Original Article

Comparison between nutritional assessment and computed tomography analysis of muscle mass in patients with lung cancer

Comparação entre avaliação do estado nutricional e análise da massa muscular por tomografia computadorizada em pacientes com câncer de pulmão

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ABSTRACT

Objective: The objective of this study was to compare nutritional assessment and computed tomography (CT) analysis of muscle mass in lung cancer patients. **Methods:** This retrospective, single-center study included 55 patients diagnosed with lung cancer who underwent surgical resection. The result of the Patient-Generated Subjective Global Assessment (PG-SGA) was compared with the muscle mass index assessed by CT at L3 level in the preoperative period. **Results:** Mean patient age was 64.9 years and 52.7% were male. According to the body mass index (BMI), only 21.8% had underweight. Most patients (72.7%) presented malnutrition on the PG-SGA and 52.7% had low muscle mass on CT analysis, however there was no statistically significant correlation between these methods (p=0.74). The association between the analysis of CT and the BMI demonstrated that obese patients had a lower rate of low muscle mass compared to the other groups (p=0.03). There was no statistically significant difference in the length of hospital stay and overall survival both by the PG-SGA and the CT analysis (p>0.05). **Conclusions:** In conclusion, lung cancer patients have a high prevalence of malnutrition, although we have not observed a correlation between PG-SGA and muscle mass CT analysis.

RESUMO

Objetivo: O objetivo deste estudo foi comparar a avaliação do estado nutricional com a análise da massa muscular pela tomografia computadorizada (TC), em pacientes com câncer de pulmão. **Método:** Estudo retrospectivo, unicêntrico, que incluiu 55 pacientes com diagnóstico de câncer de pulmão submetidos à cirurgia. O resultado da Avaliação Subjetiva Global Produzida pelo Paciente (ASG-PPP) foi comparado com o índice de massa muscular analisado pela TC ao nível de L3, no período pré-operatório. **Resultados:** A média de idade dos pacientes foi de 64,9 anos e 52,7% eram do sexo masculino. De acordo com o índice de massa corporal (IMC), apenas 21,8% estavam desnutridos. A maior parte dos pacientes (72,7%) apresentou desnutrição pela ASG-PPP e 52,7% tinham baixa massa muscular pela análise da TC. No entanto, não houve correlação significativa entre estes métodos (p=0,74). A associação entre a análise da TC e o IMC demonstrou que os pacientes obesos apresentaram menor incidência de baixa massa muscular quando comparados aos demais grupos (p=0,03). Não houve associação significativa com o tempo de internação e sobrevida global com a ASG-PPP e análise da TC (p>0,05). **Conclusões:** Em conclusão, pacientes com câncer de pulmão apresentam alta prevalência de desnutrição, no entanto, não foi observada correlação entre ASG-PPP e a análise da massa muscular pela TC.

Keywords:
Nutrition assessment. Lung neoplasms. Tomography, X-ray computed.

Unitermos:
Avaliação nutricional. Neoplasias pulmonares. Tomografia computadorizada por raios X.

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INTRODUCTION

Lung cancer is the most prevalent type of cancer worldwide, followed by breast, colon and rectum and prostate cancer[1]. It is estimated for Brazil 17,760 new cases of lung cancer in men and 12,440 in women for each year of the 2020-2022 period[2]. Lung cancer is also considered one of the most lethal cancers, with a mortality rate of approximately 90%[3]. Due to the absence of symptoms in the early stages of the disease, in most cases the diagnosis is made in advanced stages and palliative treatments with radiotherapy and/or chemotherapy are commonly used.

Malnutrition and loss of muscle mass are common conditions in cancer patients and may be due to inadequate food intake, decreased physical activity or metabolic disorders[4]. Lung cancer is considered one of the most aggressive in the nutritional assessment, and, as a consequence, during the treatment, patients may present: decreased immune response, decreased therapeutic effectiveness, worse quality of life, loss of muscle mass, difficulty in healing, occurrence of pressure ulcer, increased morbidity and mortality, and higher hospital costs[5].

The development and degree of malnutrition are related to several factors such as age, tumor location, staging and type of treatment, thus the prevalence of malnutrition can vary from 20% to 80% of cancer patients[6]. It is estimated that between 40% and 80% of lung cancer patients have some degree of malnutrition during the course of the disease, and that between 15% and 20% are malnourished at diagnosis[7].

Cancer-associated cachexia is defined as a multifactorial syndrome characterized by continuous loss of muscle mass (with or without loss of fat mass), which cannot be completely reversed by conventional nutritional therapy, leading to progressive functional impairment. Although it cannot be reversed, nutritional intervention plays an important role in the prevention and treatment of this condition, seeking to stabilize weight loss, avoid its progression, and improve the patient's quality of life[8].

The nutritional status of the cancer patient must be assessed by combining several methods, which must be analyzed by the nutritionist in order to obtain an accurate nutritional diagnosis[9]. According to Hamada[10], in the case of cancer patients, the nutritional diagnosis must be realized by a set of tools, which include anthropometry, Patient-Generated Subjective Global Assessment (PG-SGA) and, if possible, muscle mass analysis by bioimpedance and/or imaging exam. PG-SGA is an adaptation of the Subjective Global Assessment (SGA), validated for use in cancer patients and is considered a 4 in 1 instrument, as its results can be used in screening, nutritional assessment and monitoring of the nutritional intervention. In addition to diagnosing the current nutritional status, the PG-SGA facilitates the identification of patients who are at higher risk of presenting complications related to nutritional status. It is widely used in clinical practice and academic research, due to its great global acceptance, high sensitivity and specificity[11-13].

Imaging exams are important tools for analyzing the body composition in cancer patients. Currently, computed tomography (CT) is considered the gold standard for muscle mass analysis. It is also considered a convenient method since cancer patients are frequently submitted to CT for diagnosis, staging and response evaluation[14,15].

The aim of this study was to compare nutritional assessment by PG-SGA with the CT analysis of muscle mass in patients with lung cancer. Additionally, the impact of nutritional status on hospital stay and overall survival after lung cancer surgical treatment was evaluated.

METHODS

This retrospective, single-center and observational study included patients diagnosed with primary lung cancer who underwent surgical resection. Abdominal CT examination and nutritional assessment by PG-SGA were evaluated in the preoperative period, with a maximum interval of 3 months. The information was obtained by consulting the electronic medical records of patients hospitalized from May/2016 to December/2018 at an oncology referral center.

The study was previously approved by the institution's Research Ethics Committee (Antônio Prudente Foundation – A C Camargo Cancer Center - n° 2517/18), which waived the consent form of the participants because it was a retrospective research.

CT Protocol

The measurement of muscle mass was performed through the analysis of abdominal CT performed in the preoperative period. This assessment was carried out through the analysis of axial tomographic section at the level of the body of the third lumbar vertebra (L3). To measure the area of muscle mass (skeletal musculature, including psoas, paravertebral muscles and abdominal wall), a semi-automatic method was used using the 2D segmentation tool of the OsiriX software®.

For the analysis of skeletal musculature, the density of -29 to +150 Hounsfield Units (HU) was considered. The area of muscle mass was corrected for height (muscle mass in cm^2/height in m^2) to calculate the muscle mass index (MMI). For the classification of muscle mass depletion, the values of muscle mass index (MMI) of <55 cm^2/m^2 for men and <39 cm^2/m^2 for women were used[4].

Nutritional Assessment Protocols

To perform the nutritional diagnosis, the PG-SGA validated for the Portuguese language was used. This method classifies the patient as: A – well-nourished; B – moderate/suspected malnutrition; or C – severely malnourished. In addition to this classification, a score is generated, which allows the best targeting of the nutritional intervention[11].

In addition, body mass index (BMI) was calculated using weight and height data obtained from the PG-SGA. The reference values that were used for adults were from World Health Organization (WHO)[16] and for elderly patients, reference values from Pan American Health Organization (PAHO) were used[17].

Statistical Analysis

The database obtained and the statistical analysis were performed using the SPSS version 20.0 program. In the descriptive analysis, qualitative variables were presented by means of absolute and relative frequencies and quantitative variables by means of measures, such as mean and standard deviation, median and minimum and maximum values. To compare quantitative variables between two groups, the Mann-Whitney non-parametric test was used. In the case of three or more groups, the Analysis of Variance test (ANOVA) or the Kruskal-Wallis non-parametric test was used. Qualitative variables were compared using Pearson's chi-square test with correction of Fisher's exact test. The overall survival was estimated by the Kaplan-Meier method and the survival curves were compared using the Log Rank test and Cox regression to estimate the risk ratio (HR - Hazard Ratio), with a 95% confidence interval (CI 95%). The level of significance adopted was 5%.

RESULTS

Fifty-five patients were included, the majority were male (52.7%), with a mean age of 64.9 (35-88) years. The most frequent histological type was adenocarcinoma (70.9%), and lobectomy was performed in 74.5% of cases (Table 1).

In assessing nutritional status, most patients were B – moderate/suspected malnutrition (60%) by PG-SGA. On the other hand, according to the BMI, most were normal weight (36.4%) (Table 2). When comparing these two methods, we did not observe significant differences (p=0.13). Weight loss was reported by 18.2% of patients, while 67.3% had no changes and 14.5% reported weight gain.

The analysis of muscle mass by CT showed that 52.7% of the patients had low muscle mass. The association between the evaluation of muscle mass on CT and PG-SGA showed

Table 1 – Patient and disease characteristics.

Variable	Category	n (%)
Gender	Female	29 (47.3)
	Male	26 (52.7)
Age (years)	Median (Min-Max)	64 (35-88)
	Mean ± SD	64.9 ± 11.8
Histological type	Squamous cell carcinoma	10 (18.2)
	Adenocarcinoma	39 (70.9)
	Others	6 (10.9)
Staging	Uninformed	6 (10.9)
	I	31 (56.4)
	II	8 (14.5)
	III	7 (12.7)
	IV	3 (5.5)
Type of surgery	Pneumectomy	6 (10.9)
	Lobectomy	41 (74.6)
	Segmentectomy	8 (14.5)
Length of stay (days)	Median (Min-Max)	9 (3-51)
	Mean ± SD	12.6 ± 10.3
Comorbidities	SAH	27 (29.1)
	DM	46 (16.4)
	Dyslipidemia	8 (14.5)
	Others	17 (30.9)

Min: minimum; Max: maximum; SD: standard deviation; SAH: systemic arterial hypertension; DM: diabetes mellitus.

Table 2 – Nutritional assessment.

Variable	Category	n (%)
Weight (kg)	Median (Min-Max)	70 (44-130)
	Mean ± SD	73.2 ± 17.1
BMI (kg/m^2)	Median (Min-Max)	26.3 (18.3-46.6)
	Mean ± SD	26.6 ± 5.45
Rating BMI	Underweight	12 (21.8)
	Normal weight	20 (36.4)
	Overweight	8 (14.5)
	Obese	15 (27.3)
PG-SGA score	0-1	4 (7.3)
	2-3	9 (16.4)
	4-8	16 (29.1)
	≥9	26 (47.3)
PG-SGA	A – well-nourished	15 (27.3)
	B –moderate/suspected malnutrition	33 60.0)
	C – severely malnourished	7 (12.7)
MMI (cm^2/m^2)	Median (Min-Max)	43.3 (29.0-62.4)
	Mean ± SD	44.2±7.9
Rating MMI	Normal	26 (47.3)
	Low	29 (52.7)

Min: minimum; Max: maximum; SD: standard deviation; BMI: body mass index; PG-SGA: Patient-Generated Subjective Global Assessment; MMI: muscle mass index.

that 60% of those with diagnoses A – well-nourished, had low muscle mass, against 57.1% of those classified as C – severely malnourished, with no statistically significant difference (p=0.74) (Table 3).The association between the analysis of CT and the BMI demonstrated that obese patients had a lower rate of low muscle mass compared to the other groups (p=0.03) (Table 3).

Table 3 – Correlation of muscle mass analyzed by CT with BMI and PG-SGA.

Variable	Category	MM normal N (%)	MM low N (%)	p
PG-SGA	A – well-nourished	6 (40)	9 (60)	0.74
	B –moderate/ suspected malnutrition	17 (51.5)	16 (48.5)	
	C – severely malnourished	3 (42.9)	4 (57.1)	
Rating BMI	Underweight	4 (33.3)	8 (66.7)	0.03
	Normal weight	7 (35)	13 (65)	
	Overweight	3 (37.5)	5 (62.5)	
	Obese	12 (80.0)	3 (20.0)	

BMI: body mass index; PG-SGA: Patient-Generated Subjective Global Assessment; MM: muscle mass.

The length of hospital stay was compared with the results of the PG-SGA and CT analysis. Although the mean hospital stay for patients with result A – well-nourished was 8.8 days and for patients B – moderate/suspected malnutrition and C – severe malnutrition of 14 days, there was no significant difference (p=0.10). The mean number of days of hospitalization was 11.3 and 14.1 days for patients with low muscle mass and normal muscle mass, respectively (p=0.46).

Both staging and histological type did not show a significant correlation with the nutritional diagnosis of PG-SGA (p = 0.09 and p=0.43, respectively) and with the result of muscle mass on CT (p=0.82 and p=0.17, respectively). The same happened when comparing the type of surgery performed with the PG-SGA (p=0.87) and with the CT assessment (p=0.60).

The mean follow-up time for patients was 32 months (SD: 15.7 months). Although the overall survival was greater for patients in good nutritional status, this difference was not significant (p = 0.15), as shown in Figure 1. There was also no significant difference between muscle mass and the survival of patients included in the study (p=0.82) (Figure 2).

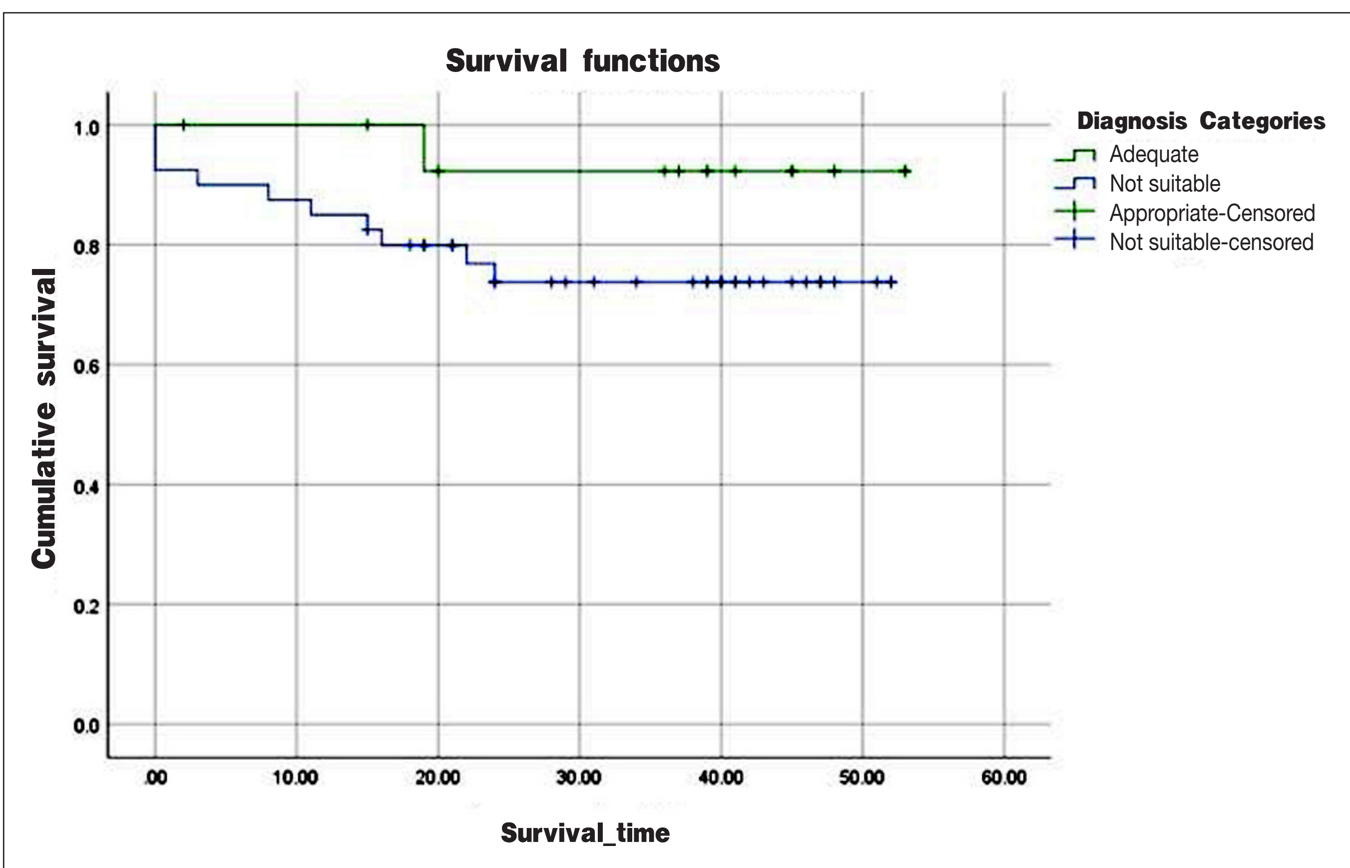

***Figure 1 -** Kaplan-Meier curve with estimated overall survival related to the diagnosis of PG-SGA. Test of Log Rank (Mantel-Cox) p= 0.150.*

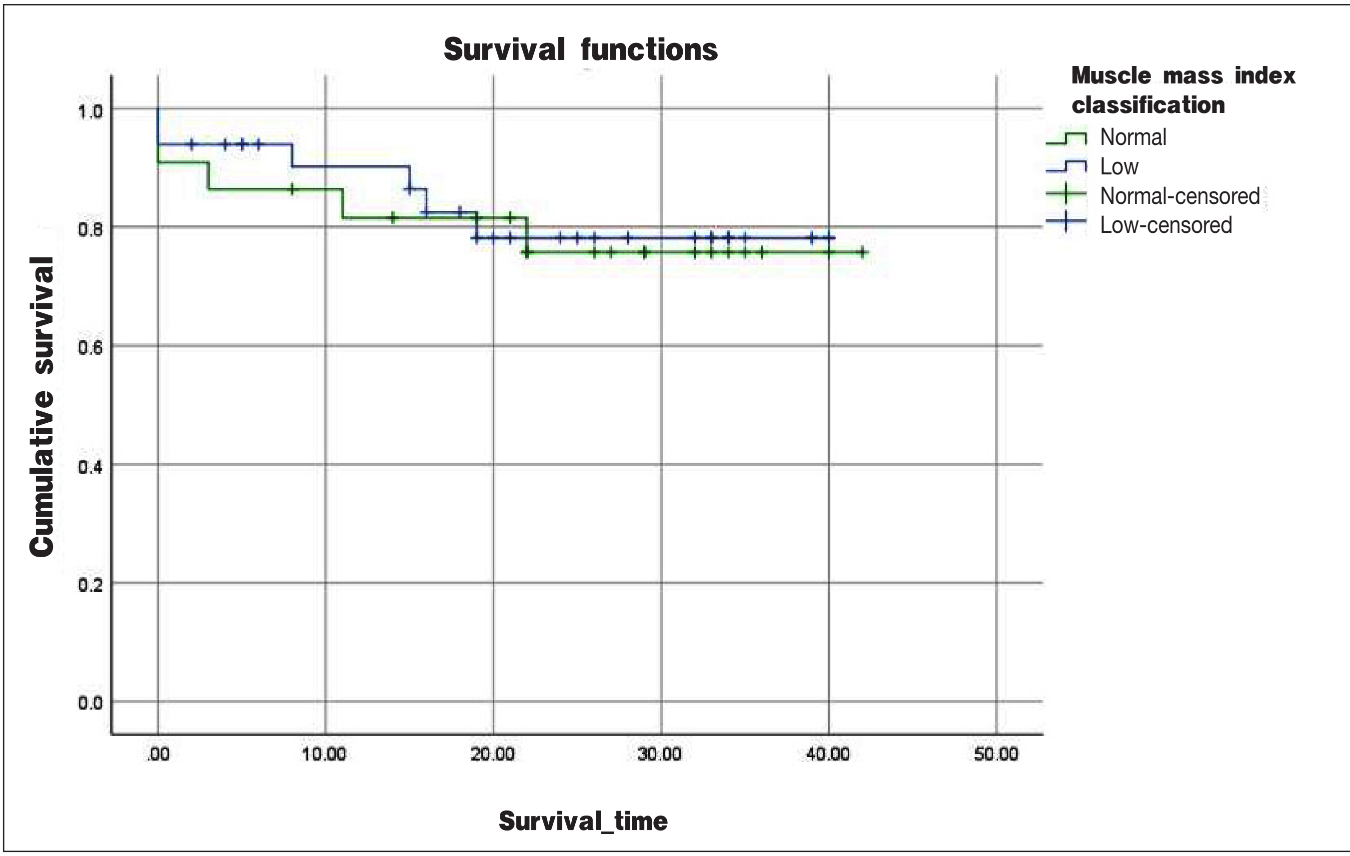

***Figure 2** - Kaplan-Meier curve with estimated MMI-related overall survival. Test of Log Rank (Mantel-Cox) p= 0.815.*

DISCUSSION

The characteristic that defines malnutrition is the low muscle mass that occurs with or without loss of fat mass, being independent of oncological cachexia[4]. The prevalence of malnutrition varies according to the location of tumor, staging and type of treatment[18]. The diagnosis of lung cancer alone considers the patient at high nutritional risk[19]. About 26-40% of patients with this type of cancer are malnourished, however, weight loss prior to treatment is present in 58-76% of cases, varying according to the histology of the tumor[20].

The present study proposed to compare 2 assessment methods, both considered gold standard, and which complement each other, as the PG-SGA doesn't assess body composition and the CT doesn't analyze food intake and symptoms. Therefore, the main objective was to identify whether patients diagnosed with malnutrition by PG-SGA had low muscle mass in their body composition.

Although we observed that 60% of patients diagnosed as well nourished by PG-SGA had low muscle mass, it was not a significant result. We also observed cases of patients diagnosed with malnutrition by PG-SGA who had adequate muscle mass.

It is worth mentioning that PG-SGA is a method developed specifically for cancer patients, which considers changes in weight, food intake and symptoms characteristic of antineoplastic treatments, presenting high sensitivity and specificity[12]. Even if the patient has an adequate body composition, regardless of the evaluation method, he may be malnourished considering other factors that are assessed by PG-SGA, such as food consumption and symptoms and interfere with his tolerance and response to treatment.

The study by Zambrano et al.[21] showed a significant association with the highest PG-SGA score with those patients with low muscle mass and/or low muscle strength ($p = 0.017$). The authors used L3-level CT to assess muscle mass in patients with liver cirrhosis.

Klassen et al.[22] didn't observe significant differences between the PG-SGA Short Form and the analysis of muscle mass by CT in patients with colorectal cancer in the preoperative period. The results of the study showed 43.4% of the patients without nutritional risk by the PG-SGA Short Form had low muscle mass and/or worse muscle quality, while 58.5% of the sample with nutritional risk, presented these results. The authors didn't observe significant differences.

Cancer-related malnutrition has many consequences, such as increased postoperative complications, increased risk of infection, reduced wound healing, reduced treatment tolerance, poor quality of life and increased mortality rate[18]. Aging, diseases and cancer therapies not only adversely affect the amount of muscle mass, but also affect its quality. The decline in muscle mass during cancer therapy can be partially attributed to the uncontrolled muscle protein catabolism that intensifies as the tumor progresses[23].

Recent systematic reviews and meta-analyzes of cancer patients have shown that patients with low muscle mass are 1.2 times more likely to have any complications after surgery and 2 times greater risk of death within 30 days after surgery, as well as reduced survival[24]. Unlike the literature, the present study didn't observe significant differences regarding the length of hospital stay and the adequate or inadequate muscle mass. PG-SGA seemed more sensitive, as patients malnourished by this method spent more time in the hospital, but also without significant differences, probably due to the small sample size.

In the study by Xiao et al.[25] with 1,630 patients, low muscle mass increased the length of hospital stay by 7 days or more for surgical patients for colorectal cancer. The authors also noticed that these patients were more likely to have 1 or more post-surgical complications and a higher risk of mortality within 30 days.

Regarding survival, low muscle mass showed no difference in the survival of patients with lung cancer in our study. PG-SGA also did not show significant differences in this comparison, but it did tend to better predict survival.

The study had some limitations, such as the retrospective nature of the research and the small sample size, which may have hindered some analyzes. However, this was one of the first studies correlating PG-SGA with CT muscle mass assessment in patients with lung cancer in our population. Only few services in our country routinely carry out these assessments.

CONCLUSION

In conclusion, lung cancer patients have a high prevalence of malnutrition. The present study didn't show a correlation between PG-SGA and muscle mass analysis by CT, but it is worth emphasizing the importance of using assertive and specific nutritional assessment tools for the oncology population. PG-SGA showed a better correlation with mean survival, but with no statistical significance. Future studies with a larger sample size are needed to confirm these findings. We also emphasize that, regardless of the limitations of the present study, research aimed at assertive diagnosis of early nutritional status with interventions that prioritize the reduction and recovery of muscle mass are of great importance for the definition of nutritional therapy and quality of life of the oncology population.

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