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CLINICAL GUIDELINES

Malnutrition risk screening in adult oncology outpatients: An ASPEN systematic review and clinical recommendations

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Abstract

Background: Malnutrition screening is not widely practiced in outpatient cancer centers. This review aims to determine the validity of malnutrition screening tools and provide recommendations for clinical use.

Methods: Studies identified by a systematic review assessed the general validity of screening tools in adult oncology outpatients from five databases through 2022. The American Society for Parenteral and Enteral Nutrition (ASPEN) convened a working group of members from the Academy of Nutrition and Dietetics, Academy of Oncology Nurse and Patient Navigators, American Cancer Society, American Society for Clinical Oncology, American Society for Nutrition, American Society for Radiation Oncology, Association of Cancer Care Centers, and Oncology Nursing Society to answer the following questions: (1) should clinicians screen for malnutrition, (2) which malnutrition screening tools are recommended, and (3) what are the clinical applications for malnutrition risk screening in adult oncology outpatients?

Results: Twenty of 738 studies met the criteria and were reviewed. Six screening tools with specific cut-points demonstrated validity and are recommended, including the Mini Nutritional Assessment (≤23.5), Malnutrition Screening Tool (MST; MST ≥ 2 and patient-led MST ≥ 2), Malnutrition Universal Screening Tool (MUST; MUST ≥ 1 and MUST ≥ 2), Nutrition Risk Screening-2002 (NRS-2002;

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NRS-2002 ≥ 2 and NRS-2002 ≥ 3), NUTRISCORE ≥ 5, and Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF; PG-SGA SF ≥ 7 and PG-SGA SF ≥ 8).

Conclusion: Six screening tools are valid for malnutrition risk identification in oncology ambulatory settings and recommended before treatment initiation and regularly thereafter, depending on treatment course. Research is needed to understand to what extent early diagnosis and management of malnutrition improves the clinical care of oncology patients.

KEYWORDS
nutrition, nutrition assessment, oncology, research and diseases, weight loss

INTRODUCTION

Malnutrition is present in 25% to 75% of patients with cancer,[1–3] increasing treatment interruptions and toxicities, hospital admissions and length of stay, and mortality.[4] The Academy of Nutrition and Dietetics (AND) and the American Society for Parenteral and Enteral Nutrition (ASPEN) recommend the use of a single set of diagnostic criteria, including validated malnutrition screening tools to rapidly identify patients at risk.[5] Yet in the United States, where 90% of patients with cancer are treated in outpatient cancer centers, there is a consistent lack of malnutrition screening. In a 2019 survey, approximately half (53%) of all cancer centers implemented screening, with only 35% of those using validated screening tools.[6] Consequently, the actual incidence and risk prevalence of malnutrition in outpatient environments remain uncertain. Thus, recommendations for malnutrition screening in outpatient cancer centers can better define malnutrition prevalence and impact on patients.

Although several validated screening tools for the outpatient oncology setting exist, there is no universally accepted approach or "gold standard" tool.[7] Diagnosing malnutrition may involve simple assessments of appetite and unintentional weight loss, whereas more complex tools measure anthropometric data and laboratory parameters.[5]

Malnutrition screening tools should be standardized, validated, and have low interrater variability and high reliability. They should be quick and easy to use in clinical practice, allowing for the identification of at-risk individuals and potentially leading to a detailed nutrition assessment and treatment plan.[7,8]

This systematic review purported to assess the literature regarding malnutrition screening tools to (1) determine the general validity of the tools in adult oncology outpatient settings and (2) evaluate whether the general validity varied based on the characteristics of the populations examined (age, cancer type, stage or treatment modality, current status, time from diagnosis, and weight status). The clinical recommendations aimed to answer specific questions, including: (1) should clinicians screen for malnutrition in outpatient cancer centers, (2) which screening tools are recommended in outpatient cancer centers, and (3) what are the clinical applications for malnutrition risk screening among adult oncology outpatients?

This paper has been approved by the ASPEN Board of Directors.

METHODS

A protocol for the systematic review on malnutrition screening tools used in oncology care was written a priori following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) checklist. The PRISMA checklist was used for reporting this review.[9,10]

Eligibility criteria

Prospective or retrospective quantitative studies, including randomized studies, cross-sectional, case-control, or cohort studies, or systematic reviews or meta-analyses, were eligible if they calculated the validity (eg, sensitivity, specificity, accuracy, and/or predictive value) of malnutrition screening tools, also known as the index test, against a reference standard for adult (age ≥16 years) oncology outpatients. The index test was defined as a malnutrition screening tool that included two or more indicators of malnutrition that generated a malnutrition risk score/rating. To be included, the index test had to be compared with at least one of the following four reference standards:

- Subjective Global Assessment (SGA).
- Patient-Generated SGA (PG-SGA).
- Global Leadership Initiative on Malnutrition (GLIM).
- The AND/ASPEN Indicators to Diagnose Malnutrition consensus statement recommendations meeting two of the following six characteristics: insufficient energy intake, weight loss, loss of muscle mass, loss of subcutaneous fat, localized or general fluid accumulation, and diminished functional status as measured by handgrip strength.

Studies not available in English and conducted in nonoutpatient adult settings were excluded. Editorials, commentaries, conference abstracts or posters, case reports, case series, systematic reviews, or

meta-analyses that included study designs that did not meet the inclusion criteria were ineligible.

Information sources and search strategy

A National Institutes of Health biomedical librarian (A.L.) conducted five citation and abstract database searches using the Cumulative Index of Nursing and Allied Health Literature (CINAHL Plus; EBSCOhost), Cochrane Library Database of Systematic Reviews (Wiley & Sons), Embase (Elsevier), PubMed/MEDLINE (US National Library of Medicine), and the Web of Science: Core Collection (Clarivate Analytics). The searches were completed in March 2021 and updated in June 2022.

Each concept of interest (ie, malnutrition, cancer, and assessment) included a combination of keywords and controlled vocabulary terms (CINAHL Subject Headings, EMTREE, and/or Medical Subject Headings). The search terms were developed by the biomedical librarian with feedback and review by the team members. Searches were limited by publication year (January 2010–June 2022) and English language. Search strategies were used to remove specific article types (letters, editorials, commentaries, errata, conference abstracts or papers, corrigenda, retractions, and protocols) that were detailed in our exclusion criteria from the database search results. See Tables S1–S5 for the final search strategies.

The biomedical librarian used EndNote 20 (Clarivate Analytics) to manage database search results and identify duplicate records.

Selection process

A two-stage screening process was used to select records for inclusion. First, the titles and abstracts of all unique records identified from the database searches were screened using the established eligibility criteria. Next, for all records included after title and abstract screening, the full text was obtained and screened using the same eligibility criteria. Two reviewers independently screened each record at both stages; a different third reviewer resolved any disagreements between the reviewers. Covidence (Veritas Health Innovations) was used for screening.

Before commencing the formal screening process, all participating reviewers completed pilot training. The biomedical librarian selected and uploaded a random sample of 45 records into Covidence. Two pilot sessions of title and abstract screening on 45 records and one session of full-text screening on 10 records were completed. After the training, the eligibility criteria were further refined and documented in the protocol for implementation.

Data extraction process and data items

Two reviewers independently extracted data from each included article using Microsoft Excel (Redmond, WA). Discrepancies were resolved by a different reviewer. If data were missing, the corresponding author was contacted.

The following data were extracted from each included article: first author's last name; publication year; study country; participant's age and sex; sample size; when possible, cancer site and stage and treatment status and modality; study design; screening tool used as the index test; reference standard used; sensitivity and specificity values; positive and negative predictive values; area-under-the-curve values; diagnostic odds ratios; positive and negative likelihood ratios; correlation coefficient; and any other relevant statistical results.

The values for sensitivity and specificity were interpreted as follows: a value >80% was good, 60% to 80% was fair, and <60% was poor.[11] The score category for each screening tool used for classifying patients at risk was noted.

Study risk-of-bias assessment

Two reviewers assessed the risk of bias for each included article independently using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) tool.[12] Disagreements between reviewers were resolved by discussion between the reviewers and an additional team member.

The QUADAS-2 tool assesses four domains of bias: patient selection (selection of patients included and whether the chosen study population aligned with the research question), index testing (centers on the administration and interpretation of the survey), the index test reference standard (reference standard defined, along with appropriate conduct and interpretation of the standard), and the flow and timing of data collection (timing and interval of reference standard and intervention delivery). Each article was scored low, moderate/unclear, or high risk for each domain criterion.

Determination of clinical recommendations

A core team (E.B.T., K.C.K., C.T., F.F.Z., K.P., T.M., A.T., V.W., D.W., M.P., and C.K.S.) compiled and shared the results of the systematic review with the larger working group, comprised of representatives from nutrition and cancer societies—ASPEN, AND, Academy of Oncology Nurse and Patient Navigators, American Cancer Society, American Society for Clinical Oncology (ASCO), American Society for Nutrition, American Society for Radiation Oncology, Association of Cancer Care Centers (ACCC), and Oncology Nursing Society.

The core team and larger working group, or the leadership committee, met via a videoconference call and discussed the results. On the same call, the leadership committee agreed on the answers to three specific questions, namely: (1) should clinicians screen for malnutrition in adult outpatient cancer centers, (2) which criteria are recommended for screening in outpatient cancer centers, and (3) what are the recommended clinical applications for malnutrition risk screening among adult oncology outpatients?

Those members who were not present on the conference call received an audio recording of the meeting and were asked for feedback on the discussion. No members dissented from the agreed upon clinical recommendations.

RESULTS

Study selection

The database search resulted in 11,551 records, of which 4445 were duplicates, leaving 7106 unique records. After title and abstract screening, 6368 were excluded, leaving 738 for full-text screening. Of these, 718 did not meet the inclusion criteria and were excluded, leaving 20 records for inclusion in the review (Figure 1).

Study characteristics

All studies were observational (18 cross-sectional, one longitudinal, and one retrospective) and included between 52 and 450 screened patients. No studies were conducted in the US.

Table 1 describes the general characteristics of the study populations. Of the 18 studies that reported mean age, the average age of the population was 59.7 years. Males and females were represented almost equally (54.7% males). Among the 20 studies, cancer site was represented by a variety of solid and hematological malignancies, including nine colorectal, eight breast, five gastrointestinal, three head and neck, three hematological, three lung, two pancreatic; one central nervous system, one gynecological, one esophageal, one prostate, one ovarian, eight other cancer types ("other" cancer types were those types that

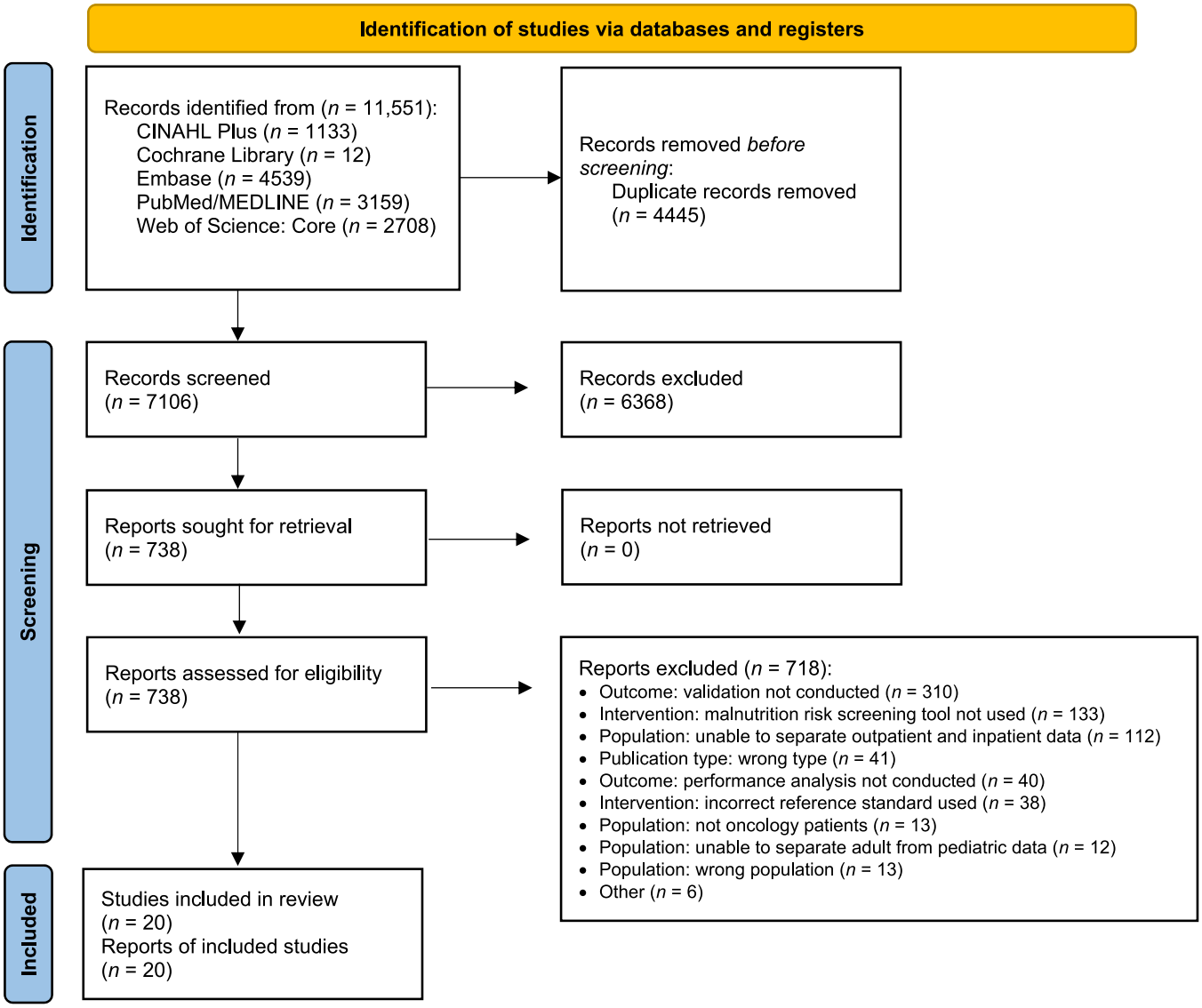

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. Database searches retrieved 11,551 records. After removing 4445 duplicates, 7106 records were screened. Title and abstract screening excluded 6368 records, and 738 records were fully text screened. Full-text screening excluded 718 records, leaving 20 records for inclusion.

TABLE 1 Baseline population characteristics of included papers.

First author, year, location	Study design	*N*	Age, mean (SD) or median (R), years	Male, %	Cancer site andstage, %	Treatment status, %	Treatment modality, %	BMI,[a] mean (SD) ormedian (R)	BMI[b] category, %	Index test	Reference standard malnourished by method % or mean (SD)
Abbott 2014,[13] 2016[14] Australia	Cross-sectional	300	58.6 (13.4)	51.7	Heme: 31.3 GI: 21.0 Breast: 19.7 Stage: NA	Active: 100	CT ± RT Targeted ± RT	27.8 (6.8)	NA	MST (≥2) and PG-SGA, PG-SGA SF	PG-SGA BC: 17
Abe Vicente 2013 Brazil[15]	Cross-sectional	Group 1: 75	60.2 (12.2)	48	CRC: 85.3 GI: 14.7 III/IV: 82.7	Pre: 40 Active: 60	CT ± S	NA	UW: 6.7 NW: 54.7 OW/OB: 38.6	NRI, MST, MUST	PG-SGA BC: 66
		Group 2: 62	61.3 (11.6)	45.2	CRC: 83.9 GI: 16.1 III/IV: 37.1	Post: 100	CT ± S	NA	UW: 3.2 NW: 46.8 OW/OB: 50	NRI, MST, MUST	PG-SGA: BC 30.9
Arribas 2017 Spain[16]	Cross-sectional	394	61.5 (12.1)	55.1	Variety solid tumors: 87.5 Heme: 12.5 All stages included	Pre/Active/Post: 100	CT ± RT: 45.4 RT: 18.8 HSCT: 7.1 Other or palliative: 28.7	26.3 (4.87)	NA	NUTRISCORE, MST	PG-SGA BC: 19
Boleo-Tome 2012 Portugal[17]	Cross-sectional	450	62 (13)	60	Breast or prostate: 40 Lung: 16.2 CRC: 13.6 III/IV: 60.7	Active: 100	RT: curative (63.3) and palliative (36.7)	NA	UW: 4 NW: 33 OW/OB: 63	MUST	PG-SGA BC: 30
Carrico 2021 Portugal[18]	Cross-sectional	355	60.6 (13.1)	40.3	Breast: 25.9 CRC: 15.8 Lung: 14.9 Panc: 10.1 Other: 33.3 Stage: NA	Active: 100	CT: 100	25.0 (4.3)	UW: 4.5 NW: 48.2 OW/OB: 47.3	PG-SGA SF	PG-SGA BC: 49.8
Chen 2022 China[19]	Cross-sectional	146	60.3 (10.1)	57.5	Lung: 33.6 Panc: 13.0 Breast: 9.6 Other: 43.8 Stage: NA	NA	NA	21.7 (3.5)	NA	NRS-2002	PG-SGA: 14.6 (5.5)
De Groot 2020	Cross-sectional	246	61.9 (13.1)	26	Breast: 45 GYN: 13	Active: 100	"In-chair IV treatment": 100	NA	UW: 14 NW: 47	PG-SGA SF, GLIM	PG-SGA BC: 29

(Continues)

TABLE 1 (Continued)

First author, year, location	Study design	*N*	Age, mean (SD) or median (R), years	Male, %	Cancer site andstage, %	Treatment status, %	Treatment modality, %	BMI,[a] mean (SD) ormedian (R)	BMI[b] category, %	Index test	Reference standard malnourished by method % or mean (SD)
Australia[20]					CRC: 11 Other: 31 Stage: NA				OW/ OB: 39		
Demirel 2018 Turkey[21]	Cross-sectional	124	52 (21–89)	64.5	HN: 59.7 CNS: 40.3 I/II: 13.7 III/IV: 86.3	Active: 61.3 Post: 38.7	CT ± RT: 100	Mean: 26.7 R: 16–55.7	OW or OB: 62.1	NRS-2002, MNA	SGA BC: 31
Di Bella 2020 Australia[22]	Cross-sectional	201	60 (48-69)	57	NA	Active: 100	CT or supportive: 100	NA	NA	Patient-led MST	SGA BC: 18
Esfahani 2017 Iran[23]	Cross-sectional	71	62.1 (14.4)	79	GI: 100 III/IV: 100	Pre: 100	CT: 100	21.1 (4.0)	NA	MS-score	SGA BC: 87 PG-SGA: 16.1 (5.0)
Faramarzi 2013 Iran[24]	Cross-sectional	52	54.1 (16.8)	76.9	CRC: 100 II: 38.5 III/IV: 61.5	Pre: 100	RT: 100	23.9 (4.9)	NA	NRI	PG-SGA BC: 52
Gabrielson 2013 Canada[25]	Cross-sectional	90	54.9 (14.8)	35.6	Breast: 46 CRC: 24 Heme: 13 Other: 17 Stage: NA	Active: 100	CT: 100	25.4 (5.0)	NA	abPG-SGA, PG-SGA	SGA BC: 36
Gascon-Ruiz 2022 Spain[26]	Cross-sectional	165	67 (60–74)	64.8	CRC: 49.7 Upper GI: 38.8 HN: 11.5 Metastatic: 69	Active: 100	CT: 83 Other: 17	26.2 (4.65)	NA	MST, MUST, NUTRISCORE, CONUT, MNA-SF	GLIM: 47
Hettiarachchi 2018 Sri Lanka[27]	Cross-sectional	100	58.6 (8.8)	32	Breast: 47 Ovary: 10 Other: 43 Stage: NA	Active: 100	CT: 100	22.2 (3.6)	UW; 15 NW: 48 OW/ OB: 37	MUST	PG-SGA BC: 45 PG-SGA: 14.5 (7.4)
Oh 2019 Korea[28]	Longitudinal	Baseline: 194 Completed: 155	60 (10.3)	55.2	CRC: 24.2 Breast: 17 Other: 58.8 III/IV: 87.1	Active: 100	CT: 100	24.0 (3.7)	NA	SNAQ	Total *N* = 152 PG-SGA BC: 25.0 (visit 1) and 23.7 (visit 4)

TABLE 1 (Continued)

First author, year, location	Study design	*N*	Age, mean (SD) or median (R), years	Male, %	Cancer site andstage, %	Treatment status, %	Treatment modality, %	BMI,[a] mean (SD) ormedian (R)	BMI[b] category, %	Index test	Reference standard malnourished by method % or mean (SD)
Orell-Kotikangas 2015 Finland[29]	Cross-sectional	65	61 (33–77)	77	HN: 100 III/IV: 81.5	Pre: 100	NA	23.7 (21–27)	OW: 42	NRS-2002	PG-SGA BC: 34
Pan 2020 China[30]	Retrospective	102	Median: 48	71.6	HN (nasopharynx): 100 III/IV: 96	Pre through Post: 100	ICT and RT: 100	NA	NA	NRS-2002	PG-SGA ≥ 4: 6.9–98.0
Szefel 2020 Poland[31]	Cross-sectional	70	≥50 years old only	48.6	CRC: 100 All stages included	NA	NA	NA	OW or OB: 51	NRS-2002	NA
Zhang 2018 China[32]	Cross-sectional	312	58.8 (11.8)	47.8	Stomach: 51 Esoph: 29.5 Other: 19.5 Stage: NA	Active or Post: 100	CT, RT, S, any combination: 100	22.2 (4.0)	NA	NRS-2002	PG-SGA BC: 94

Abbreviations: abPG-SGA, abridged Patient-Generated Subjective Global Assessment; BMI, body mass index; CONUT, Controlling Nutritional Status; CNS, central nervous system; CRC, colorectal cancer; CT, chemotherapy; Esoph, esophageal; GI, gastrointestinal; GLIM, Global Leadership Initiative on Malnutrition; GYN, gynecological; Heme, hematological; HN, head and neck; HSCT, hematopoietic stem cell transplantation; ICT, induction chemotherapy; IV, intravenous; MNA, Mini Nutritional Assessment; MNA-SF, Mini Nutritional Assessment Short Form; MS-score, Malnutrition Screening score; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NA, not available; NRI, Nutrition Risk Index; NRS-2002, Nutrition Risk Screening-2002; NW, normal weight; OB, obese; OW, overweight; Panc, pancreas; PG-SGA, Patient-Generated Subjective Global Assessment; PG-SGA BC, Patient-Generated Subjective Global Assessment boxes B and C (moderate or severe malnutrition); PG-SGA SF, Patient-Generated Subjective Global Assessment Short Form; Post, after treatment; Pre, before treatment; R, range; RT, radiation therapy; S, surgery; SGA BC, Subjective Global Assessment boxes B and C (moderate or severe malnutrition); SNAQ, Short Nutritional Assessment Questionnaire; UW, underweight.

[a]BMI calculated as weight in kilograms divided by height in meters squared.

[b]BMI categories per Centers for Disease Control and Prevention (CDC): UW < 18.5; NW = 18.5 to <25.0; OW = 25.0 to <30.0; OB ≥ 30.0.

were present in <10% of the study population), and one cancer type that was not specified. Of the 20 studies, the majority included patients who were receiving active treatment, including chemotherapy, radiation therapy, or chemoradiation, across the cancer continuum. Specifically, the studies' treatment status included three pretreatment, one before and during active treatment, nine active treatment, two pre-/active/posttreatment, two active/posttreatment, one posttreatment, and two no treatment status reported. Fifty percent of the studies included stage III/IV cancers.

The average body mass index (BMI) across the studies was 24.3 kg/m^2 (13 studies), and the BMI category distribution was 7.9% underweight (six studies), 43.2% normal weight (six studies), and 48.5% overweight/obese (eight studies). Malnutrition, according to the reference standard, was reported in 19 of the 20 studies and ranged from 6.9% to 98%.

Malnutrition screening tools evaluated for general validity

The following screening tools (index tests) were used in the studies: eight used the Malnutrition Screening Tool (MST), four used the Malnutrition Universal Screening Tool (MUST), three used the Nutrition Risk Index (NRI), six used the Nutrition Risk Screening-2002 (NRS-2002), two used the NUTRISCORE, four used the PG-SGA short form (PG-SGA SF), one used the Controlling Nutritional Status (CONUT), one used the Mini Nutritional Assessment (MNA), one used the MNA-short form, one used the Malnutrition Screening score (MS-score), and one used the Short Nutritional Assessment Questionnaire (SNAQ).

The reference standard for most of the studies ($n = 16$) was the PG-SGA, followed by the SGA in three studies, and GLIM in one study. Most studies evaluated the PG-SGA SF, MST, NRS-2002, and MUST. Table 2 describes the index tests.

General validity of the screeners evaluated

Table 3 contains a summary of the validity scores of the index tests.

MST

Most studies evaluating the MST overall had fair to good sensitivity and specificity. Although seven of nine studies evaluating the MST used a cut-point of ≥2, one did not specify the cut-point, and one used a cut-point of ≥3. Specifically using MST with the cut-point of ≥2, six of seven studies, including one that used the patient-led MST, showed fair to good sensitivity and specificity. One study using a patient-led MST with a cut-point of ≥3 had poor sensitivity and good specificity. Five of nine studies assessing the MST used the PG-SGA as the reference standard, except one that used GLIM as the reference standard and had good sensitivity and fair specificity.

MUST

Four of five studies evaluating the MUST showed fair to good sensitivity and specificity. Three of the evaluations using the MUST had good sensitivity and specificity, one had good sensitivity and fair specificity, and one had fair sensitivity and poor specificity. Three of five MUST studies used a cut-point of ≥2; the PG-SGA was used as the reference standard in three of the five studies. Using GLIM as a reference standard, the MUST had good sensitivity and specificity, and the sensitivity and specificity were good in one study using the MUST with a cut-point of ≥1.

NRS-2002

Several of the nine studies evaluating the NRS-2002 found good sensitivity and specificity using cut-points of either ≥2 or ≥3. Three studies showed good sensitivity and specificity for NRS-2002 ≥ 2. Although one examination of NRS-2002 ≥ 3 had good sensitivity and specificity, when filtered to studies that used the PG-SGA boxes B and C (BC) or SGA BC reference standard, the results were either good sensitivity and poor specificity or good specificity and fair sensitivity. One study using the NRS-2002 did not measure sensitivity and specificity and used a Spearman correlation analysis.

PG-SGA SF

All 16 evaluations using the PG-SGA SF showed fair to good performance; the best performance with PG-SGA SF was at the cut-points of ≥7 and ≥8.

Others

NUTRISCORE, evaluated in two studies, performed well when the reference standard was PG-SGA BC. Similarly, the MNA performed well in the one study for which it was evaluated. The NRI, evaluated in three studies, performed poorly, as did CONUT, MS-score, and SNAQ, in which each were evaluated in only one study.

Malnutrition screening tools were deemed valid based on at least one study reporting good sensitivity and/or specificity (see Table 4). Valid screening tools and the cut-points in which they were found to be valid included MNA ≤ 23.5, MST ≥ 2, patient-led MST ≥ 2, MUST, MUST ≥ 1, MUST ≥ 2, NRS-2002 ≥ 2, NRS-2002 ≥ 3, NUTRISCORE ≥ 5, PG-SGA SF ≥ 7, and PG-SGA SF ≥ 8.

TABLE 2 Characteristics of malnutrition screening tools.

Screening tool	Description
SGA reference standard	Nutrition assessment tool based on features of a medical history (weight change, dietary intake change, gastrointestinal symptoms that have persisted for >2 weeks, changes in functional capacity) and physical examination (loss of subcutaneous fat, muscle wasting, ankle/sacral edema and ascites).[33]
PG-SGA reference standard	Adapted from the SGA and includes additional questions regarding the presence of nutrition symptoms and short-term weight loss; components of the medical history are completed by patient using checkbox format; physical examination then performed by health professional; scored PG-SGA incorporates a numerical score as well as a global rating of well nourished, moderately or suspected of being malnourished, or severely malnourished; points 0–4 awarded depending on impact of symptom on nutrition status; total score summed and provides guideline to level of nutrition intervention required; the higher the score, the greater the risk for malnutrition; a score ≥9 indicates critical need for nutrition intervention.[34]
GLIM reference standard	3-step diagnostic structure: screening, diagnosis, and severity grading consisting of 3 phenotypic (weight loss, low BMI, and reduced muscle mass) and 2 etiologic (reduced food intake/assimilation and disease burden/inflammation) criteria; for diagnosis of malnutrition, at least 1 criterion from each phenotypic and etiologic component should be present.[35]
CONUT	Screening tool derived from laboratory information including serum albumin level, total cholesterol level, and total lymphocyte count; depending on the value, each of the laboratory values is scored and undernutrition is categorized as light (2–4), moderate (5–8), and severe (9–12); a score of 0–1 is normal.[36]
MS-score	Screener that uses serum albumin, prealbumin, and CA-125 levels to determine malnutrition risk; patients with serum albumin level ≤3.5 g/dl, serum prealbumin level <0.20 mg/dl, and serum CA-125 level >35 U/ml are allocated a score of 3; patients with 1 or 2 parameter abnormalities are allocated scores of 1 and 2, respectively; and those in whom the serum albumin level is >3.5 g/dl, serum prealbumin level is >0.20 mg/dl, and serum CA-125 level is ≤35 U/ml are allocated a score of 0.[23]
MST	Screening tool that uses a combination of questions, including "Have you lost weight recently without trying?" and "Have you been eating poorly because of a decreased appetite?" Each answer is scored; a score >2 indicates patient is at risk for malnutrition and should undergo a more detailed nutrition assessment to identify whether the patient is malnourished and to determine the most appropriate form of nutrition support.[37]
MUST	Identifies patients who are at risk for malnutrition; scores BMI, unintentional weight loss, and food intake (acute disease-related effect inducing a phase of >5 days with no food intake) and separates patients into 3 risk groups (low, medium, and high); each criterion rated 0–2; all points added up and overall score ≥2 classified as being at nutrition risk.[38–40]
MNA	Assesses nutrition status and includes 18 items in 4 categories (anthropometric, general assessment, nutrition assessment, and self-assessment); final tallied score ranges from 0 to 30; scores of 17–23.5 indicate risk for malnutrition, with <17 indicating malnutrition.[38,40,41]
MNA-Short Form	A shorter version of MNA with 6 items; final tallied score ranges from 0 to 14; scores of ≤11 signal risk for malnutrition.[38,40]
NUTRISCORE	Screener that includes questions of unintentional weight loss, specific oncologic parameters such as tumor location and anticancer treatment; sum of all categories range from 0 to 11 points; total score ≥5 indicates at risk.[16]
NRI	Nutrition assessment tool derived from serum albumin concentration and ratio of actual to usual weight; a score of >100 indicates patient not malnourished, 83.5 to <97.5 indicates moderate malnourishment, and <83.5 indicates severe malnourishment.[42,43]
NRS-2002	Screening tool using severity of disease and nutrition status to predict those who would benefit from nutrition support; uses 4 questions based on impairment of nutrition status (percentage of weight loss, general condition, BMI, and recent food intake), disease severity, and age; each category is rated 0 (normal) to 3 (severe), and age ≥70 years adds 1 point; total scores range from 0 to 7 points; patients with a total score ≥3 classified as "at nutritional risk" could benefit from nutrition support.[38,40,44]
Patient-led MST	MST completed by patients attending cancer care ambulatory settings.
PG-SGA Short Form	Also referred to as the abridged PG-SGA, eliminates the physical examination and disease/condition and metabolic demand assessment components of the PG-SGA but retains the medical history component, comprising weight, history, food intake, nutrition impact symptoms, and activities and function.[14]
SNAQ	Screening tool that asks 3 questions: "Did you lose weight unintentionally?"; "Did you experience decreased appetite over the last month?"; and "Did you use supplemental drinks or tube feeding over the last month?" Each answer is scored for maximum score of 5 points; total scores broken down into 3 groups (well nourished, moderately malnourished, and severely malnourished); each category is associated with a care plan, including supplemental drinks, snacks, and treatment by an RDN.[38,45]

Abbreviations: BMI, body mass index; CONUT, Controlling Nutritional Status; GLIM, Global Leadership Initiative on Malnutrition; MNA, Mini Nutritional Assessment; MS-score, Malnutrition Screening score; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRI, Nutrition Risk Index; NRS-2002, Nutrition Risk Screening-2002; PG-SGA, Patient-Generated Subjective Global Assessment; RDN, registered dietitian nutritionist; SGA, Subjective Global Assessment; SNAQ, Short Nutritional Assessment Questionnaire.

TABLE 3 Summary of validity scores by malnutrition risk tool (index test).

Index test	Reference standard	Sensitivity (95% CI)	Specificity (95% CI)	Other results (95% CI)	First author (year)
MST	GLIM	83	72	Accuracy: 76; k = 0.53 PPV: 68; NPV: 85	Gascon-Ruiz (2021)[26]
MST (≥2)	PG-SGA BC	70.6	69.7	AUC: 0.77 (0.72–0.82)	Abbott (2014)[13]
MST (≥2)	PG-SGA BC	52	84	NA	Abe Vicente (2013)[15]
MST (≥2)	PG-SGA BC	61.5	91.8	NA	Abe Vicente (2013)[15]
MST (≥2)	PG-SGA BC	84 (74–91)	85.6 (81–89)	0.84 (0.79–0.89) PPV: 57.7 (48–67); NPV: 95.7 (93–98)	Arribas (2017)[16]
MST (≥2)	PG-SGA BC	100	90	NA	De Groot (2020)[20]
MST (≥2)	SGA BC	81.3	72.4	AUC: 0.823	Gabrielson (2013)[25]
MST (≥2) patient-led	SGA BC	94 (81–99)	86 (79–91)	PPV: 59 (45–71); NPV: 99 (95–100)	Di Bella (2020)[22]
MST (≥3) patient-led	SGA BC	50 (33–67)	95 (90–98)	PPV: 67 (46–84); NPV: 90 (84–94)	Di Bella (2020)[22]
MUST (≥2)	PG-SGA BC	72	48.9	NA	Abe Vicente (2013)[15]
MUST (≥2)	PG-SGA BC	84	73.4	NA	Abe Vicente (2013)[15]
MUST (≥2)	PG-SGA BC	80	89	PPV: 87; NPV: 100	Boleo-Tome (2012)[17]
MUST	GLIM	86	81	Accuracy: 83; k = 0.66 PPV: 77 NPV: 89	Gascon-Ruiz (2021)[26]
MUST (≥1)	PG-SGA BC	86.70	94.50	AUC: 0.91; k = 0.79 PPV: 92.90; NPV: 89.70	Hettiarachchi (2018)[27]
NRI (≤97.5 medium/ high risk)	PG-SGA BC	68	64	NA	Abe Vicente (2013)[15]
NRI (≤97.5 medium/ high risk)	PG-SGA BC	55.8	83.6	NA	Abe Vicente (2013)[15]
NRI (<83.5–100)	PG-SGA BC	66	60	PLR: 1.65; NLR: 0.56 PPV: 64; NPV: 62	Faramarzi (2013)[24]
NRS-2002 (≥2)	PG-SGA (≥ 9)	96.8	70	Spearman r = 0.699 k = 0.698 PPV: 95.3; NPV: 77.8	Chen (2022)[19]
NRS-2002 (≥2)	PG-SGA (≥ 4)	96.9 (84–99)	78.8 (62–89)	k = 0.754 PPV: 81.6; NPV: 96.3	Orell-Kotikangas (2015)[29]
NRS-2002 (≥2)	PG-SGA (≥ 4)	76.3	90.9	MYI: 0.672	Pan (2020)[30]
NRS-2002 (≥3)	PG-SGA (≥ 9)	74.6	90	Spearman r = 0.468 k = 0.396 PPV: 97.9; NPV: 36	Chen (2022)[19]
NRS-2002 (≥3)	PG-SGA (≥ 9)	86.7 (62–96)	90 (79–96)	k = 0.717 PPV: 72.2; NPV: 95.7	Orell-Kotikangas (2015)[29]
NRS-2002 (≥3)	PG-SGA BC	77.3 (57–90)	97.7 (88–100)	k = 0.784 PPV: 94.4; NPV: 89.4	Orell-Kotikangas (2015)[29]
NRS-2002 (≥3)	SGA BC	96.0	58.0	PPV: 63; NPV: 96	Szefel (2020)[31]
NRS-2002	PG-SGA	NA	NA	Spearman r: −0.24 (men) and −0.41 (women)	Zhang (2018)[32]
NRS-2002 (≥3)	SGA BC	67.5	92.9	PLR: 12.2; NLR: 0.13 k = 0.713 PPV: 97.7; NPV: 68.4	Demirel (2018)[21]

TABLE 3 (Continued)

Index test	Reference standard	Sensitivity (95% CI)	Specificity (95% CI)	Other results (95% CI)	First author (year)
NUTRISCORE (≥5)	PG-SGA BC	97.3 (91–100)	95.9 (93–98)	AUC: 0.95 (0.92–0.98) PPV: 84.8 (76–92); NPV: 99 (98–100)	Arribas (2017)[16]
NUTRISCORE	GLIM	64	88	Accuracy: 78; k = 0.54 PPV: 80; NPV: 77	Gascon-Ruiz (2021)[26]
abPG-SGA (≥6)	SGA BC	93.8	77.6	AUC: 0.956	Gabrielson (2013)[25]
abPG-SGA (≥7)	SGA BC	84.4	89.7	AUC: 0.956	Gabrielson (2013)[25]
PG-SGA SF (≥8)	SGA BC	96.9	86.2	AUC: 0.967	Gabrielson (2013)[25]
PG-SGA SF (≥3)	PG-SGA BC	80.4	72.3	NA	Abbott (2016)[14]
PG-SGA SF boxes 1–3 (≥2)	PG-SGA BC	90.2	67.5	NA	Abbott (2016)[14]
PG-SGA SF box 3 (≥1)	PG-SGA BC	82.4	69.9	NA	Abbott (2016)[14]
PG-SGA SF boxes 1 and 3 (≥2)	PG-SGA BC	86.3	71.1	NA	Abbott (2016)[14]
PG-SGA SF boxes 2 and 3 (≥1)	PG-SGA BC	82.4	63.1	NA	Abbott (2016)[14]
PG-SGA SF (≥2)	PG-SGA BC	92	76	AUC: 0.82 (0.77–0.86)	Carrico (2021)[18]
PG-SGA SF boxes 1–3 (≥2)	PG-SGA BC	77	76	AUC: 0.78 (0.77–0.82)	Carrico (2021)[18]
PG-SGA SF boxes 1 and 3 (≥2)	PG-SGA BC	75	80	AUC: 0.78 (0.73–0.83)	Carrico (2021)[18]
PG-SGA SF box 3 (≥2)	PG-SGA BC	71	82	AUC: 0.77 (0.73–0.82)	Carrico (2021)[18]
PG-SGA SF boxes 2 and 3 (≥2)	PG-SGA BC	79	75	AUC: 0.78 (0.73–0.83)	Carrico (2021)[18]
PG-SGA SF (≥5)	PG-SGA BC	89	80	PPV: 45; NPV: 98	De Groot (2020)[20]
PG-SGA SF (≥4)	PG-SGA BC	92	71	PPV: 37; NPV: 98	De Groot (2020)[20]
PG-SGA SF (≥3)	PG-SGA BC	94	62	PPV: 31; NPV: 98	De Groot (2020)[20]
CONUT	GLIM	21	89	Accuracy: 61; k = 0.40 PPV: 60; NPV: 61	Gascon-Ruiz (2021)[26]
MNA (≤23.5)	SGA BC	96.5	92.1	PLR: 12.2; NLR: 0.04 k = 0.886 PPV: 96.5; NPV: 92.1	Demirel (2018)[21]
MNA-SF	GLIM	99	45	Accuracy: 68 k = 0.12 PPV: 57 NPV: 98	Gascon-Ruiz (2021)[26]
MS-score (≥1)	PG-SGA BC	96.8 (83.8–99.4)	50.0 (15.0–85.0)	AUC: 0.914 PPV: 93.8 (79.9–98.3) NPV: 66.7 (20.8–93.9)	Esfahani (2017)[23]
SNAQ	PG-SGA BC	NA	NA	Visit 1 (n = 152) Pearson r = −0.53 Visit 4 (n = 123) Pearson r = −0.59	Oh (2019)[28]

Note: PPV and NPV at 95% CI. abPG-SGA is equivalent to PG-SGA SF.

Abbreviations: abPG-SGA, abridged Patient-Generated Subjective Global Assessment; AUC, area under curve; CI, confidence interval; CONUT, Controlling Nutritional Status; GLIM, Global Leadership Initiative on Malnutrition; k, Cohen's kappa; MNA, Mini Nutrition Assessment; MNA-SF, Mini Nutrition Assessment Short Form; MS-score, Malnutrition Screening score; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; MYI, maximum Youden index; NA, not available; NLR, negative likelihood ratio; NPV, negative predictive value; NRI, Nutritional Risk Index; NRS-2002, Nutrition Risk Screening-2002; PG-SGA BC SF, Patient-Generated Subjective Global Assessment boxes B and C (moderate or severe malnutrition) Short Form; PLR, positive likelihood ratio; PPV, positive predictive value; r, correlation coefficient; SGA BC, Subjective Global Assessment boxes B and C (moderate or severe malnutrition); SNAQ, Simplified Nutritional Appetite Questionnaire.

General validity based on population characteristics including age, cancer type, cancer stage or cancer treatment modality, health status, time interval from diagnosis, and/or weight status

Few studies examined the validity of screening tools in relation to specific population characteristics. Hence, it is challenging to draw conclusions on the validity of these screening tools based on age, the timing relative to diagnosis, weight status, type of cancer, cancer stage, and treatment protocol. Only four studies investigated the validity of the screening tools assessing factors such as sex, age, cancer site, and treatment. Only one study conducted malnutrition screenings at three different time intervals.

The study of Demirel and Atasoy focused on distinguishing sensitivity and specificity according to age, treatment status, and cancer site.[21] They conducted a comparison of three different screening tools. The population consisted of individuals with head and neck cancers or central nervous system tumors undergoing chemoradiation. Screening tools demonstrated substantial or moderate agreement irrespective of the patient's age or treatment status. The prevalence of malnutrition in patients with head and neck cancer was between 32% and 46%, whereas it remained <10% among patients with brain tumors. Nutrition risk was higher in treatment than in follow-up groups with a range of 32% to 39% compared with 8% to 17%, respectively. There was substantial agreement between the SGA and MNA across both groups.[21]

Gascon-Ruiz et al. separated screening scores by cancer site, evaluating outpatients with tumors in the upper gastrointestinal tract, head/neck, and colorectal locations.[26] Based on the GLIM criteria, malnutrition and tumor location was correlated. Specifically, malnutrition was more prevalent in patients with cancer of the head/neck or upper gastrointestinal tract compared with colorectal locations. Malnutrition was also associated with tumor progression but not the type of treatment.

Orell-Kotikangas et al. calculated Spearman correlation coefficients separately for males and females with cancer of the head/neck.[29] The PG-SGA revealed malnutrition in 30% of males and 47% of females. On the NRS-2002, a notable positive correlation occurred between the PG-SGA and the scored PG-SGA. The latter is employed to triage patients for nutrition intervention, with scores ≥4 indicating necessity for nutrition intervention and ≥9 indicating critical necessity.[29]

Arribas et al. observed outpatients with solid or hematologic malignancies. Patients underwent either oncology-related palliative or symptomatic treatment. Significant variations influenced by the location and the type of treatment in nutrition status were observed.[16]

Pan et al. assessed nutrition risk in patients with nasopharyngeal cancer at various stages. Nutrition risk and moderate or severe malnutrition (by PG-SGA ≥ 4) rose significantly as treatment progressed. Seven of 100 patients were at nutrition risk before chemotherapy and this increased to 24 after chemotherapy. By the end of radiotherapy, all participants were at nutrition risk. As treatment advanced, nutrition risk worsened.[30]

DeGroot et al. reported outcomes for patients receiving intravenous chemotherapy. A PG-SGA SF score of ≥5 and a "severe malnutrition" score by GLIM were independently associated with 1-year mortality risk.[20]

Risk of bias in studies

Figure 2 details the risk-of-bias evaluation for each study. Twelve studies clearly outlined the criteria for eligible participants and received low ($n = 11$) or moderate/unclear risk ($n = 1$) designations for the patient selection criteria. The remaining eight studies were categorized as high risk because of the insufficient description of the selected participants. Within the "index test" domain, 11 studies had a low risk of index bias and the remainder had moderate ($n = 5$) or high risk of bias ($n = 5$). The high risk of bias was due to the lack of clarity as to whether the index test results were interpreted without knowledge of the reference test outcomes and an absence of prespecified thresholds for the index test. The third domain examined the risk of bias attributable to the reference standard used, wherein most ($n = 14$) studies were deemed at low risk of bias. Two studies were high risk and four were moderate risk, primarily owing to the absence of clarity about whether the reference standard results were interpreted without prior knowledge of index test results. Lastly, the fourth domain focused on the flow and timing of the tests conducted throughout the study period. Thirteen studies were deemed low risk because of the clear description of the time interval between the index and reference tests and the inclusion of all patients evaluated. Three studies were high risk and four were moderate risk, primarily owing to the lack of inclusion of all patients who completed the index test in the final analysis and the lack of clarity regarding the interval between the index and reference tests.

CLINICAL RECOMMENDATIONS

This is the first systematic review to examine malnutrition screening tools specifically designed and validated for use in ambulatory settings for adults and for those with cancer.

Question 1. Should clinicians screen for malnutrition in outpatient cancer centers?

Recommendation: Yes, all patients should undergo malnutrition screening using a validated tool with a nutrition-specific follow-up plan for those at risk.

Recommendation Rationale: The recommendation that all patients undergo screening is based on our expert opinion. Although not every patient with cancer is malnourished, every patient with cancer is at risk for malnutrition. Our data demonstrate the validity of multiple screening tools in detecting malnutrition risk in adult oncology outpatients receiving treatment. Using reference standards, such as the SGA, PG-SGA and GLIM, malnutrition rates varied

TABLE 4 Index tests with good sensitivity and specificity[a].

Index tests with good sensitivity (# of studies)	Index tests with good specificity (# of studies)	Index texts with good sensitivity and specificity
—	CONUT (1)	—
MNA ≤ 23.5 (1)	MNA ≤ 23.5 (1)	MNA ≤ 23.5
MNA-SF (1)	—	—
MS-score ≥1 (1)	—	—
MST (1)	—	—
MST ≥ 2 (3)	MST ≥ 2 (4)	MST ≥ 2
MST ≥ 2 patient-led (1)	MST ≥ 2 patient-led (1)	MST ≥ 2 patient-led
—	MST ≥ 3 patient-led (1)	—
MUST (1)	MUST (1)	MUST
MUST ≥ 1 (1)	MUST ≥ 1 (1)	MUST ≥ 1
MUST ≥ 2 (1)	MUST ≥ 2 (1)	MUST ≥ 2
—	NRI ≤ 97.5 med/high risk (1)	—
NRS-2002 ≥ 2 (2)	NRS-2002 ≥ 2 (1)	NRS-2002 ≥ 2
NRS-2002 ≥ 3 (2)	NRS-2002 ≥ 3 (4)	NRS-2002 ≥ 3
—	NUTRISCORE (1)	—
NUTRISCORE ≥ 5 (1)	NUTRISCORE ≥ 5 (1)	NUTRISCORE ≥ 5
PG-SGA SF ≥ 2 (1)		
PG-SGA SF ≥ 3 (2)		
PG-SGA SF ≥ 4 (1)		
PG-SGA SF ≥ 5 (1)		
PG-SGA SF ≥ 6 (1)		
PG-SGA SF ≥ 7 (1)	PG-SGA SF ≥ 7 (1)	PG-SGA SF ≥ 7
PG-SGA SF ≥ 8 (1)	PG-SGA SF ≥ 8 (1)	PG-SGA SF≥ 8
PG-SGA SF Box 3 ≥ 1 (1)		
	PG-SGA SF Box 3 ≥ 2 (1)	
PG-SGA SF boxes 1 and 3 ≥ 2 (1)		
PG-SGA SF boxes 1–3 ≥ 2 (1)		
PG-SGA SF boxes 2 and 3 ≥ 1 (1)		

Abbreviations: CONUT, Controlling Nutritional Status; MNA, Mini Nutrition Assessment; MS-score, Malnutrition Screening score; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRI, Nutritional Risk Index; NRS-2002, Nutrition Risk Screening-2002; PG-SGA SF, Patient-Generated Subjective Global Assessment Short Form.

[a]The values for sensitivity and specificity were interpreted as follows: a value >80% was considered good, 60%–80% fair, and <60% poor.

between 7% and 94%, which is consistent with the previously reported prevalence of 40% to 80%.[46] Approximately 15% to 50% of all patients with cancer present with nutrition deficiencies at the time of diagnosis before the initiation of active cancer treatment.[3,46]

The consequences of untreated malnutrition are serious. Severely malnourished patients have a twofold to fivefold higher mortality compared with patients with little or no evidence of malnutrition.[47,48] Malnutrition is associated with a lower tolerance to anticancer treatments because of increased toxicity, lower compliance, and reduced response to treatments[49] and increased complication rates, poor postoperative outcomes, longer hospitalization, and a poor quality of life.[1,50,51] Patients with cancer also face a deterioration in their health-related quality of life in terms of psychological, cognitive, social, and emotional functions.[1,52,53]

To potentially reverse malnutrition, stop unintentional weight loss or gain, improve quality of life, reduce treatment toxicity, support the management of treatment-associated symptoms, and lower the risk of mortality, diagnosing malnutrition should be made as early as possible.[54]

Several systematic reviews and international panels recommend that all patients with cancer be screened for risk of malnutrition regularly with a valid malnutrition screening tool.[55,56] Our updated evaluation of the literature supports these prior reports.

Question 2. Which malnutrition screening tools are recommended in outpatient cancer centers?

Recommendation: Six tools—MNA, MST, MUST, NRS-2002, NUTRISCORE, and PG-SGA SF—with various cut-points demonstrated validity and are recommended in ambulatory settings.

Rationale for recommendation: The following tools, which have been shown to be sensitive and specific, are recommended for use with the following cut-points. Further details can be found in Table 5.

- MNA ≤ 23.5
- MST ≥ 2
- Patient-led MST ≥ 2
- MUST (cut-point not specified)
- MUST ≥ 1
- MUST ≥ 2
- NRS-2002 ≥ 2
- NRS-2002 ≥ 3
- NUTRISCORE ≥ 5
- PG-SGA SF ≥ 7
- PG-SGA SF ≥ 8

Successful implementation of screening tools requires they be brief, economically viable, and highly sensitive and have good specificity.[55] The clinical utility of a screening tool guides routine clinical practice. Table 6 organizes screening tools based on "ease of use." Level 1's are the simplest and quickest, whereas Level 4's are the most intricate and time-consuming. The MST and patient-led MST,

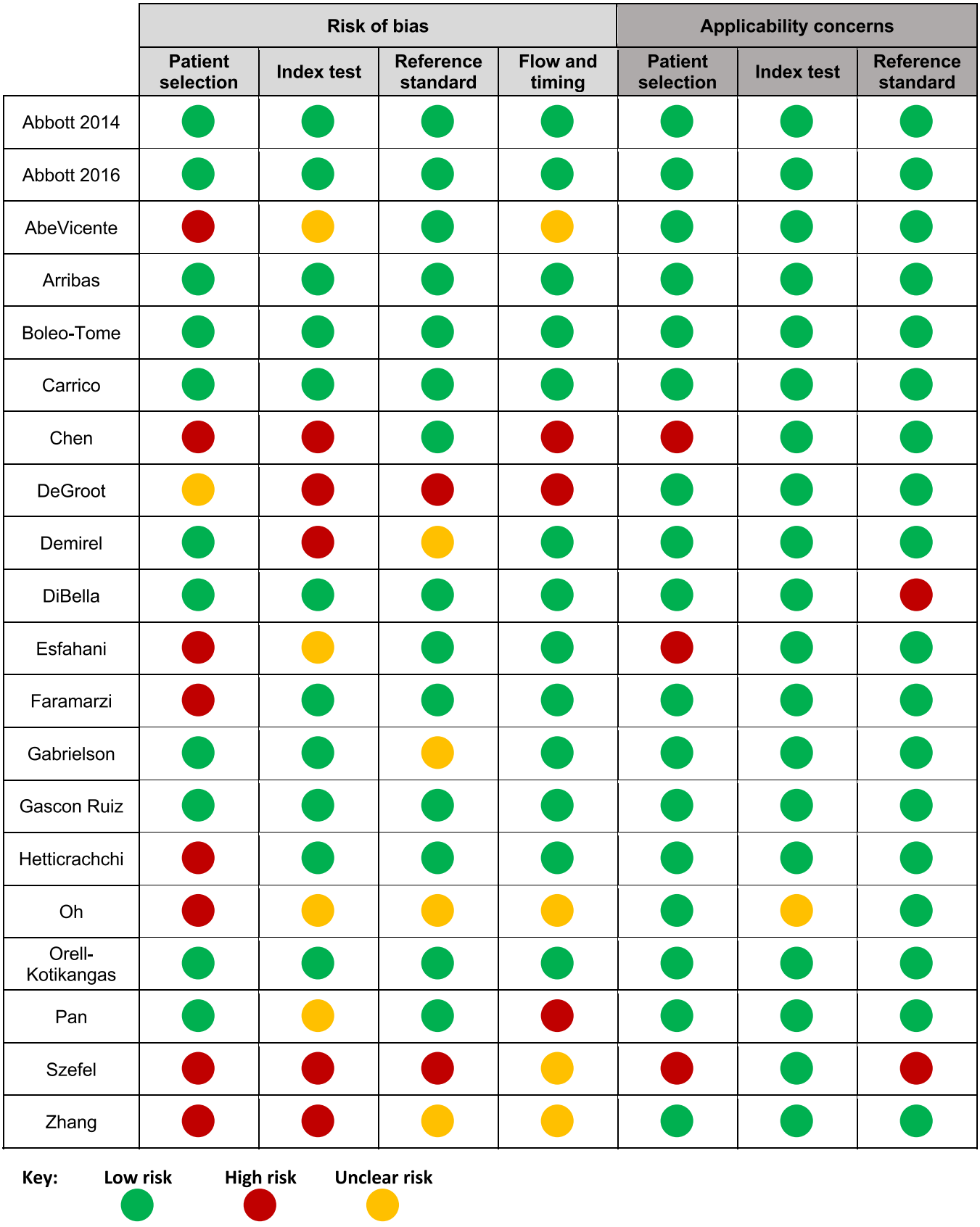

FIGURE 2 Detailed risk-of-bias evaluation. Colored dots designated risk level: green, low risk; yellow, medium/unclear risk; and red, high risk. Risk of bias was assessed for participant selection, index test, reference standard, and flow and timing. Applicability was evaluated for participant selection, index test, and reference standard.

TABLE 5 Recommended screening tools for ambulatory cancer patients and their respective patient population.

Screening tool	Study	*N*	Cancer site, %	Cancer stage, %	Treatment status	Treatment modality
MNA (≤23.5)	Demirel[21]	124	HN: 59.7 CNS: 40.3	I/II: 13.7 III/ IV: 86.3	Active: 61.3 Post: 38.7	CT ± RT: 100
MST (≥2)	Abe Vicente[15] Group 1	75	CRC: 85.3 GI: 14.7	III/IV: 82.7	Pre: 40 Active: 60	CT ± S
	Abe Vicente[15] Group 2	62	CRC: 83.9 GI: 16.1	III/IV: 37.1	Post: 100	CT ± S
	Arribas[16]	394	Variety solid tumors: 87.5 Heme: 12.5	All stages included	Pre/Active/ Post: 100	CT ± RT: 45.4 RT: 18.8 HSCT: 7.1 Other/palliative: 28.7
	DeGroot[20]	246	Breast: 45 GYN: 13 CRC: 11 Other: 31	NA	Active: 100	"In-chair IV treatment": 100
	Gabrielson[25]	90	Breast: 46 CRC: 24 Heme: 13 Other: 17	NA	Active: 100	CT: 100
MST (≥2) patient-led	Di Bella[22]	201	NA	NA	Active: 100	CT or supportive: 100
MUST	Gascon-Ruiz[26]	165	CRC: 49.7 Upper GI: 38.8 HN: 11.5	Metastatic: 69	Active: 100	CT: 83 Other: 17
MUST (≥1)	Hettiarachchi[27]	100	Breast: 47 Ovary: 10 Other: 43	NA	Active: 100	CT: 100
MUST (≥2)	Abe Vicente[15] Group 2	62	CRC: 83.9 GI: 16.1	III/IV: 37.1	Post: 100	CT ± S
	Boleo-Tome[17]	450	Breast or prostate: 40 Lung: 16.2 CRC: 13.6	III/IV: 60.7	III/IV: 60.7	RT: curative—63.3, palliative—36.7
NRS-2002 (≥2)	Chen[19]	146	Lung: 33.6 Panc: 13.0 Breast: 9.6 Other: 43.8	NA	NA	NA
	Orell-Kotikangas[29]	65	HN: 100	III/IV: 81.5	Pre: 100	NA
	Pan[30]	102	HN (nasopharynx): 100	III/IV: 96	Pre through Post: 100	ICT and RT: 100
NRS-2002 (≥3)	Chen[19]	146	Lung: 33.6 Panc: 13.0 Breast: 9.6 Other: 43.8	NA	NA	NA
	Orell-Kotikangas[29]	65	HN: 100	III/IV: 81.5	Pre: 100	NA
	Szefel[31]	70	CRC: 100	All stages included	NA	NA
NUTRISCORE (≥5)	Arribas[16]	394	Variety solid tumors: 87.5 Heme: 12.5	All stages included	Pre/Active/ Post: 100	CT ± RT: 45.4 RT: 18.8 HSCT: 7.1 Other/palliative: 28.7

(Continues)

TABLE 5 (Continued)

Screening tool	Study	*N*	Cancer site, %	Cancer stage, %	Treatment status	Treatment modality
PG-SGA SF (≥7)	Gabrielson[25]	90	Breast: 46 CRC: 24 Heme: 13 Other: 17	NA	Active: 100	CT: 100
PG-SGA SF (≥8)	Gabrielson[25]	90	Breast: 46 CRC: 24 Heme: 13 Other: 17	NA	Active: 100	CT: 100

Abbreviations: CNS, central nervous system; CRC, colorectal cancer; CT, chemotherapy; GI, gastrointestinal; GYN, gynecological; heme, hematological; HN, head and neck; HSCT, hematopoietic stem cell transplantation; ICT, induction chemotherapy; IV, intravenous; MNA, Mini Nutritional Assessment; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; *N*, number of patients; NA, not available; NRS-2002, Nutrition Risk Screening-2002; Panc, pancreas; PG-SGA SF, Patient-Generated Subjective Global Assessment Short Form; Post, after treatment; Pre, before treatment; R, range; RT, radiation therapy; S, surgery.

TABLE 6 Recommended screening tools and levels of "ease of use".

Ease of use	Screening tool
Level 1	MST
	Patient-led MST
Level 2	NUTRISCORE
	PG-SGA SF
Level 3	MUST
	NRS-2002
Level 4	MNA

Abbreviations: MNA, Mini Nutritional Assessment; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutrition Risk Screening-2002; PG-SGA SF, Patient-Generated Subjective Global Assessment Short Form.

both encompassing two questions about weight and appetite, are designated as Level 1. NUTRISCORE incorporates two questions from the MST and considers tumor site and treatment status, qualifying it as a Level 2. The PG-SGA SF is a patient-led tool derived from the PG-SGA designed to be straightforward for patients to complete and is categorized as Level 2. The MUST and NRS-2002 necessitate both BMI calculation and an indication of disease severity. These are classified as Level 3. The MNA requires a clinical assessment and anthropometrics, making it more time-consuming and categorizing it as a Level 4.

Ideally, screening tools should be "quick and easy" to use, with minimal to no calculations, biological samples, complex measurements, or clinical examinations. These criteria benefit facilities in which staffing is limited. Although several screening tools are straightforward and take into consideration additional factors such as tumor site and treatment status, others demand detailed assessments, disease severity indicators, and/or anthropometrics requiring more time and effort. Yet these advanced screening tools could provide a more comprehensive profile of a patient's nutrition status.

Question 3. What are the recommended clinical applications for malnutrition risk screening among adult oncology outpatients?

Recommendation: All patients with cancer should undergo routine malnutrition risk screenings using a valid tool after diagnosis and throughout treatment. Risk identification calls for a comprehensive nutrition assessment by a trained nutrition professional, such as a registered dietitian nutritionist (RDN).

Rationale for recommendation: This recommendation is based on our expert opinion and supported by multiple national and international organizations who recommend regular malnutrition risk screening among adult oncology patients, including ASPEN, AND, the Commission on Cancer, and the ACCC.[57–60] ASCO guidelines for geriatric oncology recommend evaluation of nutrition status in older patients with cancer.[61] The European Society for Clinical Nutrition and Metabolism advises regular screening for malnutrition risk or presence in all patients with cancer.[55,62] An independent panel, convened during a National Institutes of Health workshop, also supports the recommendation of malnutrition screening at the time of cancer diagnosis and at regular intervals throughout the course of treatment and survivorship.[63]

What constitutes "routine" screening may depend on the type of cancer, treatment course, and stability of the clinical situation. Screening is recommended every 4 to 8 weeks during treatment and may require additional screening depending on the stage of treatment (eg, surgery or radiotherapy/chemotherapy). Clinical judgment should guide the necessity of malnutrition screening during survivorship.

Timely identification of malnutrition is crucial in providing appropriate nutrition care. Those identified as at risk need a nutrition assessment completed by an appropriately trained healthcare professional, such as an RDN. Nutrition assessment should be conducted regularly, particularly when clinical conditions change and should be part of regular clinical consultations.[64]

To organize and perform screening for nutrition risk, assessment of nutrition and metabolic parameters, medical nutrition therapy, and monitoring of outcomes, each institution involved in treating patients

with cancer needs to define standard operating procedures, responsibilities, and a quality control process.[55]

The success of the screening tool largely depends on the users. Nurses or ancillary staff are usually involved in the initial nutrition screening during new patient registration. Inputs from nutrition and nursing leadership are vital for choosing and implementing a screening tool that is relevant for the target population and user-friendly. Establishing a multidisciplinary team for the selection and implementation of the screening tool provides a deeper understanding of the work constraints and capabilities of the nurses and other staff. This enables optimal use of their skills to gather the necessary information.[38]

Staff need training and education before implementing a selected screening tool. Communication should start early to ensure proper preparation. Refer to Table S6 for a staff checklist sample, useful for implementing malnutrition screening. Continuous training may enhance compliance and completion rates. The nutrition and nursing teams need to establish a system to monitor and audit the consistency, accuracy, and appropriateness of screening procedures, and this may be established by selecting malnutrition as an ongoing quality measure. Well-defined roles for each healthcare professional involved in nutrition screening is crurcial.[38] The RDN should be an integral part of the care team. A policy needs to be in place defining the responsibilities of staff in the nutrition care process.

The electronic health record (EHR) enables streamlined screening and automated RDN referrals and consultations. Implementing nutrition screenings in the EHR is feasible and can offer consistent long-term results.[65] Depending on the screening tool, the EHR programming may be straightforward, with the ability to automatically compute scores based on the responses to screening questions.[38] Programming screening tools that require more details may be challenging to automate. Yet, even complex tools like the PG-SGA have been successfully integrated with the Epic EHR system.[66] Storing data in the EHR grants easy access to previous screening information, offering valuable insights into nutrition changes in patients over time and insights into facility management of patients at nutrition risk.

Other considerations

Barriers in implementing malnutrition screening in outpatient cancer centers

Implementing malnutrition screening can be challenging, with barriers including nonstandardized patient referral protocols, limited administrative support, competing staff time constraints, limited RDN services, lack of screening tools and implementation consensus, and limited frontline or nursing support.[6]

Varying responsibility for the identification of malnutrition is another barrier.[64] Even though healthcare professionals recognize the role of nutrition in patient recovery, nutrition care often happens in an isolated manner with team members working concurrently but not collaboratively.[67] A coordinated approach with defined responsibilities within the team is needed for malnutrition screening.

The lack of staffing and resources may limit the implementation of screening measures. Unlike the inpatient setting, RDN staffing in ambulatory cancer settings is lacking.[68] In the US, there is an average of 1.7 full-time equivalent RDNs employed in outpatient oncology centers and one RDN for every 2308 patients.[6] Reimbursement for nutrition services is an obstacle to increasing RDN staffing. Many centers do not bill for nutrition services. Although medical insurance providers are increasingly covering nutrition counseling by RDN practitioners, the Centers for Medicare and Medicaid Services do not reimburse nutrition services for oncology patients.[6]

RDNs should be sufficiently staffed on cancer teams with high malnutrition rates, such as head/neck, or lung cancers and treatment teams for chemotherapy and radiation therapy. The RDN presence in outpatient oncology care should match the prevalent need to manage malnutrition effectively. The lack of sufficient RDNs in outpatient oncology teams can lead to gaps in patient care.

In the US, an estimated 1.9 million individuals were diagnosed with cancer in 2023.[69] Considering that malnutrition affects 25% to 75% of patients with cancer,[1–3] between 475,000 and 1.425 million individuals may be at risk for malnutrition. Although achieving 100% screening might be challenging, screening rates of close to 75% are feasible. Prior research confirms the integration of a large percentage of malnutrition screening into the EHR in ambulatory cancer centers.[65] Seventy-four percent of nearly 70,000 patients with cancer were screened for malnutrition using the MST in the EHR at two large institutions. Roughly 5% of patients with cancer undergoing medical treatment were at risk, whereas approximately 12% of patients undergoing radiation treatment were at risk.[65]

Based on previous findings that oncology RDNs evaluate or counsel an average of 7.4 patients in an 8-h workday,[6] 1.2 RDN full-time equivalents would be required to provide proactive nutrition counseling to patients identified at risk for malnutrition.[65] Given that the annual salary for practicing RDNs in the US in all positions is $70,000 per year,[70] the 1.2 RDN full-time equivalents would equate to $84,000 per year. Poor nutrition status is associated with higher hospital costs. These high costs are primarily due to increased rates of hospital admissions, readmissions, more frequent consultations with primary care providers, and increased use of medications.[71–73] Consequently, the financial burden of failing to address malnutrition is substantial.

This review has several limitations. The studies were conducted outside the US, limiting their applicability in the US healthcare system. Most research was focused on common solid tumors. Furthermore, the impact of malnutrition screening on clinical outcomes was not reported by these studies and therefore cannot inform these recommendations. More work is required for hematologic malignancies. As GLIM is a relatively recent screening and assessment tool, its use as a reference standard was less frequent. Finally, a more structured methodology, like the Delphi method, could have provided a clearer and more reliable framework for gathering expert opinions and reaching clinical recommendations.

TABLE 7 Future research directions.

Topic area	Study direction
Amplified research scope	Study malnutrition and nutrition interventions across various cancer types, stages, and treatments, including in outpatient settings.
Body composition measurement	Develop better screening methods to capture body composition and identify loss of muscle volume or function and develop more rigorous analysis of body composition's relationship with various cancer treatment outcomes.
Clinical outcomes	Analyze the connection of screening to assessment, interventions, and clinical outcomes.
Cost-effectiveness	Evaluate the economic impact of preventing and treating malnutrition in cancer patients.
Diversity inclusion	Study those with different body composition before and during treatment to understand the relationship between physiologic muscle wasting and cancer treatment.
Early intervention	Identify and intervene early in at-risk and malnourished individuals.
Implementation	Practice dissemination and implementation science to ensure malnutrition screening and follow-on medical nutrition therapy are routinely provided to all oncology patients.
Integrated approach	Incorporate RDNs and their expertise into the healthcare team.
Intervention efficacy	Develop more effective interventions.
Patient-centered outcomes	Investigate patient-reported outcomes and the impact of malnutrition screening programs and multidisciplinary interventions on quality of life, physical function, and symptom burden in advanced disease.
Standardization	Determine the most effective and practical application of screening for various cancer patient populations and in a variety of oncology settings.
Timing	Study optimal timing for nutrition screening and intervention and frequency of screening.
Trajectory	Research the longitudinal disease trajectory and changes in body composition/nutrition status.
Technological advances	Assess the feasibility and effectiveness of remote screening, digital data capture, and telehealth referrals for at-risk patients.

Abbreviation: RDN, registered dietitian nutritionist.

Future research directions

There are existing knowledge gaps regarding nutrition risk screening, its implementation, potential cost savings, and most importantly potential improved health outcomes. Research is crucial to close existing gaps and push the field forward. The end goal is to provide the necessary evidence and practice guidelines that can enhance health outcomes through nutrition screening and interventions for patients with cancer. Table 7 outlines priority research topics and recommendations.

CONCLUSIONS

Many patients in adult oncology ambulatory care are malnourished and require timely medical nutrition therapy. Malnutrition screening is crucial for the early identification of patients requiring nutrition intervention and across various cancer types, stages, and treatments.

There exist several validated and reliable screening tools for malnutrition risk identification in the ambulatory oncology population. Implementation is inexpensive, requires minimal time, and can be efficient.

We identified several validated screening tools that should be integrated into cancer care and are the basis of our clinical recommendations. This report provides a framework for healthcare professionals. It clarifies who should be screened, the appropriate screening tools to be used, and the proper implementation.

Indeed, barriers to implementing screening exist, but so do viable solutions. Widespread standardization and implementation of malnutrition screening would serve to reduce the massive underdiagnosis of this common and debilitating issue. Furthermore, appropriate screening would justify the additional funding and resources needed to optimally test how the timely management of malnutrition might improve the clinical care of oncology patients.

AUTHOR CONTRIBUTIONS

Elaine B. Trujillo contributed to the conceptualization, data curation, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, original draft, and review and editing. Kunal C. Kadakia contributed to the methodology, validation, review and editing, data curation, formal analysis, investigation, and project administration. Cynthia Thomson contributed to the review and editing, methodology, validation, conceptualization, data curation, formal analysis, investigation, project administration, software, and visualization. Fang Fang Zhang contributed to the methodology, validation, writing—review and editing, data curation, formal analysis, investigation, visualization. Alicia Livinski contributed to the methodology, validation, conceptualization, data curation, formal analysis,

investigation, project administration, resources, software, and review and editing. Kim Pollard contributed to the methodology and review and editing. Todd Mattox contributed to the conceptualization, data curation, formal analysis, investigation, methodology, resources, software, validation, and review and editing. Anne Tucker contributed to the conceptualization, data curation, formal analysis, investigation, methodology, validation, and review and editing. Valaree Williams contributed to the methodology and review and editing. Declan Walsh contributed to the methodology and review and editing. Steven Clinton contributed to the review and editing. Aaron Grossberg contributed to the methodology, review and editing, and project administration. Gordon Jensen contributed to the conceptualization, methodology, and review and editing. Rhone Levin contributed to the review and editing. Jeannine Mills contributed to the methodology and review and editing. Anurag Singh contributed to the methodology, review and editing, and project administration. Meredith Smith contributed to the methodology and review and editing. Renee Stubbins contributed to the review and editing. Kathleen Wiley contributed to the methodology and review and editing. Kristen Sullivan contributed to the methodology and review and editing. Mary Platek contributed to the conceptualization, data curation, formal analysis, investigation, methodology, project administration, software, validation, visualization, original draft, and review and editing. Colleen K. Spees contributed to the conceptualization, data curation, formal analysis, investigation, project administration, supervision, validation, methodology, original draft, and review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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Disclaimer: Any recommendations in this paper do not constitute medical or other professional advice and should not be taken as such. To the extent that the information published herein may be used to assist in the care of patients, this is the result of the sole professional judgment of the attending healthcare professional whose judgment is the primary component of quality medical care. The information presented here is not a substitute for the exercise of such judgment by the healthcare professional. Circumstances in clinical settings and patient indications may require actions different from those recommended in this document and in those cases, the judgment of the treating professional should prevail. This paper was approved by the ASPEN Board of Directors.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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