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Abstract: ***Background/Objectives*:** Malnutrition is a common issue among cancer patients, leading to adverse outcomes and reduced survival rates; therefore, nutritional screening and assessment are essential. Our study aims to evaluate the diagnostic efficacy of the GLIM criteria to assess malnutrition and to compare the performance of various nutritional screening tests in evaluating nutritional risk. ***Methods:*** A cross-sectional observational study was conducted on outpatient oncologic patients. Malnutrition was assessed using PG-SGA and GLIM criteria. Nutritional screening was performed using NRS-2002, MUST, MST, and NUTRISCORE. Anthropometric measurements, handgrip strength, cancer medical records and descriptive data were collected and analyzed. ***Results:*** A total of 396 patients were involved. Malnutrition was diagnosed in 37.4% according to GLIM criteria and in 25.8% according to PG-SGA ($p<0.001$). The agreement between GLIM criteria and PG-SGA was substantial ($\kappa = 0.63$). The diagnostic performance of PG-SGA showed a sensitivity of 93% and a specificity of 96.3%, whereas the GLIM criteria demonstrated a sensitivity of 81.3% and a specificity of 91.2%. Both tools had a significant association with low dynamometry and low BMI ($p<0.001$). Nutritional risk was identified in 22.7% of the patients using NRS-2002, 25.8% with MUST, 26.5% with MST, and 12.9% with NUTRISCORE. The highest agreement among the nutritional screening tests was observed between MUST and PG-SGA ($\kappa = 0.64$). ***Conclusions*:** GLIM criteria detected a higher prevalence of malnutrition compared to PG-SGA; however, PG-SGA demonstrated higher sensitivity and specificity. Both significantly agree with low dynamometry and low BMI. Among the nutritional screening tests, MUST and PG-SGA showed the highest agreement.

Keywords: malnutrition; cancer; GLIM criteria; PG-SGA; NRS-200; MUST; MST; nutriscore

Introduction

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Cancer represents a significant burden worldwide, with morbidity and mortality rates rising across the globe [1]. Malnutrition (MN) is an unfortunate condition commonly observed in the oncology population [2-5] and is acknowledged to be an important prognostic factor for outcome [6], with a high prevalence between 30% and 80% [7-11]. MN during cancer is associated with several complications, including treatment toxicity, clinical complications, reduced physical function, longer hospital stays, and higher mortality rates [12-14]. Therefore, it is crucial to identify and treat patients at nutritional risk during the early stages of the disease and throughout oncological treatment [15].

Nutritional screening (NS) aims to detect potential nutritional risk early, so that a more detailed evaluation can be conducted if necessary. It is usually the first step in the nutritional care process and should be performed within the first 24 to 48 hours of admission and repeated periodically, given the nutritional deterioration associated with prolonged hospitalization [16, 17]. NS is often overlooked and limited by oncologists, caregivers and health institutions [13, 18-21], resulting in over 50% of patients at nutritional risk going unrecognized, and only one-third of patients at nutritional risk receiving the nutritional support they need [21-23].

The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends the following tests in cancer patients: Nutritional Risk Screening 2002 (NRS-2002), Malnutrition Universal Screening Tool (MUST), the Mini Nutrition Assessment and the Malnutrition Screening Tool (MST) [8, 24]. In addition, the Academy of Nutrition and Dietetics recommends the use of the MST and MUST [5] in cancer patients. Recently, the NUTRISCORE test, a novel nutritional screening tool designed for onco-hematologic outpatients, includes questions regarding cancer site and active treatment and is now validated by ESPEN [25].

Nutritional assessment (NA) is a very different process compared to NS. It is a more detailed evaluation of a patient's nutritional status, aiming to diagnose nutritional problems and develop a tailored intervention plan. It is typically conducted after an initial NS has identified a potential nutritional risk.

The Patient-Generated Subjective Global Assessment (PG-SGA) is considered the gold standard for detecting and diagnosing malnutrition in cancer patients. It is supported by ESPEN and the Oncology Nutrition Dietetic Practice Group of the American Dietetic Association [2, 5, 8, 26, 27]. It has demonstrated high sensitivity (SE) of 98% and specificity (SP) of 82%, positive predictive value (PPV) of 95%, and negative predictive value (NPV) of 93% for NA in oncology settings but not for NS [28-33]. Interestingly, the Global Leadership Initiative on Malnutrition (GLIM) has recently put a fourth diagnostic criterion to standardize clinical practices in diagnosing malnutrition within clinical settings by incorporating the assessment of disease burden and inflammation, providing a more comprehensive approach to diagnosing MN. The validation of the GLIM criteria for the identification of MN within an ambulatory oncology population, as well as their predictive value concerning patient survival, has not been established yet, as only a few studies have been conducted in the oncology population using these criteria [34].

Interestingly, malnutrition in cancer patients is also associated with reduced handgrip strength (HGS) [35]. HGS is considered a prognostic marker and is positively correlated with survival duration, especially in older cancer patients [36, 37]. Since the objective of nutritional therapy is to restore muscle mass and strength, handgrip strength can be used as an additional parameter to identify or diagnose malnutrition. The GLIM consensus recommends assessing muscle function using grip strength as a supportive measure [34].

Both NS and NA provide valuable opportunities to identify MN early in the cancer journey and implement appropriate nutritional interventions [38]. However, since cancer patients represent the largest segment of individuals undergoing aggressive therapies in both hospital and ambulatory settings, they often present with MN. Therefore, this study focus on the comparison of nutritional risk screening and nutritional assessment in a cohort of Mexican cancer outpatients.

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Methods

An observational cross-sectional study of adult patients receiving ambulatory anticancer treatment during 2019-2021 at Hospital "*Fray Antonio Alcalde*" in Guadalajara, Mexico, was conducted. All NS and NA tests were performed during the medical follow-up of patients in the oncologic ambulatory clinic from 2019-2022 by the same accredited practicing dietitian.

Participants

Inclusion criteria were as follows: a positive diagnosis of cancer, age 18 years or older, ability to complete the process of NS and NA, willingness to participate in the study, and provision of informed consent. Patients were excluded from the study if they exhibited severe functional impairment of vital organs, were receiving hospice treatment, or lacked the capacity to understand the purpose of the study. These criteria were established to ensure the safety and appropriateness of the study's participants, as well as to protect their rights and welfare. Prior to participation, all participants were fully informed about the study's objectives upon admission, and informed consent was obtained from all enrolled participants.

Clinical and Medical Records

All data were obtained from the patient's electronic medical record as well as subsequent medical follow-ups. This included anthropometric data such as height, weight, weight loss percentage in the previous month and 6 months (considering as moderate weight loss <5% and severe weight loss >5% in the past month or as a moderate weight loss between 5-10% and severe weight loss of >10% in the past 6 months), BMI, age, cancer medical record, current treatment, consumption of nutritional supplements, and HGS. Body weight was determined using a TANITA BC 601® scale.

HGS was measured using a Jamar hand dynamometer® (Sammons Preston Inc., Bolingbrook, IL, USA); the measurements were conducted with the patient standing and with the elbow and wrist fully extended. The measurements of both hands were taken twice with 5-second intervals, and means were recorded. HGS was defined as the maximally measured grip strength of the dominant hand and was considered reduced for values <16 kg in females and <27 kg in males [39].

Criteria and Scores

GLIM criteria

The GLIM criteria represent a two-step model for the detection and diagnosis of malnutrition. The initial step in the process is nutritional screening, conducted using a validated screening test. The second step is to detect phenotypic criteria (non-volitional weight loss, low BMI, and reduced muscle mass) and etiologic criteria (reduced food intake or assimilation and disease burden/inflammation) in patients with nutritional risk [34]. Since cancer meets the etiological criterion of the GLIM criteria, patients who meet one of the three phenotypic criteria (non-volitional weight loss > 5% within the past 6 months or >10% beyond 6 months, low BMI <20 kg/m^2 for patients aged <70 years or <22 kg/m^2 in patients aged ≥70 years, and reduced muscle mass) were diagnosed with MN. The remaining participants were categorized as well-nourished.

PG-SGA

The PG-SGA was derived from the Subjective Global Assessment (SGA) for the oncology population and is considered the gold standard in these patients [2, 5, 8, 26, 27]. It consists of two sections: a patient-completed component and a clinician-completed component. The patient-completed component includes four aspects: weight loss, nutrition impact symptoms, food intake, and functional capacity. The clinician-completed component assesses three aspects: disease and age, metabolic stress, and physical examination. The aforementioned assessments permit the classification of patients into three categories: well-nourished (PG-SGA "A"), moderately nourished with suspected risk for malnutrition (PG-SGA "B"), or severely malnourished (PG-SGA "C"). For data

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analysis purposes, malnutrition was assumed with a score of B or C. The remaining participants were classified as well-nourished.

Nutritional Screening

Following established guidelines [40], all participants were screened for malnutrition using the NRS-2002, MUST, MST, and NUTRISCORE. All patients were reclassified as "at nutritional risk" if they had a score of ≥3 by the NRS-2002, a score ≥2 by the MST, ≥1 according to MUST and >5 with NUTRISCORE.

- *NRS-2002:*

The NRS-2002, developed by an ESPEN working group led by Jens Kondrup, was created in 2003 as a tool to identify malnourished hospitalized patients who could benefit from nutritional support [41]. It has been validated in over 100 clinical trials and it is known for its practicality, taking only 2 to 3 minutes to complete [13, 42]. The NRS-2002 involves a pre-screening with four questions, followed by a complete screening if any question is answered with "yes." It considers factors such as weight loss percentage, general condition, BMI, recent food intake, disease severity, and age. Each category is rated from 0 to 3, with an additional point for patients aged 70 or older. Total scores range from 0 to 7, and patients with a score of ≥3 are classified as being at nutritional risk, indicating a potential need for nutritional support to improve clinical outcomes [41].

- *MUST:*

The MUST was developed by the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition in 1992. It aims to identify patients at nutritional risk and predict their clinical outcomes [43, 44]. Recommended for outpatient screening by the ESPEN Society, it has been validated in various care settings and populations [45]. The MUST is highly reproducible, consistent and reliable, with high ratings of agreement (k = 0.88-1.00) among healthcare professionals [45]. Similar to the NRS-2002, it considers criteria such as unintentional weight loss, BMI, and food intake. Each criterion is scored from 0 to 2, and the scores are summed. Patients with an overall score of ≥1 are classified as having moderate or severe nutritional risk. While the MUST has been validated in different populations, including cancer patients, its performance in terms of sensitivity and specificity in this group has been reported as relatively low [6, 30, 46, 47].

- *MST:*

The MST was developed by Ferguson et al. in 1999 as a tool for adult inpatients. Compared to the NRS-2002 and PG-SGA, the MST performs well in cancer outpatients but less effectively in cancer inpatients [48]. The MST is a quick and easy screening tool that includes questions about appetite, food intake, and recent weight loss. The sum of these categories results in scores ranging from 1 to 5, where a score of ≥2 indicates a need for action. The MST has been well-validated in both inpatient and outpatient populations [49].

- *NUTRISCORE:*

The NUTRISCORE is a recently developed tool for oncology outpatients based on expert consensus from various dietetic and nutrition units at the Catalan Institute of Oncology. It builds upon the MST [25]. The questionnaire includes inquiries pertaining to unintentional weight loss and incorporates specific oncologic parameters, such as tumor location and anticancer treatment. The total score ranges from 0 to 11, with a score of ≥5 indicating the necessity for intervention, such as referral to a dietitian [14].

Statistical Analysis

Categorical variables are expressed as percentages and crude numbers, while continuous variables are expressed as the mean ± standard deviation (SD). Analysis was performed using Student's t-test or the Mann–Whitney nonparametric U test for quantitative data, and the chi-square test or Fisher's exact test for qualitative data. Statistical significance was defined as $p < 0.05$ (two-

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tailed). Statistical analyses were conducted using Excel 2020 (Microsoft, Redmond, WA, USA) and IBM SPSS Statistics software (version 20 for Windows; IBM Corp., Armonk, NY, USA).

To compare GLIM and NS tests with the reference instrument (PG-SGA), SE, SP, PPV, and NPV were calculated. Cohen's kappa coefficient (k) was calculated to measure the agreement between all tests, with 95% confidence intervals (CI). The Shrout classification [50] was used to interpret values as follows: 0–0.1, virtually none; 0.11–0.4, slight agreement; 0.41–0.6, fair agreement; 0.61–0.8, moderate agreement; and 0.81–1, substantial agreement.

Results

Demographic and Clinical Data

The study included a total of 396 patients, with 72% being female. The most common cancer diagnoses were breast (39.4%), followed by colorectal (32.6%), gastric (4.5%), pancreato-biliary and hepatic (4.5%), head and neck cancer (3%) and other types of cancer (15.9%). Of the total sample, 52.0% were undergoing chemotherapy, 39.4% had no active treatment, 6.3% were undergoing both chemotherapy and radiotherapy, and 2.4% were undergoing radiotherapy. Mean BMI was 26.2 ± 5 kg/m^2. Only 5.3% had undernutrition, but 37.1% presented with overweight and 23.5% with obesity.

In the last month, a total of 168 individuals (42.4%) experienced weight loss (9.4 ± 6.9%, mean percentage of weight loss), while in the last 6 months, only 132 individuals (33.3%) had weight loss, with a mean percentage of weight loss of 0.08 ± 4.8%. Regarding the percentage of weight loss in the last month, 147 individuals (37.1%) had moderate weight loss, and 21 individuals (5.3%) had severe weight loss. In the last 6 months, 66 individuals (16.7%) had moderate weight loss and 66 individuals (16.7%) had severe weight loss.

The demographic characteristics of the patients are described in Table 1.

Table 1. Outpatient cancer patient characteristics.

Variables	**n (%)**
Age (years)	51.2 ±13.2
Gender	
Male	111 (28)
Female	285 (72)
Tumor localization	
Breast	156 (39.4)
Colorectal	129 (32.6)
Other	63 (15.9)
Liver, pancreatobiliar	18 (4.5)
Gastric	18 (4.5)
Head and neck	12 (3)
Cancer treatment	
Chemotherapy and radiotherapy	24 (6.1)
Chemotherapy	198 (50)
No current treatment	150 (37.9)
Radiotherapy	9 (2.3)
Mean BMI	26.2 ± 5.06
BMI category	
Overweight	147 (37.1)
Obesity	93 (23.5)
Normal BMI	135 (34.1)
Undernutrition	21 (5.3)
Mean HGS	24.2 ± 8.4
Normal HGS	312 (78.8)
Low HGS	84 (21.2)

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WL in the last month	
No	228 (57.6)
Yes	168 (42.4)
Moderate (<5%)	147 (37.1)
Severe (>5%)	21 (5.3)
WL in the last 6 months	
No	264 (66.7)
Yes	132 (33.3)
Moderate (5-10%)	66 (16.7)
Severe (>10%)	66 (16.7)
Supplement intake	
No	294 (74.2)
Yes	102 (25.8)
Active herbalism	
No	378 (95.5)
Yes	18 (4.5)
Vitamin consumption	
No	336 (84.8)
Yes	60 (15.2)

HGS (hand grip strength); BMI (body mass index); WL (Weight loss).

Risk of Malnutrition and Malnutrition

According to PG-SGA, MN was present in 25.8% of patients, while GLIM criteria detected MN in 37.4% ($p<0.001$), with a moderate agreement of $\kappa = 0.63$. The SE of PG-SGA to detect MN was 93% and the SP was 96.3%, with a PPV of 91.1% and an NPV of 81.2%. With GLIM criteria, the SE was of 81.3%, SP was 91.2%, PPV was 62.8%, and NPV was 74.2%.

With regard to nutritional screening, NRS-2002 detected risk in 22.7% of the patients, NUTRISCORE in 12.9%, MUST in 25.8%, and MST in 26.5%. PG-SGA and MUST showed a moderate agreement ($\kappa = 0.64$) while GLIM criteria and MUST described the same moderate agreement ($\kappa = 0.68$). The remaining agreements observed between nutritional screening tests demonstrated only slight to fair agreement. The degree of concordance and the resulting outcomes between distinct screening tests can be observed in Table 2.

Table 2. Results between screening tools and nutritional assessment.

Test	Result	PG-SGA	GLIM	NRS-2002	MUST	MST	NUTRISCORE
PG-SGA	kappa	--	0.630	0.58	0.64	0.58	0.55
	Sensitivity %	--	93.0	73.3	73.5	68.6	94.1
	Specificity %	--	96.4	88.2	90.8	89.7	84.3
	PPV %	--	91.2	64.7	73.5	70.6	47.1
	NPV %	--	81.3	91.8	90.8	88.8	99.0
GLIM	kappa	0.63	--	0.53	0.68	0.61	0.32
	Sensitivity %	91.2	--	87.7	96	88.5	88.2
	Specificity %	81.3	--	77.4	82.9	81	70.1
	PPV %	62.8	--	53.3	66.2	62.8	30.4
	NPV %	74.2	--	77.2	74.2	73.4	87.1

PG-SGA: Patient-Generated Subjective Global Assessment; GLIM: Global Leadership Initiative on Malnutrition; NRS-2002: Nutritional Risk Screening-2002; MUST: Malnutrition Universal Screening Tool; PPV: Positive Predictive Value; NPV: Negative Predictive Value.

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Hand Grip Strength

The prevalence of normal HGS was observed in 312 patients (78.8%), while 84 patients (21.2%) exhibited low handgrip strength. Mean HGS was 24.2 ± 8.4 kg, men having higher values than women (33.4 ± 8.01 kg and 20.6 ± 5.2 kg, p<0.001). A low HGS was observed in 21.2% of patients, of whom 64.3% were female and 35.7% were male. Regarding the location of the tumor, patients with gastric tumors exhibited the highest prevalence (33.3%, p=0.059). Tumor localization and HGS are described in Table 3.

Table 3. Tumor localization and HGS results.

HGS Category	Colorectal n(%)	Head and Neck n(%)	Breast n(%)	Pancreatobiliar n(%)	Others n(%)	Gastric n(%)	p Value
Normal	102 (32.7)	9 (2.9)	132 (42.3)	15 (4.8)	42 (13.5)	12 (3.8)	0.059
Low	27 (32.1)	3 (3.6)	24 (28.6)	3 (3.6)	21 (25)	6 (7.1)	

HGS (hand grip strength). The data were analyzed using the Chi-squared test.

According to the actual treatment, 63% of patients with low HGS were receiving chemotherapy and 37% did not have any active treatment. No patients with low HGS were found in the combined treatment or radiotherapy groups. In contrast, among patients with normal HGS, 49% were receiving chemotherapy, 40% were not receiving any treatment, 8% were receiving combined treatment, and 3% were using radiotherapy (p=0.010). Detailed results are described in Table 4.

Table 4. Actual oncologic treatment and HGS results.

HGS Category	Chemotherapy and Radiotherapy n(%)	Chemotherapy n(%)	Radiotherapy n(%)	No current treatment n(%)	*p* Value
Normal	24 (8)	147 (49)	9 (3)	120 (40)	0.01
Low	0	51 (63)	0	30 (37)	

HGS (hand grip strength). The data were analyzed using the Chi-squared test.

Significant associations were observed between low BMI and low HGS across all screening tests and assessments (p<0.001). Additionally, HGS differed significantly in patients with nutritional risk or MN compared to those without it according to the NUTRISCORE (p=0.02), NRS-2002 (p<0.001), and GLIM criteria (p<0.001). Results can be observed in Table 5.

Table 5. Hand Grip Strength and Nutritional Risk and Malnutrition.

Test	Condition	n	Mean HGS ± SD	*p* value
GLIM criteria	No Malnutrition	248	25.5 ± 7.6	**<0.001**
	Malnutrition	148	22.1 ± 9.2	
PG-SGA	No Malnutrition	294	24.7 ±7.9	0.05
	Malnutrition	102	22.7 ± 9.4	
MST	No nutritional risk	291	24.6 ± 8.1	0.11
	Nutritional risk	105	23.1 ± 8.9	
NUTRISCORE	No nutritional risk	345	24.6 ± 8.3	**0.02**
	Nutritional risk	51	21.8 ± 8.8	
MUST	No nutritional risk	294	24.3 ± 8.4	0.67
	Nutritional risk	102	23.9 ± 8.5	
NRS-2002	No nutritional risk	306	25.5 ± 8.3	**<0.001**
	Nutritional risk	90	19.6 ± 6.9	

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GLIM (Global Leadership Initiative on Malnutrition); PG-SGA (Patient-Generated Subjective Global Assessment); MST (Malnutrition Screening Tool); MUST (Malnutrition Universal Screening Tool); NRS-2002 (Nutritional Risk Screening 2002). Student's t-test was performed to analyze data.

When analyzing the association between the GLIM tool and the PG-SGA in patients with low BMI and low HGS, it was found that out of 102 patients (25.8%) with nutritional risk according to PG-SGA, only 6 patients (1.5%) had both low BMI and low HGS, while 96 patients (24.2%) had normal scores. Additionally, 148 patients (37.4%) were identified with malnutrition (MN) according to GLIM criteria; of these, only 6 patients (1.5%) had both low BMI and low HGS, compared to 142 patients (35.9%) with normal nutritional scores. Significant results were found in both comparisons, as detailed in Table 6.

Table 6. Comparisons between PG-SGA and GLIM criteria in patients with low BMI and low HGS.

PG-SGA					GLIM criteria				
Low HGS and low BMI	**Without nutritional risk n(%)**	**With nutritional risk n(%)**	**Total n(%)**	**p Value**	**Low HGS and low BMI**	**Without nutritional risk n(%)**	**With nutritional risk n(%)**	**Total n(%)**	**p Value**
No	294 (74.2)	96 (24.2)	390 (98.5)		**No**	248 (62.6)	142 (35.9)	390 (98.5)	
Yes	0	6 (1.5)	6 (1.5)	<0.001	**Yes**	0	6 (1.5)	6 (1.5)	0.001
Total	294 (74.2)	102 (25.8)	396		**Total**	248 (62.6)	148 (37.4)	396	

GLIM (Global Leadership Initiative on Malnutrition); PG-SGA (Patient-Generated Subjective Global Assessment); HGS (hand grip strength); BMI (body mass index). The data were analyzed using the Chi-squared test.

Discussion

The GLIM criteria were developed with the objective of standardizing the diagnosis of malnutrition. This was achieved by incorporating etiological variables related to the underlying disease and its activity. Multiple studies have investigated the diagnostic capacity of these new criteria for malnutrition in cancer patients [51]. Our results indicate that 37.4% of ambulatory cancer patients were diagnosed with MN according to the GLIM criteria, compared to 25.8% with PG-SGA. This disparity suggests that the GLIM criteria may identify more patients at risk of malnutrition than the PG-SGA, potentially due to its comprehensive approach that includes disease burden and inflammation [34].

The results are comparable to those of the study by Gascón-Ruiz et al., who investigated the impact of malnutrition on cancer patients using GLIM criteria and found a prevalence of MN of 46.6% among 165 cancer outpatients [52]. Another study that aimed to assess the predictive power of the GLIM criteria for postoperative pulmonary complications in cancer patients found that 32.1% had MN according to GLIM criteria [53]. Okada G et al. also found that 44% of esophageal cancer patients were diagnosed with malnutrition based on the GLIM criteria; moreover, symptoms such as dysphagia and esophageal obstruction were significantly associated with the severity of MN [54]. In relation to PG-SGA, similar results were described in the study by Arribas L et al., where in outpatient cancer patients they observed a risk for MN in 19% of the patients with PG-SGA [55]. Additionally, Abbott J et al. found a prevalence of MN in 17% of patients according to PG-SGA among chemotherapy outpatients. It demonstrated high sensitivity and specificity, making it a reliable method for early detection of malnutrition [2]. Other studies of chemotherapy outpatients have reported malnutrition prevalence around 25% which is very similar to our results [56, 57].

While the PG-SGA has shown high sensitivity and specificity in assessing nutritional status in oncology settings [32–34], its sensitivity specifically for nutritional risk has been reported as poor in some studies [28, 29]. In our study, we observed that the performance of the PG-SGA, with its high sensitivity (93%) and specificity (96.3%), reaffirms its role as a robust tool for nutritional assessment in oncology settings. Furthermore, the high positive predictive value (PPV) of 91.1% and negative

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predictive value (NPV) of 81.2% reinforce the reliability of the PG-SGA in clinical practice. In contrast, the GLIM criteria, with a sensitivity of 81.3% and specificity of 91.2%, demonstrated slightly lower performance, which may be attributed to its broader diagnostic scope and recent introduction into clinical practice. Due to its detailed nature, the effective use of the PG-SGA requires both time and training to properly administer and interpret the results [5, 14, 58].

Nutritional risk identification showed variability across different screening tools, with NRS-2002 identifying 22.7% of patients at risk, NUTRISCORE 12.9%, MUST 25.8%, and MST 26.5%. The highest agreement was observed between MUST and PG-SGA ($\kappa = 0.64$) and between GLIM criteria and also MUST ($\kappa = 0.68$), suggesting these tools can be reliably used in combination for comprehensive nutritional assessment and risk screening. Gascón-Ruiz et al. also found a similar result regarding the agreement result between GLIM criteria and MUST ($\kappa = 0.66$), in an observational cross-sectional study conducted at the Medical Oncology Department at the Lozano Blesa Hospital in Zaragoza, recruiting 165 outpatient cancer patients [59]. Additionally, Bozzetti et al. reported that 32% of cancer outpatients exhibited nutritional risk according to the NRS-2002 [60]. In a multicenter cross-sectional study conducted across 29 clinical teaching hospitals in 14 Chinese cities [61], malnutrition was assessed among 1,000 cancer patients using PG-SGA, NUTRISCORE, and MST. PG-SGA had a prevalence of 45.0% of malnutrition. In contrast, NUTRISCORE showed a prevalence of only 2.9%, and 36.7% had malnutrition according to MST. NUTRISCORE exhibited a high specificity of 99.8% but a very low sensitivity of 6.2%. In comparison, MST showed a sensitivity of 50.9% and a specificity of 74.9%, indicating moderate discriminative ability. The kappa for NUTRISCORE was 0.066, indicating a slight degree of agreement, while for MST, it was 0.262, indicating a moderate degree of agreement and a significantly higher level of agreement compared to NUTRISCORE when both were compared with PG-SGA. These results are in accordance with our study, as we also found a higher prevalence of malnutrition with MST than with NUTRISCORE.

In contrast, in the CRC-NORDIET study [62], colorectal cancer patients were screened for malnutrition using one of four tools: NRS-2002, MST, MUST or the PG-SGA short form (PG-SGA-SF). GLIM identified 10-24% of patients as malnourished, versus 15% according to PG-SGA. The agreement between the PG-SGA and GLIM criteria was minimal using MUST ($\kappa = 0.28$), weak using the MST ($\kappa = 0.42$) and NRS-2002 first 4 questions ($\kappa = 0.49$), and moderate using PG-SGA-SF ($\kappa = 0.60$). In our study, we observed an overall agreement of 0.63 between the GLIM criteria and PG-SGA, consistent with the results reported in previous research. This level of agreement suggests that, while there are discrepancies, the GLIM criteria can serve as a reasonable alternative to the PG-SGA for diagnosing malnutrition in colorectal cancer patients.

In our study we observed that 21.2% of patients exhibited low HGS, those with gastric tumors had the highest prevalence (33.3%), with nearly statistical significance (p=0.059). Rechinelli AB et al. found similar results in their study involving 158 patients with cancer [63], with low HGS in 23.4%. The prevalence of low HGS and malnutrition according to PG-SGA was highest among patients with gastrointestinal tumors, with a rate of 59.5%. Studies conducted among both adults and the elderly have shown that low HGS is present in 24.4% of adult cancer patients [64] and 44.9% of elderly cancer patients [65]. Additionally, another study found that 30.9% of the elderly population being evaluated had low HGS [66].It has also been shown that HGS is reduced in cancer patients with MN [67]. Moreover, HGS has been shown to serve as a prognostic marker and is positively associated with survival duration, as evidenced by studies conducted on older patients with cancer [68, 69]. As the aim of nutritional therapy is to restore muscle mass and muscle strength, HGS can serve as an additional parameter to improve the recognition of malnutrition risk or MN. Our study also revealed significant associations between low HGS and low BMI, as well as all nutritional screening and assessment tools, emphasizing the physical manifestations of malnutrition in cancer patients. The significant differences in HGS among patients with and without malnutrition or nutritional risk reinforce the efficacy of HGS as a functional indicator of nutritional status.

Regarding weight loss, we observed a prevalence of 42% during the last month and 33% in the previous six months. These results are consistent with the findings of previous studies conducted over the past 35 years. Research has consistently shown that between 30% and 70% of cancer patients

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experience moderate to severe weight loss [70-72]. However, the prevalence of weight loss in the last month as well as in the previous six months was higher among those undergoing oncological treatment compared to those who were not undergoing such treatment.

Conclusions

This study indicates that while the GLIM criteria identify a higher prevalence of malnutrition compared to the PG-SGA, the latter demonstrates higher sensitivity and specificity. Both tools are significantly associated with indicators of poor nutritional status, such as low dynamometry and BMI. Among the nutritional screening tests, the MUST and PG-SGA showed the highest agreement, indicating that they may be reliably used interchangeably in this population.

Our study addresses a critical gap in the literature, providing valuable insights into the nutritional status of ambulatory cancer patients in Mexico. The scarcity of data on this population underscores the importance of our findings, which can inform future research and clinical practices. Enhancing the awareness and implementation of systematic nutritional screening and assessment in oncology is essential to improve patient outcomes and reduce the burden of malnutrition in this vulnerable population. Continued efforts to educate healthcare providers and integrate validated nutritional tools into standard care protocols are imperative for addressing malnutrition effectively in cancer patients.

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