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## Review

## A Systematic Review of Malnutrition Screening Tools for the Nursing Home Setting

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### A B S T R A C T

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**Rationale:** Malnutrition screening among nursing home residents is often performed with tools developed for use among older subjects, and sometimes with tools designed for an adult population. Only a few tools have been designed specifically for the nursing home setting. This systematic review assesses the criterion and predictive validity of malnutrition screening tools used in nursing homes.

**Methods:** The databases MEDLINE, CINAHL, and EMBASE were searched on January 30, 2013, for manuscripts including search terms for malnutrition, screening or assessment tools, and setting. Articles were eligible for inclusion if they expressed criterion validity (how well can a tool assess nutritional status) or predictive validity (how well can a tool predict clinical outcome) of malnutrition screening tools in a nursing home population. Included were articles that had been published in the English, German, French, Dutch, Spanish, or Portuguese language.

**Results:** The search yielded 8313 references. Of these, 24 met the inclusion criteria and were available; 2 extra manuscripts were retrieved by reference checking. Twenty tools were identified. Seventeen studies reported on criterion validity, and 9 on predictive validity. Four of the tools had been designed specifically for use in long term care. None of the tools, not even the ones specifically designed for the nursing home setting, performed (on average) better than “fair” in either assessing the residents’ nutritional status or in predicting malnutrition-related outcomes.

**Conclusion:** The use of existing screening tools for the nursing home population carries limitations, as none performs better than “fair” in assessing nutritional status or in predicting outcome. Also, no superior tool can be pointed out. This systematic review implies that further considerations regarding malnutrition screening among nursing home residents are required.

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Screening for malnutrition has received increasing attention over the past 2 decades. After 1982, when the Subjective Global Assessment (SGA) was introduced as the first screening tool for malnutrition, a few dozen screening tools have been developed. These tools are intended for the quick identification of patients at risk of

malnutrition, for more in-depth nutritional assessment, or for identifying patients at risk of developing complications or even increased risk of mortality.

Malnutrition prevalence rates increase with age, due to factors such as multimorbidity, decreased appetite, diminished physical function, oral health, the ability to eat alone or with help, and/or cognitive decline. Depending on the method or parameters used for the nutritional assessment, prevalence rates of malnutrition among elderly subjects range between 6.5% and 85.0%.<sup>1</sup> For nursing home patients, the same ranges were recently described.<sup>2,3</sup>

Early identification of nursing home residents at nutritional risk, followed by adequate nutritional intervention, is expected to contribute to conservation of muscle function and muscle strength, and herewith to maintenance of independency, quality of life, and possibly prolonged survival.

MAEvB, PRG, HCWdV, and EPJ designed the study. IJ performed the systematic literature search. PRG and MAEvB judged eligibility of papers and performed data extraction. MAEvB and PRG drafted the manuscript. All authors contributed to the writing of the manuscript. All authors approved the final version of the manuscript.

The authors declare no conflicts of interest.

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**Table 1**  
Cutoff Points Applied to Rate the Validity of the Screening Tools

	Good (g)	Good/Fair (g/f)	Fair (f)	Poor (p)	Unable to Rate (?)
Sensitivity/ specificity	se AND sp > 80%		se OR sp <80%, but both >50%	se OR sp < 50%	
AUC	>0.8		0.6–0.8	<0.6	
Correlation coefficient	>0.75		0.40–0.75	<0.40	
Kappa	>0.6		0.4–0.6	<0.4	
Odds ratio/ hazard ratio	>3		2–3	<2	
P value		$P < .05$ and $n < 200^*$		$>.05$	$P < .05$ and $n > 200^†$

AUC, area under the curve; se, sensitivity; sp, specificity.

\*No indication of effect size.

†Significance of effect uncertain.

Of all malnutrition screening tools, a reasonable number have been developed for the elderly population, but only 4 were specifically developed and validated for use in long term care.<sup>4–7</sup> Consequently, nutrition risk screening among nursing home residents is usually performed using tools for the general (older) population.

In this article, we systematically review the validity of screening tools used among the nursing home population, both the “general” tools, and the tools specifically designed for use in the nursing home setting. The research questions focus on the criterion validity and predictive validity of tools.

## Methods

A systematic literature search was performed to identify all relevant articles to the research questions. The bibliographic databases PubMed, EMBASE, and CINAHL (via EBSCO) were searched from inception until January 30, 2013. Search terms expressing “malnutrition” were used in combination with search terms comprising “screening or assessment tools” and terms for “nursing home setting.” The references of the identified articles were searched for relevant publications.

Studies were included if they had been published in the English, French, German, Spanish, Portuguese, or Dutch language. The complete search strategy is depicted in [Appendix 1](#).

Articles were included if they described (1) criterion validity (ie, the validity of a tool to screen or assess a resident’s nutritional status, compared with a valid reference method) or (2) predictive validity (ie, the validity of a tool to predict outcome [infections, readmissions, mortality, poor discharge outcomes]).

As no gold standard for malnutrition exists, defining valid reference methods to rate the validity of a screening tool is challenging. By expert opinion, we decided to consider the following methods as “valid” reference methods:

- objective assessment by a professional
- nutritional assessment and anthropometry (ie, body weight [loss], body mass index [BMI], arm circumference)
- the assessment tools Mini-Nutritional Assessment (MNA) and SGA

Studies were excluded if they only described malnutrition prevalence rates, but not the validation of the tool, if they included fewer than 25 patients, if they focused on a specific disease or treatment (eg, AIDS or hemodialysis), or if the tools were adapted to the local situation (eg, the Taiwanese version of a tool).

Criterion validity is often expressed by sensitivity (se) and specificity (sp), area under the curve (AUC), correlation coefficients, and

kappa values. Predictive validity is often expressed by odds ratios (ORs) and hazard ratios (HRs) or by *P* values.

To be able to rate the validity of the studied tools as good, good/fair, or poor, we applied cutoff points ([Table 1](#)). For correlation coefficients, we used the cutoff points described by Guilford.<sup>8</sup> For kappa values, we used the classification system described by Landis and Koch.<sup>9</sup> For sensitivity and specificity, no general cutoff points are mentioned in the literature; the optimal cutoff points highly depend on the clinical consequences. For the sake of transparency and clarity, we decided to indicate a sensitivity and specificity greater than 80% and an AUC of greater than 0.8 as good. Also, cutoff points for fair and poor performance were defined ([Table 1](#)). However, [Tables 2](#) and [3](#) (the tables depicting the study data) give all the validity data, allowing the readers to form their own opinion if they do not agree with our proposed cutoff points. The cutoff points for OR and HR were chosen, based on the fact that a predictive ability with an OR/HR smaller than 2.0 will not have much practical value, the predictive ability with an OR between 2 and 3 implicates a moderate/fair effect, and the predictive effect of greater than 3 will be large. If authors published only *P* values we scored good/fair when the sample size was smaller than 200. However, when the study had a large sample size, very small effects can become statistically significant, and the clinical significance can be doubted. We rated these as “unable to rate” (in tables depicted with a “?”).

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement was followed as a guide for reporting.<sup>10</sup>

## Results

### Literature Search

The literature search yielded, after de-duplication, 8313 references ([Figure 1](#)).

Two reviewers were independently responsible for the selection of the articles for inclusion. First, all titles and abstracts, blinded for author, journal, and year, were screened for selection. This resulted in 44 articles to be retrieved full text; 2 of those could not be found. The remaining 42 articles were read full text, resulting in exclusion of another 18. The remaining 24 articles were included in this systematic review. Two articles were included from checking the reference lists of relevant articles and review articles, totaling 26 references.

During the selection process, all differences in judgment were resolved by consensus.

### Tools

Twenty tools were identified. Criterion validity was described for all 20 tools, in 17 articles. Predictive validity was described for 8 tools, in 9 articles. Some tools were used for both purposes.

In this section, we describe the validity of tools, distinguishing between criterion validity ([Table 2](#)) and predictive validity ([Table 3](#)). We (in alphabetical order) first describe the tools that were originally developed for the nursing home setting, then the tools developed for the older population, and finally the tools that were developed for the adult population. For each tool, we briefly describe how the tool was developed (with which purpose, in which population), because this may be illustrative for the performance of the tool. Following the description of a tool, we describe how the tool performed in later studies with regard to the 2 research question in 2 subsections:

- how valid is a tool to assess a nursing home resident’s nutritional status?
- how valid is a tool to predict a nursing home resident’s clinical outcome?

### Criterion validity

The 17 articles (20 tools) describing criterion validity against a reference method are summarized in Table 2.

The following are tools specifically developed for the nursing home population:

- Chinese Nutrition Screen (CNS): The CNS was developed based on the MNA, with assessment by a physician as the reference method. It was developed in a population of elderly people in nursing homes and hospitals.<sup>5</sup> After its development, the tool was cross-validated in a sample of 867 elderly subjects (nursing home and hospital); the tool then showed fair validity with assessment by a professional as the reference method.<sup>5</sup> In another study, using SGA and BMI as a reference, the tool showed poor validity.<sup>11</sup>
- Minimum Data Set (MDS): The MDS, a Health Care Financing Administration–mandated resident assessment used in community nursing homes in the United States, contains resident characteristics on weight, height, and BMI. These questions were validated versus 7 different anthropometric measures and measures of body composition (derived from bioelectrical impedance analyses), collected by a professional in a nursing home population.<sup>4</sup> For men, the correlations to the reference measures were mostly good; for women, in contrast, the correlations were only moderate.
- Simplified Nutritional Appetite Questionnaire (SNAQ [US]): This tool is widely used in the United States, and differs from another tool (confusingly also called SNAQ) that is predominantly used in the Netherlands. The American SNAQ consists of 4 questions about appetite, early satiety, food taste, and number of meals consumed daily, described to be predictive for weight loss in community-dwelling adults and nursing home residents.<sup>6</sup> Two studies were identified in which this SNAQ (US) was used to screen patients' nutritional status by validating the tool against another reference method. One study used 2 reference methods, MNA and SGA. It showed a different performance for each: when compared with the SGA its validity was poor, but it performed fair against MNA.<sup>12</sup> The other study also showed fair validity against the MNA.<sup>13</sup>
- Short Nutritional Assessment Questionnaire for Residential Care (SNAQ-RC) (+BMI): The idea of this tool was to provide a practical screening instrument for undernutrition screening for use in the nursing home setting without needing calculations. Based on the hospital SNAQ (the Dutch tool, described later<sup>14</sup>) the tool was developed and cross-validated in a population of residents living in nursing homes and residential homes. When it proved that the validity of the SNAQ-RC was insufficient in the cross-validation study, BMI was added to the SNAQ-RC in the second instance, originating into the final tool SNAQ-RC (+BMI), a tool with fair validity against the reference method used.<sup>7</sup>

The following are the tools specifically developed for the older population:

- DETERMINE: The “checklist” DETERMINE is a self-administered screening tool originally developed and validated in older Americans and subsequently adapted for older Australians.<sup>15</sup> It has been found to be significantly predictive of a less nutritionally adequate food intake and poor health status after adjustment for age and gender. Only one study was found applying this tool in the nursing home setting and in this study the tool showed a poor validity using the MNA as the reference method.<sup>16</sup>

- Geriatric Nutrition Risk Index (GNRI): The GNRI is an adaptation of the screening tool Nutrition Risk Index (NRI) (described later) to the elderly population. In the GNRI, ideal weight (which is often impossible to obtain in elderly patients) is replaced by usual weight.<sup>17</sup> The GNRI was designed and cross-validated with the aim to predict morbidity and mortality (which was good in the design study, OR > 4). In the present review, only one study used this tool to express criterion validity and the result was fair. The reference method applied was a combined index of 6 screening tools, including the GNRI itself, which may be considered as incorporation bias.<sup>18</sup>
- MNA: The MNA was developed and validated in 1994, using assessment by a professional as the reference method. The original aim of this tool was to identify elderly in home-care programs, nursing homes, and hospitals at risk of malnutrition.<sup>19</sup> Six studies were identified using the MNA expressing criterion validity again in the nursing home setting and 4 of them revealed that the MNA had a poor validity to assess the residents' nutritional status.<sup>7,20–22</sup> All studies used a different reference method. One study showed fair validity of MNA, when compared with the criteria for undernutrition of the American Institute of Nutrition.<sup>23</sup> Another study showed controversial results, with poor validity when all patients with an MNA score lower than 24 were classified as malnourished (single-tiered MNA, low specificity), and good validity when patients at risk (MNA 17.0–23.5) were further assessed by a professional for nutritional status and then subdivided into nourished or malnourished (2-tiered MNA).<sup>24</sup>
- MNA Short Form (MNA-SF) and revised Mini Nutritional Assessment Short Form (revised MNA-SF): The short form and the revised short form of MNA were both developed and validated using the MNA as a reference.<sup>25</sup> The revised MNA-SF used the data of 27 earlier studies and replaced BMI by calf circumference.<sup>26</sup> Because the first 7 questions of the MNA-SF are identical to the full MNA questionnaire, it is not surprising to see that the validity of the short version is excellent when compared with the full version (which is, in fact, incorporation bias).<sup>25</sup> Two studies expressing criterion validity of the MNA-SF in the nursing home setting showed fair validity, one against SGA and MNA<sup>12</sup> and the other using a combined index of 6 screening tools, including the MNA-SF itself, which again may be considered as incorporation bias.<sup>18</sup> In another study, the MNA-SF was validated using body weight and/or weight loss as a reference method, and the result was poor.<sup>7</sup> In only one study in nursing home residents the validity of the MNA-SF was found to be good, but the reference method applied was the MNA (note: risk of incorporation bias).<sup>27</sup>
- Malnutrition Universal Screening Tool (MUST): The MUST was developed in different groups of hospitalized and community-dwelling patients, both adults and elderly: in adult medical, surgical, and orthopedic patients its validity to screen/assess nutritional status was found to be good. In contrast, the validity of the tool in an elderly population was only fair.<sup>28</sup> For this review, we identified 4 studies in which MUST was used to assess the nutritional status of nursing home residents. In 2 of these the validity of the tool was found to be fair,<sup>12,18</sup> and in 2 the validity was poor.<sup>2,7</sup> These data indicate poor to fair validity of MUST to identify older persons at nutritional risk.
- Nutritional Risk Index (NRI): This tool was designed specifically for use with older persons, aiming to screen for those at risk of developing nutritionally related disabilities who could benefit from interventions while reducing their health services use.<sup>29</sup> The tool was developed in the community-living elderly

**Table 2**  
Studies Expressing Criterion or Construct Validity of Nutrition Screening or Assessment Tools to Establish Nutritional Status

Screening Tool	Author (Year) (Reference No.)	Population	Sample Size	Reference Method Applied	Diagnostic Accuracy	Other* Rating†
<b>Tools Developed for the Nursing Home Population</b>						
Chinese Nutrition Screen (CNS)	Woo, J (2005) (5)	Elderly ( $\geq 65$ y)	867	Assessment by a professional	se = 60, sp = 90, kappa to assessment by professional in 2 different populations = 0.5 and 0.8	f
	Lok, K (2009) (11)	Elderly ( $\geq 65$ y)	511	SGA, BMI	BMI <18.5; se = 37, sp = 83, ppv = 25, npv = 89.8	p
MDS (weight, height, and BMI from MDS)	Blaum, CS (1997) (4)	Elderly mean age 89.9 $\pm$ 5.6 y	186	Anthropometric and body composition measures of nutritional status derived from bioelectrical impedance measurements (<25 <sup>th</sup> percentile)	CCs for MDS parameters of weight and BMI ranged between 0.06 (fat free mass men–MDS BMI) to 0.83 (% body fat men–MDS weight), with good correlations (>0.75) only between MDS weight and mid-arm muscle area, %BF and fat free mass in men (but not in women)	p-g
SNAQ (Simplified Nutrition Appetite Questionnaire)	Isenring, EA (2012) (12)	Older adults (>55 y)	127	SGA, MNA	to SGA: se = 46 sp = 77	p
	Rolland, Y (2012) (13)	Elderly ( $\geq 65$ y)	175	MNA	to MNA: se = 71 sp = 77	f
SNAQ-RC (Short Nutritional Assessment Questionnaire for Residential Care) without BMI	Kruizenga, HM (2010) (7)	Elderly (mean age = 84 y)	720	Body weight and/or weight loss	SNAQ $\leq 14$ : se = 71 sp = 74	f
					se = 59–45, sp = 64–87, ppv = 52–50 npv = 71–95	f
SNAQ-RC (Short Nutritional Assessment Questionnaire for Residential Care) + BMI					se = 87–87, sp = 64–82, ppv = 61–59 npv = 89–95	f
<b>Tools Developed for the Older Population</b>						
DETERMINE	Charlton, KE (2007) (16)	Elderly (>60 y)	283	MNA	se = 91, sp = 11, ppv = 56, npv = 50	p
	Pouliia, K-A (2012) (18)	Elderly (>60 y)	248	Combined Index of 6 screening tools, patients malnourished if they score positively on 4 out of the 6 tools	se = 66, sp = 92, ppv = 95, npv = 56	f
MNA	Tarazona-Santabalbina, FJ (2009) (23)	Elderly (>70 y)	52	Criteria for undernutrition of the American Institute of Nutrition	se = 60 (95% CI 40.7–76.6) sp = 95 (95% CI 75–99) ppv = 94 (95% CI 72–99) npv = 64 (95% CI 46–79)	f
	Cereda, E (2008) (20)	Elderly (mean age 85.3 $\pm$ 8.4 y)	123	BMI, %WL, lab, oral intake	Pearson correlations of MNA to: age –0.11, BMI 0.66, %WL 0.44, AMA 0.40, diff lab parameters 0.01–0.23, oral intake 0.53	p
	Christensson, L (2002) (21)	Elderly ( $\geq 65$ y)	261	Combination of anthropometry and serum-proteins	se = 96 sp = 26 diagnostic predictivity 31	p
	Ferreira, LS (2008) (22)	Elderly (>60 y)	89	Anthropometry (corrected arm muscle area - AMAc)	se = 84 sp = 36 ppv = 77 npv = 47 ROC: 0.71	p
	Visvanathan, R (2004) (24)	Elderly ( $\geq 65$ y)	65	SNA (Standard Nutritional assessment-based on dieticians' clinical practices)	Two-tiered MNA: se = 89 (95% CI 69–97) sp = 87 (95% CI 64–96)	g
					single-tiered MNA: se = 92 (95% CI 77–98) sp = 38 (95% CI 24–54)	p
	Kruizenga, HM (2010) (7)	Elderly (mean age = 84 y)	308	Body weight and/or weight loss	se = 90–56, sp = 36–58, ppv = 26–26 npv = 94–95	p
MNA-SF	Isenring, EA (2012) (12)	older adults (>55 y)	127	SGA, MNA	to SGA: se = 86 sp = 62	f
	Pouliia, K-A (2012) (18)	Elderly (>60 y)	248	Combined Index of 6 screening tools, patients malnourished if they score positively on 4 out of the 6 tools	to MNA: se = 100 sp = 56	f
	Kruizenga, HM (2010) (7)	Elderly (mean age 84 y)	308	Body weight and/or weight loss	se = 98, sp = 50, ppv = 80, npv = 93	f
	Isenring, EA (2009) (35)	Elderly (mean age 84 y)	285	SGA	se = 98–96, sp = 18–16, ppv = 23–10 npv = 98–98	p
					se = 84 sp = 66 ppv = 65 npv = 84	f

Revised MNA-SF	Garcia-Mesenguier, MJ (2013) (27)	Elderly ( $\geq 65$ y)	895	MNA	BMI-MNA-SF: "malnourished-risk" vs "well nourished": se = 86, sp = 88, ppv = 83, npv = 90, AUC = 95 (95% CI 94–96)	g	
					CC-MNA-SF: "malnourished-risk" vs "well nourished": se = 86, sp = 83, ppv = 78, npv = 93, AUC = 92 (95% CI 91–94)	g	
					BMI-MNA-SF: "malnourished" vs "risk-well nourished": se = 84, sp = 97, ppv = 45, npv = 99, AUC = 98 (95% CI 96–99)	g	
					CC-MNA-SF: "malnourished" vs "risk-well nourished": se = 92, sp = 94, ppv = 31, npv = 100, AUC = 98 (95% CI 97–99)	g	
MUST	Diekmann, R (2013) (2)	Elderly ( $\geq 65$ y)	200	MNA	kappa = 0.16	p	
	Isenring, EA (2012) (12)	Older adults ( $>55$ y)	127	SGA, MNA	To SGA: se = 69 sp = 97 to MNA: se = 76 sp = 87	f	
	Pouliia, K-A (2012) (18)	Elderly ( $>60$ y)	248	Combined Index of 6 screening tools, patients malnourished if they score positively on 4 out of the 6 tools	se = 87 sp = 77 ppv = 88,4 npv = 75	f	
	Kruizenga, HM (2010) (7)	Elderly (mean age = 84 y)	308	Body weight and/or weight loss	se = 53–39, sp = 94–96, ppv = 67–48 npv = 89–94	p	
NRI	Pouliia, K-A (2012) (18)	Elderly ( $>60$ y)	248	Combined Index of 6 screening tools, patients malnourished if they score positively on 4 out of the 6 tools	se = 72, sp = 49, ppv = 85, npv = 29	p	
NUFFE	Soderhamn, U (2002) (31)	Elderly ( $\geq 65$ y)	114	MNA, anthropometry	Spearman rank to MNA: $-0,74$ Spearman rank (at admission) to BMI $-0,25$ , to mid arm circumference $-0,23$ and to calf circumference $-0,25$	f	
Rapid Screen	Visvanathan, R (2004) (24)	Elderly ( $\geq 65$ y)	65	SNA (Standard Nutritional assessment-based on dieticians' clinical practices)	se = 92 (95% CI 77.4–98.0), sp = 38 (95% CI 24.2–53.9)	p	
Simple ScreeningTool# 1	Laporte, M (2001) (33)	Elderly ( $\geq 65$ y)	70	Assessment by a professional	se = 77 sp = 70	f	
	Laporte, M (2001) (32)	Elderly ( $\geq 65$ y)	49	Assessment by a professional	se = 85 sp = 76	f	
Simple ScreeningTool# 2	Laporte, M (2001) (33)	Elderly ( $\geq 65$ y)	70	Assessment by a professional	se = 87 sp = 65	f	
	Laporte, M (2001) (32)	Elderly ( $\geq 65$ y)	49	Assessment by a professional	se = 90 sp = 45	p	
Tools Developed for the Adult Population							
MST	Isenring, EA (2012) (12)	older adults ( $>55$ y)	127	SGA, MNA	to SGA: se = 89 sp = 93 to MNA: se = 94 sp = 81	g	
NRS	Diekmann, R (2013) (2)	Elderly ( $\geq 65$ y)	200	MNA	kappa = 0.13	p	
NRS-2002	Pouliia, K-A (2012) (18)	Elderly ( $>60$ y)	248	Combined Index of 6 screening tools, patients malnourished if they score positively on 4 out of the 6 tools	se = 99, sp = 6 ppv = 68 npv = 83	p	
SGA	Pouliia, K-A (2012) (18)	Elderly ( $>60$ y)	248	Combined Index of 6 screening tools, patients malnourished if they score positively on 4 out of the 6 tools	se = 84, sp = 91, ppv = 95, npv = 74	g	
	Christensson, L (2002) (21)	Elderly ( $\geq 65$ y)	261	Combination of anthropometry and serum-proteins	se = 93, sp = 61, diagnostic predictivity = 47	f	
SNAQ (Short Nutritional Assessment Questionnaire)	Kruizenga, HM (2010) (7)	Elderly (mean age = 84 y)	308	Body weight and/or weight loss	se = 50–62, sp = 85–89, ppv = 44–33 npv = 88–96	f	

AUC, area under the curve; BF, body fat; BMI, body mass index; CC, correlation coefficient; CI, confidence interval; diff, difference; GNRI, Geriatric Nutrition Risk Index; MDA, Minimum Data Set; MNA, Mini Nutritional Assessment; MNA-SF, MNA Short Form; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; npv, negative predictive value; NRI, Nutritional Risk Index; NRS, Nutrition Risk Screening; NUFFE, Nutritional form for the Elderly; ppv, positive predictive value; ROC, receiver operator curve; se, sensitivity; SGA, Subjective Global Assessment; sp, specificity; WL, weight loss.

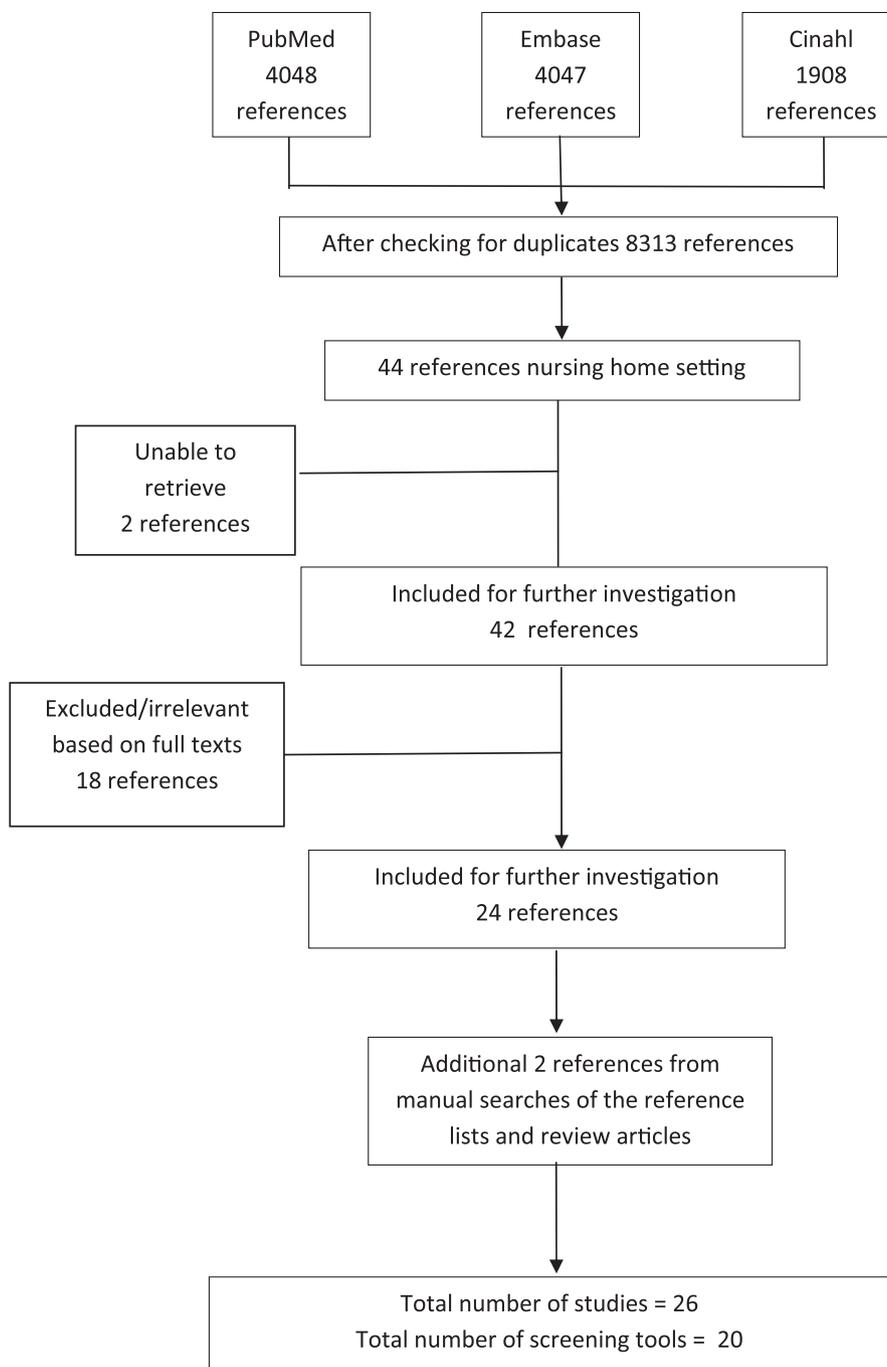
\*k = kappa.

<sup>†</sup>Rating: g = good, f = fair, g/f = good/fair, p = poor, ? = unable to be rated.

**Table 3**  
Studies Expressing Predictive Validity of Nutrition Screening or Assessment Tools to Predict Clinical Outcome

Tool	Author (Year) (Reference No.)	Population	Sample Size	LOS	Rating*	Mortality	Rating*	Complications	Rating*	Other	Rating*
Tools Developed for the Nursing Home Population											
Chinese Nutrition Screen (CNS)	Lok, J (2005) (10)	Elderly ( $\geq 65$ y)	515			CNS score associated with mortality $P < .0001$ , CNS $< 22$ se for mortality 61, sp 73	?		f		
Tools developed for the Older Population											
GNRI	Cereda, E (2008) (38)	Elderly ( $\geq 65$ y)	245			GNRI "severe-moderate" related to death, OR = 2.17, 95% CI 1.10–4.28 HR = 1.76, 95% CI 1.34–2.23 GNRI "severe" best independent predictor of death, OR = 5.29, 95% CI 1.43–19.57 HR = 2.76, 95% CI 1.89–40.3 GNRI "moderate" not significant OR = 1.86, 95% CI 0.92–3.75 HR = 1.56, 95% CI 1.19–2.04	f		p		
	Cereda, E (2008) (39)	Elderly (mean age $80.7 \pm 7.9$ y)	220			GNRI not significantly correlated to 3-mo health outcomes, infections and bedsores GNRI significantly correlated to death OR = 0.82, 95% CI 0.68–0.99			p		
MNA	Diekmann, R (2013) (2)	Elderly ( $\geq 65$ y)	200			Association with 6-mo mortality $P = .003$ and with 1-y mortality $P = .001$	g/f				
	Sharifi, F (2012) (42)	Elderly ( $\geq 65$ y)	247			Mortality: adjusted HR for survival 1.72, 95% CI 1.15–2.57			p		
	Chan, M (2010) (41)	Elderly (mean age $77 \pm 12$ y)	154			Mortality: MNA $< 17$ unadjusted OR = 3, 95% CI 1.43–6.41. MNA $< 17$ adjusted (for age, gender, Barthel and Charlson scores, nutritional supplementation): OR = 2, 95% CI 0.83–6.60; $P = .106$			g	f	
MNA-SF	Chan, M (2010) (41)	Elderly (mean age $77 \pm 12$ y)	154			Mortality: MNA-SF $< 12$ unadjusted OR = 1, 95% CI 0.10–10.1 MNA-SF not included in the multivariate model because not significant in univariate model			p		
	Torma, J (2012) (42)	Elderly (mean age $86.3 \pm 8.0$ y)	172			In multivariate model malnutrition significantly predictive for 1-y mortality OR = 2, 95% CI 1.07–5.26			f		
MUST	Diekmann, R (2013) (2)	Elderly ( $\geq 65$ y)	200			Association with 6-mo mortality $P = .001$ and with 1-y mortality $P = .012$			g/f		g/f





**Fig. 1.** Flow chart and selection process of the systematic review of the measurement properties on screening tools.

the validity of NRS in this review, the result was also poor by validating the tool against MNA in the elderly population.<sup>2</sup>

- Nutritional Risk Screening 2002 (NRS-2002): Differently from the other screening tools, the NRS-2002 is a screening system based on a retrospective analysis of controlled trials and the nutritional criteria or characteristics and clinical outcome. It was validated against a complete database of 128 randomized controlled trials of the effect of nutritional support versus no support or spontaneous intake on clinical outcome. Most studies were carried out in hospital, but outpatient studies were also included. Despite its original purpose, it is usually applied to assess patients' nutritional status.<sup>37</sup> In the nursing home setting, only one study was identified evaluating the

validity of this tool and in this study the tool performed poorly when compared with the combined index of 6 screening tools, including the NRS-2002 itself (note again, risk of incorporating bias).<sup>18</sup>

- SGA: The SGA was developed in 1982 in an adult surgical population based on clinical evaluations. It is an assessment tool mostly used to predict clinical outcome. The validity of this tool was demonstrated by correlation of the clinical classification and objective measures of nutritional status plus 3 measures of hospital morbidity: incidence of infections, length of stay, and use of antibiotics.<sup>38</sup> Criterion validity of this tool was described in 2 studies in the nursing home setting. In one study the tool performed well in the elderly population, but

the reference method, again, was the combined index of 6 tools, one of them SGA itself (thus there may be incorporating bias).<sup>18</sup> In the other study, the SGA showed fair validity when the reference method applied was a combination of anthropometry and serum-proteins, although the last one is not considered as a “valid” reference in our review.<sup>21</sup>

- Short Nutritional Assessment Questionnaire (SNAQ [NL]): Very confusing, 2 tools are abbreviated as SNAQ. This “other” SNAQ was developed in the Netherlands and is the tool most frequently used in this country. The purpose of this tool was to be a “quick and easy” 4-item instrument capable of identifying adult hospitalized patients (medical and surgical) at nutritional risk, without the need to calculate percentage of weight loss or BMI. The reference method applied for its development and validation was the nutritional assessment and anthropometry.<sup>14</sup> In this review, the SNAQ showed fair validity against body weight and/or weight loss in elderly nursing home patients.<sup>7</sup>

Of 20 tools applied in the nursing home population, 4 were originally developed for use in this specific setting (CNS, MDS, SNAQ [US tool] and SNAQ-RC [without, and with BMI]), 8 were originally developed for use among elderly (DETERMINE, GNRI, MNA, MNA-SF [and its revised form], NRI, NUFFE, Rapid Screen), 5 for use among adult persons (MST, NRS, SGA, SNAQ [Dutch tool], NRS-2002), and 3 (MUST, and the Simple Screenings Tools #1 and #2) for use in both adult and older persons. Nevertheless, the criterion validity of all tools, also the ones aiming specifically at the long term care setting, was, in general, only fair.

The tools were validated against many different semigold reference methods, arising from the fact that no accepted gold standard exists for defining malnutrition. The study by Poulia et al<sup>18</sup> even used a combination of 6 existing tools as the reference method. The 6 individual tools were validated against the combination of all 6, which deserves at least a methodological comment, this can induce incorporation bias, but even then the tools performed only poorly or fair.

The relative good performance of the revised form of the MNA-SF in the study by Garcia-Meseguer and Serrano-Urrea<sup>27</sup> may raise the suggestion that this tool deserves a better judgement than “fair.” However, the MNA-SF was validated against the full-MNA in this study, with the first 6 questions being identical. Incorporation bias is, therefore, likely to explain the good result.

#### Predictive validity

Nine studies, applying 8 different tools, were identified describing the predictive validity of malnutrition screening tools for nursing home residents (Table 3).

The following tool was developed for the nursing home population:

- CNS: In a study among 515 nursing home residents, both CNS and SGA were associated with mortality; the strength of the association between either tool and mortality was fair and comparable for both tools.<sup>11</sup>

The following tools were developed for the older population:

- GNRI: The GNRI was developed with the specific aim to predict nutrition-related morbidity and mortality among older persons.<sup>17</sup> For this review, 2 studies were identified, both by Cereda et al.<sup>39,40</sup> In one study, severe malnutrition had fair to good predictive validity for mortality, but moderate malnutrition was not predictive.<sup>39</sup> In the other, malnutrition (by GNRI) was independently associated with death, but not with other health-related outcomes.<sup>40</sup>

- MNA: The MNA, originally developed to identify malnutrition among frail and healthy elderly in all health care settings, was applied in 3 studies to predict mortality among nursing home patients.<sup>2,41,42</sup> In the study by Chan et al,<sup>41</sup> the MNA had good predictive validity for mortality in the unadjusted analyses; however, after adjusting for age, gender, comorbidities, and function, the predictive validity disappeared. The study by Sharifi et al<sup>42</sup> showed poor predictive validity of MNA to mortality, both in the unadjusted and in the adjusted model. Finally, in the study by Diekmann et al,<sup>2</sup> the association between MNA and mortality was expressed by *P* values only (*P* < .05), which complicates the rating of the tool because *P* values do not give an impression of the strength of the association. Taking into account the sample size studied (*n* = 200), the predictive validity of MNA for mortality in this study was most likely fair or good.
- MNA-SF: The study by Chan et al,<sup>41</sup> mentioned previously, also assessed the predictive validity of the short form of the MNA. MNA-SF was not predictive for mortality in the univariate or in the multivariate model. In a study by Torma et al,<sup>43</sup> in contrast, MNA-SF showed fair to good predictive validity for mortality, with an OR of 2, adjusted for other parameters.
- MUST: Diekmann and coworkers<sup>2</sup> assessed the predictive validity of more than one tool in the same population: MNA (see earlier), MUST and NRS (see later). As described in the section under MNA, data were, unfortunately, expressed only by *P* values. MUST showed comparable results to MNA and NRS, with most likely fair to good predictive validity to predict mortality.
- Rapid Screen: The tool Rapid Screen was applied not to predict mortality, but to predict poor discharge outcomes of patients admitted to a subacute care facility.<sup>24</sup> Patients identified malnourished were more likely to be admitted to an acute hospital or accommodation; however, this conclusion is not too convincing, as data were expressed by *P* values only (unable to rate the strength of the association).

The following tools were developed for the adult population:

- NRS: As a follow-up to the text described under MNA and MUST, Diekmann et al<sup>2</sup> also described the results for NRS in predicting mortality, suggesting fair to good predictive validity of the tool.
- SGA: In a study by Sacks et al,<sup>44</sup> SGA class and SGA composite score were associated with mortality, infections, and readmissions in a geriatric population to a long term care facility. SGA classes were derived according to the original study by Baker et al.<sup>38</sup> A composite score was derived based on (subjective) severity scoring of each clinical feature in the SGA. Depending on the method (SGA class or composite score), SGA showed good/fair (SGA class, *P* < .05), respectively fair (SGA composite score, sensitivity 75, specificity 84) predictive validity for mortality; poor (SGA class) or good/fair (SGA composite score) predictive validity for major infections; and fair predictive validity (SGA composite score only) for readmission. Lok and colleagues<sup>11</sup> studied the predictive validity of the SGA in a group of 515 nursing home residents, concurrently with the CNS; both tools showed fair predictive validity.

Nine studies described the predictive validity of screening tools in the nursing home setting. All showed mostly fair predictive validity of tools, with no tool being superior to the other ones. The interpretation of the data was hampered by the fact that many of the studies presented data as *P* values only.

Two studies applied more than one tool in the same population. In one study, the tools were SGA and CNS,<sup>11</sup> in the other study, the tools

were MNA, MUST, and NRS.<sup>2</sup> It was striking to see that the performance of the different tools in the same study population was more or less the same.

## Discussion

This review shows that malnutrition screening in long term care facilities using existing tools has serious limitations. None of the nutrition screening or assessment tools included in the studies in this review performed consistently well in assessing the nutritional status of the residents, not even the tools that were originally designed for assessing the nutritional status of older persons. When reviewing these results, the question may arise whether the nutritional status of a nursing home resident can be captured well enough by a simple screening or assessment tool, whether the tools are all poor, or whether the different reference methods were perhaps inadequate for the older population.

In addition, evaluating the predictive validity of malnutrition was hindered by the identification of only 9 studies, and in some of these studies only *P* values were presented without any indication of the strength of the association between malnutrition and outcome. In addition, prediction validity of tools may be affected by many confounding factors, such as disease and the proximity to end of life. Therefore, validation using prediction may not reach a high degree of accuracy, as the contribution of malnutrition to, for example, the risk of dying is only small.<sup>45</sup> None of the tools showed good predictive validity for malnutrition-related outcomes.

### Validity of Tools

It is expected that a tool performs best when it is applied in the same population and with the same goal as in the development study. In contrast, a tool that was developed for screening nutritional status in, for example, an adult surgical population is expected to perform less adequately in predicting outcome in an older nursing home population. This review illustrates that even the tools that were specifically developed for use in the long term care setting did not show good criterion or predictive validity. The question may arise whether the nutritional status (often resulting from a multifactorial background) of a nursing home resident can be captured well enough by a simple nutrition screening/assessment tool that is often largely based on weight (loss), BMI, and appetite questions, whether the tools are all poor, or whether the different reference methods were perhaps inadequate for the older population. Perhaps, for the nursing home setting, factors specific to the nursing home population, for example the ability to eat alone or with help, oral health, or dietary intake, should be included in the tools.

### Gold Standard

Expressing validity of tools in the absence of a gold standard is a challenge.<sup>46</sup> By expert opinion, we decided to regard the assessment tools SGA, MNA, a full nutritional assessment, or assessment by a professional as reference methods. However, these reference methods were not specifically designed for use in the nursing home population, and may, therefore, not be the ideal reference methods (missing, for example, specific nursing home problems). Thus, difficulty of having good validity might come from the validation criteria, which might not relate to the nutritional risks encountered in nursing homes.

### Weight, Height, BMI, and Anthropometric Measurements

Each tool consists of different components. Almost all tools contain questions on weight, recent (involuntary) weight loss, height,

and/or BMI. Although no unanimously shared definition of malnutrition exists, most experts will agree that weight, weight changes, BMI, and/or decreased intake are most likely to be part of a definition.<sup>46</sup>

Loss of weight and BMI carry different weights in the different screening tools; for example, BMI is very important in MUST, whereas it represents maximally 21% of the MNA-SF and 10% of the MNA, and is not present in SNAQ.

Moreover, for older persons, cutoff points for weight, and derived BMI, are not agreed on. The elderly are known to suffer from an age-related decrease in lean mass and an increase in body fat. This age-related phenomenon, called sarcopenia, may be accelerated by, among others, nutritional deficiencies and disuse of muscle.<sup>47,48</sup> Because of its inability to detect age-related changes in body composition (eg, spinal deformities, changed body fat redistribution), BMI is thought not to be the most appropriate predictor of morbidity and mortality in the elderly. Although the World Health Organization defines severe thinness by a BMI cutoff point lower than 18.5, this cut-point is disputed for the elderly. The screening tools studied apply BMI cutoff points ranging between 15<sup>36</sup> and 22,<sup>24</sup> and these might not be indicative for malnutrition in older subjects. In a recent systematic review, the optimal BMI range for the lowest mortality in the elderly was overweight ( $25 \text{ kg/m}^2 \leq \text{BMI} < 30 \text{ kg/m}^2$ ) or mildly obese ( $30 \text{ kg/m}^2 \leq \text{BMI} < 35 \text{ kg/m}^2$ ).<sup>49</sup> Higher cutoff points for BMI are therefore suggested, but the optimal cutoff point remains to be determined.

Another disadvantage of including weight and BMI in malnutrition screening tools for the elderly is that advanced dependency in activities of daily living may hinder the measurement of weight and height. Studies report missing weights in up to 50% of included elderly individuals.<sup>4,50</sup>

Moreover, height measurements may have the constraints of standing problems, spinal deformities, and fluid disturbances. Different studies contradict on the best anthropometric predictor for mortality among older persons. Arm circumference, calf circumference, lean body mass, waist circumference, or waist-hip ratio have all been mentioned. For the detection of undernutrition, arm circumference or calf circumference have been included in some of the tools, as substitutes, or even as better alternatives for BMI.<sup>26,51</sup> These measures are more easy to obtain and the assumption is that low (arm or calf) circumference is a better measure of actual body composition than BMI, whereas arm or calf circumference are a better reflection of muscle mass.

### Appetite and Intake

Appetite and/or insufficient dietary intake are part of most screening tools as well. It is well known that older persons have a linear decrease in food intake with increasing age. This is explained by decreased physical activity and altered metabolism with aging.<sup>52</sup> In addition, a high level of care dependency, polypharmacy, chewing problems, and swallowing problems have been identified as factors contributing to a poor intake, specifically in the nursing home setting.

Objectifying food intake, in relation to nutritional needs, may be a challenge. Studies have shown that residents living in long term care facilities frequently have intakes of energy, proteins, and micronutrients below requirements.<sup>53,54</sup> Energy requirements are thought to be at least 1500 kcal per day, as has recently been shown among hospitalized geriatric patients, and protein requirements are thought to be higher than the general recommendation of 0.8 g/kg per day.<sup>55–57</sup>

If a deficient nutritional intake can be reversed, this might improve clinical outcome. Milne et al's Cochrane review<sup>58</sup> suggests

that providing extra energy and protein to malnourished and/or geriatric older individuals (eg, nursing home residents) is likely to decrease complications and mortality. It has, in addition, been suggested that not only the nutritional content of the nutrition offered, but also the eating environment (the environment itself, assistance with eating) may play a role in improving the intake of the residents.<sup>59</sup>

### *Multifactorial Background*

A study using the Minimum Data Set in US nursing homes showed that deficient oral intake, loss of ability to eat independently, pressure ulcers, and chewing disorders were all factors associated with signs of malnutrition.<sup>4</sup> Other studies have pointed out that malnutrition in the elderly is almost always a combination of a poor intake on the one hand, and multiple other problems (either in the somatic, functional, cognitive, or social domain) on the other hand.<sup>60,61</sup> Some authors even suggest considering malnutrition a geriatric syndrome, having multiple underlying causes, and needing a multifactorial approach.<sup>61,62</sup> Screening tools that investigate the causes of undernutrition, next to the nutritional status itself, are therefore of more interest than screening tools only inquiring for weight changes or BMI. Perhaps the ideal screening tool for the nursing home resident should include more factors addressing the multifactorial problems that nursing home residents are faced with; that is, dietary factors, being (in)dependent of help for eating, environment, and oral health, next to general and anthropometric factors.

Following screening, a comprehensive geriatric assessment is necessary to obtain more information on the possible underlying causes for malnutrition.<sup>62</sup>

### *Nutritional Intervention*

Screening is meant to identify residents at nutritional risk, who are expected to benefit from nutritional support with regard to (physical or cognitive) function, quality of life, occurrence of complications, or even mortality. However, none of the studies included in this review described whether the residents had received a nutritional intervention, and whether this had influenced their outcome. This kind of study should be planned for the near future, especially when investigating the predictive validity of tools (because of the longitudinal nature of this kind of study). For studies describing criterion validity, this is less important, because these studies usually have a cross-sectional design.

More in general, the evidence for the effectiveness of nutritional supplements containing protein and energy, often prescribed for older people, is still limited. Supplementation is known to produce a small weight gain in older people and mortality and complications may be reduced in those who are undernourished. However, the latest Cochrane review found no evidence of improvement in functional benefit or reduction in length of hospital stay with supplements.<sup>58</sup>

Naturally, residents close to the end of life, or residents with ongoing cachexia (due to progressive disease) should not be offered “aggressive” nutritional therapy, as this is known to be ineffective.<sup>63,64</sup> For these persons, the therapy should aim at providing maximal comfort and end-of life care.

### *Comparing Tools*

The variety in study design, population, tools, reference methods, outcome measures, and follow-up time made it impossible to pool data or to perform meta-analyses. To be able to compare tools, we had to rely on studies applying more than one tool in the same patient population. These studies have the advantage that they are

not biased by (differences) in study population, methodology, or outcome measures. We identified 2 such studies. In the study by Diekmann et al,<sup>2</sup> MUST, NRS, and MNA were used; in the study by Lok et al,<sup>11</sup> the tools were SGA and CNS. As mentioned previously, the tools performed strikingly similarly in predicting malnutrition-related outcomes. This raises a few questions:

Is the general condition of the resident probably more predictive of outcome than the tool? Or, is the multicausal background of malnutrition in this population (malnutrition as a “geriatric syndrome”) too complex for a “simple” nutrition tool to pick up the deficiency? Or, the most straightforward explanation: are the tools simply not good enough for this specific population? This last question is substantiated by the fact that the tools did not perform well with regard to criterion validity either. We recommend that more studies be performed in which more tools are applied to the same study population. Only then will we be able to appoint a superior tool, if there is such a tool.

### *Earlier Reviews*

In 2012, Dent and coworkers<sup>65</sup> published a systematic review on nutritional screening tools as predictors of mortality, functional decline, and move to higher-level care in older people. This review was broader than our review with respect to types of studies and outcome measures included: studies were also included if they had been performed in the community or in the hospital setting; also the outcome measures of functioning and moving to higher level of care were considered. On the other hand, the review by Dent et al<sup>65</sup> was more narrow, as it studied predictive validity only, whereas we also included studies establishing criterion validity.

Nevertheless, the conclusions of Dent et al’s review<sup>65</sup> (including 7 studies in the nursing home setting, 6 overlapping with our review) are very similar to ours: whereas Dent et al<sup>65</sup> concludes that nutrition screening tools have only modest positive predictive power, we conclude that the predictive validity of tools is not better than fair.

As for criterion validity, we recently published a study on the validity of screening tools for the hospital setting.<sup>66</sup> Both the earlier review and the present one conclude that there is not a single screening tool that is capable of optimal nutrition screening, not for hospitalized patients, nor for nursing home residents. This implies that a good clinical assessment, by a doctor, specialized nurse, or dietitian with interest and knowledge of (symptoms of) malnutrition remains to play a major role. These professionals should not only ask for the components that are included in the tools (weight loss, BMI, or appetite), but also rely on their clinical impression and inquire for possible underlying causes (eg, poor dentition, swallowing problems, cognitive impairment, impaired physical functioning) of malnutrition. For the nursing home population, we suggest performing such an assessment at admission and then every 3 months thereafter.

Elia and Stratton<sup>67</sup> recently described that screening tools designed for different age groups often incorporate factors that are nonmodifiable by nutritional support, among which is age itself. They emphasize that relying disproportionately on a particular tool or on a particular tool characteristic can be problematic, especially if age alone can predict outcome more effectively. This suggestion is especially true for nursing home residents, who are often close to the end of life. Indeed, the studies included in this systematic review support the conclusion by Elia and Stratton.<sup>67</sup> Not a single tool was capable of perfectly assessing nutritional status or predicting outcome.

### *Strength and Limitations*

For this review, we performed an extensive literature search in 3 different databases and we included studies published in 5 different

languages. We, therefore, believe that the search has been quite complete. Still, we excluded studies in specific subgroups of patients, for example, hemodialysis patients, small studies, and studies involving modifications of tools for, for example, the Taiwanese or Korean population.

The studies describing predictive validity of tools should be interpreted with caution, especially if only univariate analyses were presented. Outcome, especially in older subjects, is known to be largely influenced by underlying disease, comorbidities, age, social situation, and cognitive functioning. Studies not adjusting for these other variables are less valuable.

For reasons of comparison, we decided to rate the performance of the tools as good, fair, or poor. However, the cutoff points for these ratings may be discussed; they were decided on by expert opinion within our own research group. Depending on the purpose of the screening, other groups may want to tighten or loosen the cutoff points proposed by us. This may influence the conclusions; loosening the cutoff points may lead to more tools performing well, tightening may lead to the contrary. Therefore, the tables present all validity values of the tools, allowing for the reader's own interpretation.

## Conclusion

Existing screening tools, even those developed for the nursing home setting, are only fairly able of assessing the nutritional status of nursing home residents, or of predicting poor nutrition-related outcomes. The ideal tool for the nursing home population should perhaps contain more items referring to the multifactorial background of malnutrition in this specific population. The present tools could be used as a first step in identifying residents at risk of malnutrition, preferably in combination with a comprehensive geriatric assessment investigating possible causes of malnutrition.

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### Appendix 1. Search strategy

To identify all relevant publications, we performed systematic searches in the bibliographic databases PubMed, [EMBASE.com](http://EMBASE.com), and CINAHL (via EBSCO) from inception to January 30, 2013. Search terms included controlled terms from MeSH in PubMed, Emtree in [EMBASE.com](http://EMBASE.com), and CINAHL Headings in CINAHL, as well as free text terms. Search terms expressing “malnutrition” were used in

combination with search terms comprising “screening or assessment instruments” and terms for “nursing home setting” and “adults.” The references of the identified articles were searched for relevant publications.

Search strategy in PubMed, January 30, 2013 (read from bottom-up).

Set	Search Terms	Result
#6	#5 NOT (“addresses”[Publication Type] OR “biography”[Publication Type] OR “case reports”[Publication Type] OR “comment”[Publication Type] OR “directory”[Publication Type] OR “editorial”[Publication Type] OR “festschrift”[Publication Type] OR “interview”[Publication Type] OR “lectures”[Publication Type] OR “legal cases”[Publication Type] OR “legislation”[Publication Type] OR “letter”[Publication Type] OR “news”[Publication Type] OR “newspaper article”[Publication Type] OR “patient education handout”[Publication Type] OR “popular works”[Publication Type] OR “congresses”[Publication Type] OR “consensus development conference”[Publication Type] OR “consensus development conference, nih”[Publication Type] OR “practice guideline”[Publication Type]) NOT (“animals”[MeSH Terms] NOT “humans”[MeSH Terms])	4048
#5	#4 NOT (“Adolescent”[Mesh] OR “Child”[Mesh] OR “Infant”[Mesh] OR adolescen*[tiab] OR child*[tiab] OR schoolchild*[tiab] OR infant*[tiab] OR girl*[tiab] OR boy*[tiab] OR teen[tiab] OR teens[tiab] OR teenager*[tiab] OR youth*[tiab] OR pediater*[tiab] OR paediatr*[tiab] OR puber*[tiab]) NOT (“Adult”[Mesh] OR adult*[tiab] OR man[tiab] OR men[tiab] OR woman[tiab] OR women[tiab]))	4196
#4	#1 AND #2 AND #3	5366
#3	“Nursing Homes”[Mesh] OR “Hospitals”[Mesh] OR “Home Care Services”[Mesh] OR “Housing for the Elderly”[Mesh] OR “Community Health Services”[Mesh] OR “Housing for the Elderly”[Mesh] OR “General Practice”[Mesh] OR “Ambulatory Care”[Mesh] OR “Institutionalization”[Mesh] OR “Long-Term Care”[Mesh] OR “Hospitalization”[Mesh] OR ((hospital*[tiab] OR home[tiab] OR homes[tiab] OR housing[tiab] OR Community Health Service*[tiab] OR communite*[tiab] OR General Practice*[tiab] OR Family Practice*[tiab] OR outpatient*[tiab] OR ambulatory[tiab] OR Institution*[tiab] OR “Long-Term Care”[tiab] OR Hospitalization[tiab] OR Hospitalisation[tiab]) NOT medline[sb])	970871
#2	(“Questionnaires”[Mesh] OR Questionnaire*[tiab] OR Instrument*[tiab] OR Screen[tiab] OR Screening[tiab] OR Screener[tiab] OR Assessment*[tiab] OR Assessing[tiab] OR Self-report[tiab] OR Inventory[tiab] OR Scale[tiab] OR Checklist*[tiab] OR Form[tiab] OR tool[tiab] OR tools[tiab] OR evaluation[tiab] OR rating[tiab] OR monitor*[tiab] OR score*[tiab] OR scoring[tiab] OR index[tiab] OR indices[tiab] OR interview*[tiab] OR survey*[tiab] OR methods[sh] OR “Validation Studies”[pt] OR “Comparative Study”[pt] OR clinimetr*[tw] OR clinometr*[tw] OR “outcome assessment (health care)”[MeSH:noexp] OR “outcome assessment”[tiab] OR “outcome measure”[tw] OR “observer variation”[MeSH] OR “observer variation”[tiab] OR “reproducibility of results”[MeSH] OR reproducib*[tiab] OR “discriminant analysis”[MeSH] OR reliab*[tiab] OR unreliab*[tiab] OR valid*[tiab] OR “coefficient of variation”[tiab] OR coefficient[tiab] OR homogeneity[tiab] OR homogeneous[tiab] OR “internal consistency”[tiab] OR (cronbach*[tiab] AND (alpha[tiab] OR alphas[tiab])) OR (item[tiab] AND (correlation*[tiab] OR selection*[tiab] OR reduction*[tiab])) OR agreement[tw] OR precision[tw] OR imprecision[tw] OR “precise values”[tw] OR test-retest[tiab] OR (test[tiab] AND retest[tiab]) OR (reliab*[tiab] AND (test[tiab] OR retest[tiab])) OR stability[tiab] OR interrater[tiab] OR inter-rater[tiab] OR intrarater[tiab] OR intra-rater[tiab] OR intertester[tiab] OR inter-tester[tiab] OR intratester[tiab] OR intra-tester[tiab] OR interobserver[tiab] OR inter-observer[tiab] OR intraobserver[tiab] OR intra-observer[tiab] OR intertechnician[tiab] OR inter-technician[tiab] OR intratechnician[tiab] OR intra-technician[tiab] OR interexaminer[tiab] OR inter-examiner[tiab] OR intraexaminer[tiab] OR intra-examiner[tiab] OR interindividual[tiab] OR inter-individual[tiab] OR intraindividual[tiab] OR intra-individual[tiab] OR interparticipant[tiab] OR inter-participant[tiab] OR intraparticipant[tiab] OR intra-participant[tiab] OR kappa[tiab] OR kappa's[tiab] OR kappas[tiab] OR repeatab*[tw] OR specifcit*[tiab] OR sensitiv*[tiab] OR responsive*[tiab] OR ((replicab*[tw] OR repeated[tw]) AND (measure[tw] OR measures[tw] OR findings[tw] OR result[tw] OR results[tw] OR test[tw] OR tests[tw])) OR generaliza*[tiab] OR generalisa*[tiab] OR concordance[tiab] OR (intraclass[tiab] AND correlation*[tiab])	7900330
#1	“Malnutrition”[Mesh:NoExp] OR “Protein Deficiency”[Mesh] OR “Nutritional Status”[Mesh] OR “Nutrition Assessment”[Mesh] OR Malnutrition[tiab] OR Undernutrition[tiab] OR ((nutritional deficienc*[tiab] OR nutrition deficienc*[tiab] OR depletion[tiab] OR malnourishment[tiab] OR underfeeding[tiab] OR undernourishment[tiab] OR protein deficienc*[tiab] OR energy deficienc*[tiab] OR nutritional risk*[tiab] OR nutritional status[tiab]) NOT medline[sb])	78966