Original Article

Nutritional assessment, functional capacity and thumb adductor muscle thickness in cancer patients

Associação entre parâmetros de avaliação nutricional, capacidade funcional e espessura do músculo adutor do polegar em pacientes oncológicos

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ABSTRACT
Introduction: Cancer is a chronic non-communicable disease characterized by abnormal growth and division and spread of cancer cells to other tissue. Malnutrition can cause muscle and functional depletion. Nutritional screening, assessment and monitoring are essential components in the care of all cancer patients, using combined tools. Thickness of the adductor pollicis muscle (TAPM) and handgrip strength (HS) help identify changes in nutritional status. Thus, the objective was to evaluate the association between TAPM and HS with anthropometric data and Self-Produced Subjective Global Assessment (PG-SGA) in cancer patients undergoing treatment at a hospital in Rio Grande do Sul, Brazil. **Method:** Cross-sectional and quantitative, descriptive study, with a non-probabilistic convenience sample. Sociodemographic, clinical and anthropometric data were collected during outpatient care. **Results:** The sample consisted of 73 patients, the majority (52%) of whom were male. Tumors of the reproductive system and breast were more frequent in well-nourished individuals, while severe malnutrition was associated with head and neck cancers ($p<0.001$). TAPM, calf circumference (CC) and arm circumference (AC) were significantly associated with PG-SGA ($p<0.05$), although HS did not demonstrate an association with nutritional status ($p=0.08$). Well-nourished patients increase the TAPM value by 56%. **Conclusion:** There was a positive association in nutritional diagnosis using different assessment instruments when compared to PG-SGA and conventional anthropometric measurements, making HS and TAPM promising tools for early diagnosis of malnutrition in patients.

RESUMO
Introdução: O câncer é uma doença crônica não transmissível caracterizada pelo crescimento, divisão e disseminação anormais de células cancerígenas para outros tecidos. A desnutrição pode causar depleção muscular e funcional. A triagem nutricional, avaliação e monitoramento são componentes essenciais no cuidado de todos os pacientes oncológicos, por meio de ferramentas combinadas. A espessura do músculo adutor do polegar (EMAP) e a força de preensão manual (FPM) auxiliam na identificação de alterações do estado nutricional. Assim, o objetivo foi avaliar a associação entre a EMAP e FPM com dados antropométricos e Avaliação Subjetiva Global Produzida pelo Próprio Paciente (ASG-PPP) em pacientes oncológicos sob tratamento, em um hospital do Rio Grande do Sul, Brasil. **Método:** O estudo foi transversal e quantitativo, descritivo, com amostra não probabilística por conveniência. Dados sociodemográficos, clínicos e antropométricos foram coletados durante o atendimento ambulatorial. **Resultados:** A amostra foi composta por 73 pacientes, sendo a maioria (52%) do sexo masculino. Tumores do aparelho reprodutor e de mama foram mais frequentes nos bem nutridos, enquanto a desnutrição grave associou-se aos cânceres de cabeça e pescoço ($p<0{,}001$). A EMAP, circunferência da panturrilha (CP) e circunferência do braço (CB) associaram-se significativamente com a ASG-PPP ($p<0{,}05$), embora a FPM não demonstrou associação com o estado nutricional ($p=0{,}08$). Pacientes bem nutridos aumentam em 56% o valor da EMAP. **Conclusão:** Houve associação positiva no diagnóstico nutricional utilizando diferentes instrumentos de avaliação quando comparado à ASG-PPP e medidas antropométricas convencionais, tornando a FPM e EMAP ferramentas promissoras para diagnóstico precoce de desnutrição de pacientes.

Keywords:
Nutrition assessment. Medical oncology. Skeletal muscle.

Unitermos:
Avaliação nutricional. Oncologia médica. Músculo esquelético.

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INTRODUCTION

Cancer is a non-communicable chronic disease (NCD) characterized by uncontrolled cell growth and the ability to invade adjacent tissues or distant organs[1]. The most recent estimate from the National Cancer Institute (INCA) projects that 704 million new cancer cases will emerge worldwide between 2023 and 2025[2].

Among the problems faced by cancer patients, malnutrition is considered the most frequent. This condition negatively impacts treatment outcomes, overall survival, and quality of life[3]. According to INCA[1], malnutrition can lead to metabolic impairments, loss of skeletal muscle mass, decline in gastrointestinal and immune system functions, postoperative complications, reduced quality of life, prolonged hospital stays, and increased healthcare costs. Malnourished individuals often experience a significant decline in functional capacity, resulting in the inability to perform basic activities independently, such as personal care and managing their immediate environment[4].

Early assessment of nutritional status is essential. To ensure greater sensitivity and specificity in diagnosis, it is crucial to combine both objective and subjective methods, allowing for timely nutritional interventions. Objective nutritional assessment tools traditionally used in clinical practice may obscure the diagnosis of malnutrition in cancer patients, particularly when edema leads to an overestimation of body weight[3]. The nonspecific nature of some tools, along with their limitations when used in isolation, makes accurate diagnosis more difficult and contributes to the lack of consensus on a gold-standard tool for this population[5].

It is known that skeletal muscle decline affects functional capacity, as malnutrition directly impacts muscle tissue, leading to reduced muscle strength. Assessing this variable using a dynamometer is the most recommended approach in clinical practice to detect early nutritional deficits or functional loss[6]. Handgrip strength (HS) is a widely used method to evaluate functionality in both adults and elderly across various clinical conditions[7-10].

Another parameter for detecting muscle loss is the thickness of the adductor pollicis muscle (TAPM), which enables monitoring of the muscle compartment and nutritional recovery. This measure ment is strongly associated with malnutrition[4], as thumb opposition is essential for performing routine tasks, explaining why this metric reflects an individual's functional capacity. According to Nascimento et al.[11], although TAPM is a promising method for assessing musculature, its use needs to be further explored and consolidated in studies related to the nutritional status of cancer patients.

Using different nutritional assessment tools and methods, especially in combination, can enhance the sensitivity of cancer patient screening for early detection of nutritional risk and/or malnutrition. Therefore, this study aimed to evaluate TAPM and HS in conjunction with anthropometric data and the Patient-Generated Subjective Global Assessment (PG-SGA) in cancer patients treated at a hospital in Rio Grande do Sul, Brazil.

METHODS

This was a cross-sectional, quantitative, descriptive-analytical study aimed at providing information on the health conditions of oncology patients over a specific period, as well as collecting data on exposure and outcomes without researcher interference. The study included patients aged over 18 and under 85, of both sexes, diagnosed with neoplasia, undergoing outpatient treatment with radiotherapy and/or chemotherapy, who agreed to participate by signing the Informed Consent Form (ICF). Patients who were bedridden, had edema or amputations of the dominant upper limb, or did not consent to sign the ICF were excluded from the study. This study was approved by the Research Ethics Committee (REC) under number 6.008.056.

Procedures

Data collection was conducted during the nutritional consultation at an oncology outpatient clinic by the researcher. Demographic variables (age, sex, and education), clinical data (cancer diagnosis), anthropometric measurements (weight, height, arm circumference - AC, and calf circumference - CC), functional capacity (HS and TAPM), and the application of the PG-SGA were evaluated.

Sociodemographic data and clinical variables were obtained from the electronic medical records. Weight was measured using a BK-00 FAN Balmak electronic scale on a flat surface, with the patient standing at the center of the equipment, barefoot and wearing minimal clothing, feet together, and arms extended alongside the body. For height measurement, the patient remained barefoot, with no head accessories, standing upright, arms along the body, and head positioned in the Frankfurt Plane. The measurement was then taken by lowering the adjustable part of the equipment and pressing it gently against the head with enough pressure to compress the hair.

For CC, a measuring tape was used with the individual seated, feet flat on the floor, knees bent at a 90-degree angle, and the right calf exposed. The tape was placed horizontally around the widest part of the calf without compressing the tissue, and the exact measurement was recorded without rounding. A cut-off point of <31 cm was considered indicative of lean mass depletion, as established by Chumlea[12].

AC was measured with the individual standing, the right arm exposed and unclothed. With the arm flexed at a 90° angle, the midpoint between the acromion and olecranon was identified. The tape measure was then wrapped around the arm at this midpoint without compressing the soft tissues, and the value was recorded without rounding. Standard values (50th percentile) for adults and the elderly were used for interpretation, as per Jelliffe[13] and the World Health Organization (WHO)[14], respectively.

Using the weight and height results, the body mass index (BMI) of the patient was calculated for subsequent nutritional status classification, based on parameters established by WHO[14] and Lipschitz[15] for adults and the elderly, respectively.

To identify nutritional risk early and assist in defining nutritional intervention, the PG-SGA nutritional screening tool was applied, considered the gold standard for oncology patients due to its consideration of their specificities. Patients were classified according to a numerical score: 0 to 1 (no intervention needed), 2 to 3 (education for the patient and their family), 4 to 8 (nutritional intervention needed), and ≥9 (critical need for nutritional intervention), using a cutoff point of ≥4 to classify as nutritional risk. In addition to this classification, there is also a categorization focused on six aspects, labeling the nutritional status as SGA-A (well-nourished), SGA-B (moderately malnourished), and SGA-C (severely malnourished) (Gonzalez et al., 2010)[16].

TAPM was measured according to the technique recommended by Lameu et al.[17], with the individual seated, hand resting on the knee, and elbow at approximately a 90° angle over the same side lower limb. Using a skinfold caliper with a continuous pressure of 10 g/mm^2, the adductor muscle was pinched at the apex of an imaginary triangle formed by the extended thumb and index finger. This procedure was performed on the dominant hand three times, with the average used as the TAPM measurement. Currently, since there is no defined cutoff point for oncology patients, the average found in healthy individuals from this study, which was 11.50 mm, was used as a parameter.

Functional capacity was assessed by measuring HS, as recommended by Schussel et al.[18], with the individual standing, arms unflexed and parallel to the body. The highest value among three repeated measures, with a minimum one-minute interval between each, was recorded. Care was taken regarding the intensity of instructions given to the individual being assessed, opting for the fewest and simplest standardized instructions possible.

After measuring HS, the results were classified using the recommended cutoff points for identifying sarcopenia, which establishes values of <27 kg for men and <16 kg for women as indicative of low strength[19].

Data Analysis

The collected data were stored in an Excel spreadsheet. Statistical analysis was performed using SPSS version 20.0.0. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess the normality of the data. Parametric samples were presented as mean ± standard deviation (SD). Counts and percentages were presented as n (%), and nominal categorical variables (cancer category) and ordinal variables (PG-SGA) were analyzed using the Chi-square test (χ^2) and presented as percentages. Adjusted z residuals were used, with a standard criterion for post-hoc analysis set at ±1.96. A bilateral p-value ≤0.05 was employed to determine the statistical significance of differences between mean values and standard deviations (±SD).

For cross-sectional analyses, generalized linear models (GLMs) were employed as the dependent variable of the study, "PG-SGA", met the assumptions for ordinal analysis, since the parallel lines test did not yield a significant result (p>0.05). To determine the most appropriate model, the lowest Akaike Information Criterion (AIC) value was used. By applying ordinal logistic regression, it was possible to ascertain that the model fit information was significant, indicating that the proposed model could predict better than the null model.

It is noteworthy that the nutritional category "well-nourished" served as the reference. To analyze the intercorrelations among quantitative variables (age, BMI, AC, CC, HS, and TAPM), a multivariate Principal Component Analysis was employed. The "Oblimin" rotation method was used. A p-value <0.05 was considered statistically significant for all analyses and the odds ratio (OR) and 95% confidence interval (CI) were also reported.

RESULTS

Future estimates predict a 50% increase in cancer cases by the year 2025, partly due to population aging and the rise of lifestyle risk factors[20]. Among the 73 patients evaluated, the largest proportion (74%) consisted of elderly individuals (61.83±10.47 years), ranging from 26 to 78 years, with an asymmetric distribution. BMI had an average of 24.11±4.17 kg/m^2, with symmetrical data distribution. There was no significant difference in the proportion of men and women in the population (p=0.81).

Regarding education, the majority had completed (39.72%, n=29) or partially completed (38.35%, n=28) elementary school, while 12.32% (n=9) had completed high school, and 4.10% (n=3) had not finished it. Only 1.4% were illiterate, and there was a lack of data in the electronic medical records for 4% (n=3).

In Table 1, it can be observed that, among the patients surveyed, the highest incidence of neoplasms occurred in the lower gastrointestinal tract (27.39%), followed by head and neck cancers (20.54%). The remaining neoplasms did not show statistical divergence.

Table 2 describes the results obtained from assessing nutritional status using different nutritional evaluation methods.

Table 1 – Characterization of the study sample according to demographic variables and classification of neoplasms in oncology patients undergoing outpatient treatment with radiotherapy and/or chemotherapy.

Variable	n (%)
Sex	
Male	38 (52.0)
Female	35 (48.0)
Life stage	
Adults (<60 yeas)	19 (26.02)
Elderly (≥60 yeas)	54 (73.98)
Oncological diagnosis	
Upper digestive tract	
Stomach	3 (4.10)
Small intestine	2 (2.73)
Pancreas	2 (2.73)
Liver	1 (1.36)
Lower digestive tract	
Large intestine	20 (12.28)
Head and neck	15 (20.54)
Hematological neoplasms	
Lymphoma	5 (6.54)
Leukemia	1 (1.36)
Reproductive system	
Uterus	3 (4.10)
Ovary	2 (2.73)
Prostate	2 (2.73)
Penis	1 (1.36)
Respiratory system	
Lung	7 (9.58)

n = sample size.

Table 2 – Nutritional Status Classification by Different Assessment Methods

BMI	n (%)	
Underweight	18 (24.65)	
Normal weight	37 (50.68)	
Overweight	18 (24.65)	
PG-SGA		
Well-nourished (A)	24 (32.87)	
Moderate malnutrition or nutritional risk (B)	37 (50.68)	
Severe malnutrition (C)	12 (16.43)	
TAPM		
Muscle reserve depletion	18 (24.65)	
No muscle reserve depletion	55 (75.34)	
HS	**Female**	**Male**
Low strength	9 (25.71)	16 (42.10)
Adequate strength	26 (74.29)	22 (57.90)

IBMI = body mass index; PG-SGA = Pacient-Generated Subjective Global Assessment; TAPM = thickness of the adductor pollicis muscle; HS = handgrip strength; n = sample size.

Additionally, we can state that well-nourished individuals have approximately a 56% higher chance of having elevated EMAP values compared to individuals in other nutritional classification categories (β = 0.447; OD: 1.56; 95% CI: 1.21-2.01) (Figure I). Furthermore, higher values in well-nourished individuals were also observed for CB, with a 14% chance (β = 0.135; OD: 1.14; 95% CI: 1.005-1.303) (Figure II), and CP with a 24% chance (β = 0.219; OD: 1.24; 95% CI: 1.05-1.46). However, the FPM variable did not show a significant odds effect measure (β = -0.61; OD: 0.94; 95% CI: 0.877-1.009).

When evaluating the effect of sex and the covariates age and BMI of the studied patients on the ASG-PPP classification, it was found that only BMI showed statistical significance (β=0.334; X^2=22.52; p<0.0001). The variables sex (β=-0.642; X^2=2.07; p=0.15) and age (β=-0.003; X^2=0.14; p=0.90) did not show any association with the PG-SGA classification of the evaluated patients.

To evaluate whether the variables TAMP, HS, AC, and CC could predict an association with nutritional classifications through ASG-PPP, a generalized linear model of ordinal logistic regression was used, which demonstrated a significant association of the variables TAMP (X^2=11.84; df=1;

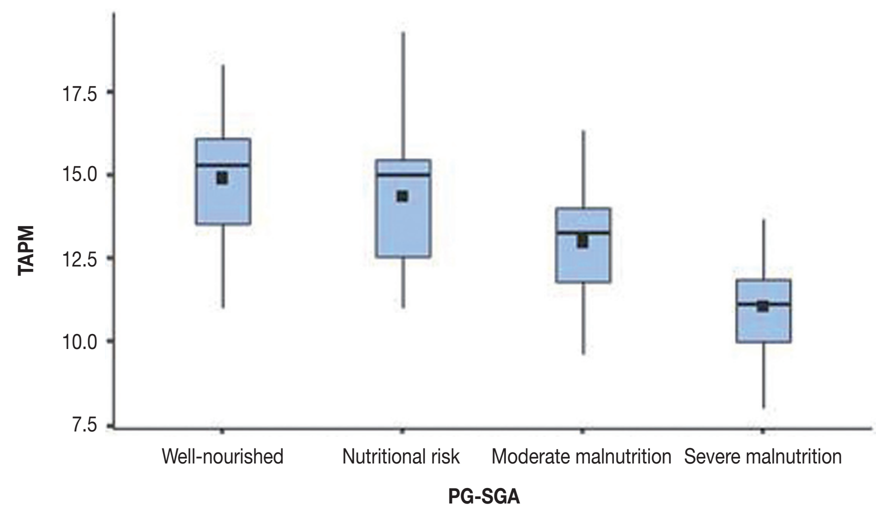

Figura 1 - *Box-plot representing the observed thickness of the adductor pollicis muscle (TAPM) values for each of the four Pacient-Generated Subjective Global Assessment (PG-SGA) nutritional categories. The mean is represented by the black square and the horizontal line in the box represents the median value.*

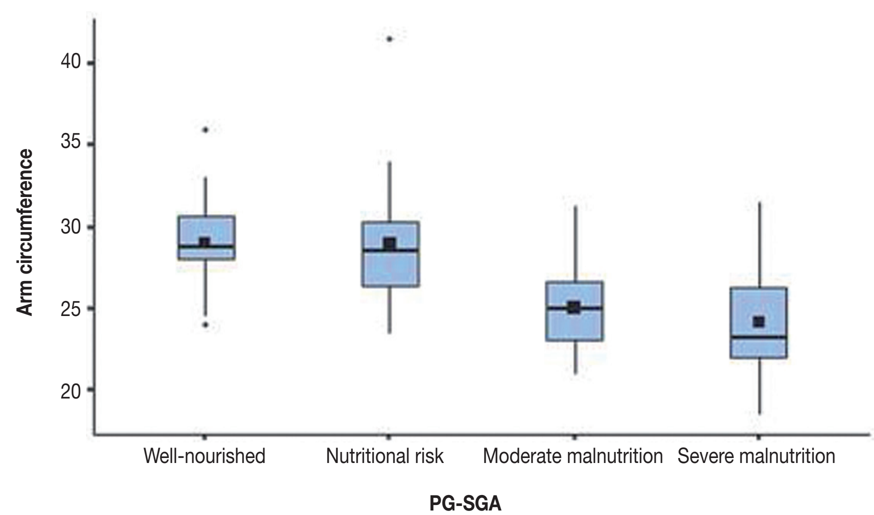

Figura 2 - *Box-plot representing the observed arm circumference values for each of the four Pacient-Generated Subjective Global Assessment (PG-SGA) nutritional categories. The mean is represented by the black square and the horizontal line in the box represents the median value.*

p=0.001), AC (X^2=4.17; df=1; p=0.04), and CC (X^2=7.07; df=1; p=0.008) with PG-SGA. In contrast, the variable HS did not show a significant effect concerning nutritional status (X^2=2.91; df=1; p=0.08).

Finally, to assess the intercorrelations among variables, the main assumption of PCA was tested using Bartlett's test of sphericity, which yielded a significant result (X^2=136; df=15; p<0.001), and the Kaiser-Meyer-Olkin (KMO) measure was 0.67, indicating moderate sampling adequacy. Based on the analysis, two principal components were identified. The first component showed a strong positive correlation among the variables BMI, AC, CC, and TAPM. The second component, composed of HS, age, and TAPM demonstrated a moderate correlation among themselves and a weak correlation compared to the other variables. TAPM showed a factor loading greater than 0.4 in both components. The first component explained 43.4% of the variance, while the second explained 20.3% of the model variance.

Through the analysis, a strong positive correlation between CP and IMC can be inferred. When evaluating the communalities of the model, all variables, except for age, were significant (above 0.4). Thus, the age variable being excluded from the model (Figure 3).

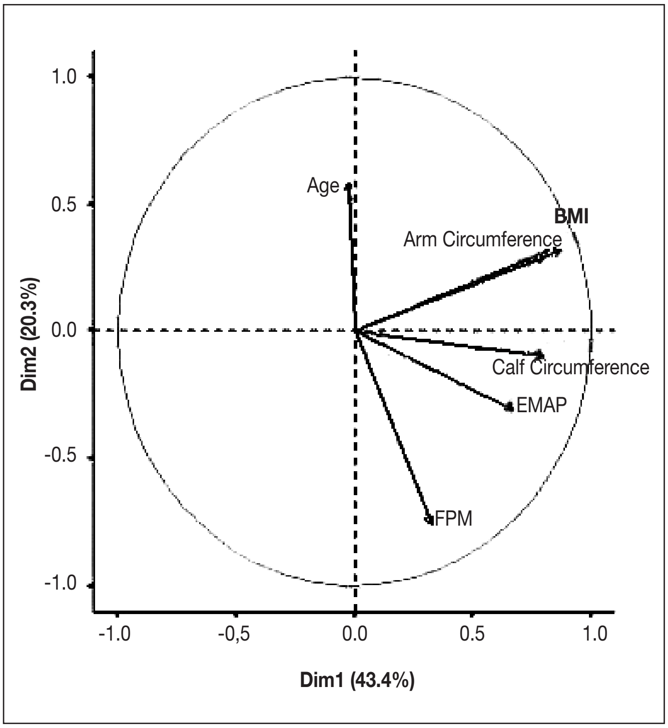

***Figure 3** - Biplot of the variables handgrip strength (FPM), thickness of the adductor pollicis muscle (EMAP), arm circumference, calf circumference, age, and body mass index (BMI) assessed in the Principal Component Analysis.*

DISCUSSION

The diagnosis of cancer can lead to a significant decline in nutritional status, either due to the tumor itself and/or the combined therapeutic treatment. Furthermore, the inflammatory and hypermetabolic response, which is quite common in this population, intensifies the depletion of lean mass and causes physiological alterations, such as impaired immune competence, which can contribute to unfavorable outcomes and mortality. It is important to note that certain neoplasms are more hypermetabolic than others, differing by location and aggressiveness[1,3].

According to the National Cancer Institute (INCA)[2], when analyzing the number of new cancer cases in Brazil, it is shown that breast cancer (15%) and prostate cancer (15%) have the highest incidence, followed by cancers of the lower digestive system (9,4%) and lung cancer (6,7%).

In this study, it was possible to verify that the proportion of neoplasms in the reproductive system and breast tumors occurred on a larger scale in individuals with adequate nutritional status compared to those with some degree of nutritional impairment or depletion. On the other hand, respiratory system neoplasms were more frequent in those classified with moderate malnutrition, and head and neck tumors were more common in severely malnourished patients ($X^2=57.27$; df=24; $p<0.001$). Some studies support this finding, such as Levonyak et al. (2022)[21], which highlighted a higher occurrence of malnutrition in gastrointestinal cancers than in other tumor types, showing higher rates of weight loss, especially in colon, pancreas, and gastric cancers.

Analyses of the clinical-epidemiological profile of cancer patients conducted by other authors (Fernandes, 2023)[22], demonstrated similar results, where the majority of the sample had completed or incomplete elementary education (31.3% vs 14.8%), respectively. However, a higher percentage of illiteracy (8.6%) was found compared to our study.

Considering BMI, the majority of the sample was in the eutrophic range. Similarly, preservation of muscle mass and strength was observed in at least 50% of the evaluated sample. On the other hand, according to the PG-SGA, at least half of the evaluated patients presented nutritional risk or some degree of existing malnutrition. According to Almeida et al.[23], the PG-SGA is more relevant and sensitive for diagnosing nutritional alterations in cancer patients compared to BMI. To explain this effect, it is important to remember that cancer patients often exhibit edema in the limbs, expansion of body compartments, such as extracellular fluid, and an increase in inflammatory mediators, which together may lead to an overestimation of BMI.

CC is a significant predictor of muscle mass, as it assesses the presence of an increased risk for disabilities and dependence in the elderly. It is considered the gold standard for nutritional assessment in this age group. Barbosa-Silva et al.[24] proposed combining CC with sarcopenia risk screening scales to improve sensitivity and provide a more comprehensive evaluation of muscle mass loss. Additionally, this study suggests using measures that consider the anatomical variability of the female and male body in future studies to refine such measurements. Equally important, the inadequacy of AC can indicate longer hospitalization, and it is among the measures that assist in nutritional assessment[25]. TAPM, on the other hand, can be used to assess nutritional status and clinical progression of patients, as the thumb adductor muscle undergoes significant atrophy during malnutrition. It is also considered a precise, low-cost measure and a good prognostic indicator for mortality in critical, oncological, and nephropathic patients, in addition to predicting neurological complications in hepatic steatosis[26].

As observed, the only variable that did not show a positive association with the PG-SGA was the HS measurement ($p=0.08$), a result that differs from that found by Valente et al.[4], where such a correlation was observed. This discrepancy may have been influenced by the methodology used to measure this variable in the present study, where HS was measured in standing individuals, while Valente et al.[4] measured it in seated individuals. This difference in the measurement method may have caused variation in the result, and we suggest considering this factor in future studies.

Based on the results of the present study, we highlight as limitations the cross-sectional nature of the study, which limits causal relationships, as well as the heterogeneity of diagnoses, sociodemographic variables, and treatments administered. On the other hand, the relevance of using TAPM and HS as potential tools for nutritional assessment and functional capacity in cancer patients is emphasized, since few studies have been conducted in this population, aiding in the understanding of these variables in cancer patients undergoing outpatient treatment.

CONCLUSION

Most cancer outpatients undergoing treatment were found to be at nutritional risk or presented some degree of malnutrition according to the PG-SGA tool. Significant impairments in lean body mass and functionality were also observed. Furthermore, in the studied population, TAPM showed a positive correlation with PG-SGA, AC, CC, and BMI. However, HS did not show a statistically significant correlation, a finding that may have been influenced by sample heterogeneity and size, as well as the measurement method employed, which may have affected the results. TAPM appears to be a promising tool for the early diagnosis of malnutrition in individuals with cancer, reinforcing the need to apply diverse methods of nutritional and functional assessment throughout the entire course of antineoplastic treatment.

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