Nutrition and Cancer

Routledge
Taylor & Francis Group

ISSN: 0163-5581 (Print) 1532-7914 (Online) Journal homepage: https://www.tandfonline.com/loi/hnuc20

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To cite this article: Nélia Pinheiro Mendes, Thalita Alves de Barros, Carla de Oliveira Barbosa Rosa & Sylvia do Carmo Castro Franceschini (2019): Nutritional Screening Tools Used and Validated for Cancer Patients: A Systematic Review, Nutrition and Cancer

To link to this article: https://doi.org/10.1080/01635581.2019.1595045

Published online: 29 Apr 2019.

NUTRITION AND CANCER
https://doi.org/10.1080/01635581.2019.1595045

Nutritional Screening Tools Used and Validated for Cancer Patients: A Systematic Review

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ABSTRACT

The purpose of this systematic review was to identify validated nutritional screening tools for cancer patients. The research was conducted in the electronic databases Pubmed, Cochrane Library, Scopus, and *Biblioteca Virtual de Saúde (BVS)*, using the descriptors "Nutrition Assessment", "Neoplasms", and "Validation studies". Initially, we identified 168 articles. After assessing eligibility, we included 21 studies. In selected studies, 14 nutritional screening tools were validation objects. The Patient-Generated Subjective Global Assessment (PG-SGA) showed better sensitivity, specificity and positive and negative predictive values (98, 82, 95, and 93%, respectively), as well as predictive of overall survival in cancer patients. In many countries, in addition to PG-SGA, the Nutrition Risk Screen (NRS-2002) is recommended for these patients. We did not identify, however, manuscripts that proposed validation. Validation studies of nutritional screening tools should be performed on patients with cancer, using representative samples of these individuals for better reliability of their results.

ARTICLE HISTORY
Received 23 April 2018
Accepted 18 February 2019

Introduction

The global estimate of 2012 by the World Health Organization (WHO) showed the incidence of 14 million new cancer cases, excluding non-melanoma skin cancer, and the forecast for 2030 of more than 21 million (1). As for mortality, the WHO global forecast for the year 2030 is over 13 million deaths.

Malnutrition is prevalent in cancer patients, with large clinical and economic consequences (2). Studies indicate prevalence of malnutrition between 39 and 87% among cancer patients (3–5). Some factors are related to changes in the nutritional status of these patients, as the presence of metabolic disorders related to the neoplastic process, insufficient nutrient intake and high incidence of gastrointestinal adverse effects to treatment, including mucositis, diarrhea, and nausea (2). Malnutrition has been associated with an increased risk of complications, longer hospital stay, lower tolerance and response to treatments, lower survival rates, and a significant decline in quality of life (2,5,6).

Therefore, nutritional screening aims to identify and treat early on patients at nutritional risk; and to be efficient, it must be practical, cost-effective, highly sensitive, have good specificity, and high reliability, that is, a small variation between observers (7,8). There is no gold standard to define malnutrition (9). Some instruments, however, have been used for nutritional diagnosis in hospitalized patients, as Subjective Global Assessment (SGA) (10), Patient-Generated Subjective Global Assessment (PG-SGA) (11), Mini Nutritional Assessment (MNA) (12), Malnutrition Screening Tool (MST) (13), Malnutrition Universal Screening Tool (MUST) (14), Prognostic Nutritional Index (PNI) (15), and Nutrition Risk Screen (NRS-2002) (16). For the use of these and other nutritional diagnostic instruments existing in the literature on cancer patients, they should be validated in studies, whose representative sample consists of these individuals (17). The validation indicates whether a tool measures what it intends to be measured (18), being important in its development and essential in evaluating the performance of the instrument developed (17).

The criterion validity involves the ability to predict the performance of the tool according to comparisons (17), which can be concurrent validity or predictive validity (18). Ideally, the concurrent validity evaluates

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the tool against a highly qualified standard measure (gold standard), while predictive validity evaluates the instrument's ability to predict future events or results (19).

The early identification of nutritional risk in cancer patients is necessary, since the aggravations caused by this clinical condition. Efficient treatment still in the initial phase can reverse them, regaining nutritional status. Thus, it is necessary to evaluate the validity for the choice of the nutritional screening method to be used. Therefore, this study intends to identify validated nutritional diagnostic tools for patients with cancer.

Method

This is a systematic review of literature constructed according to the recommendations of the Preferred Reporting Items for Systematic Reviews (PRISMA) (20), from April to September 2017, based on the following question: "What are the nutritional diagnostic tools used and validated for patients with cancer?".

The bibliographic survey was carried out in the following databases: Publisher Medline (Pubmed), Cochrane Library, Scopus, and *Biblioteca Virtual de Saúde (BVS)*. For the search in Pubmed, Cochrane Library, and Scopus, descriptors were identified in the Medical Subject Headings (Mesh), available from the US National Library of Medicine (http://www.nlm.nih.gov/mesh/). In addition to the term Mesh, the "entry terms" were combined by the Boolean operator OR. For the search in BVS, the descriptors were identified in the *Descritores em Ciências da Saúde (DeCS)*, available from the *Biblioteca Virtual em Saúde* (http://decs.bvs.br). The descriptors used were "Nutrition Assessment", "Neoplasms", and "Validation studies", which were combined through the Boolean OR and AND operators. There was no restriction on the year of publication of the studies so that there was no loss of important data.

The eligibility criteria were: original studies carried out with cancer patients (whether or not they underwent surgical treatment, chemotherapy, and radiotherapy, hospitalized or not), adults and/or elderly patients (aged over 18 years); written in Portuguese, English, and Spanish languages; and studies that used concurrent validity, evaluating the association of a nutritional diagnostic instrument with another instrument or reference measure, or predictive validity for one or more outcomes (length of hospital stay, mortality, survival, percentage of weight loss, and infectious complications).

The eligibility assessment of the studies found followed two steps. Initially, the articles were screened with titles and abstracts, followed by reading the full articles. A reverse search was performed, with the reading of the reference lists of the selected studies, in order to identify articles not found by the search strategy. After selecting the articles, we extracted the data, which were tabulated in the program Microsoft Office Excel 2013.

The proposal of Landis and Koch (21) was used to analyze the Kappa concordance index in the studies that performed such a statistic, where k from 0 to 0.20 corresponds to poor agreement, from 0.21 to 0.40 weak agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and 0.81 to 1.00 perfect agreement.

Results

Initially, we identified 168 articles. The titles and abstracts were evaluated, with 91 excluded studies that did not include the objectives of the review, and 61 that were indexed in the three databases. After a complete reading of the remaining 16 articles, 14 studies met the eligibility criteria. From the list of references, they were added seven articles, totaling 21 included for review (Fig. 1).

The period of publication of articles was from 2002 (42) to 2017 (22). The sample size ranged from 24 (27) to 1,767 (33) individuals. The composition of the samples varied as to the location of the cancer; inpatient or outpatient; and submitted to different treatments as surgical, chemotherapeutic, and radiotherapeutic procedure. As for gender, two studies were carried out with only women (36,40), while the others were composed by both genders (Table 1).

As for the validation method, 12 studies performed concurrent validation (22,26–29,31,32,37,39–42), seven carried out predictive validation (23–25,30,33,36,38), and two proposed both methods (34,35). In the selected studies, the most used instrument as a reference method for concurrent validation was the Patient-Generated Subjective Global Assessment (PG-SGA) (22,26,28,29,31,32,37,39) and for the predictive validation, the overall survival (OS) stands out (24,25,30,33,36,38). Only three studies (27,34,40) used objective reference measurements for concurrent validation, they being dual-energy absorptiometry (DXA); anthropometric parameters and laboratory tests; and Prognostic Nutritional Index (PNI), respectively (Table 2).

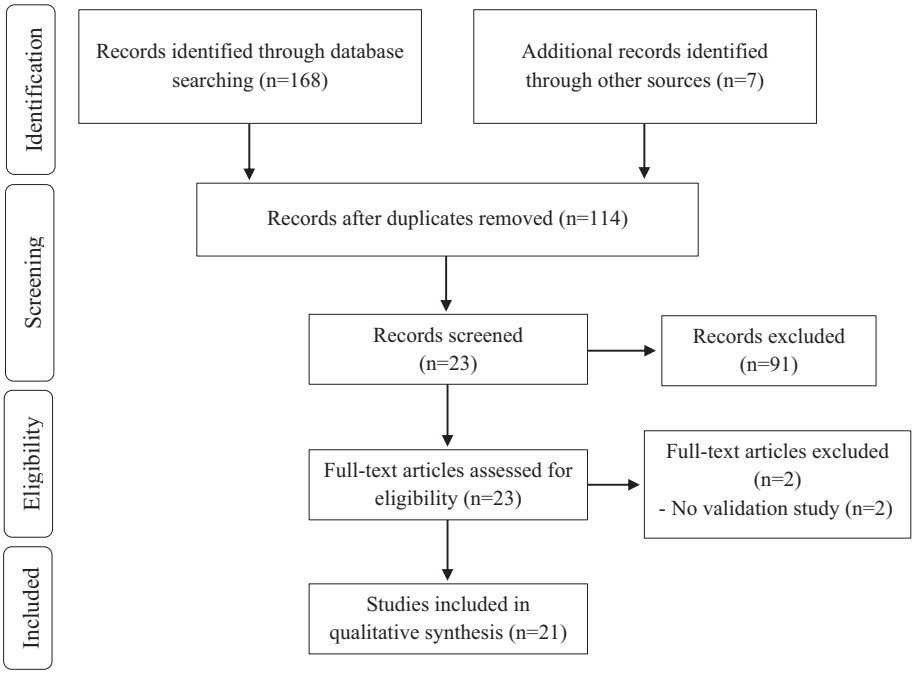

Figure 1. Flowchart of the search and selection process for articles included in the systematic review, according to PRISMA recommendation.

Among the instruments that were validation focus, authors used the instrument NUTRISCORE (22); other researchers used a questionnaire of their own, consisting of three questions related to unintentional weight loss in the last 5 months and changes in habitual eating and physical activity (32); and the tool developed by the British Association of Parenteral and Enteral Nutrition (BAPEN) (41). Other studies aimed at validating age–gender-specific body mass index percentile (AG-BMI) (25) and Bioelectrical Impedance (BIA) (27). The other instruments destined at validation were the Patient-Generated Subjective Global Assessment (PG-SGA) (33,42), Subjective Global Assessment (SGA) (34,36,38,40), Mini Nutritional Assessment (MNA) (23,39), Malnutrition Screening Tool (MST) (26,35,37), Malnutrition Universal Screening Tool (MUST) (29,35), Malnutrition Screening Tool for Hospitalized Cancer Patients (MSTC) (31), Prognostic Nutritional Index (PNI) (24,30), Head and Neck Patient Symptom Checklist (HNSC) (28), and Royal Marsden Nutrition Screening Tool (RMNST) (26) (Table 2).

In the concurrent validation, of the studies that presented values of sensitivity, specificity, and predictive values, the instrument that best had such values was PG-SGA (42) followed by NUTRISCORE (22). The MST presented excellent results in one study (37), but in the other two (26,35), its sensitivity values were low (66 and 48.7%, respectively). The MUST, validation object in two studies, had good values in one study (29) and in another one (35), showed great sensitivity and negative predictive value (97.3 and 98.6%, respectively), but low specificity and positive predictive value (77.4 and 63.2%, respectively). The tool developed by BAPEN (41) did not show good sensitivity and positive predictive value (59 and 38%, respectively) and the MNA (39) and RMNST (26) had good sensitivity (97 and 93%, respectively), but low specificity (54 and 53%, respectively). The MSTC (31) had good values except the positive predictive value (67.8%). In order to validate the HNSC, a list of symptoms that interfere with the dietary intake of patients with head and neck cancer, authors found values greater than 79% for each symptom (28) (Table 3).

Still on the concurrent validation, but using different statistical analysis described above, two studies have assessed the SGA through the Kappa consistency tests. This tools had moderate agreement compared to the PNI (40) and the percentage of weight loss ($\kappa = 0.435$ and $\kappa = 0.59$, respectively), and poor agreement with triceps skinfold thickness, serum albumin (ALB) and prealbumin levels (PA) ($\kappa = 0.31$, $\kappa = 0.27$ and $\kappa = 0.21$, respectively) (34). The study showed a good correlation between the proposed questionnaire and the PG-SGA (ROC = 0.85; IC 95%: 0.785–0.914; $P < .001$) (32) and another obtained similar results between BIA and DXA at the times analyzed ($P = .081$, $P = .0.447$ and $P = .957$) (27).

Table 1. Characteristics of validation studies of nutritional screening tools in adult and/or elderly patients with cancer selected for the systematic review.

Author (year)	Country (*n*)	Design	Population characteristics
Arribas et al., 2017 (22)	Spain ($n = 394$)	Cross-sectional study	Outpatients diagnosed with malignant neoplasm submitted to different types of treatments. Age range: over 18 years (mean age: 61.5 years ± 12.1). 55.1% men and 44.9% women. 18.8% abdominal and pelvic, 14.5% breast, 12.4% head and neck, 11.7% leukemia and other lymphomas, 10.4% lung, 9.9% upper GI tract (esophagus, gastric, pancreas, intestinal), 9.6% colorectal, 7.9% prostate, 3.8% central nervous system, 0.8% lymphomas that compromised GI tract and 0.3% others.
Bourdel-Marchasson et al., 2016 (23)	France ($n = 606/n = 229$)*	Cohort study	Patients with chemotherapy indication. Age range: over 70 years (mean age: NI). 55.3% men and 44.7% women. 30.2% colon, 12.3% lung, 11.6% pancreas, 10.7% stomach, 8.6% breast, 8.3% prostate, 7.9% bladder, 7.8% ovary, 1.8% cholangiocarcinoma and 0.8% unknown.
Geng et al., 2015 (24)	China ($n = 110/211$)*	Cohort study	Patients with advanced or metastatic pancreatic adenocarcinoma undergoing chemotherapy. Age range: NI (mean age: 62.2 years ± 10.2 and 60.4 years ± 11.0 to PNI < 47.3 and PNI ≥ 47.3, respectively). 65.6% men and 34.4% women. 36.9% pancreatic head and 63.1% pancreatic body-tail.
Van Veer et al., 2015 (25)	Belgium and Canada ($n = 642/n = 407$)**	Cohort study	Patients hospitalized in the preoperative esophagectomy. Age range: NI [mean age: 63.3 years (base study) and 63.5 years (validation study)]. 75.9% men and 24.1% women (base study); 80.7% men and 19.3% women (validation study).
Shaw et al., 2014 (26)	UK ($n = 126$)	Cross-sectional study	Patients on hospital admission. Age range: 19–81 years (mean age: 59 years). 46% men and 54% women. 23% haemato-oncology, 21% gastrointestinal, 11% urology, 10% breast, 10% gynecology, 9% sarcoma, 7% head and neck, 3% lung and 6% other.
Jager-Wittenaar et al., 2013 (27)	The Netherlands ($n = 24$)	Longitudinal study	Hospitalized patients with head and neck cancer. Age range: over 18 years (mean age: 60.4 ± 8.3 years). 83% men and 17% women. 38% oropharynx, 29% oral cavity, 25% larynx and 8% hypopharynx.
Schmidt et al., 2013 (28)	Canada ($n = 368$)	Cross-sectional study	Patients on hospital admission with head and neck cancer. Age range: 18–94 years (mean age: 62 years). 70.4% men and 29.6% women. 36.1% pharynx, 20.1% larynx, 23.1% lip and oral cavity and 20.6% salivary gland, hypopharynx, nasal and paranasal.
Boléo-Tomé et al., 2012 (29)	Portugal ($n = 450$)	Cross-sectional study	Ambulatory patients referred for radiotherapy. Age range: 18–95 years (mean age: 62 ± 13 years). 60% men and 40% women. Most frequent: 20.9% breast, 19.1% prostate, 16.2% lung and 13.6% colorectal.
Pinato et al., 2012 (30)	UK ($n = 112$)	Retrospective study	Hospitalized patients with hepatocellular carcinoma. Age range: 20–83 years (median age: 65 years; range: 20–83). 83.6% men and 16.4% women. 63% underlying cirrhosis and 65% compensated liver function.
Kim et al., 2011 (31)	Korea ($n = 800/n = 257$)*	Cross-sectional study	Hospitalized patients with cancer of stomach, colon, lung, liver (pancreas and gall bladder), breast, prostate, uterus, brain and spinal cord, head and neck cancer, and urinary organs. Age range: NI (mean age: 58.3 ± 11 years and 59.4 years ± 11.2 of development and validation groups, respectively). 58% men and 42% women (development study); 63% men and 37% women (validation study).
Candela et al., 2010 (32)	Spain ($n = 129$)	Cross-sectional study	Outpatients at the first visit. Age range: over 18 years (mean age: NI). 58.9% men and 41.1% women. 27.1% gastrointestinal, 16.3% breast, 17.8% otorhinolaryngological location, 7.7% genitourinary and 11.1% tumors at different sites.
Martin et al., 2010 (33)	Canada ($n = 1164/n = 603$)*	Cohort study	Outpatients with metastatic cancer in palliative care. Age range: over 18 years (mean age: 66.8 ± 13 years and

(*Continued*)

Table 1. Continued.

Author (year)	Country (*n*)	Design	Population characteristics
			60.5 ± 12.4 years of training and validation groups, respectively). 49% men and 51% women (training group); 48% men and 52% women (validation group). 29% lung, 25% gastrointestinal, 10% genitourinary, 9% breast, 6% hematology and 21% other (training group). 26% lung, 21% gastrointestinal, 18% genitourinary, 14% breast, 4% hematology and 16% other (validation group).
Wu et al., 2010 (34)	China ($n = 505$)	Cross-sectional study	Hospitalized patients with newly diagnosed gastrointestinal cancer without metastases in preoperatively. Age range: over 18 years (mean age: 60.7 ± 12.8 years). 60.8% men and 39.2% women. 51.1% stomach and 48.9% colorectal.
Amaral et al., 2008 (35)	Portugal ($n = 130$)	Prospective longitudinal study	Hospitalized patients. Age range: 22–97 years (mean age: 57.1 ± 13.5 years). 30.9% men and 69.1% women. 20.8% head and neck, 19.2% peritoneal and gastrointestinal, 17.7% breast, 13.1% genital-urinary system, 7.7% lymph ganglia, 4.6% endocrine glands, 3.8% soft tissues, 3.8% respiratory system and thoracic organs, 3.1% bones and joints, 1.5% hematopoietic system and endothelial reticulum, 0.8% eye and lachrymal gland and 0.8% other.
Gupta et al., 2008 (36)	USA ($n = 132$)	Cohort study	Hospitalized women with ovarian cancer. Age range: 25.5–82.5 years (mean age: 54.4 years). 18.2% newly diagnosed and 81.8% received prior treatment.
Isenring et al., 2006 (37)	Australia ($n = 50$)	Cross-sectional study	Outpatients undergoing chemotherapy. Age range: over 18 years (mean age: 59.1 ± 13.8 years). 36% men and 64% women. 38% breast, 28% gastrointestinal, 14% lymphoma, 6% head and neck, 4% ovarian, 4% lung and 6% other (leukemia, multiple myeloma, cervical).
Gupta et al., 2005 (38)	USA ($n = 234$)	Cohort study	Hospitalized patients with advanced colorectal cancer (stages III and IV). Age range: 29–82 years (mean age: 58.4 ± 10.6 years). 56.8% men and 43.2% women. 72.6% were diagnosed and treated before admission in hospital and 26.9% had a recent diagnosis.
Read et al., 2005 (39)	Australia ($n = 157$)	Cross-sectional study	Newly diagnosed outpatients. Age range: 32–81 years (median age: 65 years; range: 32–81). 63% men and 37% women. 50% colorectal, 28% lung, 4% esophagus, 8% stomach and 10% pancreas.
Santoso et al., 2004 (40)	USA ($n = 67$)	Cohort study	Hospitalized women with gynecological cancer. Age range: 25–99 (mean age: 51.5 ± 12.9 years). 49% admitted for surgical procedures and 51% admitted for medical or chemotherapy needs. 58% cervical, 24% endometrial, 16% ovarian and 2% vulvar carcinoma.
Bauer and Capra 2003 (41)	Australia ($n = 65$)	Cross-sectional study	Hospitalized patients. Age range: over 18 years (mean age: 56.4 ± 15.2 years). 60% men and 40% women. Main diagnoses were 49% of lymphoma and 13% of breast cancer.
Bauer et al. 2002 (42)	Australia ($n = 71$)	Cross-sectional study	Hospitalized patients. Age range: 18–92 years (mean age: 57.6 ± 15.4 years). 56% men and 44% women. Main diagnoses: 49% lymphoma, 13% breast, 4% prostate, esophagus, lung, sarcoma and myeloma.

GI: gastrointestinal; NI: not informed; PNI: Prognostic Nutritional Index.
*The authors use two sample groups (group training/development/testing and validation group).
**The authors describe the studies in "base study" conducted in Belgium and "validation study" conducted in Canada.

By predictive validation, among the studies using overall survival (OS) as an outcome measure, lower scores on the PG-SGA instrument showed higher OS ($P < 001$) (32). The SGA was used in two studies (36,38), and its A score (without nutritional risk) was related to the highest OS ($P = .0013$ and $P = .0003$, respectively). The PNI was used only focus on this type of validation, two items selected for this review (24,30), which showed correlation between PNI $<$ 47.3 (nutritional risk) with an OS shorter than those patients with PNI $\geq$ 47.3 (no nutritional risk). Overall survival was greater for percentiles greater than or

Table 2. Tool evaluated, tool/reference measure or outcome of interest and purpose of the studies selected for the systematic review.

Author (year)	Tool evaluated	Tool/reference measure or outcome of interest	Objective
Arribas et al., 2017 (22)	NUTRISCORE	PG-SGA	To design a new nutritional screening tool for outpatient oncology to detect nutritional risk.
Bourdel-Marchasson et al., 2016 (23)	MNA complete and the reduced version	Mortality in 1 year	To evaluate the prognostic value for mortality one year of items included in the full MNA or in short form.
Geng et al., 2015 (24)	PNI	OS	To study the prognostic value of PNI and demonstrate its association with the systemic inflammatory response.
Van Veer et al., 2015 (25)	AG-BMI	OS	To validate the general applicability of AG-BMI.
Shaw et al., 2014 (26)	RMNST and MST	PG-SGA	To evaluate the sensitivity and specificity of RMNST and MST against PG-SGA.
Jager-Wittenaar et al., 2013 (27)	BIA	DXA	To validate the BIA using the Geneva equation for fat-free mass (FFM).
Schmidt et al., 2013 (28)	HNSC	PG-SGA	To validate the HNSC.
Boléo-Tomé et al., 2012 (29)	MUST	PG-SGA	To validate the MUST for routine nutritional screening in the radiotherapy oncology environment.
Pinato et al., 2012 (30)	PNI	OS	To investigate whether the PNI is associated with OS.
Kim et al., 2011 (31)	MSTC	PG-SGA	To develop and validate a nutritional screening tool that could be used to identify cancer patients at risk of malnutrition.
Candela et al., 2010 (32)	Proposed questionnaire with three questions*	PG-SGA	To validate the proposed nutritional screening method.
Martin et al., 2010 (33)	PG-SGA	OS	To define PG-SGA elements in the prognosis of survival and determine its prognostic accuracy.
Wu et al., 2010 (34)	SGA	Anthropometric parameters and laboratory tests** Hospital stay, occurrence of complications and hospital medical expenses.	To verify the validity of the EMS in nutritional assessment and prognosis.
Amaral et al., 2008 (35)	MST and MUST	NRS-2002 Hospital stay	To compare three nutritional screening tools and its ability to predict longer hospital stay.
Gupta et al., 2008 (36)	SGA	OS	To evaluate the prognostic role of SGA.
Isenring et al., 2006 (37)	MST	PG-SGA	To validate the MST.
Gupta et al., 2005 (38)	SGA	OS	To evaluate the prognostic significance of SGA.
Read et al., 2005 (39)	MNA	PG-SGA	To compare the two nutritional screening tools.
Santoso et al., 2004 (40)	SGA	PNI	To study the correlation between SGA and PNI.
Bauer and Capra 2003 (41)	BAPEN Tool	SGA	To evaluate the sensitivity and specificity of malnutrition screening tool against SGA.
Bauer et al. 2002 (42)	PG-SGA	SGA	To evaluate the use of PG-SGA as a nutritional assessment tool.

AG-BMI: age–gender-specific body mass index percentile; BAPEN: British Association of Parenteral and Enteral Nutrition; BIA: bioelectrical impedance; DXA: dual-energy absorptiometry; HNSC: Head and Neck Patient Symptom Checklist; MNA: Mini-Nutritional Assessment; MST: Malnutrition Screening Tool; MSTC: Malnutrition Screening Tool for Hospitalized Cancer Patients; MUST: Malnutrition Universal Screening Tool; NRS-2002: Nutritional Risk Screening 2002; PG-SGA: Patient-Generated Subjective Global Assessment; PNI: Prognostic Nutritional Index; OS: overall survival; SGA: Subjective Global Assessment; RMNST: Royal Marsden Nutrition Screening Tool.
*Questionnaire with three questions (weight loss of 5 kg unintentional within the last 5 months, changes in usual eating and physical activity).
**Anthropometric parameters (percentage of weight loss and triceps skinfold) and laboratory tests (serum albumin and prealbumin levels).

equal to 10 in the age–gender-specific body mass index percentile (AG-BMI $\geq$ 10p) than the percentile lower than 10 (AG-BMI $<$ 10p) (25).

Concerning other outcomes for predictive validation, MUST and MST presented substantial ($\kappa = 0.64$) and moderate ($\kappa = 0.49$) agreement regarding hospital stay time, respectively (35); SGA presented a difference in length of hospital stay and medical expenses, where these outcomes increased according to the increasing degree of SGA (higher in the classification of severe malnutrition) (34); and MNA had a good correlation with mortality at 1 year for the full and reduced version (OR = 0.712 and OR = 0.793; $P < 0001$) (23).

Discussion

The ideal nutritional screening tool would be that 100% sensitive and specific (41). Due to the impossibility of it, however, the sensitivity has advantage compared to the specificity, so the method must be highly sensitive and have a good specificity (7). This is because the need to correctly classify all patients who are at nutritional risk has preference for the poor rating of well-nourished patients (41).

The PG-SGA showed better sensitivity, specificity, and predictive values. This instrument includes all aspects of the SGA, the initial four sections being completed by the patient himself and the other by the

Table 3. Statistical analysis and results of selected studies for the systematic review.

Author (year)	Statistical analysis	Results
Arribas et al., 2017 (22)	S, E, VPP and VPN. ROC curve. Kappa concordance index.	S = 97.3%; E = 95.9%; VPP = 84.8; VPN = 99. ROC AUC: 0.95 (IC 95%: 0.92–0.98). $\kappa = 0.88$ ($P < .0001$; IC 95%: 0.82–0.94).
Bourdel-Marchasson et al., 2016 (23)	Univariate and multivariate logistic models to estimate. Odds ratio (OR). IC 95%.	The final model had better prognostic discrimination value than the scores of MNA: the AUC of the complete MNA was 0.712 compared to 0.793, $P < .0001$.
Geng et al., 2015 (24)	Kaplan–Meier method*. Log-rank test.	Base study: log-rank = 14.304; $P < .001$ (low PNI correlated significantly with a shorter OS than those with a high PNI). Validation study: log-rank = 12.566; $P < .001$ (low PNI had a significantly shorter SG than those with a high PNI). Cox: HR = 0.627 (IC 95%: 0.453–0.868); $P < .001$.
Van Veer et al., 2015 (25)	Kaplan–Meier method*. Log-rank test.	Survival rate of 5 years 38.19% (AG-IMC $\geq$ 10p) and 19.44% (AG-IMC < 10p) for the validation cohort ($P < .001$), and 49.03% (AG-IMC $\geq$ 10p) and 30.93% (AG-IMC < 10p) for the base cohort ($P = .003$).
Shaw et al., 2014 (26)	S, E, VPP and VPN. ROC curve.	RMNST: S = 93%; E = 53%; VPP = 83%; VPN = 76%. MST: S = 66%; E = 83%; VPP = 91%; VPN = 49%. ROC AUC: 0.84 (IC 0.77–0.91) for RMNST and 0.83 (IC 0.74–0.91) for MST, both rated as having excellent performance.
Jager-Wittenaar et al., 2013 (27)	X^2 test**. Significance level of 95%.	$P = .081$ (T_0); $P = .447$ (T_1) and $P = .957$ (T_2).
Schmidt et al., 2013 (28)	S, E, VPP and VPN.	S = 79–98%; E = 99–100%; VPP = 92–100%; VPN = 94–100%.
Boléo-Tomé et al., 2012 (29)	S, E, VPP and VPN. Kappa concordance index.	S = 80%; E = 89%; VPP = 87%; VPN = 100%. $\kappa = 0.86$ ($P < .002$).
Pinato et al., 2012 (30)	Cox proportional hazard model.	Univariate and multivariate analyzes: $P < .05$. Cox: HR = 2.02 (IC 95%: 1.26–3.23); $P = .03$.
Kim et al., 2011 (31)	S, E, VPP and VPN. ROC curve. Kappa concordance index.	S = 94%; E = 84.2%; VPP = 67.8%; VPN = 97.6%. ROC AUC: 0.948. $\kappa = 0.70$ ($P < .0001$).
Candela et al., 2010 (32)	ROC curve. IC 95%.	ROC AUC: 0.85 (IC 95%: 0.785–0.914); $P < .001$.
Martin et al., 2010 (33)	Kaplan–Meier method*. Log-rank test.	PG-SGA PS Score from 0 to 2: 4.3 months (IC 95%: 3.8 to 4.8 months); score from 3: 2.5 months (IC 95%: 2.2 to 2.8 months); score from 4: 1.3 months (IC 95%: 0.5 to 2.0 months); $P < .001$.
Wu et al., 2010 (34)	Kappa concordance index. IC 95%. χ^2 test. ANOVA and post hoc. Significance level of 95%.	$\kappa = 0.59$ ($P < .001$): SGA and the weight loss percentage; $k = 0.31$ ($P < .001$): SGA and TSF; $\kappa = 0.27$ ($P < .001$): SGA and ALB; $\kappa = 0.21$ ($P < .001$): SGA and PA. $X^2 = 4.16$ ($P = .125$): postoperative complications; $F = 7.07$ ($P = .001$): hospital stay; $F = 11.5$ ($P = .000$): medical expenses. Post hoc: hospital stay and hospital medical expenses increased according to the increasing degree of SGA (higher in the SGA group C) ($P < .01$).
Amaral et al., 2008 (35)	S, E, VPP and VPN. Kappa concordance index. Odds ratios (OR) adjusted for sex and age. IC 95%.	MUST: S = 97.3%; E = 77.4%; VPP = 63.2%; VPN = 98.6%. MST: S = 48.7%; E = 94.6%; VPP = 78.3%; VPN = 82.2%. $\kappa = 0.64$ (MUST); $\kappa = 0.49$ (MST). NRS-2002: OR = 2.47 (1.05–5.80; $P = .003$); MUST: OR = 3.24 (1.50–7.00; $P = .038$); MST: OR = 2.31 (0.84–6.36; $P \geq .05$).
Gupta et al., 2008 (36)	Kaplan–Meier method*. Log-rank test. Proportional risk model. Multivaring Cox after adjustment for stage in diagnosis and previous treatment history.	SGA A was 19.3 months (IC 95%: 14.1–24.5); SGA B was 15.5 months (IC 95%: 5.8–25.1); SGA C was 6.7 months (IC 95%: 4.1–9.3). Log-rank = 15.9; $P = .0003$. SGA B associated with a relative risk of 2.1 (IC 95%: 1.2–3.6; $P = .008$) and SGA C associated with a relative risk of 3.4 (IC 95% 1.9–5.8; $P < .001$), compared to the SGA A.
Isenring et al., 2006 (37)	S, E, VPP and VPN.	S = 100%; E = 92%; VPP = 80%; VPN = 100%.
Gupta et al., 2005 (38)	Kaplan–Meier method*. Log-rank test.	SGA A was 12.8 months (IC 95%: 9.1–16.5); SGA B was 8.8 months (IC 95%: 6.7–10.9); SGA C was 6 months (IC 95%: 3.9–8.1); $P = .0013$.
Read et al., 2005 (39)	S, E and VPP.	S = 97%; E = 54%; VPP = 59%.
Santoso et al., 2004 (40)	Kappa concordance index. IC 95%.	$\kappa = 0.435$ (IC 95%: 0.28–0.59).
Bauer and Capra 2003 (41)	S, E, VPP and VPN.	S = 59%; E = 75%; VPP = 88%; VPN = 38%.
Bauer et al. 2002 (42)	S, E, VPP and VPN.	S = 98%; E = 82%; VPP = 95%; VPN = 93%.

AG-BMI: age–gender-specific body mass index percentile; ALB: albumin; IC: confidence interval; MNA: Mini-Nutritional Assessment; MST: Malnutrition Screening Tool; MUST: Malnutrition Universal Screening Tool; NIS: symptoms of nutritional impact; NRS-2002: Nutritional Risk Screening 2002; OS: overall survival; PA: prealbumin; PNI: Prognostic Nutritional Index; RMNST: Royal Marsden Nutrition Screening Tool; SGA: Subjective Global Assessment; TSF: triceps skinfold thickness; S: sensitivity; E: specificity; VPP: positive predictive value; VPN: negative predictive value; κ: kappa statistics; T_0: the week before treatment begins; T_1: 1 month after the end of treatment; T_2: 4 months after the end of treatment.

*Kaplan–Meier method: calculate the overall survival (OS).

**χ^2 test: chi-square test.

clinician (physician, nurse or dietitian) (11). Thus, it requires that patients are able to read and write, and the conclusion of the evaluation depends on qualified technicians (35). It is a more specific method for cancer patients compared to SGA because it considers more acute changes in weight and dietary intake and a greater variety of symptoms of nutritional impact likely to be experienced by them (37). In addition to the categorical classification, a common feature of SGA, the PG-SGA measures the nutritional status in a continuous scoring scale, allowing the detection of subtle changes over short periods of time and enabling follow-up through more frequent evaluations of the patient (38). We found in the search for this review, but it was not included, the study that proposed a cross-cultural adaptation of the Portuguese language version of PG-SGA (43).

The NUTRISCORE tool, which also presented high values, was developed using the MST as a base, and the items tumor location and cancer treatment were introduced, both of which have a huge effect on the nutritional status of the patient (22).

The MNA appeared highly sensitive, but with a low specificity when used in cancer patients 32–81 years (39). This nutritional risk assessment tool was validated in the elderly, presenting sensitivity of 96% and specificity of 98%, using anthropometry, biochemical markers, and dietary parameters as reference measures; and was predictive of hospital mortality and cost (12).

As the Prognostic Nutritional Index (PNI), this proved to be predictive of OS (24,30); however, as is mainly based on laboratory tests, it is calculated by means of serum albumin and blood lymphocyte counts (24) cannot be considered easy and fast, since it requires the collection of blood and the waiting time for laboratory results (40). This index, which was originally proposed as a preoperative and determinant risk factor for surgical indication in colorectal cancer, is widely used as a parameter for nutritional assessment in patients with cancer (24).

Although the importance of malnutrition to the clinical course of cancer patients was recognized, there is still no standard method for its evaluation in these patients (2). The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends, in hospitalized patients, the use of NRS-2002 (8), which includes the diagnosis of cancer as a risk factor for malnutrition (2). However, according to the ESPEN guideline of 2017, specific for cancer patients, there is no consensus on the nutritional screening methods (7). To detect nutritional disorders early, it is recommended regular evaluation of the change in weight, BMI, and food intake, which can be obtained directly or through screening tools, as the NRS-2002, MUST, MST, and complete MNA and its reduced form (7).

The American Society for Parenteral & Enteral Nutrition (ASPEN) recommend NRS-2002 in preoperative assessment, including cancer surgery patients, who are defined in nutritional risk for a higher score than 3 and at high risk with higher scores than or equal to 5 (44).

The Oncology Nutrition Dietetic Practice Group of the American Dietetic Association adopted the PG-SGA as the standard of nutritional screening tool for patients with cancer (42). This instrument is also recommended in UK guidelines (45).

In Brazil, the *Consenso Nacional de Nutrição Oncológica* of 2016 (46) recommends for adult cancer patients critical the use of NRS-2002, SGA, and PG-SGA; and for elderly oncologic patients, advises PG-SGA and MNA on hospital admission (first 24 to 48 h) and PG-SGA and MNA reduced version in the outpatient setting. During hospitalization, the same consensus does not propose the use of any of the instruments identified in the present study.

Despite being widely recommended by European and American organizations, as in Brazil, no studies were found that aimed at validating the NRS-2002 in this study, and it was used as a reference tool in only one study (35). By means of this tool, patients are classified by two components: malnutrition (weight loss, BMI, and food intake in the previous week) and disease severity, with a score of 0 to 3 for each of the components (absent, mild, moderate, or severe) (16). The total score calculated from these two components and added to score 1 for patients over 70 years of age, a score greater than or equal to 3 is classified as a nutritional risk (47).

In the absence of nutritional screening, malnutrition may be neglected, particularly in patients who are still within the considered adequate or overweight weight, but who have lost significant amounts of weight (13). Thus, the evaluation should be performed early in the treatment to guide the nutritional intervention, being repeated at appropriate intervals to monitor its effects (7).

The main limitation was the non-accomplishment of the calculation of the sample size in the majority of the selected studies, being realized only in two manuscripts (22,26). A validation study, in addition to being conducted in the environment in which the instrument will be used and the subjects selected by

random sampling or convenience, must be representative of the population, which is intended, ensuring the representation of the study (17).

Conclusion

The PG-SGA stood out and its use is recommended in cancer patients in many countries. In addition to this, international organizations recommend the NRS-2002, despite the no identification papers to propose their validation in the present study. We suggest that nutritional screening tools validation studies be performed on cancer patients using representative samples for better reliability of their results.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Funding

The authors thank the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG, Brazil), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brazil) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil) for their financial support for research.

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References

1. International Agency for Research on Cancer (IARC). *Cancer Today*. World Health Organization (WHO). Disponível em: www.gco.iarc.fr/today/home.
2. Planas M, Álvarez-Hernández J, León-Sanz M, Celaya-Pérez S, and Araujo K: Prevalence of hospital malnutrition in cancer patients: a sub-analysis of the PREDyCES® study. *Support Care Cancer* **24**, 429–435, 2016.
3. Baldwin C, McGough C, Spiro A, Thomas K, Cunningham DC, et al.: Nutritional and clinical characteristics of patients with gastrointestinal tract (GI) cancers at presentation. *Proc Nutr Soc* **68**, E18, 2009.
4. Bozzetti F: Screening the nutritional status in oncology: a preliminary report on 1,000 outpatients. *Support Care Cancer* **17**, 279–284, 2009.
5. Hébuterne X, Lemarié E, Michallet M, Montreuil CB, Schneider SM, et al.: Prevalence of malnutrition and current use of nutrition support in patients with cancer. *J Parenter Enteral Nutr* **38**, 196–204, 2014.
6. Cutsem EV, and Arends J: The causes and consequences of cancer-associated malnutrition. *Eur J Oncol Nurs* **9**, S51–S63, 2005.
7. Arends J, Bachmann P, Baracos V, Barthelemy N, Bertz H, et al.: ESPEN guidelines on nutrition in cancer patients. *Clin Nutr* **36**, 11–48, 2017.
8. Kondrup J, Allison SP, Elia M, Vellas B, and Plauth M: ESPEN Guidelines for Nutrition Screening 2002. *Clin Nutr* **22**, 415–421, 2003.
9. Tan CSY, Read JA, Phan VH, Beale PJ, Peat JK, et al.: The relationship between nutritional status, inflammatory markers and survival in patients with advanced cancer: a prospective cohort study. *Support Care Cancer* **23**, 385–391, 2015.
10. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, et al.: What is subjective global assessment of nutritional status? *J Parenter Enteral Nutr* **11**, 8–13, 1987.
11. Ottery FD: Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition* **12**, S15–S19, 1996.
12. Vellas B, Guigoz Y, Garry PJ, Nourhashemi F, Bennahum D, et al.: The mini nutritional assessment (MNA) and its use in grading the nutritional state of elderly patients. *Nutrition* **15**, 116–122, 1999.
13. Ferguson M, Capra S, Bauer J, and Banks M: Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. *Nutrition* **15**, 458–464, 1999.
14. Stratton RJ, Hackston A, Longmore D, Dixon R, Price S, et al.: Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. *BJN* **92**, 799–808, 2004.
15. Buzby GP, Mullen JL, Matthews DC, Hobbs CL, and Rosato EF: Prognostic nutritional index in gastrointestinal surgery. *Am J Surg* **139**, 160–167, 1980.
16. Kondrup J, Rasmussen HH, Hamberg O, and Stanga Z: Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr* **22**, 321–336, 2003.
17. Jones JM: Validity of nutritional screening and assessment tools. *Nutrition* **20**, 312–317, 2004.
18. Kimberlin CL, and Winterstein AG: Validity and reliability of measurement instruments used in research. *Am J Health Syst Pharm* **65**, 2276–2284, 2008.
19. Bolarinwa OA: Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Niger Postgrad Med J* **22**, 195–201, 2015.
20. Moher D, Liberati A, Tetzlaff J, and Altman DG: and The PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Disponível em: www.prisma-statement.org.
21. Landis JR, and Koch GG: The measurement of observer agreement for categorical data. *Biometrics* **33**, 159–174, 1977.
22. Arribas L, Hurtós L, Sendrós MJ, Peiró I, Salleras N, et al.: NUTRISCORE: a new nutritional screening tool for oncological outpatients. *Nutrition* **33**, 297–303, 2017.

23. Bourdel-Marchasson I, Diallo A, Bellera C, Blanc-Bisson C, Durrieu J, et al.: One-year mortality in older patients with cancer: development and external validation of an MNA-based prognostic score. *PLoS One* **11**, e0148523, 2016.
24. Geng Y, Qi Q, Sun M, Chen H, Wang P, et al.: Prognostic nutritional index predicts survival and correlates with systemic inflammatory response in advanced pancreatic cancer. *Eur J Surg Oncol* **41**, 1508–1514, 2015.
25. Van Veer H, Moons J, Darling G, Lerut T, Coosemans W, et al.: Validation of a new approach for mortality risk assessment in oesophagectomy for cancer based on age- and gender-corrected body mass index. *Eur J Cardiothorac Surg* **48**, 600–607, 2015. DOI:10.1093/ejcts/ezu503.
26. Shaw C, Fleuret C, Pickard JM, Mohammed K, Black G, et al.: Comparison of a novel, simple nutrition screening tool for adult oncology inpatients and the Malnutrition Screening Tool (MST) against the Patient-Generated Subjective Global Assessment (PG-SGA.). *Support Care Cancer* **23**, 47–54, 2014. DOI: 10.1007/s00520-014-2319-8.
27. Jager–Wittenaar H, Dijkstra PU, Earthman CP, Krijnen WP, Langendijk JA, et al.: Validity of bioelectrical impedance analysis to assess fat-free mass in patients with head and neck cancer: an exploratory study. *Wiley Online Library* **36**, 585–591, 2013. DOI: 10.1002/hed.23336.
28. Schmidt KN, Olson K, Kubrak C, Parliament M, and Ghosh S: Validation of the head and neck patient symptom checklist as a nutrition impact symptom assessment tool for head and neck cancer patients. *Support Care Cancer* **21**, 27–34, 2013.
29. Boléo-Tomé C, Monteiro-Grillo I, Camilo M, and Ravasco P: Validation of the Malnutrition Universal Screening Tool (MUST) in cancer. *Br J Nutr* **108**, 343–348, 2012.
30. Pinato DJ, North BV, and Sharma R: A novel, externally validated inflammation-based prognostic algorithm in hepatocellular carcinoma: the prognostic nutritional index (PNI). *Br J Cancer* **106**, 1439–1445, 2012.
31. Kim JY, Wie GA, Cho YA, Kim SY, Kim SMA, et al.: Development and validation of a nutrition screening tool for hospitalized cancer patients. *Clin Nutr* **30**, 724–729, 2011.
32. Candela CG, Roldán JO, García M, Marín M, Madero R, et al.: [Assessment of a malnutrition screening tool in cancer patients]. *Nutr Hosp* **25**, 400–405, 2010.
33. Martin L, Watanabe S, Fainsinger R, Lau F, Ghosh S, et al.: Prognostic factors in patients with advanced cancer: use of the patient-generated subjective global assessment in survival prediction. *J Clin Oncol* **28**, 4376–4383, 2010.
34. Wu B, Yin T, Cao W, Gu ZD, Wang X, et al.: Validation of the Chinese version of the Subjective Global Assessment scale of nutritional status in a sample of patients with gastrointestinal cancer. *Int J Nurs Stud* **47**, 323–331, 2010.
35. Amaral TF, Antunes A, Cabral S, Alves P, and Kent-Smith L: An evaluation of three nutritional screening tools in a Portuguese oncology centre. *J Hum Nutr Diet* **21**, 575–583, 2008.
36. Gupta D, Lammersfeld CA, Vashi PG, Dahlk SL, and Lis CG: Can subjective global assessment of nutritional status predict survival in ovarian cancer? *J Ovarian Res* **1**, 5, 2008. DOI: 10.1186/1757-2215-1-5.
37. Isenring E, Cross G, Daniels L, Kellett E, and Koczwara B: Validity of the malnutrition screening tool as an effective predictor of nutritional risk in oncology outpatients receiving chemotherapy. *Support Care Cancer* **14**, 1152–1156, 2006.
38. Gupta D, Lammersfeld CA, Vashi PG, Burrows J, Lis CG, et al.: Prognostic significance of Subjective Global Assessment (SGA) in advanced colorectal cancer. *Eur J Clin Nutr* **59**, 35–40, 2005.
39. Read JA, Crockett N, Volker DH, MacLennan P, Choy STB, et al.: Nutritional assessment in cancer: comparing the mini-nutritional assessment (MNA) with the scored patient-generated subjective global assessment (PGSGA). *Nutr Cancer* **53**, 51–56, 2005.
40. Santoso JT, Cannada T, O'Farrel B, Alladi K, and Coleman RL: Subjective versus objective nutritional assessment study in women with gynecological cancer: a prospective cohort trial. *Int J Gynecol Cancer* **14**, 220–223, 2004.
41. Bauer J, and S C: Comparison of a malnutrition screening tool with subjective global assessment in hospitalised patients with cancer – sensitivity and specificity. *Asia Pacific J Clin Nutr* **12**, 257–260, 2003.
42. Bauer J, Capra S, and Ferguson M: Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. *Eur J Clin Nutr* **56**, 779–785, 2002.
43. Campos J, and Prado CD: Cross-cultural adaptation of the Portuguese version of the patientgenerated subjective global assessment. *Nutr Hosp* **27**, 583–589, 2012.
44. McClave SA, Kozar R, Martindale RG, Heyland DK, Braga M, et al.: Summary points and consensus recommendations from the North American surgical nutrition summit. *J Parenter Enteral Nutr* **37**, 99S–105S, 2013.
45. Talwar B, Donnelly R, Skelly R, and Donaldson M: Nutritional management in head and neck cancer: United Kingdom National Multidisciplinary Guidelines. *J Laryngol Otol* **130**, S32–S40, 2016.
46. Instituto Nacional de Câncer José Alencar Gomes da Silva. *Consenso Nacional de Nutrição Oncológica*. 2th ed. Rio de Janeiro, RJ: INCA, 2015.
47. Schwegler I, Von Holzen A, Gutzwiller JP, Schlumpf R, Mühlebach S, et al.: Nutritional risk is a clinical predictor of postoperative mortality and morbidity in surgery for colorectal cancer. *Br J Surgery* **97**, 92–97, 2009.