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Meta-analysis

Harmonization and standardization of malnutrition screening for all adults – A systematic review initiated by the Norwegian Directorate of Health

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SUMMARY

Background & aims: The Norwegian Directorate of Health has identified a need to harmonize and standardize the malnutrition screening practice in Norwegian hospitals and primary health care settings, in order to provide a seamless communication of malnutrition screening along the patient pathway. Our aim was to perform a systematic review of the validity and reliability of screening tools used to identify risk of malnutrition across health care settings, diagnoses or conditions and adult age groups, as a first step towards a national recommendation of one screening tool.

Methods: A systematic literature search for articles evaluating validity, agreement, and reliability of malnutrition screening tools, published up to August 2020, was conducted in: MEDLINE, Embase, APA PsycInfo, Cinahl, Cochrane Databases, Web of Science, Epistemonikos, SveMed+, and Norart. The systematic review was registered in PROSPERO (CRD42022300558). For critical appraisal of each included article, the Quality Criteria Checklist by The Academy of Nutrition and Dietetics was used.

Results: The review identified 105 articles that fulfilled the inclusion and exclusion criteria. The most frequently validated tools were Mini Nutritional Assessment short form (MNA), Malnutrition Universal Screening Tool (MUST), Malnutrition Screening Tool (MST), and Nutritional Risk Screening 2002 (NRS-2002). MNA, MST and NRS-2002 displayed overall moderate validity, and MUST low validity. All four tools displayed low agreement. MST and MUST were validated across health care settings and age groups. In general, data on reliability was limited.

Conclusions: The screening tools MST and NRS-2002 displayed moderate validity for the identification of malnutrition in adults, of which MST is validated across health care settings. In addition, MNA has moderate validity for the identification of malnutrition in adults 65 years or older.

1. Introduction

Malnutrition is a common condition and can be both a cause and a consequence of disease. Malnutrition also negatively affects the prognosis of disease. The Global Leadership Initiative on Malnutrition (GLIM) criteria are international consensus-based diagnostic criteria for malnutrition [1]. The first step in diagnosing malnutrition in GLIM is screening to identify individuals at risk of

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malnutrition using a validated screening tool [1]. Thus, tools used for screening are not diagnostic tools, but identifies persons at risk of becoming malnourished or persons who already are malnourished. Several malnutrition screening tools are available, but with a large variation in level of validity, reliability, and generalizability, that will affect the ability to accurately identify adults who are malnourished and in need of nutritional treatment [2].

Internationally, a wide array of screening tools are used to identify the risk of malnutrition. Since 2009, the Norwegian Directorate of Health has recommended the use of Malnutrition Universal Screening Tool (MUST), Nutritional Risk Screening 2002 (NRS-2002), Mini Nutritional Assessment Long form (Full MNA), Subjective Global Assessment (SGA) or "Ernæringsjournal" [translates to "Nutrition journal"] depending on the health care setting [3]. The use of various screening tools complicates the comparison of both clinical evaluations and research results on malnutrition. Additionally, the use of several screening tools may lead to miscommunication between health care providers and may pose a risk to patient safety. Discontinuities of care in the transition between different levels in the health care systems have been identified as risk factors for increased readmission rates and adverse medical events [4]. A harmonization and standardization of the screening method may lead to more accurate screening practice and comparison of the risk of malnutrition [5] during the patients' journey from one health care setting to another [6]. The harmonization and standardization of the malnutrition screening may also facilitate a national overview of the burden of malnutrition and its distribution across care settings and regions [6].

The Norwegian Directorate of Health has therefore identified a need to harmonize the malnutrition screening practice across health care settings, diagnoses or conditions and adult age groups. Such a harmonization is in line with former work in other countries. The British Association for Parenteral and Enteral Nutrition (BAPEN) has since 2003 implemented MUST as the recommended screening tool [7,8] providing comparable data across care settings [8]. The American Academy of Nutrition and Dietetics [9] recommended the Malnutrition Universal Screening tool (MST) to screen adults for malnutrition regardless of their age, medical history or setting [2,10]. However, one specific malnutrition screening tool with outstanding validity, reliability, and strong supportive evidence across all care settings among adults has not yet been identified.

As a first step towards a national recommendation of one screening tool for the risk of malnutrition in the entire Norwegian health care system, we conducted a systematic review as an update and extension of the systematic review performed by Skipper et al. [10], by adding more recent literature, revising the comparison standard (including GLIM), and expanding with a Scandinavian literature search. The aim of this systematic review was to summarize the validity of commonly used screening tools to identify risk of malnutrition across health care settings, diagnoses or conditions, and adult age groups.

2. Materials and methods

The PRISMA (Preferred reporting Items for Systematic Reviews and Meta-Analysis) statement was used as the guideline for the review and reporting [11] to ensure objectivity, transparency, and reproducibility of the process. The systematic review has been registered in PROSPERO (CRD42022300558). For critical appraisal of each included article, the Quality Criteria Checklist [12] by The Academy of Nutrition and Dietetics [9] was used.

2.1. Research question and eligibility criteria

The research question was formed using the population, intervention, comparison intervention and outcome (PICO) format, to ensure specificity and relevance to the aim of the project (Table 1). The population criteria for eligibility of studies were adults 18 years or older, any health care settings, and any diagnoses or conditions. The inclusion criteria for studies were quantitative validation studies, published in peer-reviewed journals, written in English, Norwegian, Swedish or Danish language, and at least 20 participants for each comparison. Exclusion criteria were studies using country-specific or modified versions of a tool, tools exclusively consisting of laboratory values and studies only published as abstracts.

The intervention included the 15 common screening tools used in relevant care settings, listed in Table 1. There is no agreed upon gold standard in order to compare the validity of screening tools [6]. Therefore, a set of comparison standards for the validation of screening tools were used, as listed in Table 1. The comparison standards were defined based on well validated "semi-gold standards", and as defined by Skipper et al. [10] in order to facilitate comparison. Furthermore, the GLIM criteria [1] were added as a "semi-gold standard" during the literature review. When used as the sole criterion, BMI was not considered an acceptable gold standard for malnutrition.

The usefulness of a malnutrition screening tool can be measured as the ability to measure the important dimensions of malnutrition in the population at quest (content validity), test-retest and inter-observer variation (reliability), and ability to measure the agreement between the screening tool and the gold-standard or semi-gold-standard (concurrent validity) [6]. Concurrent validity refers to the ability of the screening tool to identify malnutrition, and can be quantified through: sensitivity (the probability of a positive screening result given that the person is malnourished), specificity (the probability of a negative screening result given that the person is not malnourished), positive predictive value (PPV) (the proportion of true positive screening tests among all positive tests), negative predictive value (NPV) (the proportion of true negative tests among all negative tests), and kappa values (the agreement between tools using Cohen's kappa coefficient). In addition, reliability (consistency of results when using the screening tool) was included in the search. All relevant outcomes are listed in Table 1, and in the complete search strategies in Supplementary Table 1.

To be able to harmonize and standardize the malnutrition screening practice for all adults, the tool needed to be validated across adult age groups, health care settings, and diagnoses or conditions.

2.2. Systematic literature search

A systematic literature search was performed in: Ovid MEDLINE(R) and Epub Ahead of Print, Embase, APA PsycInfo, Cinahl, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Web of Science, Epistemonikos, SveMed+, and Norart. The searches were performed by a librarian (RAT) at the Library for the Healthcare Administration, Norwegian Institute of Public Health, Oslo, Norway, after peer-internal review by another librarian from the same library. The search strategies combined search terms for the screening tools and comparison standards for the validation of screening tools (in Table 1) with search terms to identify validation studies. Synonyms with appropriate truncations and abbreviations combined with search terms for malnutrition was used for searching title, abstract, and author keywords. The search strategy was tailored to each database's search interference. The strategies were limited to English, Swedish, Danish, and

Norwegian languages. No further limits were applied. The searches were performed for articles published from the earliest published articles in the databases, and up until the search dates of the 17th-19th of August 2020. In August of 2022, an expanded search was performed where also GLIM was included among the search terms. In this expanded search, 33 additional records were identified, of which all were excluded during literature review. The complete search strategies can be found in Supplementary Table 1.

All identified records were added, sorted, screened for duplicates (using different combinations of fields in preferences), and organized in the EndNote ×9 software by Clarivate Analytics, Web of Science TM. The list of records was independently screened based on title and abstract, and on eligibility criteria identified by the PICO, by two reviewers (THT, IP) blinded for each other's decisions. In the case of disagreement on screening status, consensus was reached between the two reviewers through a third common review.

One additional record was identified through the reviews of relevant literature. The tools Nutritional Risk Index (NRI) and Prognostic Nutritional Index (PNI) were excluded during the review process (after the literature search) since both tools exclusively assess laboratory values. There were no articles validating the tool "Ernæringsjournal" (Norwegian) [translates to "Nutrition journal"].

2.3. Review of the evidence and data extraction

The identified records that met the eligibility criteria were systematically reviewed full-text by both reviewers (independently and blinded) according to inclusion and exclusion criteria, quality of evidence, and outcome of interest. One reviewer (IP) extracted the data, and another reviewer (THT) double checked the extracted data. The following data was retrieved from each eligible research article: reference, publication year, quality of evidence, sample size, country, setting, condition/ward/diagnosis, mean/median age, lower age limit for inclusion, intervention tool, comparison tool, and relevant results of sensitivity, specificity, PPV, NPV, correlation coefficient (CC) and concordance (Cohen's kappa values) (Table 2). Each separate performance indicator (sensitivity, specificity, PPV, NPV, agreement (Cohen's kappa)) was evaluated based on predefined cut-off values as listed in Table 2 [13,14], while overall validity of each screening tool was determined using an algorithm based on the algorithm developed by Skipper et al. [10].

Table 2
Interpretation of performance indicators for overall validity and reliability of screening tools based on Neelemaat et al. and McHugh et al. [13,14].

Validity	High	Moderate	Low
Sensitivity	≥90%	70%–89%	<70%
Specificity	≥90%	70%–89%	<70%
Negative predictive value	≥90%	70%–89%	<70%
Positive predictive value	≥90%	70%–89%	<70%
Agreement (Cohen's kappa)	≥0.8	0.6–0.79	<0.6
Reliability			
Correlation coefficient	≥0.8	0.6–0.79	<0.6
Reliability (Cohen's kappa)	≥0.8	0.6–0.79	<0.6
Gwet's AC1	≥0.8	0.6–0.79	<0.6

2.4. Quality of evidence

The quality of articles was critically appraised independently by both reviewers for each of the included articles, using the Academy's Quality Criteria Checklist of The Academy of Nutrition and Dietetics [12]. The reviewers were blinded for the results of the other reviewer. The critical appraisal includes issues of inclusion/exclusion, bias, and data collection and analysis. When there was initial disagreement between the researchers on the quality assessment, consensus was reached through a third common review. Each article was graded as positive (+) indicating that the report has clearly addressed the issues, negative (−) indicating that these issues have not been adequately addressed, and neutral (ø) indicating that the report is neither exceptionally strong nor exceptionally weak in quality.

2.5. Reliability

Studies reporting on the reliability of Mini Nutritional Assessment Short Form (MNA), MST, MUST or NRS-2002 were summarized in Supplementary Table 2 either with test-retest or inter-rater reliability of the respective tools. One reviewer (THT) extracted the data from each eligible research article, and the other reviewer (IP) checked the extracted data. The following data were extracted: reference, publication year, sample size, country, setting, condition/ward/diagnosis, mean/median age, lower age limit for inclusion, intervention tool, observer comparison, comparison period, and relevant results of CC, intraclass correlation coefficient (ICC), and agreement coefficients (Gwet's AC1 and Cohen's kappa values). To

Table 1
PICO.

Population	Intervention	Comparison	Outcome
• Patients admitted to hospitals or other health institutions within secondary care • Persons living in nursing home or long term care facilities within the primary health care • Persons receiving home based care within the primary health care system • Persons with high risk of malnutrition who are in contact with the primary health care system	• Malnutrition Screening Tool (MST) • Malnutrition Universal Screening tool (MUST) • Mini Nutritional Assessment short form (MNA) • Nutritional Form for the Elderly (NUFFE) • Nutritional Risk Index (NRI) • Nutritional Risk Screening 2002 (NRS-2002) • Patient generated subjective global assessment short form (PG-SGA-SF) • Prognostic Nutritional Index (PNI) • Short nutritional assessment questionnaire (SNAQ) • Simplified nutrition appetite questionnaire (SimplifiedNAQ) • Subjective global assessment (SGA) • Nutriscore • Ernæringsjournal [Nutrition journal]	• Mini Nutritional Assessment Long form (Full MNA) [35] • Subjective Global Assessment (SGA) [36,37] • Patient-Generated Subjective Global Assessment (PG-SGA) [38,39] • McWhirter and Pennington Criteria [40] • A nutrition assessment including at least body composition and change in body weight over time [10] • Malnutrition Inflammation Score (MIS) (when used for nutrition assessment) [10,41] • The GLIM criteria [1] (added after the original search)	• Sensitivity • Specificity • Validity • Reliability • Agreement • Generalization • Positive predictive value • Negative predictive value • Kappa

summarize the evidence only agreement coefficients were comparable and were interpreted as described in Table 2.

3. Results

The inclusion of records is summarized in a PRISMA diagram (Fig. 1). The literature search provided 12,882 records as well as 33 additional records in an updated search including GLIM, and one record identified through other sources resulting in 7042 records after the removal of duplicates. After the exclusion of 6564 through the initial screening rounds, 485 full-text records were screened for the eligibility of inclusion. Of these, 380 records were excluded based on the given inclusion and exclusion criteria, resulting in the inclusion of 105 records for the summary of results (Supplementary Table 3).

The validity (sensitivity, specificity, PPV, and NPV) and agreement (Cohen's kappa) is summarized in Table 3. In addition, validity, agreement, quality, and characteristics of all included studies can be found in the following tables: MNA (Table 4), MST (Table 5), MUST (Table 6), NRS-2002 (Table 7), and Nutritional Form for the Elderly (NUFFE), Nutriscore, Patient generated subjective global assessment short form (PG-SGA-SF), Short nutritional assessment questionnaire (SNAQ), and Simplified nutritional appetite questionnaire (SimplifiedNAQ) (Table 8). A list of the 105 included studies can be found in Supplementary Table 3, and the completed Quality Check List for all included studies is presented in Supplementary Table 4. For each tool a summary and a conclusion is presented in alphabetical order below:

3.1. Mini Nutritional Assessment short form (MNA)

MNA was validated in 34 articles and with a total of 44 comparisons of which 34 were against Full MNA, eight against SGA, and one each for Malnutrition Inflammation Score (MIS) and Patient

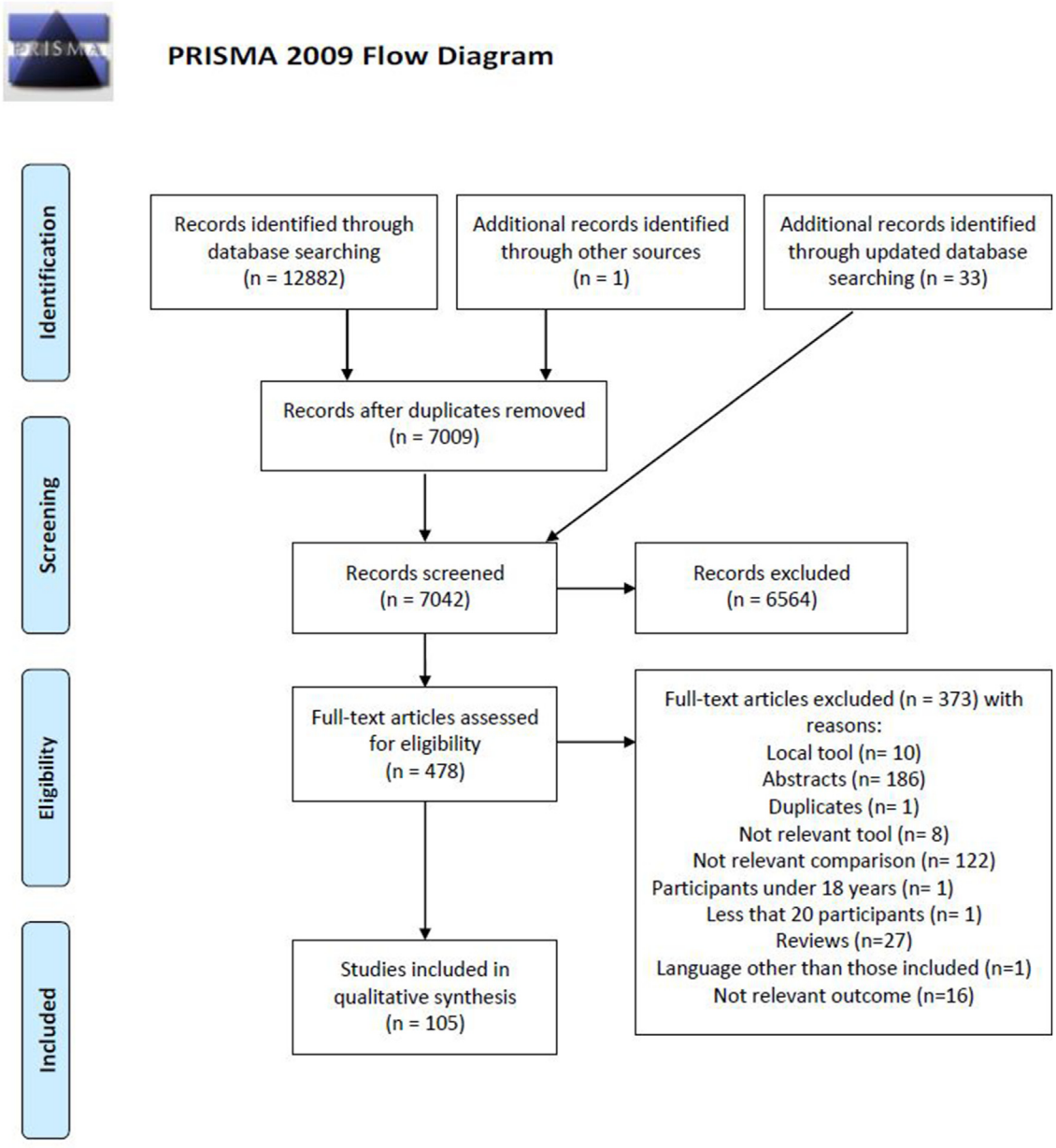

Fig. 1. PRISMA flow chart.

Table 3
Summary of validity.

	Sensitivity Median (range)	Specificity Median (range)	PPV Median (range)	NPV Median (range)	Agreement (Cohen's kappa) Median (range)
MNA (n = 34)					
Against all comparisons	85.9 (64–100)	86.3 (44–100)	77.7 (16–100)	90.5 (58–100)	0.62 (0.14–0.92)
Against other comparisons than Full-MNA	84.3 (70–100)	77.9 (53–95)	57.0 (20–76)	98.4 (93–100)	0.52 (0.14–0.92)
MST (n = 26)	72.9 (32–100)	84.4 (25–98)	69.9 (36–98)	87.1 (49–100)	0.59 (0.23–0.9)
MUST (n = 35)	69.7 (16–100)	87.3 (45–100)	80.5 (30–100)	88.7 (34–100)	0.52 (0.16–0.91)
NUFFE (n = 1)	69.8	75.7	80.8	30.3	–
NRS-2002 (n = 35)	70.4 (37–97)	90.1 (30–98)	85.0 (32–99)	77.5 (35–100)	0.53 (0.13–0.89)
Nutriscore (n = 1)	97.3	95.6	84.8	99.0	0.88
PG-SGA-SF (n = 3)	89.0 (78–94)	72.3 (62–94)	41 (31–91)	98.0 (84–98)	0.39 (0.31–0.49)
SNAQ (n = 5)	79.0 (51–92)	90.3 (81–100)	80.0 (29–100)	86.9 (56–100)	–
SimplifiedNAQ (n = 6)	69.3 (28–87)	78.9 (77–94)	89.0 (78–90)	57.1 (44–88)	0.27 (0.18–0.36)

Abbreviations: MNA: Mini Nutritional Assessment (short form); MST: Malnutrition Screening Tool; MUST: Malnutrition Universal Screening Tool; NRS-2002: NPV: negative predictive value; Nutritional Risk Screening 2002; (PG-)SGA(-SF): (Patient Generated) Subjective Global Assessment (short form); PPV: positive predictive value; SimplifiedNAQ: Simplified nutrition appetite questionnaire; SNAQ: Short nutritional assessment questionnaire.

Generated Subjective Global Assessment (PG-SGA) (Table 4). Median sample size was 250. Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement against all references, and against other references than Full MNA. The majority of comparisons (37 comparisons) were done in older adults, and the most common setting was community-dwelling [12], nursing homes [9] or inpatients [10] within a variety of conditions/wards. Risk of bias was summarized as quality of primary research in 34 articles of which 16 was graded as positive (+) and 18 was graded as neutral (ø). One article was found to report on reliability of the MNA tool, with an inter-rater reliability of 0.31 [15]. In conclusion, MNA obtained moderate validity, low agreement and validation studies limited to the older adult population across health care settings and conditions or wards. The quality of research was positive in 47% of the articles, and data on reliability was limited.

3.2. Malnutrition screening tool (MST)

MST was validated in 26 articles and with a total of 31 comparisons, of which 16 against SGA, nine against PG-SGA, three against Full MNA, two against GLIM, and one against McWhriter (Table 5). Median sample size was 134. Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement. Of the comparisons, 15 were in populations of 18 years or above, and seven in older adults. The most common comparison setting was inpatients [15], outpatients [12], within a variety of conditions or wards. The quality of primary research was graded as positive (+) in 17 of the articles and neutral (ø) in nine articles. Six articles were found to report on reliability of MST [16,18–22], with a total of 10 comparisons. The mean inter-rater reliability between comparisons was 0.64 (0.28–0.93) measured in kappa values and 0.8 (0.6–0.9) with Gwet's AC1. In conclusion, MST obtained moderate validity, low agreement, and validated across age groups, health care settings, and conditions or wards. The quality of research was positive in 65% of the articles, and data on reliability was moderate.

3.3. Malnutrition Universal Screening tool (MUST)

MUST was validated in 35 articles with a total of 41 comparisons of which 21 against SGA, six against PG-SGA, 11 against Full MNA, two against GLIM, and one against a nutrition assessment including body composition and change in body weight over time (Table 6). Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement. Most of the comparisons were performed in inpatients [26] or outpatients [9], within a variety of conditions or wards. Of the comparisons, 19 were in adult populations, and 15 in older adults. Quality of primary research was graded as positive (+) in 19 articles and neutral (ø) in 16 articles. Reliability was reported in three studies [16–18], with a mean inter-rater reliability between two studies of 0.68 (0.58–0.78). In conclusion, MUST obtained low validity, low agreement, and validity across age groups, health care settings, and conditions or wards. The quality of research was positive in 56% in of the articles, and data on reliability was limited.

3.4. Nutritional Form for the elderly (NUFFE)

NUFFE was validated in one article and with one comparison against Full MNA with a sensitivity of 70, specificity of 76, PPV of 81, and NPV of 30 (Tables 3 and 8). The validation was performed in 97 older adults in a nursing home setting. Quality of primary research was graded as positive (+) in the included article.

3.5. Nutritional Risk Screening 2002 (NRS-2002)

NRS-2002 was validated in 36 articles and with a total of 46 comparisons of which 26 against SGA, three against PG-SGA, 12 against Full MNA, three against GLIM, one against McWhriter, and one nutrition assessment including body composition and change in body weight over time (Table 7). Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement. Median sample size was 210, and the majority of comparisons (23 comparisons) were done in populations 18 years or above and in older adults (14 comparisons). Most of the comparisons were performed in inpatients [42], within a variety of conditions or wards. Quality of primary research was graded as positive (+) in 27 articles and neutral (ø) in nine articles. Reliability was reported in three studies with five comparisons [23–25]. The median inter-rater reliability between comparisons was 0.78 (0.65–0.96). In conclusion, NRS-2002 obtained moderate validity, low agreement, and validation studies limited to inpatients within a variety of wards. The quality of research was positive in 75% of the articles, and data on reliability was moderate.

3.6. Nutriscore

Nutriscore was validated in one article and with comparison against PG-SGA, with a sensitivity of 97, specificity 96, PPV 85, NPV 99, and kappa 0.88 (Tables 3 and 8). The validation was performed in a population of 394 oncology outpatients. Quality of primary research was graded as positive (+) in the included article.

Table 4
Validation of MNA.

Reference	Quality	Publication year	Sample size	Country	Setting	Condition/ward/ diagnosis	Mean/Median age	Lower age limit for inclusion	Validated tool	Comparison	Sensitivity	Specificity	PPV	NPV	AUC	CC	Kappa
Albay et al. [42]	Ø	2020	75	Turkey	Outpatient	Parkinson's Disease	67	45	MNA	Full MNA	87.1	70.5	88.6	77.3			
Borowiak et al. [43]	Ø	2003	160	Poland	Community-dwelling	Older adults	74	65	MNA	Full MNA	73.6		93	82			
		2003	151	Poland	Nursing home	Older adults	79	65	MNA	Full MNA	64.4		100	58			
Charlton et al. [44]	Ø	2007	220	South Africa	Community-dwelling and nursing home	Older adults	72	60	MNA	Full MNA	100.0	94.6	16.3	62.9			
Charlton et al. [45]	+	2010	1615	Australia	Rehabilitation	Rehabilitation	81	65	MNA	Full MNA	77	44	72.8	77.5			0.532
Christner et al. [46]	+	2016	201	Germany	Inpatient	Geriatric	83	65	MNA	Full MNA							0.7
Cohendy et al. [47].	Ø	2001	408	France	Day care	Surgery	70	60	MNA	Full MNA	89	86	79	93			
Cuervo, et al. [48]	+	2009	22,007	Spain	Community-dwelling	Older adults	75	65	MNA	Full MNA	85.2		76.4	93.4	0.942		
De La Montana et al. [49]	Ø	2011	728	Spain	Community-dwelling	Older adults	81	65	MNA	Full MNA	81	93	96	68			
Dent et al. [50]	+	2017	100	Australia	Inpatients	Geriatric	85	70	MNA	Full MNA					0.93	0.87	
Donini et al. [51]	Ø	2016	246	Italy	Nursing home	Older adults	women 82; men 77	60	MNA	Full MNA	96.4	55.8	89	80.6			0.588
Duran Alert et al. [52]	Ø	2012	40	Spain	Inpatients	Geriatric	Female: 85; male 83	75	MNA	Full MNA							0.81
Garcia-Meseguer, et al. [53]	Ø	2013	895	Spain	Nursing home	Older adults	82	65	MNA	Full MNA	86.1	87.9	82.6	90.4	0.95		0.685
Holvoet et al. [54]	Ø	2020	216	Belgium		Dialysis	67	18	MNA	Full MNA					0.909		
Isenring et al. [55]	Ø	2012	127	Australia	Nursing home		83	55	MNA	Full MNA	100	56.4					0.257
		2012	127	Australia	Nursing home		83	55	MNA	SGA	85.7	62					0.377
Joaquin et al. [56]	+	2019	151	Spain	Outpatient	Heart failure	69	adult	MNA	Full MNA	71	93.8	79.4	90.5			0.67
		2019	151	Spain	Outpatient	Heart failure	69	adult	MNA	SGA	79.1	88.1	55.8	95.7			0.66
Kaiser et al. [57]	Ø	2011	657	Germany	Community-dwelling	Older adults	81		MNA	Full MNA							0.586
		2011	657	Germany	Nursing home	Older adults	86		MNA	Full MNA							0.775
		2011	657	Italy	Rehabilitation	Older adults	75		MNA	Full MNA							0.626
Keller et al. [58]	Ø	2019	638	Canada	Nursing home	Older adults	?	65	MNA	PG-SGA	83.99	70.22					
Kiesswetter et al. [59]	Ø	2014	309	Germany	Community-dwelling	home care	81	65	MNA	Full MNA							0.62
Kostka et al. [60]	+	2014	932	Poland	Community-dwelling	Older adults	72	65	MNA	Full MNA	82.7	88.9					
		2014	812	Poland	Community-dwelling	Older adults	73	65	MNA	Full MNA	89.3	87.9					
		2014	859	Poland	Nursing home	Older adults	79	65	MNA	Full MNA	85.7	91.6					
Lei Z [61]	+	2009	184	China	Inpatients		68	60	MNA	Full MNA	89.6	88			0.932		
Lilamand et al. [62]	+	2015	267	France	Day care	Frail	82	65	MNA	Full MNA					0.954		
Lomivorotov et al. [63]	Ø	2013a	441	Russia	Inpatients	Cardio-vascular disease	58	18	MNA	SGA	84.6	77.9	27.1	98.1			
Lomivorotov et al. [64]	+	2013b		Russia	Inpatients	Cardio-vascular disease	59	18	MNA	SGA	81.8	80.7	20.4	98.6			
Martín et al. [65]	Ø	2016	591	Spain	Inpatients	Diabetes	78	65	MNA	Full MNA	90.6	85.1					
Montejano Lozoya et al. [66]	+	2017	660	Spain	Community-dwelling	Older adults	74	65	MNA	Full MNA	73.4	86.6	62.4	91.4	0.88	0.78	0.54
Olivares et al. [67]	+	2014	537	Spain	Inpatients	Medical and surgery	61	adult	MNA	SGA	69.9	94.7	75.8	93			0.666
Rubenstein et al. [68]	Ø	2001	155	France	Inpatients and community-dwelling	Older adults	79		MNA	Full MNA	98	100			0.961		
Santin et al. [69]	+	2016	137	Brazil		Dialysis	70	60	MNA	MIS							0.14
		2016	137	Brazil		Dialysis	70	60	MNA	SGA							0.24
Schrader et al. [70]	+	2016	190	Germany	Day care	Geriatric	80	65	MNA	Full MNA							0.53
Sheard et al. [71]	Ø	2013	125	Australia	Community-dwelling	Parkinson's disease	70	18	MNA	SGA	94.7	78.3	58.1	98.8			0.92
Sheean et al. [72]	+	2013	253	USA	ICU	Medical and surgery		65	MNA	Full MNA	72	98				0.76	

(*continued on next page*)

Table 4 (*continued*)

Reference	Quality	Publication year	Sample size	Country	Setting	Condition/ward/ diagnosis	Mean/Median age	Lower age limit for inclusion	Validated tool	Comparison	Sensitivity	Specificity	PPV	NPV	AUC	CC	Kappa
							Medical ICU 75; surgical ICU 74										
Simsek et al. [73]	Ø	2014	640	Turkey	Community-dwelling	Older adults	74	65	MNA	Full MNA	88.7				0.87		0.63
		2014	243	Turkey	Nursing home	Older adults	79	65	MNA	Full MNA	88.9				0.85		0.62
Wikby et al. [74]	+	2008	127	Sweden	Nursing home	Older adults	men: 84; women 86	65	MNA	Full MNA	89.00	82.00	92.00				
Young et al. [75]	+	2013	134	Australia	Inpatients	Medical	80	65	MNA	Full MNA	95.6	79.1	90.5	89.5	0.96		
		2013	134	Australia	Inpatients	Medical	80	65	MNA	SGA	100	52.8	64.6	100	0.95		

Abbreviations: AUC: area under the curve; CC: correlation coefficient; Full MNA: Full Mini Nutritional Assessment; ICU: Intensive Care Unit; MIS: Malnutrition Inflammation Score; MNA: Mini Nutritional Assessment (short form); NPV: negative predictive value; (PG-)SGA: (Patient Generated) Subjective Global Assessment; PPV: positive predictive value.

3.7. Patient generated subjective global assessment short form (PG-SGA-SF)

PG-SGA-SF was validated in three articles and with a total of five comparisons, all against PG-SGA (Table 8). The median sample size was 246, of which all validations were performed in populations 18 years or above. Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement. The setting for four comparisons were in oncology and one nephrology ward. It should be noted that three of the comparisons were performed with different cut-off values for risk of malnutrition in the same population. Quality of primary research was graded as positive (+) in all three articles.

3.8. Short nutritional assessment questionnaire (SNAQ)

SNAQ was validated in five articles and with a total of six comparisons of which four against SGA, one against GLIM, and one against Full MNA (Table 8). The median sample size was 170, and four validations were performed in inpatients, and one in outpatients. Four of the comparisons were in populations 18 years or above, and two in populations 65 years or above. Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement. Quality of primary research was graded as positive (+) in three articles and neutral (ø) in two articles.

3.9. Simplified nutritional appetite questionnaire (SimplifiedNAQ)

SimplifiedNAQ was validated in six articles and with a total of eight comparisons of which six against Full MNA and two against SGA (Table 8). Median sample size was 180, and all validations were performed in populations above 55, 60 or 65 years of age within different health care settings. Table 3 lists the median sensitivity, specificity, PPV, NPV, and agreement. Quality of primary research was graded as positive (+) in three articles and neutral (ø) in three articles.

3.10. Overall validity

For each screening tool, the overall validity was based on the algorithm as shown in Fig. 2.

4. Discussion

In this systematic review, we summarized the validation of malnutrition screening tools for adults (18 years or older) in any setting and independent of medical diagnoses or conditions. The four screening tools MNA, MST, MUST, and NRS-2002 were the most frequently validated against “semi-gold standards” for malnutrition screening.

This systematic review was initiated by the Norwegian Directorate of Health as a first step towards choosing one malnutrition screening tool to be used in the entire health care system. The main objective for choosing one tool was to facilitate seamless communication of malnutrition screening along the patient pathway.

Screening for malnutrition is the first step in the approach of diagnosing malnutrition suggested in the GLIM framework [1]. Thus, it is of great importance that the screening tool used can identify those at risk of malnutrition in an accurate and timely manner. The European Society of Parenteral and Enteral Nutrition (ESPEN) guidelines for nutrition screening states that the purpose of nutritional screening is to “predict the probability of a better or worse outcome due to nutritional factors, and whether nutritional treatment is likely to influence this” [26]. The screening tools MNA, MST, and NRS-2002 all displayed overall moderate validity for the identification of malnutrition. MUST had low validity due to a

Table 5
Validation of MST.

Reference	Quality	Publication year	Sample size	Country	Setting	Condition/ward/ diagnosis	Mean/Median age	Lower age limit for inclusion	Validated tool	Comparison	Sensitivity	Specificity	PPV	NPV	AUC	CC	Kappa
Abbott et al. [101]	Ø	2014	300	Australia	Outpatient	Oncology	59	18	MST	PG-SGA	70.6	69.5			0.77		
Abe Vicente et al. [76]	Ø	2013	75	Brazil	Outpatient	Oncology	60		MST	PG-SGA	52	84					
		2013	62	Brazil	Outpatient	Oncology	61		MST	PG-SGA	61.5	91.8					
Arribas et al. [102]	+	2017	394	Spain	Outpatient	oncology	62	18	MST	PG-SGA	84	85.6	57.7	95.7	0.84		0.59
Byrnes et al. [103]	+	2018	75	Australia	Inpatient	surgery	74	65	MST	PG-SGA	86	80	50	96	0.83		
Clark, et al. [104]	+	2020	444	Australia	Hospital	Geriatric rehabilitation	82		MST	GLIM	56.7	69	66.5	59.5	0.63		0.26
De Groot et al. [105]	+	2020	246	Australia	?	oncology	62	18	MST	PG-SGA	100	90					0.737
Ferguson et al. [19]	+	1999	408	Australia	inpatients	medical and surgery	58	18	MST	SGA	93	93	98.4	72.7			
Ferguson, et al. [106]	+	1999	106	Australia	Outpatient	oncology	60	?	MST	SGA	100.00	81.00	40	100			
Fiol-Martinez et al. [82]	+	2017	73	Spain	inpatients	hematology	64	18	MST	SGA	72.7	65.4	72.70	90.9	0.691		
Fiorindi, et al. [83]	Ø	2020	53	Italy	Inpatients	GI surgery	51		MST	GLIM	63.6	96.8			0.878		
Gabrielson et al. [107]	+	2013	90	Canada	Outpatient	oncology	55	18	MST	PG-SGA	81.3	72.4			0.823		
Georgiou et al. [84]	+	2019	170	Greece	Outpatient	hepatology	59	18	MST	SGA	51.3	97.7	87	87.1	0.814		
Hogan et al. [108]	Ø	2017	29	Vietnam	Outpatient	pulmonary disease	70		MST	SGA	38	94	83	65			
Isenring et al. [109]	Ø	2006	50	Australia	Outpatient	oncology	59	18	MST	PG-SGA	100.00	92.00	80.00	100.00			
Isenring et al. [55]	Ø	2012	127	Australia	nursing home		83	55	MST	Full MNA	94.1	80.9					0.501
		2012	127	Australia	nursing home		83	55	MST	SGA	88.6	93.5					0.806
Isenring et al. [110]	+	2009	346	Australia	nursing home		84		MST	SGA	83.60	65.6	65	84			
Joaquin et al. [56]	+	2019	151	Spain	Outpatient	heart failure	69	adult	MST	Full MNA	31.5	91.1	54.5	79.8			0.26
		2019	151	Spain	Outpatient	heart failure	69	adult	MST	SGA	33.3	88.9	36.3	87.5			0.23
Lawson et al. [16]	+	2012	145	UK	inpatients	nephrology	65	?	MST	SGA	48.7	85.5	78.7	60.2			0.335
Leipold et al. [111]	+	2018	160	Australia	rehabilitation	rehabilitation	74	18	MST	SGA	72.2	83.8	69.6	85.4			
Morris et al. [112]	Ø	2018	608	Australia	inpatients	medical	62	18	MST	SGA	84	70.7	66.7	86.3	0.81		
Mourão et al. [113]	+	2004	100	Portugal	inpatients	surgery	55	18	MST	McWhirter							0.72
		2004	100	Portugal	inpatients	surgery	55	18	MST	SGA	54	25					0.9
Nor Azian et al. [18]	Ø	2014	151	Malaysia	inpatients and outpatient	medical	45	18–65	MST	SGA	93.3	80.9	54.9	98			
Shaw et al. [114]	+	2015	126	UK	inpatients	oncology	59	18	MST	PG-SGA	66	83	91.00	49.00	0.83		
Ulltang et al. [115]	Ø	2013	65	Australia	inpatients	medical	62		MST	SGA	73	76	38	93			
Wu et al. [116]	+	2012	157	Australia	inpatients	rehabilitation	78	65	MST	SGA	94.00	89	70	98			0.74
Young et al. [75]	+	2013	134	Australia	inpatients	medical	80	65	MST	Full MNA	67.7	88.3	92.4	56.7	0.87		
		2013	134	Australia	inpatients	medical	80	65	MST	SGA	90.3	84.7	83.6	91	0.92		

Abbreviations: AUC: area under the curve; CC: correlation coefficient; Full MNA: Full Mini Nutritional Assessment; GI: Gastrointestinal; GLIM: Global Leadership Initiative on Malnutrition; MST: Malnutrition Screening Tool; NPV: negative predictive value; (PG-)SGA: (Patient Generated) Subjective Global Assessment; PPV: positive predictive value.

Table 6
Validation of MUST.

Reference	Quality	Publication year	Sample size	Country	Setting	Condition/ward/ diagnosis	Mean/Median age	Lower age limit for inclusion	Validated tool	Comparison	Sensitivity	Specificity	PPV	NPV	AUC	CC	Kappa
Abe Vicente et al. [76]	Ø	2013	75	Brazil	Outpatient	Oncology	60		MUST	PG-SGA	72	48.9					
		2013	62	Brazil	Outpatient	Oncology	61		MUST	PG-SGA	72	73.4					
Almeida et al. [77]	+	2012	300	Portugal	Inpatient	Surgery	60	18	MUST	SGA	85	93	89	99		0.912	0.912
Bellanti, et al. [78]	+	2020	152	Italy	Hospital	Internal and aging medicine	78/79	65	MUST	GLIM	64.3	81.7	75	72.8			0.89
Bobčíková et al. [79]	Ø	2020	103	Czech Republic	Inpatient	Cardio-vascular disease	76	65	MUST	Full MNA							0.44
Boleo-Tome et al. [80]	+	2012	450	Portugal	Outpatient	Oncology	62		MUST	PG-SGA	80	89	87	100			0·86
Diekmann et al. [81]	+	2013	200	Germany	Nursing home	Older adults	86	65	MUST	Full MNA							0.16
Donini et al. [51]	Ø	2016	246	Italy	Nursing home	Older adults	women 82; men 77	60	MUST	Full MNA	47.9	98.1	98.8	33.6			0.27
Fiol-Martinez et al. [82]	+	2017	73	Spain	Inpatients	Hematology	64	18	MUST	SGA	90.9	75	43.5	97.5	0.83		
Fiorindi, et al. [83]	Ø	2020	53	Italy	Inpatients	GI surgery	51		MUST	GLIM	63.6	96.8			0.878		
Georgiou et al. [84]	+	2019	170	Greece	Outpatient	Hepatology	59	18	MUST	SGA	59	96.9	85.2	88.8	0.777		
Gibson et al. [85]	Ø	2012	262	Australia	Inpatients	Medical	71	?	MUST	SGA	80	85					
Hettiarachchi et al. [86]	Ø	2018	100	Sri Lanka	Outpatient	Oncology	59	18	MUST	PG-SGA	86.7	94.5	92.9	89.7			0.79
Holst et al. [87]	+	2013	233	Denmark and Sweden	Inpatients	Gastroenterology and Geriatric	81	65	MUST	Full MNA							0.38
Isenring et al. [55]	Ø	2012	127	Australia	Nursing home		83	55	MUST	Full MNA	76.5	87.3					0.51
		2012	127	Australia	Nursing home		83	55	MUST	SGA	68.6	96.7					0.703
Jackson et al. [88]	Ø	2019	141	UK	Inpatients	Nephrology	64	18	MUST	SGA	44.4	100	100	69.0			0.47
Joaquin et al. [56]	+	2019	151	Spain	Outpatient	Heart failure	69	Adult	MUST	Full MNA	34.2	95.5	72.2	81.2			0.36
		2019	151	Spain	Outpatient	Heart failure	69	Adult	MUST	SGA	62.5	97.6	83.3	93.2			0.65
Kosters et al. [89]	+	2020	123	Netherlands	Inpatients and outpatients	Nephrology		18	MUST	PG-SGA	24	94	76	61			
Kozakova et al. [90]	Ø	2014	470	Czech Republic	Community-dwelling	Home care	77	65	MUST	Full MNA							0.451
		2014	470	Czech Republic	Community-dwelling	Home care	77	65	MUST	SGA							0.522
Kyle et al. [91]	+	2006	995	Switzerland	Inpatients	Medical and surgery	LOS 1–10 days 51; LOS >11 d 65; LOS unknown 44	Adult	MUST	SGA	61	76	65	76			0.26
Lawson et al. [16]	+	2012	147	UK	Inpatients	Nephrology	65	?	MUST	SGA	53.8	78.3	73.7	60			0.316
Lomivorotov et al. [63]	Ø	2013	441	Russia	Inpatients	Cardiovascular disease	58	18	MUST	SGA	100	82.3	35.5	100			
Lomivorotov et al. [64]	+	2013	894	Russia	Inpatients	Cardiovascular disease	59	18	MUST	SGA	97.9	87.1	29.7	99.9			
Martin Palmero et al. [92]	Ø	2017	384	Spain	Inpatients	Medical and surgery	65	18	MUST	SGA							0.422
Naik et al. [93]	Ø	2018	331	India	Outpatient	Older adults	?	60	MUST	Full MNA	15.79	44.71					
	Ø	2014	151	Malaysia		Medical	45	18–65	MUST	SGA	96.6	80.9	55.7	98.8			

Nor Azian et al. [18]					Inpatients and outpatient											
Olivares et al. [67]	+	2014	537	Spain	Inpatients	Medical and surgery	61	Adult	MUST	SGA	64.1	91.9	65.3	91.5		0.564
Pereira Borges et al. [94]	Ø	2009	144	Brazil	Inpatients	Oncology	56	Adult	MUST	SGA						0.799
Raupp et al. [95]	Ø	2018	577	Brazil	Inpatients	Emergency	54	18	MUST	SGA						0.67
Sharma et al. [96]	+	2017	132	Australia	Inpatients	Medical	80	60	MUST	PG-SGA	69.70	75.80	75.40	70.10	0.73	0.45
Stratton et al. [7]	Ø	2004	50	UK	Inpatients	Medical	45	Under 65	MUST	SGA						0.783
Tripathy et al. [97]	+	2015	111	India	ICU	Medical and surgery	75	65	MUST	"Standard" based on low BMI AND unplanned weight loss	96.5	72.3	80.9	94.4		0.65
Tu et al. [98]	+	2012	45	Taiwan	Inpatients	Oncology	62	?	MUST	SGA	96	75	82.7	93.8		0.724
Vallen et al. [99]	+	2011	100	Sweden	Inpatients	Orthopedics, cardiovascular disease	80	65	MUST	Full MNA	57.00	93.00	86	75		
Velasco et al. [100]	+	2011	400	Spain	Inpatients	Medical and surgery	67	18	MUST	Full MNA						0.388
		2011	400	Spain	Inpatients	Medical and surgery	67	18	MUST	SGA	71.6	90.3	80.1	85.4		0.635
Young et al. [75]	+	2013	134	Australia	Inpatients	Medical	80	65	MUST	Full MNA	67.8	93	95.3	58	0.82	
		2013	134	Australia	Inpatients	Medical	80	65	MUST	SGA	87.1	86.1	84.4	88.6	0.89	

Abbreviations: AUC: area under the curve; BMI: Body Mass Intex; CC: correlation coefficient; Full MNA: Full Mini Nutritional Assessment; GLIM: Global Leadership Initiative on Malnutrition; ICU: Intensive Care Unit; GI: Gastrointestinal; LOS: Length of stay; MUST: Malnutrition Universal Screening Tool; NPV: negative predictive value; (PG-)SGA: (Patient Generated) Subjective Global Assessment; PPV: positive predictive value.

Table 7
Validation of NRS-2002.

Reference	Quality	Publication year	Sample size	Country	Setting	Condition/ward/ diagnosis	Mean/Median age	Lower age limit for inclusion	Validated tool	Comparison	Sensitivity	Specificity	PPV	NPV	AUC	CC	Kappa
Almeida et al. [77]	+	2012	300	Portugal	Inpatient	Surgery	60	18	NRS-2002	SGA	80	89	87	100		0.854	0.853
Badia-Tahull et al. [117]	+	2014	45	Spain	Inpatient	Digestive surgery patients on parenteral nutrition	65	18	NRS-2002	PG-SGA							0.31
		2014	45	Spain	Inpatient	Digestive surgery patients on parenteral nutrition	65	18	NRS-2002	SGA							0.53
Bauer et al. [118]	+	2005	121	Germany	Inpatient	Geriatric	80	65	NRS-2002	Full MNA	39.3	83.3	84.6	37			
		2005	121	Germany	Inpatient	Geriatric	80	65	NRS-2002	SGA	70.4	84.6	79.2	77.5			
Bellanti et al. [78]	+	2020	152	Italy	Inpatient	Internal and Aging Medicine clinic	Malnourished 78, not malnourished 80	65	NRS-2002	GLIM	47.1	75.6	62.3	62.6			0.62
Boulhosa et al. [119]	+	2020	166	Brazil	Inpatient	Advanced chronic liver disease	58	18	NRS-2002	GLIM	54.7	91	90	60			0.43
Chavez-Tostado et al. [120]	+	2020	196	Mexico	Inpatient	Gastro-enterology	46	18	NRS-2002	SGA							0.53
Cunha et al. [32]	Ø	2015	173	Brazil	Inpatient	Oncology	70	18	NRS-2002	PG-SGA							0.322
		2015	173	Brazil	Inpatient	Oncology	70	18	NRS-2002	SGA							0.345
Demirel et al. [121]	+	2018	124	Turkey	Inpatient and outpatients	Oncology	52	?	NRS-2002	Full MNA	96.5	92.1	96.5	92.1			0.886
		2018	124	Turkey	Inpatient and outpatients	Oncology	52	?	NRS-2002	SGA	67.5	92.9	97.7	68.4			0.713
Diekmann et al. [81]	+	2013	200	Germany	Nursing home	Older adults	86	65	NRS-2002	Full MNA							0.13
Donini et al. [51]	Ø	2016	246	Italy	Nursing home	Older adults	Women 82; men 77	60	NRS-2002	Full MNA	50.5	98.1	99	34.7			0.291
Fiorindi, et al. [83]	Ø	2020	53	Italy	Inpatients	GI surgery	51		NRS-2002	GLIM	81.1	90.3			0.919		
Georgiou et al. [84]	+	2019	170	Greece	Outpatient	Hepatology	59	18	NRS-2002	SGA	46.2	87	51.4	84.4	0.747		
Hartz et al. [122]	+	2019	594	USA	Inpatients	Medical and surgery	63	18	NRS-2002	Assessment incl. NFPE	63.5	94.3	93.3	67.6			0.56
Holst et al. [87]	+	2013	233	Denmark and Sweden	Inpatients	Gastroentero-logy and geriatric	81	65	NRS-2002	Full MNA							0.52
Javid Mishamandani et al. [123]	Ø	2018	1311	Iran	ICU		?	16	NRS-2002	SGA					0.691		0.226
Juntao Chi et al. [124]	+	2017	280	China	Inpatients	Oncology	63	18	NRS-2002	SGA							0.54
Kyle et al. [91]	+	2006	995	Switzerland	Inpatients	Medical and surgery	LOS 1–10 days 51; LOS >11 d 65; LOS unknown 44	adult	NRS-2002	SGA	62	93	85	79			0.48
Leandro-Merhi et al. [125]	+	2015	210	Brazil	Inpatients	Gastroenterology	?	20	NRS-2002	SGA							0.461
		2015	290	Brazil	Inpatients	Oncology	?	20	NRS-2002	SGA							0.526
Leandro-Merhi et al. [126]	Ø	2017	79	Brazil	Inpatients	Oncology	72	65	NRS-2002	Full MNA							0.528
		2017	79	Brazil	Inpatients	Oncology	72	65	NRS-2002	SGA							0.239
Lomivorotov et al. [63]	Ø	2013	441	Russia	Inpatients	Cardiovascular disease	58	18	NRS-2002	SGA	43.6	93.5	39.5	94.5			
Lomivorotov et al. [64]	+	2013	894	Russia	Inpatients	Cardiovascular disease	59	18	NRS-2002	SGA	38.3	95.4	31.6	96.5			
Martin Palmero et al. [92]	Ø	2017	384	Spain	Inpatients	Medical and surgery	65	18	NRS-2002	SGA							0.758
Martins et al. [127]	+	2005	143	Portugal	Inpatients	Orthopedic	74	65	NRS-2002	Full MNA	81.7	84.6	92.1	67.9			0.62

		2005	143	Portugal	Inpatients	Orthopedic	74	65	NRS-2002	SGA	85.9	69.2	85.9	69.2		0.55
Meireles et al. [128]	+	2012	124	Brazil	Inpatients	Surgery	52	19	NRS-2002	SGA						0.49
Miao et al. [129]	+	2019	425	China	Inpatients	Geriatric	81	70	NRS-2002	Full MNA						0.521
Mourão et al. [113]	+	2004	100	Portugal	Inpatients	Surgery	55	18	NRS-2002	McWhirter						0.29
		2004	100	Portugal	Inpatients	Surgery	55	18	NRS-2002	SGA	96	30				0.39
Olivares et al. [67]	+	2014	537	Spain	Inpatients	Medical and surgery	61	adult	NRS-2002	SGA	68.9	90.1	62.3	92.4		0.567
Orell-Kotikangas et al. [130]	+	2015	65	Finland	Outpatient	Oncology	61	?	NRS-2002	PG-SGA	77.3	97.7	94.4	89.4		0.784
Raslan et al. [131]	+	2011	705	Brazil	Inpatients	Medical and surgery	57	18	NRS-2002	SGA						0.56
Raupp et al. [95]	Ø	2018	577	Brazil	Inpatients	Emergency	54	18	NRS-2002	SGA						0.62
Ryu et al. [132]	Ø	2010	80	South-Korea	Inpatients	Oncology	subtotal gastrecto-my: 58,5; total gastrecto-my: 56,5		NRS-2002	SGA	80	96				0.685
Sheean et al. [72]	+	2013	232	USA	ICU	Medical and surgery	Medical ICU 75; surgical ICU 74	65	NRS-2002	Full MNA	87	44			0.78	
Velasco et al. [100]	+	2011	400	Spain	Inpatients	Medical and surgery	67	18	NRS-2002	Full MNA						0.392
		2011	400	Spain	Inpatients	Medical and surgery	67	18	NRS-2002	SGA	74.4	87.2	76.1	86.2		0.62
Wang et al. [133]	+	2016	332	China	Inpatients	Gastroenterology	53	18–90	NRS-2002	SGA						0.514
Westergren, et al. [134]	+	2011	85	Sweden	Inpatients	Medical and surgery	75	65	NRS-2002	Full MNA	37	82	76	47		
Young et al. [75]	+	2013	134	Australia	Inpatients	Medical	80	65	NRS-2002	Full MNA	72.2	95.3	97	62.1	0.9	
		2013	134	Australia	Inpatients	Medical	80	65	NRS-2002	SGA	90.3	83.3	82.4	90.9	0.89	

Abbreviations: AUC: area under the curve; CC: correlation coefficient; Full MNA: Full Mini Nutritional Assessment; GLIM: Global Leadership Initiative on Malnutrition; ICU: Intensive Care Unit; LOS; Length of stay; NFPE: Nutritional Focused Physical Exam; NPV: negative predictive value; NRS-2002: Nutritional Risk Screening 2002; (PG-)SGA: (Patient Generated) Subjective Global Assessment; PPV: positive predictive value.

Table 8
Validation of NUFFE, Nutriscore, PG-SGA-SF, SNAQ and SimplifiedNAQ.

Reference	Quality	Publication year	Sample size	Country	Setting	Condition/ward/ diagnosis	Mean/Median age	Lower age limit for inclusion	Validated tool	Comparison	Sensitivity	Specificity	PPV	NPV	AUC	CC	Kappa
Sharifi et al. [135]	+	2018	97	Iran	Nursing home	Older adults	74	60	NUFFE	Full MNA	69.8	75.7	80.8	30.30	0.796		
Arribas et al. [102]	+	2017	394	Spain	Outpatient	Oncology	62	18	Nutriscore	PG-SGA	97.3	95.6	84.8	99	0.95		0.88
De Groot et al. [105]	+	2020	246	Australia	?	Oncology	62	18	PG-SGA-SF (≥3)	PG-SGA	94	62	31	98			0.311
		2020	246	Australia	?	Oncology	62	18	PG-SGA- SF (≥4):	PG-SGA	92	71	37	98			0.387
		2020	246	Australia	?	Oncology	62	18	PG-SGA- SF (≥5)	PG-SGA	89	80	45	98			0.493
Abbott et al. [136]	+	2016	300	Australia	Outpatient	Oncology	59		PG-SGA-SF	PG-SGA	80.4	72.3			0.85		
Kosters et al. [89]	+	2020	123	Netherlands	Inpatients and outpatients	Nephrology	?	18	PG-SGA-SF (≥6)	PG-SGA	78	94	91	84			
Yaxley et al. [137]	+	2015	185	Australia	Community-dwelling	Rehabilitation	78	60	Simplified NAQ	Full MNA	28	94	89	44			0.176
Akin et al. [138]	Ø	2019	871	Turkey	Community-dwelling	Older adults	71	65	Simplified NAQ	Full MNA					0.725		
Young et al. [75]	+	2013	134	Australia	Inpatients	Medical	80	65	Simplified NAQ	Full MNA	69.3	83.7	89.7	57.1	0.83		
		2013	134	Australia	Inpatients	Medical	80	65	Simplified NAQ	SGA	86.9	78.9	77.9	87.5	0.87		
Rolland et al. [139]	Ø	2012	175	France	Inpatients and outpatients	Older adults	78	65	Simplified NAQ	Full MNA					0.767	0.48	
Isenring et al. [55]	Ø	2012	127	Australia	Nursing home		83	55	Simplified NAQ	Full MNA	70.6	77.3					0.32
		2012	127	Australia	Nursing home		83	55	Simplified NAQ	SGA	45.7	77.2					0.225
İlhan et al. [140]	+	2018	442	Turkey	Outpatient	Older adults	77	60	Simplified NAQ	Full MNA							0.355
Young et al. [75]	+	2013	134	Australia	Inpatients	Medical	80	65	Short NAQ	Full MNA	62.2	100	100	55.8	0.89		
		2013	134	Australia	Inpatients	Medical	80	65	Short NAQ	SGA	79	90.3	87.5	83.3	0.93		
Lomivorotov et al. [63]	Ø	2013	441	Russia	Inpatients	Cardio-vascular disease	58	18	Short NAQ	SGA	92.3	81.3	32.4	99.1			
Lomivorotov et al. [64]	+	2013	894	Russia	Inpatients	Cardiovascular disease	59	18	Short NAQ	SGA	91.5	87.5	28.9	99.5			
Georgiou et al. [84]	+	2019	170	Greece	Outpatient	Hepatology	59	18	Short NAQ	SGA	51.3	96.2	80	86.9	0.81		
Wojteczek et al. [141]	Ø	2020	56	Poland		SYSTEMIC sclerosis	54	18	Short NAQ	GLIM						0.52	

Abbreviations: AUC: area under the curve; CC: correlation coefficient; Full MNA: Full Mini Nutritional Assessment; GLIM: Global Leadership Initiative on Malnutrition; MNA: Mini Nutritional Assessment (short form); NUFFE: Nutritional Form for the Elderly; NPV: negative predictive value; (PG-)SGA: (Patient Generated) Subjective Global Assessment; SNAQ: Short nutritional assessment questionnaire; SimplifiedNAQ: Simplified nutrition appetite questionnaire; PPV: positive predictive value.

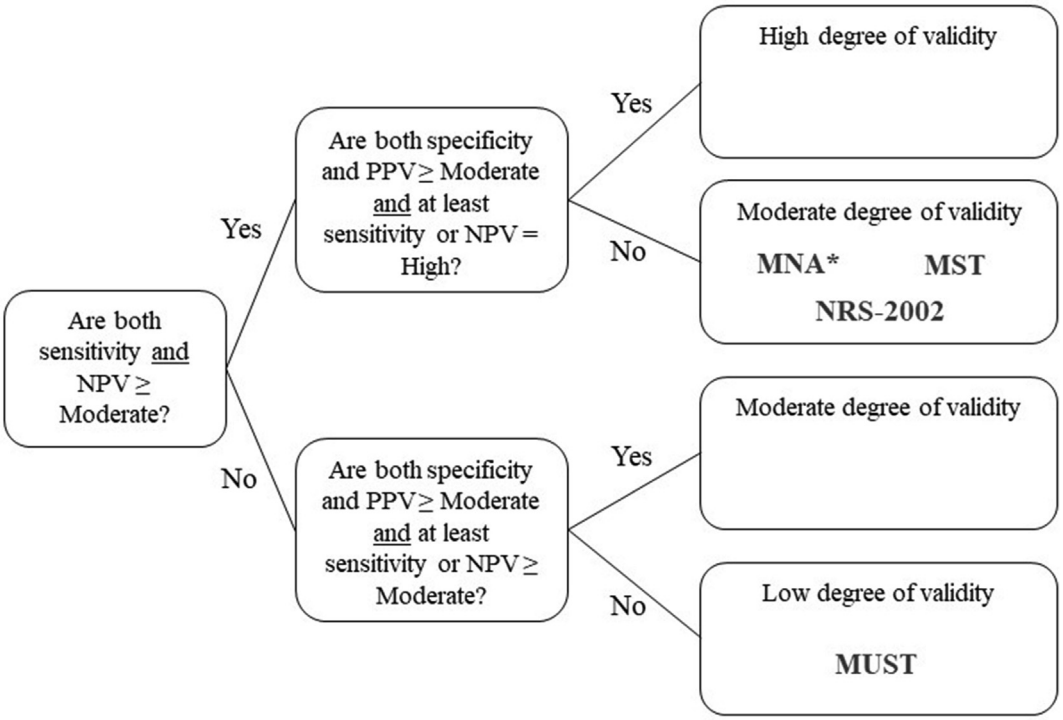

Fig. 2. Summary of overall validity for MNA, MST, MUST, and NRS-2002. The figure is based on the algorithm developed by Skipper et al. [10]. The overall validity is given as the median for all validation studies for the respective malnutrition screening tools. *MNA against other comparisons than Full MNA.

sensitivity below the cut-off value of 70% sensitivity, however, the sensitivity of MST and NRS-2002 was only slightly higher. Of the four most validated screening tools, the NRS-2002 had the highest, while the MNA had the lowest percentage of high-quality studies.

The validation across age groups, settings and diagnoses or conditions varied for MNA, MST, MUST, and NRS-2002. The tools MNA, MST, and MUST were validated in a broader variety of settings as compared to NRS-2002, which was almost exclusively validated in hospital settings. MST, MUST, and NRS-2002 were validated in both all adults (18 years or older) and separately for older adults, while the MNA was mostly validated for the use in older adults (65 years and older) reflecting the target population of the MNA.

According to national quality indicators in Norway, malnutrition screening is inadequate among older adults in the primary health and care service [27]. Lack of time, resources and knowledge are identified as barriers to malnutrition screening and follow-up by community nurses [28] and in hospitals [29,30]. Given the same validity, it will therefore be of interest if the screening tool is quick and easy to carry out in order to meet some of the barriers to conduct screening. The four tools MNA, MST, MUST, and NRS-2002 differ in time for completion and ease of use as the number of items range from two (MST) to fourteen (MNA) for initial screening, and time to complete varies from less than 2 min to about 10 min [31,32].

In total, our systematic review and the systematic review by Skipper et al. [10] includes 126 studies of which only 47 are included in both reviews. Even with a substantially different selection of articles, our findings are in line with the results presented in the systematic review performed by Skipper et al. [10], which summarized the findings from 67 studies published until July of 2017. We identified 58 additional studies included in our summary of which 30 were published after July of 2017. Thus, our review includes 156% more studies as compared to the review published by Skipper et al. [10]. The main reason for exclusion of studies in our review, of those included in the review by Skipper et al. [10], was the use of BMI as the sole reference standard for malnutrition. We do not consider BMI alone as sufficient and adequate to identify disease-related malnutrition in adults. This decision is supported by the fact that BMI is only one of three possible phenotypic criteria in the recently proposed GLIM diagnostic criteria for malnutrition [1], and in the diagnostic criteria for malnutrition by American Society for Parenteral and Enteral Nutrition (ASPEN) BMI is not even included [33]. In addition, if BMI alone was appropriate for the diagnosis of malnutrition, we do not see the need for a screening tool.

Strengths of this publication is the ability to update and extend on previous work in the field, by including the GLIM criteria as a comparison standard, by adding articles from the Scandinavian countries (databases) and by adding additional years of publications. The literature search identified records that were in correspondence to previous work. Additionally, 30 of the included validation studies were published after July of 2017. The present review used systematically methods to ensure objectivity, transparency, and reproducibility of the process.

Possible limitations of the review process are related to the ability to select relevant inclusion and exclusion criteria, as well as relevant reference standards. Such bias may have been reduced by involving a working group appointed by the Norwegian Directorate of Health in discussing the selected inclusion and exclusion criteria. This systematic review is an extension to previous reviews in the field. Although most of the selected screening tools reported in relevant literature were included, there is a possibility that unidentified instruments capable of accurately predicting malnutrition have been excluded. Reference standards for the validation of screening tools were chosen on the basis of previous work [10], the newly introduced GLIM criteria for diagnosing malnutrition, as well as well-known validated tools for identification of malnutrition. Missing available data in the included studies may have excluded

some studies from comparison with others, however the extension of such is not known.

Comparison between subgroups were limited due to lack of standardization in the reported description of age (range), setting, diagnosis or condition. In order to recommend one screening tool across health care settings, the instrument should be validated within different age groups, settings and/or conditions or wards where the tool will be implemented. This was only true in a reasonable range for two of the screening tools – MST and MUST.

Risk of bias was considered for all the included studies, of which 44 studies scored neutral indicating neither exceptionally strong nor weak data. None of the included studies were scored as negative. The reminding 61 studies scored positive, indicating clearly addressing risk of bias related issues. The most frequent negative scores were related to the lack in description of handling withdraws of study participants. The most unclear scores were related to whether blinding was used to prevent introduction of bias, as well as some uncertainty regarding the likelihood of bias due to relevant funding or sponsorship. Reports on the inter-rater reliability were available for MNA, MST, MUST, and NRS-2002, although only one article reported reliability for the MNA tool.

This systematic review was not able to identify one outstanding screening tool for malnutrition with high validity, agreement, and reliability for use across health care settings, diagnoses or conditions, and adult age groups. The MST was supported by a considerable amount of evidence, had a moderate ability to predict malnutrition in the adult population, had supportive evidence of reliable results, was validated across health care settings, and a limited risk of bias. This evidence may guide decision-making for the choice of one tool for screening of malnutrition in all levels of the health care system in order to minimize discontinuities of care in the transition between them. The Norwegian Directorate of Health utilized the results of this review in the process of revising the Norwegian guideline for prevention and treatment of malnutrition from 2009. The revised guideline was published in 2022 [34]. The decision-making process for the screening recommendation is co-published in this number of Clinical Nutrition ESPEN [142].

As such, these results have the potential to improve communication and optimalization of nutritional care along the patient pathway, and thus ultimately reduce the burden of malnutrition. The results can contribute to the process of establishing a national overview of the burden and distribution of malnutrition across health care settings and regions, and may set an example for a standardized, systematic malnutrition screening practice as the first step in the implementation of GLIM in clinical practice. This may be a starting point towards a harmonization of screening and diagnosing for malnutrition also in other countries.

5. Conclusions

The screening tools MST and NRS-2002 display moderate concurrent validity for the identification of malnutrition in adults, of which MST is validated across health care settings. In addition, MNA has moderate validity for the identification of malnutrition in adults 65 years or older.

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Statement of authorship

THT: Methodology, Investigation, Validation, Formal analysis, Writing original draft, Writing review & editing. HWK: Conceptualization, Methodology, Writing review & editing, Project administration. GBS: Conceptualization, Methodology, Writing review & editing. RAT: Methodology, Data Curation, Writing review & editing. AB: Conceptualization, Methodology, Writing review & editing. IP: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Visualization, Supervision, Writing original draft, Writing review & editing.

Declaration of competing interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2022.09.028.

References

[1] Cederholm T, Jensen GL, Correia M, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM criteria for the diagnosis of malnutrition - a consensus report from the global clinical nutrition community. Clin Nutr 2019;38(1):1–9. https://doi.org/10.1016/j.clnu.2018.08.002.

[2] Skipper A, Coltman A, Tomesko J, Charney P, Porcari J, Piemonte TA, et al. Position of the Academy of nutrition and Dietetics: malnutrition (undernutrition) screening tools for all adults. J Acad Nutr Diet 2020;120(4):709–13. https://doi.org/10.1016/j.jand.2019.09.011.

[3] Norwegian guidelines for prevention and treatment of malnutrition [Internet]. Oslo: The Norwegian Directorate of Health; 2009. Available from: https://www.helsedirektoratet.no/tema/underernaering.

[4] Starr KNP, McDonald SR, Bales CW. Nutritional vulnerability in older adults: a continuum of concerns. Curr Nutr Rep 2015;4(2):176–84. https://doi.org/10.1007/s13668-015-0118-6.

[5] Leij-Halfwerk S, Verwijs MH, van Houdt S, Borkent JW, Guaitoli PR, Pelgrim T, et al. Prevalence of protein-energy malnutrition risk in European older adults in community, residential and hospital settings, according to 22 malnutrition screening tools validated for use in adults ≥65 years: a systematic review and meta-analysis. Maturitas 2019;126:80–9. https://doi.org/10.1016/j.maturitas.2019.05.006.

[6] Elia M, Stratton RJ. Considerations for screening tool selection and role of predictive and concurrent validity. Curr Opin Clin Nutr Metab Care 2011;14(5):425–33. https://doi.org/10.1097/MCO.0b013e328348ef51.

[7] Stratton RJ, Hackston A, Longmore D, Dixon R, Price S, Stroud M, et al. Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. Br J Nutr 2004;92(5):799–808.

[8] Russell CA, Elia M. Malnutrition in the UK: where does it begin? Proc Nutr Soc 2010;69(4):465–9. https://doi.org/10.1017/s0029665110001850.

[9] Eat right [Internet]. Ohio: Academy of Nutrition and Dietetics; 2022. Available from: https://www.eatright.org/.

[10] Skipper A, Coltman A, Tomesko J, Charney P, Porcari J, Piemonte TA, et al. Adult malnutrition (undernutrition) screening: an evidence analysis center systematic review. J Acad Nutr Diet 2020;120(4):669–708. https://doi.org/10.1016/j.jand.2019.09.010.

[11] Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol 2009;62(10):e1–34. https://doi.org/10.1016/j.jclinepi.2009.06.006.

[12] Handu D, Moloney L, Wolfram T, Ziegler P, Acosta A, Steiber A. Academy of nutrition and Dietetics methodology for conducting systematic reviews for the evidence analysis library. J Acad Nutr Diet 2016;116(2):311–8. https://doi.org/10.1016/j.jand.2015.11.008.

[13] Neelemaat F, Meijers J, Kruizenga H, van Ballegooijen H, van Bokhorst-de van der Schueren M. Comparison of five malnutrition screening tools in one hospital inpatient sample. J Clin Nurs 2011;20(15–16):2144–52. https://doi.org/10.1111/j.1365-2702.2010.03667.x.

[14] McHugh ML. Interrater reliability: the kappa statistic. Biochem Med 2012;22(3):276–82.

[15] Kaiser R, Winning K, Uter W, Lesser S, Stehle P, Sieber CC, et al. Comparison of two different approaches for the application of the mini nutritional assessment in nursing homes: resident interviews versus assessment by nursing staff. J Nutr Health Aging 2009;13(10):863–9. https://doi.org/10.1007/s12603-009-0243-2.
[16] Lawson CS, Campbell KL, Dimakopoulos I, Dockrell ME. Assessing the validity and reliability of the MUST and MST nutrition screening tools in renal inpatients. J Ren Nutr 2012;22(5):499–506. https://doi.org/10.1053/j.jrn.2011.08.005.
[17] Mosli MH, Albeshri MA, Alsolami AA, Addas FA, Qazli AM, Alsahafi M, et al. Arabic translation and psychometric testing of the self-screening malnutrition universal screening tool in inflammatory bowel disease patients. Saudi Med J 2019;40(8):828–35. https://doi.org/10.15537/smj.2019.8.24427.
[18] Nor Azian MZ, Suzana S, Romzi MA. Sensitivity, specificity, predictive value and inter-rater reliability of malnutrition screening tools in hospitalised adult patients. Malays J Nutr 2014;20(2):209–19.
[19] Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. Nutrition 1999;15(6):458–64. https://doi.org/10.1016/s0899-9007(99)00084-2.
[20] Wester P, Angus R, Easlea D, Lin M, Chen B, Bisset L. Use of the malnutrition screening tool by non-dietitians to identify at-risk patients in a rehabilitation setting: a validation study. Nutr Diet 2018;75(3):324–30. https://doi.org/10.1111/1747-0080.12416.
[21] Bell JJ, Bauer JD, Capra S. The malnutrition screening tool versus objective measures to detect malnutrition in hip fracture. J Hum Nutr Diet 2013;26(6):519–26. https://doi.org/10.1111/jhn.12040.
[22] Nursal TZ, Noyan T, Atalay BG, Köz N, Karakayali H. Simple two-part tool for screening of malnutrition. Nutrition 2005;21(6):659–65. https://doi.org/10.1016/j.nut.2004.10.016.
[23] Bolayir B, Arik G, Yeşil Y, Kuyumcu ME, Varan HD, Kara Ö, et al. Validation of nutritional risk screening-2002 in a hospitalized adult population. Nutr Clin Pract 2019;34(2):297–303. https://doi.org/10.1002/ncp.10082.
[24] Tevik K, Thürmer H, Husby MI, de Soysa AK, Helvik AS. Nutritional risk screening in hospitalized patients with heart failure. Clin Nutr 2015;34(2):257–64. https://doi.org/10.1016/j.clnu.2014.03.014.
[25] Cuong TQB M, Hannan-Jones M, Diep DTN, Gallegos D. Validity, reliability and feasibility of nutrition screening tools NRS-2002 and MST administered by trained medical doctors in routine practice. Hosp Pract 2019;47(5):259–66. https://doi.org/10.1080/21548331.2019.1699760.
[26] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003;22(4):415–21. https://doi.org/10.1016/s0261-5614(03)00098-0.
[27] National health care quality indicators [Internet]. Oslo: The Norwegian Directorate of Health; 2022. Available from: https://www.helsedirektoratet.no/english/national-health-care-quality-indicators#nationalqualityindicator.
[28] Green SM, James EP, Latter S, Sutcliffe M, Fader MJ. Barriers and facilitators to screening for malnutrition by community nurses: a qualitative study. J Hum Nutr DietOff J Br Dietetic Assoc 2014;27(1):88–95. https://doi.org/10.1111/jhn.12104.
[29] Paulsen MM, Varsi C, Paur I, Tangvik RJ, Andersen LF. Barriers and facilitators for implementing a decision support system to prevent and treat disease-related malnutrition in a hospital setting: qualitative study. JMIR Formative Res 2019;3(2):e11890. https://doi.org/10.2196/11890.
[30] Fjeldstad SH, Thoresen L, Mowe M, Irtun O. Changes in nutritional care after implementing national guidelines-a 10-year follow-up study. Eur J Clin Nutr 2018. https://doi.org/10.1038/s41430-017-0050-5.
[31] van Venrooija LMWdV R, Borgmeijer-Hoelen AMMJ, Kruizenga HMJ-S CF, de Mol BAMJ. Quick-and-easy nutritional screening tools to detect disease-related undernutrition in hospital in- and outpatient settings: a systematic review of sensitivity and specificity. E Spen Eur E J Clin Nutr Metab 2007;2(2):21–37. https://doi.org/10.1016/j.eclnm.2007.03.001.
[32] Cunha CD, Sampaio ED, Varjao ML, Factum CS, Ramos LB, Barreto-Medeiros JM. Nutritional assessment in surgical oncology patients: a comparative analysis between methods. Nutr Hosp 2015;31(2):916–21. https://doi.org/10.3305/nh.2015.31.2.7715.
[33] White JV, Guenter P, Jensen G, Malone A, Schofield M. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). JPEN - J Parenter Enter Nutr 2012;36(3):275–83. https://doi.org/10.1177/0148607112440285.
[34] The National Guideline for Prevention and Treament of Malnutrition (Nasjonal faglig retningslinje for forebygging og behandling av underernæring [Norwegian])[Internet]. Oslo: Norwegian Directorate of Health; 2022. Available from: https://www.helsedirektoratet.no/retningslinjer/forebygging-og-behandling-av-underernaering.
[35] Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev 1996;54(1 II):S59–65. https://doi.org/10.1111/j.1753-4887.1996.tb03793.x.
[36] Detsky AS, Baker JP, Mendelson RA, Wolman SL, Wesson DE, Jeejeebhoy KN. Evaluating the accuracy of nutritional assessment techniques applied to hospitalized patients: methodology and comparisons. JPEN - J Parenter Enter Nutr 1984;8(2):153–9. https://doi.org/10.1177/0148607184008002153.
[37] Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? JPEN - J Parenter Enter Nutr 1987;11(1):8–13. https://doi.org/10.1177/014860718701100108.
[38] Jager-Wittenaar H, Ottery FD. Assessing nutritional status in cancer: role of the patient-generated subjective global assessment. Curr Opin Clin Nutr Metab Care 2017;20(5):322–9. https://doi.org/10.1097/mco.0000000000000389.
[39] Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. Nutrition 1996;12(1, Supplement):S15–9. https://doi.org/10.1016/0899-9007(95)00067-4.
[40] McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. BMJ 1994;308(6934):945–8. https://doi.org/10.1136/bmj.308.6934.945.
[41] Kalantar-Zadeh K, Kopple JD, Block G, Humphreys MH. A malnutrition-inflammation score is correlated with morbidity and mortality in maintenance hemodialysis patients. Am J Kidney Dis 2001;38(6):1251–63. https://doi.org/10.1053/ajkd.2001.29222.
[42] Albay VB, Tutuncu M. MNA-SF is not sufficient without questioning protein and fruit-vegetable consumption to detect malnutrition risk in Parkinson's Disease. Acta Neurol Belg 2020;5:5. https://doi.org/10.1007/s13760-020-01350-1.
[43] Borowiak E, Kostka T. Usefulness of short (MNA-SF) and full version of the Mini Nutritional Assessment (MNA) in examining the nutritional state of older persons. New Med 2003;6(4):125–9.
[44] Charlton KE, Kolbe-Alexander TL, Nel JH. The MNA, but not the DETERMINE, screening tool is a valid indicator of nutritional status in elderly Africans. Nutrition 2007;23(7–8):533–42.
[45] Charlton KE, Nichols C, Bowden S, Lambert K, Barone L, Mason M, et al. Older rehabilitation patients are at high risk of malnutrition: evidence from a large Australian database. J Nutr Health Aging 2010;14(8):622–8. https://doi.org/10.1007/s12603-010-0307-3.
[46] Christner S, Ritt M, Volkert D, Wirth R, Sieber CC, Gaßmann KG. Evaluation of the nutritional status of older hospitalised geriatric patients: a comparative analysis of a Mini Nutritional Assessment (MNA) version and the Nutritional Risk Screening (NRS 2002). J Hum Nutr Diet 2016;29(6):704–13. https://doi.org/10.1111/jhn.12376.
[47] Cohendy R, Rubenstein LZ, Eledjam JJ. The Mini Nutritional Assessment-Short Form for preoperative nutritional evaluation of elderly patients. Aging Clin 2001;13(4):293–7. https://doi.org/10.1007/BF03353425.
[48] Cuervo M, García A, Ansorena D, Sánchez-Villegas A, Martínez-González M, Astiasarán I, et al. Nutritional assessment interpretation on 22,007 Spanish community-dwelling elders through the Mini Nutritional Assessment test. Public Health Nutr 2009;12(1):82–90. https://doi.org/10.1017/s136898000800195x.
[49] De La Montana J, Miguez M. Suitability of the short-form Mini Nutritional Assessment in free-living elderly people in the northwest of Spain. J Nutr Health Aging 2011;15(3):187–91. https://doi.org/10.1007/s12603-010-0332-2.
[50] Dent E, Chapman I, Piantadosi C, Visvanathan R. Screening for malnutrition in hospitalised older people: comparison of the Mini Nutritional Assessment with its short-form versions. Austr J Ageing 2017;36(2):E8–13. https://doi.org/10.1111/ajag.12402.
[51] Donini LM, Poggiogalle E, Molfino A, Rosano A, Lenzi A, Fanelli FR, et al. Mini-nutritional assessment, malnutrition universal screening tool, and nutrition risk screening tool for the nutritional evaluation of older nursing home residents. J Am Med Dir Assoc 2016;17(10). https://doi.org/10.1016/j.jamda.2016.06.028. 959.e11–.e18.
[52] Duran Alert P, Mila Villarroel R, Formiga F, Virgili Casas N, Vilarasau Farre C. Assessing risk screening methods of malnutrition in geriatric patients: mini nutritional assessment (MNA) versus geriatric nutritional risk Index (GNRI). Nutr Hosp 2012;27(2):590–8. https://doi.org/10.1590/S0212-16112012000200036.
[53] Garcia-Meseguer MJ, Serrano-Urrea R. Validation of the revised mini nutritional assessment short-forms in nursing homes in Spain. J Nutr Health Aging 2013;17(1):26–9. https://doi.org/10.1007/s12603-012-0079-z.
[54] Holvoet E, Vanden Wyngaert K, Van Craenenbroeck AH, Van Biesen W, Eloot S. The screening score of Mini Nutritional Assessment (MNA) is a useful routine screening tool for malnutrition risk in patients on maintenance dialysis. PLoS One 2020;15(3):e0229722. https://doi.org/10.1371/journal.pone.0229722.
[55] Isenring EA, Banks M, Ferguson M, Bauer JD. Beyond malnutrition screening: appropriate methods to guide nutrition care for aged care residents. J Acad Nutr Diet 2012;112(3):376–81. https://doi.org/10.1016/j.jada.2011.09.038.
[56] Joaquin C, Puig R, Gastelurrutia P, Lupon J, de Antonio M, Domingo M, et al. Mini nutritional assessment is a better predictor of mortality than subjective global assessment in heart failure out-patients. Clin Nutr 2019;38(6):2740–6. https://doi.org/10.1016/j.clnu.2018.12.001.
[57] Kaiser MJ, Bauer JM, Uter W, Donini LM, Stange I, Volkert D, et al. Prospective validation of the modified mini nutritional assessment short-forms in the community, nursing home, and rehabilitation setting. J Am Geriatr Soc 2011;59(11):2124–8. https://doi.org/10.1111/j.1532-5415.2011.03659.x.
[58] Keller H, Vucea V, Slaughter SE, Jager-Wittenaar H, Lengyel C, Ottery FD, et al. Prevalence of malnutrition or risk in residents in long term care: comparison of four tools. J Nutr Gerontol Geriatr 2019;38(4):329–44. https://doi.org/10.1080/21551197.2019.1640165.

[59] Kiesswetter E, Pohlhausen S, Uhlig K, Diekmann R, Lesser S, Uter W, et al. Prognostic differences of the Mini Nutritional Assessment short form and long form in relation to 1-year functional decline and mortality in community-dwelling older adults receiving home care. J Am Geriatr Soc 2014;62(3):512–7. https://doi.org/10.1111/jgs.12683.
[60] Kostka J, Borowiak E, Kostka T. Validation of the modified mini nutritional assessment short-forms in different populations of older people in Poland. J Nutr Health Aging 2014;18(4):366–71. https://doi.org/10.1007/s12603-013-0393-0.
[61] Lei Z, Qingyi D, Feng G, Chen W, Hock RS, Changli W. Clinical study of mini-nutritional assessment for older Chinese inpatients. J Nutr Health Aging 2009;13(10):871–5. https://doi.org/10.1007/s12603-009-0244-1.
[62] Lilamand M, Kelaiditi E, Cesari M, Raynaud-Simon A, Ghisolfi A, Guyonnet S, et al. Validation of the mini nutritional assessment-short form in a population of frail elders without disability. Analysis of the toulouse frailty platform population in 2013. J Nutr Health Aging 2015;19(5):570–4. https://doi.org/10.1007/s12603-015-0457-4.
[63] Lomivorotov VV, Efremov SM, Boboshko VA, Nikolaev DA, Vedernikov PE, Shilova AN, et al. Evaluation of nutritional screening tools among patients scheduled for heart valve surgery. J Heart Valve Dis 2013;22(2):239–47.
[64] Lomivorotov VV, Efremov SM, Boboshko VA, Nikolaev DA, Vedernikov PE, Lomivorotov VN, et al. Evaluation of nutritional screening tools for patients scheduled for cardiac surgery. Nutrition 2013;29(2):436–42. https://doi.org/10.1016/j.nut.2012.08.006.
[65] Martín A, Ruiz E, Sanz A, García J, Gómez-Candela C, Burgos R, et al. Accuracy of different mini nutritional assessment reduced forms to evaluate the nutritional status of elderly hospitalised diabetic patients. J Nutr Health Aging 2016;20(4):370–5. https://doi.org/10.1007/s12603-015-0618-5.
[66] Montejano Lozoya R, Martinez-Alzamora N, Clemente Marin G, Guirao-Goris SJA, Ferrer-Diego RM. Predictive ability of the Mini Nutritional Assessment Short Form (MNA-SF) in a free-living elderly population: a cross-sectional study. PeerJ 2017;5:e3345. https://doi.org/10.7717/peerj.3345.
[67] Olivares J, Ayala L, Salas-Salvado J, Muniz MJ, Gamundi A, Martinez-Indart L, et al. Assessment of risk factors and test performance on malnutrition prevalence at admission using four different screening tools. Nutr Hosp 2014;29(3):674–80. https://doi.org/10.3305/nh.2014.29.3.7120.
[68] Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci 2001;56(6):M366–72.
[69] Santin FG, Bigogno FG, Dias Rodrigues JC, Cuppari L, Avesani CM. Concurrent and predictive validity of composite methods to assess nutritional status in older adults on hemodialysis. J Ren Nutr 2016;26(1):18–25. https://doi.org/10.1053/j.jrn.2015.07.002.
[70] Schrader E, Grosch E, Bertsch T, Sieber C, Volkert D. Nutritional and functional status in geriatric day hospital patients-MNA short form versus full MNA. J Nutr Health Aging 2016;20(9):918–26. https://doi.org/10.1007/s12603-016-0691-4.
[71] Sheard JM, Ash S, Mellick GD, Silburn PA, Kerr GK. Nutrition screening and assessment in Parkinson's disease: acomparison of methods. ESP J 2013;8(5):e187–92. https://doi.org/10.1016/j.clnme.2013.08.001.
[72] Sheean PM, Peterson SJ, Chen Y, Liu D, Lateef O, Braunschweig CA. Utilizing multiple methods to classify malnutrition among elderly patients admitted to the medical and surgical intensive care units (ICU). Clin Nutr 2013;32(5):752–7. https://doi.org/10.1016/j.clnu.2012.12.012.
[73] Simsek H, Sahin S, Ucku R, Sieber CC, Meseri R, Tosun P, et al. The diagnostic accuracy of the Revised Mini Nutritional Assessment Short Form for older people living in the community and in nursing homes. J Nutr Health Aging 2014;18(8):725–9. https://doi.org/10.1007/s12603-014-0460-1.
[74] Wikby K, Ek A-C, Christensson L. The two-step Mini Nutritional Assessment procedure in community resident homes. J Clin Nurs 2008;17(9):1211–8. https://doi.org/10.1111/j.1365-2702.2007.02012.x.
[75] Young AM, Kidston S, Banks MD, Mudge AM, Isenring EA. Malnutrition screening tools: comparison against two validated nutrition assessment methods in older medical inpatients. Nutrition 2013;29(1):101–6. https://doi.org/10.1016/j.nut.2012.04.007.
[76] Abe Vicente M, Barao K, Silva TD, Forones NM. What are the most effective methods for assessment of nutritional status in outpatients with gastric and colorectal cancer? Nutr Hosp 2013;28(3):585–91. https://doi.org/10.3305/nh.2013.28.3.6413.
[77] Almeida AI, Correia M, Camilo M, Ravasco P. Nutritional risk screening in surgery: valid, feasible, easy. Clin Nutr 2012;31(2):206–11. https://doi.org/10.1016/j.clnu.2011.10.003.
[78] Bellanti F, Lo Buglio A, Quiete S, Pellegrino G, Dobrakowski M, Kasperczyk A, et al. Comparison of three nutritional screening tools with the new glim criteria for malnutrition and association with sarcopenia in hospitalized older patients. J Clin Med 2020;9(6):17. https://doi.org/10.3390/jcm9061898.
[79] Bobčíková K, Lukšová H. Nutritional Status of Hospitalized elderly with coronary heart disease. Cent Eur J Nurs Midw 2020;11(2):70–7. https://doi.org/10.15452/CEJNM.2020.11.0012.
[80] Boleo-Tome C, Monteiro-Grillo I, Camilo M, Ravasco P. Validation of the malnutrition universal screening tool (MUST) in cancer. Br J Nutr 2012;108(2):343–8. https://doi.org/10.1017/S000711451100571X.
[81] Diekmann R, Winning K, Uter W, Kaiser MJ, Sieber CC, Volkert D, et al. Screening for malnutrition among nursing home residents - a comparative analysis of the mini nutritional assessment, the nutritional risk screening, and the malnutrition universal screening tool. J Nutr Health Aging 2013;17(4):326–31. https://doi.org/10.1007/s12603-012-0396-2.
[82] Fiol-Martinez L, Calleja-Fernandez A, Pintor de la Maza B, Vidal-Casariego A, Villar-Taibo R, Urioste-Fondo A, et al. Comparison of two nutritional screening tools to detect nutritional risk in hematologic inpatients. Nutrition 2017;34:97–100. https://doi.org/10.1016/j.nut.2016.09.009.
[83] Fiorindi C, Luceri C, Dragoni G, Piemonte G, Scaringi S, Staderini F, et al. GLIM criteria for malnutrition in surgical IBD patients: a pilot study. Nutrients 2020;12(8). https://doi.org/10.3390/nu12082222.
[84] Georgiou A, Papatheodoridis GV, Alexopoulou A, Deutsch M, Vlachogiannakos I, Ioannidou P, et al. Evaluation of the effectiveness of eight screening tools in detecting risk of malnutrition in cirrhotic patients: the KIRRHOS study. Br J Nutr 2019;122(12):1368–76. https://doi.org/10.1017/S0007114519002277.
[85] Gibson S, Sequeira J, Cant R, Ku C. Identifying malnutrition risk in acute medical patients: validity and utility of malnutrition universal screening tool and modified malnutrition screening tool. Nutr Diet 2012;69(4):309–14. https://doi.org/10.1111/j.1747-0080.2012.01605.x.
[86] Hettiarachchi J, Madubhashini P, Miller M. Agreement between the malnutrition universal screening tool and the patient-generated subjective global assessment for cancer outpatients receiving chemotherapy: a cross-sectional study. Nutr Cancer 2018;70(8):1275–82. https://doi.org/10.1080/01635581.2018.1539186.
[87] Holst M, Yifter-Lindgren E, Surowiak M, Nielsen K, Mowe M, Carlsson M, et al. Nutritional screening and risk factors in elderly hospitalized patients: association to clinical outcome? Scand J Caring Sci 2013;27(4):953–61. https://doi.org/10.1111/scs.12010.
[88] Jackson HS, MacLaughlin HL, Vidal-Diez A, Banerjee D. A new renal inpatient nutrition screening tool (Renal iNUT): a multicenter validation study. Clin Nutr 2019;38(5):2297–303. https://doi.org/10.1016/j.clnu.2018.10.002.
[89] Kosters CM, van den Berg MGA, van Hamersvelt HW. Sensitive and practical screening instrument for malnutrition in patients with chronic kidney disease. Nutrition 2020;72:110643. https://doi.org/10.1016/j.nut.2019.110643.
[90] Kozakova R, Zelenikova R. Assessing the nutritional status of the elderly living at home. Eur Geriatr Med 2014;5(6):377–81. https://doi.org/10.1016/j.eurger.2014.07.003.
[91] Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. Clin Nutr 2006;25(3):409–17. https://doi.org/10.1016/j.clnu.2005.11.001.
[92] Martin Palmero A, Serrano Perez A, Chinchetru Ranedo MJ, Camara Balda A, Martinez de Salinas Santamari MA, Villar Garcia G, et al. Malnutrition in hospitalized patients: results from La Rioja. Nutr Hosp 2017;34(2):402–6. https://doi.org/10.20960/nh.458.
[93] Naik R, Dudeja P, Thamban N, Jain C, Aggarwal V. Nutrition assessment of elderly residing in urban areas and urban slum: a comparative study. Ind J Community Health 2018;30(4):390–4.
[94] Pereira Borges N, D'Alegria Silva B, Cohen C, Portari Filho PE, Medeiros FJ. Comparison of the nutritional diagnosis, obtained through different methods and indicators, in patients with cancer. Nutr Hosp 2009;24(1):51–5.
[95] Raupp D, Silva FM, Marcadenti A, Rabito EI, da Silva Fink J, Becher P, et al. Nutrition screening in public hospital emergency rooms: malnutrition Universal Screening Tool and Nutritional Risk Screening-2002 can be applied. Publ Health 2018;165:6–8. https://doi.org/10.1016/j.puhe.2018.07.005.
[96] Sharma Y, Thompson C, Kaambwa B, Shahi R, Miller M. Validity of the Malnutrition Universal Screening Tool (MUST) in Australian hospitalized acutely unwell elderly patients. Asia Pac J Clin Nutr 2017;26(6):994–1000. https://doi.org/10.6133/apjcn.022017.15.
[97] Tripathy S, Mishra JC. Assessing nutrition in the critically ill elderly patient: a comparison of two screening tools. Ind J Crit Care Med 2015;19(9):518–22. https://doi.org/10.4103/0972-5229.164798.
[98] Tu MY, Chien TW, Chou MT. Using a nutritional screening tool to evaluate the nutritional status of patients with colorectal cancer. Nutr Cancer 2012;64(2):323–30. https://doi.org/10.1080/01635581.2012.650778.
[99] Vallen C, Hagell P, Westergren A. Validity and user-friendliness of the minimal eating observation and nutrition form - version II (MEONF - II) for undernutrition risk screening. Food Nutr Res 2011;55:12. https://doi.org/10.3402/fnr.v55i0.5801.
[100] Velasco C, Garcia E, Rodriguez V, Frias L, Garriga R, Alvarez J, et al. Comparison of four nutritional screening tools to detect nutritional risk in hospitalized patients: a multicentre study. Eur J Clin Nutr 2011;65(2):269–74. https://doi.org/10.1038/ejcn.2010.243.
[101] Abbott J, Teleni L, McKavanagh D, Watson J, McCarthy A, Isenring E. A novel, automated nutrition screening system as a predictor of nutritional risk in an oncology day treatment unit (ODTU). Support Care Cancer 2014;22(8):2107–12. https://doi.org/10.1007/s00520-014-2210-7.
[102] Arribas L, Hurtos L, Sendros MJ, Peiro I, Salleras N, Fort E, et al. NUTRISCORE: a new nutritional screening tool for oncological outpatients. Nutrition 2017;33:297–303. https://doi.org/10.1016/j.nut.2016.07.015.
[103] Byrnes A, Young A, Banks M, Mudge A, Bauer J. Use of hand grip strength in nutrition risk screening of older patients admitted to general surgical wards. Nutr Diet 2018;75(5):520–6. https://doi.org/10.1111/1747-0080.12422.
[104] Clark AB, Reijnierse EM, Lim WK, Maier AB. Prevalence of malnutrition comparing the GLIM criteria, ESPEN definition and MST malnutrition risk in

geriatric rehabilitation patients: resort. Clin Nutr 2020;23:23. https://doi.org/10.1016/j.clnu.2020.03.015.
[105] De Groot LM, Lee G, Ackerie A, van der Meij BS. Malnutrition screening and assessment in the cancer care ambulatory setting: mortality predictability and validity of the patient-generated subjective global assessment short form (PG-SGA SF) and the GLIM criteria. Nutrients 2020;12(8):30. https://doi.org/10.3390/nu12082287.
[106] Ferguson ML, Bauer J, Gallagher B, Capra S, Christie DR, Mason BR. Validation of a malnutrition screening tool for patients receiving radiotherapy. Austr Radiol 1999;43(3):325–7.
[107] Gabrielson DK, Scaffidi D, Leung E, Stoyanoff L, Robinson J, Nisenbaum R, et al. Use of an abridged scored Patient-Generated Subjective Global Assessment (abPG-SGA) as a nutritional screening tool for cancer patients in an outpatient setting. Nutr Cancer 2013;65(2):234–9. https://doi.org/10.1080/01635581.2013.755554.
[108] Hogan D, Lan LT, Diep DT, Gallegos D, Collins PF. Nutritional status of Vietnamese outpatients with chronic obstructive pulmonary disease. J Hum Nutr Diet : Off J Br Dietetic Assoc 2017;30(1):83–9. https://doi.org/10.1111/jhn.12402.
[109] Isenring E, Cross G, Daniels L, Kellett E, Koczwara B. Validity of the malnutrition screening tool as an effective predictor of nutritional risk in oncology outpatients receiving chemotherapy. Support Care Cancer 2006;14(11):1152–6. https://doi.org/10.1007/s00520-006-0070-5.
[110] Isenring EA, Bauer JD, Banks M, Gaskill D. The Malnutrition Screening Tool is a useful tool for identifying malnutrition risk in residential aged care. J Hum Nutr Diet 2009;22(6):545–50. https://doi.org/10.1111/j.1365-277X.2009.01008.x.
[111] Leipold CE, Bertino SB, L'Huillier HM, Howell PM, Rosenkotter M. Validation of the malnutrition screening tool for use in a community rehabilitation program. Nutr Diet 2018;75(1):117–22. https://doi.org/10.1111/1747-0080.12365.
[112] Morris NF, Stewart S, Riley MD, Maguire GP. A comparison of two malnutrition screening tools in acute medical inpatients and validation of a screening tool among adult Indigenous Australian patients. Asia Pac J Clin Nutr 2018;27(6):1198–206. https://doi.org/10.6133/apjcn.201811_27(6).0005.
[113] Mourao F, Amado D, Ravasco P, Vidal PM, Camilo ME. Nutritional risk and status assessment in surgical patients: a challenge amidst plenty. Nutr Hosp 2004;19(2):83–8.
[114] Shaw C, Fleuret C, Pickard JM, Mohammed K, Black G, Wedlake L. 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 2015;23(1):47–54. https://doi.org/10.1007/s00520-014-2319-8.
[115] Ulltang M, Vivanti AP, Murray E. Malnutrition prevalence in a medical assessment and planning unit and its association with hospital readmission. Aust Health Rev 2013;37(5):636–41. https://doi.org/10.1071/AH13051.
[116] Wu ML, Courtney MD, Shortridge-Baggett LM, Finlayson K, Isenring EA. Validity of the malnutrition screening tool for older adults at high risk of hospital readmission. J Gerontol Nurs 2012;38(6):38–45. https://doi.org/10.3928/00989134-20120509-03.
[117] Badia-Tahull MB, Cobo-Sacristan S, Leiva-Badosa E, Miquel-Zurita ME, Mendez-Cabalerio N, Jodar-Masanes R, et al. Use of subjective global assessment, patient-generated subjective global assessment and nutritional risk screening 2002 to evaluate the nutritional status of non-critically ill patients on parenteral nutrition. Nutr Hosp 2014;29(2):411–9. https://doi.org/10.3305/nh.2014.29.2.7045.
[118] Bauer JM, Vogl T, Wicklein S, Trogner J, Muhlberg W, Sieber CC. Comparison of the mini nutritional assessment, subjective global assessment, and nutritional risk screening (NRS 2002) for nutritional screening and assessment in geriatric hospital patients. Z Gerontol Geriatr 2005;38(5):322–7. https://doi.org/10.1007/s00391-005-0331-9.
[119] Boulhosa R, Lourenco RP, Cortes DM, Oliveira LPM, Lyra AC, de Jesus RP. Comparison between criteria for diagnosing malnutrition in patients with advanced chronic liver disease: GLIM group proposal versus different nutritional screening tools. J Hum Nutr Diet 2020;7:7. https://doi.org/10.1111/jhn.12759.
[120] Chavez-Tostado M, Cervantes-Guevara G, Lopez-Alvarado SE, Cervantes-Perez G, Barbosa-Camacho FJ, Fuentes-Orozco C, et al. Comparison of nutritional screening tools to assess nutritional risk and predict clinical outcomes in Mexican patients with digestive diseases. BMC Gastroenterol 2020;20(1):79. https://doi.org/10.1186/s12876-020-01214-1.
[121] Demirel B, Atasoy BM. Comparison of three nutritional screening tools to predict malnutrition risk and detect distinctions between tools in cancer patients receiving radiochemotherapy. Nutr Cancer 2018;70(6):867–73. https://doi.org/10.1080/01635581.2018.1491606.
[122] Hartz LLK, Stroup BM, Bibelnieks TA, Shockey C, Ney DM. ThedaCare nutrition risk screen improves the identification of non-intensive care unit patients at risk for malnutrition compared with the nutrition risk screen 2002. JPEN - J Parenter Enter Nutr 2019;43(1):70–80. https://doi.org/10.1002/jpen.1315.
[123] Javid Mishamandani Z, Norouzy A, Hashemian SM, Khoundabi B, Rezaeisadrabadi M, Safarian M, et al. Nutritional status of patients hospitalized in the intensive care unit: a comprehensive report from Iranian hospitals, 2018. J Crit Care 2019;54:151–8. https://doi.org/10.1016/j.jcrc.2019.08.001.
[124] Juntao C, Shaohua Y, Yongjian Z, Fengli G, Xinna S, Zhenlan S, et al. A comparison of the nutritional risk screening 2002 tool with the subjective global assessment tool to detect nutritional status in Chinese patients undergoing surgery with gastrointestinal cancer. Gastroenterol Nurs 2017;40(1):19–25. https://doi.org/10.1097/SGA.0000000000000157.
[125] Leandro-Merhi VA, Braga de Aquino JL. Comparison of nutritional diagnosis methods and prediction of clinical outcomes in patients with neoplasms and digestive tract diseases. Clin Nutr 2015;34(4):647–51. https://doi.org/10.1016/j.clnu.2014.07.001.
[126] Leandro-Merhi VA, de Aquino JLB, Reis LO. Predictors of nutritional risk according to NRS-2002 and calf circumference in hospitalized older adults with neoplasms. Nutr Cancer 2017;69(8):1219–26. https://doi.org/10.1080/01635581.2017.1367942.
[127] Martins CP, Correia JR, do Amaral TF. Undernutrition risk screening and length of stay of hospitalized elderly. J Nutr Elder 2005;25(2):5–21.
[128] Meireles MS, Wazlawik E, Bastos JL, Garcia MF. Comparison between nutritional risk tools and parameters derived from bioelectrical impedance analysis with subjective global assessment. J Acad Nutr Diet 2012;112(10):1543–9. https://doi.org/10.1016/j.jand.2012.07.005.
[129] Miao JP, Quan XQ, Zhang CT, Zhu H, Ye M, Shen LY, et al. Comparison of two malnutrition risk screening tools with nutritional biochemical parameters, BMI and length of stay in Chinese geriatric inpatients: a multicenter, cross-sectional study. BMJ Open 2019;9(2):e022993. https://doi.org/10.1136/bmjopen-2018-022993.
[130] Orell-Kotikangas H, Osterlund P, Saarilahti K, Ravasco P, Schwab U, Makitie AA. NRS-2002 for pre-treatment nutritional risk screening and nutritional status assessment in head and neck cancer patients. Support Care Cancer 2015;23(6):1495–502. https://doi.org/10.1007/s00520-014-2500-0.
[131] Raslan M, Gonzalez MC, Torrinhas RS, Ravacci GR, Pereira JC, Waitzberg DL. Complementarity of subjective global assessment (SGA) and nutritional risk screening 2002 (NRS 2002) for predicting poor clinical outcomes in hospitalized patients. Clin Nutr 2011;30(1):49–53. https://doi.org/10.1016/j.clnu.2010.07.002.
[132] Ryu SW, Kim IH. Comparison of different nutritional assessments in detecting malnutrition among gastric cancer patients. World J Gastroenterol 2010;16(26):3310–7.
[133] Wang F, Chen W, Bruening KS, Raj S, Larsen DA. Nutrition screening tools and the prediction of clinical outcomes among Chinese hospitalized gastrointestinal disease patients. PLoS One 2016;11(8):e0159436. https://doi.org/10.1371/journal.pone.0159436.
[134] Westergren A, Norberg E, Hagell P. Diagnostic performance of the minimal eating observation and nutrition form - version II (MEONF-II) and nutritional risk screening 2002 (NRS 2002) among hospital inpatients - a cross-sectional study. BMC Nurs 2011;10:24. https://doi.org/10.1186/1472-6955-10-24.
[135] Sharifi F, Mirarefin M, Alizadeh-Khoei M, Nazari N, Najafi B, Fakhrzadeh H, et al. Psychometric properties of the Persian version of the nutritional form for the elderly (NUFFE) in nursing home residents. Med J Islam Repub Iran 2018;32:105. https://doi.org/10.14196/mjiri.32.105.
[136] Abbott J, Teleni L, McKavanagh D, Watson J, McCarthy AL, Isenring E. Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) is a valid screening tool in chemotherapy outpatients. Support Care Cancer 2016;24(9):3883–7. https://doi.org/10.1007/s00520-016-3196-0.
[137] Yaxley A, Crotty M, Miller M. Identifying malnutrition in an elderly ambulatory rehabilitation population: agreement between mini nutritional assessment and validated screening tools. Healthcare 2015;3(3):822–9. https://doi.org/10.3390/healthcare3030822.
[138] Akın S, Ozer FF, Ertürk Zararsız G, Şafak ED, Mucuk S, Göçer Ş, et al. Validity of simplified nutritional appetite questionnaire for Turkish community-dwelling elderly and determining cut-off according to mini nutritional assessment. Arch Gerontol Geriatr 2019;83:31–6. https://doi.org/10.1016/j.archger.2019.03.008.
[139] Rolland Y, Perrin A, Gardette V, Filhol N, Vellas B. Screening older people at risk of malnutrition or malnourished using the Simplified Nutritional Appetite Questionnaire (SNAQ): a comparison with the Mini-Nutritional Assessment (MNA) tool. J Am Med Dir Assoc 2012;13(1):31–4. https://doi.org/10.1016/j.jamda.2011.05.003.
[140] İlhan B, Bahat G, Oren MM, Kiliç C, Durmazoglu S, Karan MA. Reliability and validity of Turkish version of the simplified nutritional appetite questionnaire (SNAQ). J Nutr Health Aging 2018;22(9):1039–44. https://doi.org/10.1007/s12603-018-1051-3.
[141] Wojteczek A, Dardzinska JA, Malgorzewicz S, Gruszecka A, Zdrojewski Z. Prevalence of malnutrition in systemic sclerosis patients assessed by different diagnostic tools. Clin Rheumatol 2020;39(1):227–32. https://doi.org/10.1007/s10067-019-04810-z.
[142] Paur I, Smedshaug GB, Haugum B, Bye A, Eliassen E, Flottorp TL, et al. The Norwegian Directorate of Health recommends Malnutrition Screening Tool (MST) for all adults. Clin Nutr ESPEN 2022. https://doi.org/10.1016/j.clnesp.2022.09.029.