3)	0.396	-1.3 (1.1)	0.009
Deficit	5.2 (1.2)		-2.4 (1.7)	
Albumin[c]				
Adequate	5.6 (0.9)	0.587	-2.6 (1.0)	0.561
Deficit	5.1 (1.5)		-1.9 (1.9)	
Creatinine				
Adequate	5.3 (1.2)	0.143	-1.8 (1.5)	0.828
Deficit	6.5 (1.5)		-1.6 (1.7)	
Hemoglobin[d]				
Adequate	5.3 (1.0)	0.754	-1.6 (1.5)	0.664
Deficit	5.4 (1.3)		-1.9 (1.5)	
Hematocrit[d]				
Adequate	5.3 (1.1)	0.665	-1.7 (1.4)	0.805
Deficit	5.4 (1.3)		-1.8 (1.5)	

SD = standard deviation; BMI = body mass index; CC = calf circumference; AMC = arm muscle circumference; APMT = adductor pollicis muscle thickness; NRS-2002 = Nutritional Risk Screening 2002; ASMM = appendicular skeletal muscle mass; ASMM/H^2 = appendicular skeletal muscle mass/height^2. [a]n= 44; [b]n=47; [c]n=11; [d]n=51.

Table 3 – Pearson' correlation between PhA and SPhA with age, nutritional and biochemical markers.

Variables	PhA	SPhA
	r (p)	r (p)
Age	-0.42 (0.002)	0.57 (<0.001)
BMI	0.11 (0.443)	0.19 (0.166)
CC	0.12 (0.425)	0.15 (0.314)
AMC	0.14 (0.307)	0.22 (0.113)
APMT	0.39 (0.005)	-0.01 (0.932)
NRS-2002	-0.28 (0.070)	-0.16 (0.285)
ASMM	0.33 (0.016)	-0.06 (0.676)
ASMM/H^2	0.31 (0.025)	0.15 (0.301)
Albumin	-0.02 (0.944)	-0.02 (0.527)
Creatinine	0.09 (0.487)	0.12 (0.388)
Hemoglobin	0.23 (0.102)	0.29 (0.039)
Hematocrit	0.29 (0.038)	0.26 (0.071)

BMI = body mass index; CC = calf circumference; AMC = arm muscle circumference; APMT = adductor pollicis muscle thickness; NRS-2002 = Nutritional Risk Screening 2002; ASMM = appendicular skeletal muscle mass; ASMM/H^2 = appendicular skeletal muscle mass/height^2.

Table 4 – Agreement in the diagnosis of malnutrition between PhA and SPhA and other methods of nutritional status assessment.

Nutritional and biochemical markers	PhA		SPhA	
	k coefficient (p)	Agreement (%)	k coefficient (p)	Agreement (%)
BMI	0.23 (0.048)	61.5	0.09 (0.386)	51.9
CC	0.16 (0.260)	59.5	0.12 (0.357)	53.2
AMC	0.02 (0.948)	50.0	0.35 (0.012)	67.3
APMT	0.42 (0.001)	71.2	0.11 (0.400)	57.7
NRS-2002	0.27 (0.060)	63.6	-0.03 (0.820)	47.7
ASMM	0.19 (0.165)	59.6	0.08 (0.554)	53.8
ASMM/H^2	0.12 (0.405)	55.7	0.31 (0.028)	65.3
Creatinine	-0.12 (0.158)	44.2	0.07 (0.455)	57.7
Hemoglobin	0.07 (0.478)	52.9	0.05 (0.638)	49.0
Hematocrit	-0.01 (0.952)	49.0	0.05 (0.638)	49.0

BMI = body mass index; CC = calf circumference; AMC = arm muscle circumference; APMT = adductor pollicis muscle thickness; NRS-2002 = Nutritional Risk Screening 2002; ASMM = appendicular skeletal muscle mass; ASMM/H^2 = appendicular skeletal muscle mass/height^2.

Thus, the study showed that PhA was consistent with BMI and APMT, indicating that this marker may contribute to the early identification of malnutrition in the hospital setting. In addition, the results demonstrated an association between advanced age and reduced cell membrane integrity. This finding is corroborated by other studies that point to reduced PhA as an early marker of functional decline and worse clinical prognosis in hospitalized elderly patients[15,34].

Furthermore, the results point to a high prevalence of nutritional deficiency in patients assessed by different nutritional markers. These findings reiterate the nutritional vulnerability often observed in hospital settings and support the need for systematic screening and early intervention strategies[3,4].

In turn, a correlation was observed with muscle mass indicators (APMT, ASMM and ASMM/H^2) and hematocrit, reinforcing the idea that PhA may reflect the muscular and hematological changes that occur in the context of hospitalization[35].

This finding is consistent with scientific evidence correlating low PhA values with protein-energy malnutrition[16], especially in populations with chronic diseases or prolonged hospitalization. Although BMI has limitations as an isolated indicator, its correlation with PhA in this context suggests complementarity between the methods.

The analysis of agreement between the methods reinforces the findings in the literature on the applicability of PhA in identifying nutritional deficits[10]. The emphasis on the good agreement between PhA and APMT reinforces the relevance of this measure in clinical practice, given its potential to directly reflect protein reserves and body cell mass[36].

On the other hand, SPhA showed better agreement with markers directly related to muscle composition, such as AMC and ASMM. This characteristic may be associated with the standardization of PhA by age and sex, which makes its application more accurate in comparative analyses involving muscle mass measurements.

It is important to note that PhA correlated with hemoglobin and hematocrit levels, indicating a possible relationship between cell integrity and hematological condition, although this relationship should be interpreted with caution, given the influence of multiple factors on the levels of these markers[5]. Meanwhile, SPhA was only related to hemoglobin levelsIn analyses stratified by sex, Dias et al.[16] found that, among men, PhA was positively correlated with APMT, hemoglobin, and hematocrit, while among women, PhA was negatively correlated with age. These results reflect distinct physiological and hormonal aspects, such as greater muscle mass in men and greater susceptibility to early functional loss in women, reinforcing the importance of stratification by sex in nutritional analyses.

The results of this study point to the use of PhA and SPhA as complementary tools in assessing the nutritional status of hospitalized patients. Both demonstrated a relationship with variables related to muscle mass and cellular functionality, showing their potential as prognostic markers. In clinical practice, combined use with other nutritional markers may improve diagnostic accuracy, contributing to more effective nutritional interventions. However, our results should be interpreted with caution, given the small sample size and the absence of clinical outcome measures. It is hoped that new studies will be conducted with larger, representative samples, allowing stratification by sex, age group, and clinical condition. In addition, longitudinal follow-up studies are suggested to improve understanding of the relationship between PhA and SPhA with clinical outcomes, thus allowing for more in-depth analysis.

CONCLUSION

PhA and SPhA showed a relationship and agreement with nutritional and biochemical parameters and can be used complementarily in the nutritional assessment of hospitalized patients, as they demonstrate good parameters for assessing individuals' muscle reserves. PhA proved to be more robust for estimating the overall nutritional risk in hospitalized patients and should be prioritized in assessment protocols.

It should be noted that its use must be integrated into a multidimensional approach that includes anthropometric, clinical, and biochemical assessment, respecting the specificities of each patient. The treatment and prevention of hospital malnutrition is a major challenge. Thus, obtaining an accurate diagnosis is essential for rapid and effective diet therapy.

REFERENCES

1. Toledo DO, Piovacari SMF, Horie LM, Matos LBN, Castro MG, Ceniccola GD. et al. Campanha "Diga não à desnutrição": 11 passos importantes para combater a desnutrição hospitalar. BRASPEN J. 2018;33(1):86-100. Portuguese.
2. Segui E.M, Costa BO, Costa AFG. Campanha "Diga não à desnutrição": o cenário atual na visão do nutricionista. BRASPEN J. 2024;39(2):e202439112. Portuguese.
3. Associação Brasileira de Nutrição. Manual orientativo: sistematização do Cuidado de Nutrição. São Paulo: Associação Brasileira de Nutrição; 2014. Portuguese.
4. Waitzberg DL. Nutrição oral, enteral e parenteral na prática clínica. Rio de Janeiro: Atheneu; 2017. Portuguese.
5. Guterres AS, Tavares GF, Carvalho GA, Estumano NV, Dias AEJ, Ferreira EFR, et al. Correlação entre perfil nutricional, bioquímico e físico em pacientes críticos admitidos em um hospital de referência em Belém-PA. Braz J Desenvolver. 2021;7(8):83419-35. Portuguese.
6. Catapano A, Trinchese G, Cimmino F, Petrella L, D'Angelo M, Maio GD, et al. Impedance analysis to evaluate nutritional status in physiological and pathological conditions. Nutrients, 2023;15(10):2264.
7. Player EL, Morris P, Thomas T, Chan WY, Vyas R, Dutton J, et al. Bioelectrical impedance analysis (BIA)-derived phase angle (PA) is a practical aid to nutritional assessment in hospital in-patients. Clin Nutr. 2018;38(4):1700-6.
8. Stuqui M, Beccaria LM, Albertini SM, Godoy MF. Phase angle as a potential marker of nutritional status of intensive care patients. Cogitare Enferm. 2022;27:e87605.
9. Abreu LLC, Almeida AA, Soares T, Alencar M, Santana AGS. Relação entre o ângulo de fase e a concentração sérica de albumina de doentes renais em hemodiálise submetidos a suplementação alimentar. Rev Multi Saúde. 2021;2(4):383. Portuguese.
10. Pereira MME, Wiegert EVM, Oliveira LC, Lima LC. Ângulo de fase e estado nutricional em indivíduos com câncer avançado em cuidados paliativos. Rev Bras Cancerol. 2019;65(1). Portuguese.
11. Silva TBD, Libonati RMF. Ângulo de fase e indicadores do estado nutricional em pessoa vivendo com HIV/Aids com síndrome lipodistrófica secundária à terapia antirretroviral. Braz J Hea Rev. 2020;3(4):10710-27. Portuguese.
12. Kyle UG, Soundar EP, Genton LL, Pichard C. Can phase angle determined by bioelectrical impedance analysis assess nutritional risk? A comparison between healthy and hospitalized subjects. Clin Nutr. 2012;31(6):875-81.
13. Ferreira TMS, Sousa IN, Mendes ABD, Miranda BLG, Silva ACLP, Azevedo CCMC, et al. Positiva entre o ângulo de fase padronizado e o estadiamento clínico em indivíduos com câncer. Rev Bras Cancerologia. 2021;67(4):e-191513. Portuguese.
14. Weschenfelder C, Figueira LV, Cabral TSS, Santos JS. Associação entre ferramenta de triagem e avaliação nutricional entre pacientes hospitalizados no município de Porto Alegre. BRASPEN J. 2020;35(2):144-8. Portuguese.
15. Silva GC, Santos AA, Leitão MPC, Cortes ML, Junior ACRB. Ângulo de fase baixo associado ao risco nutricional e ao percentual de adequação da circunferência do braço em pacientes com câncer hospitalizados. Rev Bras Cancerol. 2024;70(3):e-124735. Portuguese.
16. Dias TMS, Carvalho JAS, Freitas TEC, Aguiar JRS, Silva MCM, Sales ALCC, et al. Ângulo de fase e sua relação com albumina e risco nutricional em pacientes hospitalizados. BRASPEN J. 2018;33(2):188-93. Portuguese.
17. Kondrup J, Rasmussen HH, Hamberg O, Satanga Z. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. Clin Nutr. 2003;22(3):321–36.
18. Lameu EB, Gerude MF, Correa RC, Lima KA. Adductor pollicis muscle: a new anthropometric parameter. Rev Hosp Clin Fac Med Sao Paulo. 2004;59(2):57-62.
19. Lohman TG, Roche AF, Martorell R. Anthropometric standardization reference manual. Champaign: Human Kinetics; 1988.
20. Chumlea WC, Steinbaugh ML, Roche AF, Mukherjee D, Gopalaswamy N. Nutritional anthropometric assessment in elderly persons 65 to 90 years of age. JNE. 1985;4(4):39–52.
21. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: World Health Organization; 2000.
22. Organização Panamericana da Saúde. Encuesta multicéntrica: Salud, Bienestar y Envejecimiento (SABE) en América Latina y el Caribe - informe preliminar. In: XXXVI Reunión del Comité Asesor de Investigaciones en Salud; 9-11 jul. 2001; Kingston, Jamaica. Washington, D.C.: Organização Panamericana da Saúde; 2001. Spanish.
23. Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. Am J Clin Nutr. 1981;34(11):2540–5.
24. Blacburn GL, Thornton PA. Nutritional assessment of the hospitalized patient. Med Clin North Am. 1979; 63 (5):1103-15.
25. Nunes FFM Fernandes SA, Bertolini CM, Rabito EI, Gottschall CBA. Nutritional evaluation of cirrhotic patients: comparison between several methods. Sci Medica. 2012;22(12).
26. Borges VC, Oliveira GPC, Gonçalves RCC, Guaitoli PMR, Ferrini MT, Bottoni A, et al. Eletrólitos e min erais, elementos traço e elementos ultra-traço ln: Waitzberg DL. Nutrição oral, enteral e parenteral na prática clínica. São Paulo: Atheneu; 2009. Portuguese.

27. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva: World Health Organization; 2011.
28. Kyle UG, Laurence G, Hans D, Pichard C. Validation of a bioelectrical impedance analysis equation to predict appendicular skeletal muscle mass (ASMM). Clin Nutr. 2003;22(6):537–43.
29. Barbosa-Silva MC, Barros AJD, Wang J, Heymsfield SB, Pierson RN. Bioelectrical impedance analysis: population reference values for phase angle by age and sex. Am J Clin Nutr. 2005;82(1):49–52.
30. Studenski SA, Peters CW, Alley DE, Cawthon PM, McLean RR, Harris TB, et al. The FNIH sarcopenia project: rationale, study description, conference recommendations, and final estimates. J Gerontol Biol. 2014;69(5):547-58.
31. Gould H, Brennan SL, Kotowicz MA, Nicholson GC, Pasco JA. Total and appendicular lean mass reference ranges for Australian men and women: the Geelong osteoporosis study. Calcif Tissue Int. 2014;94(4):363–72.
32. Petrie A, Sabin C. Medical statistics at a glance. Oxford: Blackwell Science; 2002.
33. Eickemberg M, Oliveira CC, Roriz AKC, Sampaio LR. Bioimpedância elétrica e sua aplicação em avaliação nutricional. Rev Nutr. 2011;24(6):883-93. Portuguese.
34. Costa TY, Cristaldo MRA, Marin FA, Spexoto MCB. Nutrition impact symptoms, sarcopenia, and malnutrition in hospitalized patients. ABCS Health Sci. 2023;48:e023206.
35. Yokomachi J, Fakuda T, Mizushima Y, Nozawa N, Ishizaka H, Matsumoto K, et al. Clinical usefulness of phase angle as an indicator of muscle wasting and malnutrition in inpatients with cardiovascular diseases. Asia Pac J Clin Nutr. 2023;32(3):297-307.
36. Braga MCS, Marcelo TLP, Fernandez M, Gradinar ALT, Paternez ACAC. Associação do estado nutricional com espessura do músculo adutor do polegar e escore fisiológico agudo simplificado em pacientes de UTI. Rev Aten Saúde. 2022;20(72): 272-81. Portuguese.

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