Mid arm circumference as a predictor of the nutritional status and prognosis of patients with acquired human immunodeficiency syndrome

Circunferência braquial como preditor do estado nutricional e prognóstico de pacientes com síndrome da imunodeficiência humana adquirida

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ABSTRACT

Introduction: The purpose of this study is to determine mid arm circumference as a predictor of nutritional status and prognosis of hospitalized patients diagnosed with acquired human immunodeficiency syndrome. **Methods:** Cross-sectional study with a quantitative approach involving hospitalized patients with acquired human immunodeficiency syndrome. Clinical, nutritional, biochemical, sociodemographic and anthropometric data were collected, based on information in medical records and follow-up forms. Data were statistically analyzed according to the nature of their variables, using Minitab® software. Normality was seen from the Kolmogorov-Smirnov test. Spearman's rho (r) and Pearson's chi-square (χ2) tests were applied for correlation and association, respectively. The reliability of the arm circumference was evaluated from the precision measures and its reproducibility was measured by the Kappa coefficient. **Results:** The sample consisted of medical records of 95 patients, with an age range predominantly between 18 and 45 years, comprising about 80% of the sample universe. Approximately 70% of the sample presented malnutrition by arm circumference. Individuals who received this diagnosis had an increased risk of developing hypoalbuminemia, high C-reactive protein, high Rits Index, and greater chances of developing an inadequate caloric and protein intake (p<0.05). The arm circumference showed an excellent negative likelihood ratio value (VR- = 0.11), despite modest accuracy. The value of the kappa coefficient demonstrates a moderate agreement between the malnutrition classification by arm circumference and the classification by body mass index. **Conclusion:** Mid arm circumference can be used as a predictor of the nutritional status and prognosis of patients with acquired human immunodeficiency syndrome in hospital follow-up.

RESUMO

Objetivo: Determinar a circunferência braquial como preditor do estado nutricional e prognóstico de pacientes hospitalizados com diagnóstico de síndrome de imunodeficiência humana adquirida. **Métodos:** Estudo transversal com abordagem quantitativa, envolvendo pacientes hospitalizados com síndrome da imunodeficiência humana adquirida. Foram coletados dados clínicos, nutricionais, bioquímicos, sociodemográficos e antropométricos, com base nas informações dos prontuários e fichas de acompanhamento. Os dados foram analisados estatisticamente de acordo com a natureza de suas variáveis, utilizando o *software* Minitab®. A normalidade foi verificada a partir do teste de Kolmogorov-Smirnov. Os testes rho (r) de Spearman e qui-quadrado de Pearson (χ2) foram aplicados para correlação e associação, respectivamente. A confiabilidade da circunferência do braço foi avaliada a partir das medidas de precisão e sua reprodutibilidade foi medida pelo coeficiente Kappa. **Resultados:** A amostra foi composta por prontuários de 95 pacientes, com faixa etária predominantemente entre 18 e 45 anos, compreendendo cerca de 80% do universo amostral. Aproximadamente 70% da amostra apresentaram desnutrição pela circunferência do braço. Indivíduos que receberam esse diagnóstico apresentaram maior risco de desenvolver hipoalbuminemia, proteína C-reativa elevada, índice Rits elevado e maiores chances de desenvolver ingestão calórica e proteica inadequada (p<0,05). A circunferência do braço apresentou excelente valor de razão de verossimilhança negativa (VR- = 0,11), apesar de precisão modesta. O valor do coeficiente kappa demonstra concordância moderada entre a classificação da desnutrição pela circunferência do braço e a classificação pelo índice de massa corporal. **Conclusão:** A circunferência bBraquial pode ser utilizada como preditor do estado nutricional e prognóstico de pacientes com sSíndrome da imunodeficiência humana aAdquirida em seguimento hospitalar.

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INTRODUCTION

Brazil has registered a reduction in the number of cases of infection by the human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS), from 21.9/100 thousand inhabitants in 2012, to 17.8/100 thousand inhabitants, in 2019, which represents a decrease of 18.7%. The mortality rate associated with the disease decreased by 17% in the same period[1]. The campaigns carried out by the government that encourages the public to seek diagnosis and adherence to antiretroviral treatment (ART) can justify this reduction in the number of cases and mortality. It is estimated that by October 2020 around 642,000 individuals were using ART[1].

Although the use of ART increases the survival of HIV-positive patients, it is associated with some side effects such as gastrointestinal manifestations (vomiting, diarrhea and nausea) and lipodystrophy syndrome, which results in changes in body composition due to increased accumulation of fat in addition to causing insulin resistance, dyslipidemia and increased risk for cardiovascular disease[2,3].

On the other hand, malnutrition and depletion of muscle mass are important conditions that may result in negative outcomes. They can be presented even in patients who use ART and are associated with prolonged hospital stay and worse clinical outcome[4,5]. Furthermore, data indicate that weight loss, even if relatively small (5%), results in a lower survival rate[6].

In this context, nutrition plays a fundamental role in the treatment of HIV-positive individuals. Anthropometric measurements represent a good method of nutritional assessment since they have good efficacy and low cost, making it possible through them to screen for malnutrition and other nutritional disorders[7,8].

The causes of malnutrition in individuals with HIV-AIDS appear to be multifactorial, including opportunistic infections, diarrhea, food consumption disorders, malabsorption and wasting syndrome[4]. Furthermore, HIV *per se* affects nutritional status (NS) by increasing energy demand through changes in metabolism and oxidative stress, with low weight being a characteristic associated with this group of individuals[7,8].

Furthermore, studies show that body mass index (BMI) seems to be a good predictor of NS and prognosis in AIDS patients[9], since individuals with low BMI had worse outcomes, while BMI within the range of eutrophy was associated with normal levels of CD4 lymphocytes and longer survival[5].

However, it is understood that when starting a more individualized nutritional assessment, BMI becomes a limited parameter. as it does not directly help an estimate of body composition, especially muscle mass. It is important to use methods that maintain practicality and low cost, favoring clinical applicability, but with good accuracy against the protein-muscle status of these individuals, life is its prognostic importance.

Thus, it is important to develop studies using more specific muscle mass measures, such as mid arm circumference (MAC), which is a predictor of adiposity and indirect measure of muscle mass, in view of the lack in scientific literature. The aim of this study was to determine MAC as a predictor of NS and prognosis of hospitalized patients diagnosed with AIDS.

METHODS

Research Design

This is a retrospective cross-sectional study with a quantitative approach involving patients with AIDS/HIV hospitalized for clinical control in the ward of infectious and parasitic diseases (IPD) of the Hospital of Clínicas of the Federal University of Pernambuco (HC-UFPE), in the city of Recife, Pernambuco, from January to December 2018.

Clinical, nutritional, biochemical, sociodemographic and anthropometric data were obtained from information recorded in medical records and monitoring forms from the Nutrition sector of that hospital. Regarding to sampling, this was done by convenience, including patients of both sexes and aged over 18 years. Thus, 95 medical records were randomly selected to compose this study.

A structured questionnaire was used to systematize the data collection, containing items that included: sociodemographic, epidemiological and clinical data, such as length of stay; presence of comorbidities; nutritional and anthropometric data, such as weight loss prior to and/or during hospitalization, measurement of the BMI, classified according to the World Health Organization[10] and MAC calculated its percentage (%) of adequacy, as recommended by Frisancho[1].

Biochemical data were collected and evaluated according to the reference value of the laboratory of the hospital in question. Caloric and protein consumption were calculated according to the total daily consumption and per kilogram of weight.

The caloric and protein intake were evaluated based on the categorical nutritional recommendations of the Association of Nutrition Services Agencies (ANSA)[12] for the patient with AIDS, stratified into three classes: clinical category A (asymptomatic HIV, Persistent generalized lymphadenopathy, acute HIV): 35 kcal/kg/day and 1.1-1.5g protein/kg/day and, clinical category B (symptomatic HIV, HIV complications): 35-40 kcal/kg/day and 1 5-2.0 g protein/kg/day an, clinical category C (presence of a defining condition of AIDS and/or opportunistic infection): 40-50 kcal/kg/day and 2.0-2.5g protein/kg/day. All the patients in this study had their prescribed diet, during hospitalization length, calculated in a nutritional software (DietBox®) to get their energy and protein intake. The use of ART and performance of nutritional screening at the time of hospitalization were also considered, using the Nutritional Risk Screening (NRS) as recommended by European Society for Clinical Nutrition and Metabolism (ESPEN)[13] for screening the hospitalized patient.

Ethical Aspects

Data collection was performed after consideration and approval by the Research Ethics Committee, complying with the rules established by resolution 466/12, from the National Health Council, which describes the research involving Human Beings. There was no need to sign the Informed Consent Term (ICT) due to the indirect nature of collections.

Statistical Analysis

All statistical analyzes were performed using Minitab® software - version 19. Data were treated according to the nature of the variables, applying descriptive statistics, corresponding to measures of central tendency: frequency and percentage (%). Variables were also tested for normality using the Kolmogorov-Smirnov test. Correlation analysis was performed using Spearman's rho (r) test. The dependent variable "Malnutrition due to MAC" was related to other categorical variables to determine associations, through Pearson's chi-square analysis (χ2).

The feasibility and reliability of measuring MAC as a rapid screening test to establish the presence of malnutrition in patients with AIDS/HIV was evaluated by precision measures (accuracy, sensitivity, specificity and likelihood ratio positive - RV+ and negative - RV-), taking the BMI classification as a reference standard. The level of agreement and reproducibility between MAC and BMI was measured by the kappa coefficient. Landis and Koch[14] classify the different levels of agreement as shown in Table 1. Statistical significance was defined as $p < 0.05$. All p values shown are two-tailed.

Table 1 – Classification of the Kappa coefficient.

Kappa Coefficient	Level of Agreement
< 0	There is no Agreement
0 – 0.20	Minimum Agreement
0.21 – 0.40	Reasonable Agreement
0.41 – 0.60	Moderate Agreement
0.61 – 0.80	Substantial Agreement
0.81 – 1.0	Perfect Agreement

RESULTS

The sample consisted of 95 individuals (mean age = 39.4±12.5 years), with age distribution, predominantly between 18 and 45 years, comprising about 80% of the sample. Of these, about 60% (n = 44) were men and approximately 40% women (n = 27). Among ART users, there was a similar distribution between genders: 30 women

and 38 men. As for the length of hospital stay, on average, the patients included in this study spent 22.3±39.7 days in the hospital, ranging from 1 day to a maximum of 380 days. Most participants did not have any comorbidity (more than 80%), as can be seen in Table 2.

Table 2 – Main demographic and clinical characteristics of AIDS patients admitted to the HC-UFPE ward, Recife-PE, 2018.

Variable	Frequency	Percentage	CI95%
Gender			
Male	58	61.05%	–
Female	37	38.95%	
Use of ART			
Yes	68	71.58%	–
No	27	28.42%	
Age			
18 - 59 years old	91	95.79%	36.86-41.89
≥ 60 years old	4	4.21%	
Hospitalization Time			
< 14 days	47	49.47%	14.35-30.32
≥ 14 days	48	50.53%	
Comorbidities			
Systemic Arterial Hypertension (SAH)	3	3.16%	
Diabetes Mellitus (DM)	3	3.16%	–
SAH + DM	4	4.21%	
Others	5	5.26%	

ART = Antirretroviral therapy.

Based on the nutritional screening criteria, most patients (61%) had non-intentional weight loss prior to admission, with approximately 85% of those who showed severe and significant weight loss. Thus, approximately 70% of hospitalized patients were at nutritional risk (NRS ≥ score 3) (Table 3).

According to the results of the BMI, it was observed that less than 50% of the sample had some nutritional disorder (malnutrition or obesity). However, when evaluated by the percentage of adequacy of the MAC (mean value = 25.65±4.44 cm; CI95%: 24.64-26.65), it is observed that this result changes, showing that approximately 70% of the sample had some degree of malnutrition.

When observing the mean caloric intake of the patients, a number of 2703.68 kcal/day ±911.48 was obtained, with intake in kcal/kg/day around 49 kcal/kg/day ±21.28. The protein quota corresponded to 121.11g of protein/day, with an average intake of 2g of protein/kg/day ±0.96. Of these values, it appears that approximately 80% of patients reached their nutritional caloric and protein requirements (n = 77).

Table 3 – Anthropometric characteristics of patients with AIDS admitted to the ward of the HC-UFPE, Recife-PE, 2018.

Variable	Frequency	Percentage	CI95%
New Classification – BMI			
Malnutrition	23	24.21%	
Eutrophy	54	56.84%	20.75-22.48
Overweight	18	18.95%	
Previous Weight Loss (WL)			
Yes	58	61.05%	–
No	37	38.95%	
Classification of previous WL			
Severe WL	43	74.14%	
Significant WL	6	10.34%	2.37-4.81
Non-significant WL	9,0	15.52%	
WL during hospitalization			
Yes	35	36.84%	
No	60	63.16%	–
Malnutrition (% of MAC adequacy)			
Yes	55*	69.62%	
No	24*	30.37%	–
Nutritional Screening Classification			
NRS with risk	68	71.58%	–
NRS with no risk	27	28.42%	

*Only 79 subjects were evaluated for MAC.

When considering the occurrence of malnutrition based on the adequacy (%) of the MAC, it was possible to observe that those who presented some degree of malnutrition had 11.43 times the chance of developing hypoalbuminemia than those who did not present malnutrition (95%CI: 1.94-67.26; p=0.003). Furthermore, patients with malnutrition had 4.71 times the chance to develop some liver dysfunction/injury considering the Rits Index (95%CI: 1.54-14.46; p=0.005), as well 3.21 times the chance to develop some degree of inflammation, with increased CRP (95%CI: 1.03-9.98; p=0.040), as shown in Table 4.

In addition, it was seen that those with malnutrition had 6.86 and 5.78 times the chance to present inadequate caloric and protein intake, respectively (95%CI: 2.22-21.15; p=0.001; 95%CI: 1 .31-25.53; p=0.012).

In this study, despite the modest accuracy, the MAC presented an excellent negative likelihood ratio value (RV- = 0.11) (Table 5). The value of the Kappa coefficient demonstrates a moderate agreement between the malnutrition classification by MAC and the classification by BMI.

Table 4 – Logistic regression of factors associated with malnutrition by MAC in AIDS patients (n = 95) admitted to the HC-UFPE ward, Recife-PE, 2018.

Variable	OR	CI95%	P Value
Gender			
Male	2.06	0.77; 5.47	0.070
Female	0.49	0.18; 1.29	
Hospitalization Time			
≥14 days	1.53	0.58; 4.00	0.070
<14 days	0.66	0.25; 1.72	
ART			
Yes	2.56	0.91; 7.19	0.070
No	0.40	0.14; 1.10	
WL during hospitalization			
Yes	2.26	0.81; 6.30	0.115
No	0.44	0.16; 1.23	
Nutritional Risk			
Yes	1.62	0.56; 4.63	0.370
No	0.62	0.22; 1.77	
Hemoglobin			
≥14 g/dL	0.41	0.08; 2.21	0.288
<14 g/dL	2.43	0.45; 13.02	
Urea*			
≥0.5 mg/dL	__	__	0.120
<0.5 mg/dL	__	__	
Creatinine			
≥0.6 mg/dL	0.25	0.05; 1.22	0.070
<0.6 mg/dL	3.95	0.82; 19.00	
Albumin			
≥3.5 g/dL	0.09	0.01; 0.52	0.003
<3.5 g/dL	11.43	1.94; 67.26	
Alkaline phosphatase			
≥240 U/L	2.29	0.70; 7.55	0.168
<240 U/L	0.44	0.13; 1.44	
Rits Index			
≥0.8	4.71	1.54; 14.46	0.005
<0.8	0.21	0.07; 0.65	
CRP			
≥0.5 mg/dL	3.21	1.03; 9.98	0.040
<0.5 mg/dL	0.31	0.10; 0.97	
Caloric Consumption			
Adequate	0.15	0.05; 0.45	0.0001
Inadequate	6.86	2.22; 21.15	
Protein Consumption			
Adequate	0.17	0.04; 0.77	0.012
Inadequate	5.78	1.31; 25.53	

* It was not possible to adjust the model adequately by the statistics applied to the biochemical marker in question, thus, the results could not be reliable.

Table 5 – Results of precision measures for classification of the presence of malnutrition in patients with AIDS/HIV using the MAC measure.

Variable	Accuracy	Sensibility	Especificity	Kappa Coefficient	RV+	RV-
MAC	56.96%	95.65%	41.07%	0.44	1.62	0.11

DISCUSSION

The impairment of NS is a frequent complication in people living with HIV, especially in the more advanced stages of the disease[15]. The increase in energy requirements, in association with the reduction in food intake and the compromised absorption of nutrients caused by the infection, are highlighted as important causes of this outcome[16,17].

In this context, the nutritional assessment of this group with a view to early intervention is of great relevance, since malnutrition is directly related to a worse prognosis, greater susceptibility to opportunistic infections and, therefore, poor quality of life[18].

In this research, according to the BMI, 24.2% were malnourished. This frequency is a reflection of the study site itself, as it is a public hospital in northeastern Brazil and whose patients, for the most part, have a low socioeconomic status and low level of education, which can compromise access to and purchase of food in sufficient quality and quantity, as well as favoring poor adherence to ART.

Superior results were found by Thesome et al.[17], in a study with 305 HIV-infected individuals from a city in southern Ethiopia, in which 27.2% had a BMI below 18.5 kg/m². Low dietary diversity, alcohol consumption and advanced stages of the disease were considered independent predictors of malnutrition. In a similar study carried out in the same region by Gebremichael et al.[9], the frequency of malnutrition was 23.6% and food insecurity was identified as one of the determinants, showing the greater severity of this event in countries with limited resources.

Back to Brazilian reality, in Goiânia-Goiás, 25.7% of people living with HIV investigated by Pires et al.[19] had low weight, according to BMI, in addition to higher frequencies of malnutrition when evaluated by other parameters such as triceps skinfold (74.3%), arm muscle circumference (62.9%), and through of MAC (75.7%). Correspondingly in the present investigation, the MAC also showed a higher number of malnourished people when compared to the BMI.

It is important to infer that the BMI has the limitation of not distinguishing the body compartments, in this sense, additional assessment methods become necessary. MAC is a simple and easily reproducible measure, which allows for the classification of the individual's degree of malnutrition.

In addition to anthropometric parameters, biochemical assessment can also function as an important way of tracking NS. In this study, when investigating the association between MAC and such parameters, it was found that individuals classified as malnourished through MAC had a greater chance of hypoalbuminemia, which despite being a negative acute phase protein, that is, it tends to be reduced in the face of inflammatory process also functions as a marker of malnutrition.

However, it is important to consider that, in a hospital context, where patients present worsening of inflammatory conditions, hypoalbuminemia becomes unused as a marker of NS, and is interpreted as a prognostic factor. In the present study, we observed that malnutrition due to MAC was associated with an 11-fold higher risk for the development of hypoalbuminemia, indicating a worse prognosis of morbidity and mortality in the population in question. Corroborating this, a study carried out by Ferreira et al.[20] showed that individuals with AIDS and opportunistic co-infections who had higher mortality had hypoalbuminemia.

Another evaluation parameter is the involuntary weight loss, which, especially in this population, is considered an important predictor of morbidity and mortality[21]. In this design, 61% of participants reported weight loss prior to hospitalization, of which 74.14% had severe loss and reflected in the percentage of 71.6% of individuals classified as at nutritional risk at the time of hospital admission from the screening of risk - NRS (2002).

The result presented in Table 5 shows the ability to use the MAC measure in the screening of malnutrition in patients with AIDS/HIV, since if the test is negative, it means that there is a reduction of about 10 times in the chance of having the condition. The high sensitivity can also support the referred application of MAC, despite its moderate accuracy.

Another important relationship was evidenced with the Rits index (Table 4). This association was already expected since hypoalbuminemia, in addition to being an indicator of protein-energy malnutrition, also acts as an inflammatory marker, which may also indicate hepatic impairment and is common in this group of patients. NS seems to be the main factor in this web of relationships, as malnourished individuals progress to hypoalbuminemia and are more likely to develop liver damage and inflammation. However, it is important to consider that drug treatment for AIDS, clinically known as ART, can also contribute to an overload of the hepatobiliary function, triggering both acute conditions, such as drug-induced hepatitis, and chronic ones, such as

chronic liver disease (CLD). Thus, it is necessary to better understand the reality of the study population in question, considering that it was not possible to determine the influence of ART on liver function. In contrast, a study by Gebremicael et al.[22] shows that ART may be associated with a reduction in the risk of developing liver diseases, when compared to the risk promoted by the AIDS disease picture itself. Thus, it is possible that malnutrition diagnosed by MAC may contribute to an increased risk for hepatic impairment, in addition to presenting a higher risk for general inflammatory conditions, based on the serum CRP measurement.

Another alarming fact found in the study is that malnutrition diagnosed by MAC was associated with a higher risk of inadequate caloric and protein intake. Thus, it is understood that the inflammatory and malnutrition condition can be aggravated by this increased risk, worsening the morbidity and mortality of the patients in question.

Therefore, the importance of nutritional monitoring and, above all, adequate screening and diagnosis is highlighted, reinforcing the use of MAC in this process, especially in situations in which the BMI cannot be measured, in addition to its viability as a complementary data, see its sensitivity to NS. This will make it possible to intervene with an early nutritional intervention, ensuring that the demands are met and avoiding the development of malnutrition or promote the recovery of the nutritional status. Consequently, this will result in a reduction of the risk of morbidity and mortality and promotion of health and quality of life to this population.

This study presents a non-probabilistic sample, in addition to the absence of a control group and the impossibility of collecting MAC from all patients included as the main limitations to be overcome.

Clinical Relevance Statement

The proposed research is relevant because it brings another picture to the use of mid arm circumference in clinical practice to dietitians, physicians and other health professionals due to its correlation to nutritional impact and prognosis in HIV/AIDS patients. Beyond that it is known that the HIV/AIDS leads to severe malnutrition, which leads to adverse outcomes and poor quality of life of these individuais. So, this research was developed considering the need to find more accurate ways that can early identify the nutritional damage.

On the other hand, it is important to consider the lack in scientific literature of researches that in terms of Public Health found low-cost ways to better and accurate assess body composition and muscle impact in HIV/AIDS patients. So, this research brings a new scenario for anthropometric evaluation, considering the absence of high-tech equipment.

CONCLUSION

The present study showed that MAC can be used as a good predictor of NS, especially in situations to exclude the diagnosis of malnutrition, given its high sensitivity. Furthermore, it was seen that malnutrition when diagnosed by MAC shows an already compromised picture of NS, severely increasing the risk of developing a worse prognosis, considering the statistical values found in the OR for high CRP and hypoalbuminemia.

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