

REVIEW AND ANALYSIS OF INDICATORS IN NUTRITION SCREENING TOOLS THAT IDENTIFY MALNUTRITION AMONG LONG TERM CARE RESIDENTS

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Abstract: *Background:* Malnutrition is common among nursing home residents and it occurs when the nutrient intake is not sufficient, precipitated by a complex array of physiological, psychosocial and other factors. The importance of addressing malnutrition as early as possible in an efficient and effective manner has resulted in the development of several nutrition screening tools (NSTs) to identify those at risk for malnutrition. However, a recent systematic review of the NSTs concluded that «none performs better than «fair» in assessing nutritional status or in predicting outcomes.» *Objectives:* Thus, the purpose of this systematic review is to identify and review the indicators included in NSTs that identify malnutrition among LTC residents. *Methods:* For this systematic review, relevant publications were identified using a comprehensive search of electronic databases based on pre-established search criteria. A final list of 17 articles were reviewed and relevant data pertinent to the NSTs and the specific indicators used were extracted and entered into an excel spreadsheet for further analysis. The indicators were grouped as anthropometric measurements, biochemical, clinical factors, dietary assessment, psychological, social and physical factors, and then the individual indicators within each of the groupings were examined. *Results:* This paper shows that NSTs rely heavily on anthropometric measurements (93%) especially on body mass or weight based indicators (BMI, weight loss). Only 12% of NSTs include any biochemical indicator. Heavy reliance on certain indicators could compromise the effectiveness of NSTs in identifying individuals with malnutrition or in predicting outcomes. *Conclusions* NSTs, encompassing combinations of varied indicators, provides an alternate choice, however the optimal and best combination of these indicators has yet to be determined.

Key words: Nutrition screening, long term care, malnutrition.

Introduction

Malnutrition occurs when the nutrient intake is not sufficient. It is precipitated by a complex array of physiological, psychosocial and other factors and the elderly group and those in long term care (LTC) are particularly vulnerable. (1-7). The literature is rich in documenting the effects of malnutrition including risk of morbidity, extended hospital stays (8), loss of cognitive functions (9), lower wellbeing (9, 10) and mortality (1). A high prevalence of malnutrition in LTC residents is consistently reported in the literature (4, 11, 12). Estimates, using various methods, suggest that between 6 to 85 % residents of LTC are either at high risk for malnutrition or suffer from it (11-15). A multinational study, comprising of 4,507 LTC residents over age 65 from 12 countries representing all continents, reported that half were at risk and 14% were malnourished (3). Early identification of malnutrition in this age group outweighs the concomitant negative outcomes (4). Consequently, a number of nutrition screening tools (NSTs) have been developed to identify those at risk for malnutrition at earlier stages based on risk factors and/or indicators of malnutrition (16, 17).

A risk factor of malnutrition is an aspect or characteristic which can predispose an individual to malnutrition. Malnutrition risk or malnutrition could be ascribed to the presence of a single risk factor or combination of factors.

A malnutrition indicator is a measurable parameter which provides evidence that malnutrition exists. Nutrition screening is a simple standardized method to detect malnourished individuals and/or at risk individuals that may need a further nutrition assessment (14). In the absence of a gold standard to determine malnutrition; nutritional risk or malnutrition is usually detected by indicators including Body Mass Index (BMI), weight loss and dietary intake (4, 18).

NSTs designed to assess nutritional status, are developed in the form of a questionnaire or checklist with the list of indicators related to malnutrition. Responses to these indicators are indicative of whether the individual is malnourished or at risk. Many NSTs exist in the literature, however there is no consensus on the effectiveness of NSTs specifically for LTC residents (13, 19). In 2013, Diekmann and colleagues (13) reported significant differences in the identification of malnutrition in LTC residents by examining three NSTs recommended by the European Society for Clinical Nutrition and Metabolism. The differences may be attributable to the indicators used in these NSTs and may under or overestimate residents as malnourished. In 2014, Van Bokhorst-de van der Schueren and colleagues (11) identified 18 NSTs which were used in the LTC setting and compared them with the rating of good, fair or poor based on the psychometric properties. They concluded that “none performs better than “fair” in

Table 1
Articles inclusion and exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Language	English language	Non English language
Population	Elderly	Infants Children Adults Elderly population with specific disease condition (e.g., cancer, renal disease, dementia)
Setting	Long term care/ Nursing homes	Retirement facility Senior housing Assisted living facilities in the community Hospital
Measure	Report malnutrition risk using validated nutrition screening tool	Report malnutrition risk without using validated nutrition screening tool Disease specific malnutrition screening tools for instance use in cancer or renal disease Specific markers of nutrition such as blood tests Perceptions and practices related to screening tool Focus on specific disease
Nature of Article	Primary research	Review articles Systematic reviews

assessing nutritional status or in predicting outcomes.” The importance of addressing malnutrition as early as possible in an efficient and effective manner requires the researchers and practitioners to step back and assess the indicators used in the NSTs. The purpose of this paper is to identify and review the indicators included in NSTs that identify malnutrition among LTC residents and critically examine the merits and limitations of indicators used in the NSTs to assess malnutrition among LTC residents.

Method

Search Strategy

Relevant publications for this review were identified using a systematic search of electronic databases, specifically Pub Med and CINAHL using the following terms: nutritional status; under-nutrition; malnutrition; older people; elderly; long term care; nursing home; residential care homes; nutrition screening; nutritional screening tools. The searches were conducted from the earliest date available in the databases to November 2016. In addition, along with the retrospective searches of publications, the reference lists of the identified publications were reviewed to identify a comprehensive listing of articles. Inclusion and exclusion criteria for articles were defined based on the scope of the review and are described in Table 1.

Selection Process and Data Extraction

Articles obtained in the initial search (n=1319) were reviewed to make sure that they were consistent with the aim of the review; the articles which did not fit the aim were excluded. The full text of the remaining articles (n=19) was reviewed

thoroughly and articles that did not match the pre-defined inclusion criteria were excluded (n=3). Figure 1 summarizes each step of the article selection process and shows the number of articles retrieved and excluded at each step. The final list of 17 articles and original studies (in which identified NSTs were developed) were reviewed and relevant data pertinent to the NSTs and the specific indicators used were extracted and entered into an excel spreadsheet for further analysis. The indicators were grouped as anthropometric measurements, biochemical, clinical factors, dietary assessment, psychological, social and physical factors. Individual indicators within each group were then examined.

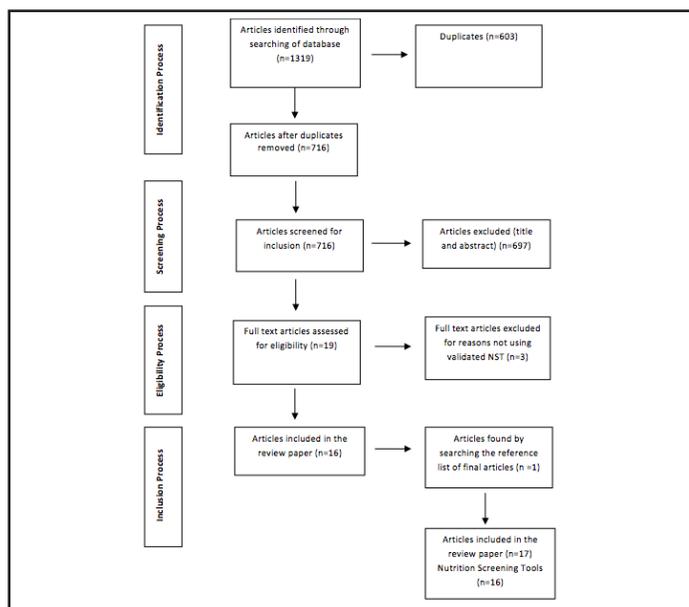
Results

The systematic review resulted in the identification of 16 validated NSTs currently used in LTC settings developed from 1987 (SGA) to 2010 (SNAQ-RC - Dutch). As shown in Table 2, considerable variation is evident in the number and type of indicators used in the NSTs. In the first step, the indicators were grouped broadly as anthropometric measurements, biochemical, clinical, dietary assessment, psychological, social and physical indicators. Most tools used an amalgamation of different indicators. Except for SNAQ (US), all 15 out of 16 of the NSTs (94%) used anthropometric indicators. Few NSTs (2 out of 16 (12%)) included biochemical indicators. Some NSTs incorporated clinical indicators (9 out of 16 (56%)). Dietary indicators were assessed by 12 out of 16 NSTs (75%) and psychological, social and physical indicators were used by 7 out of 16 NSTs (44%).

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Figure 1

Flow chart summarizing the search process



Further analysis of the indicators within these groups revealed further variability not only in the specific indicators but also how they were measured. The specific indicators used in the NSTs to assess malnutrition in LTC residents are presented in Table 3. Anthropometric measurements are significant components of most NSTs. Weight loss is an important characteristic of NSTs and incorporated in 81% of NSTs. A wide variation in weight loss values, ranging from 1% to 10% between one week to six months, is evident as presented in Table 4. Four tools specifically asked whether the weight loss was unintentional. BMI is included in 44% of NSTs. BMI criteria and cutoff values to determine malnutrition differ among NSTs as shown in Table 5. Calf circumference (CC) is used by MNA-SF, whereas MNA incorporated both CC and mid arm circumference (MAC). Clinical indicators such as the presence of illness are used in 50% of NSTs and use of medication is included in 25% of NSTs. The least used indicator is the biochemical component with only 12% NSTs using this indicator (serum albumin being the most common).

Dietary assessment and related factors are part of many NSTs. Low appetite is integrated in 50% of NSTs. Overall dietary intake is included in 31% of NSTs. Some other features related to dietary assessment used in NSTs include consumption of specific foods (12%), use of therapeutic diet & supplements (12%), fluid intake (12%), tube/IV feeding (12%) and meals/day (31%). Many factors, which hinder food intake including feeding dependency (19%), food taste (12%), mouth/teeth problems (6%) and swallowing problem (6%) are also incorporated in some of the NSTs.

Psychological, social and physical factors are also

considered in a few NSTs as indicators, such as mobility (25%), neuro-psychological problems (19%) and living alone (16%). Other factors used in NSTs included eating alone (6%), psychological wellbeing (6%), perception of health (6%), happiness (6%), mood and behaviour problems (6%), and stress (6%). Some NSTs explored the physical functioning and activity levels through items such functional capacity (6%) and activity level (6%). Physical functioning and activity pursuit patterns are unique to MDS (6%). Only one NST (6%) NSI-DETERMINE incorporated financial status and consumption of alcohol as indicators of malnutrition.

Discussion

The purpose of this paper was to identify and review the indicators included in NSTs that assess malnutrition among LTC residents. In addition, the paper was to critically examine the merits and limitations of those indicators. The review identified 16 NSTs relevant to LTC residents. Given that the etiology of malnutrition is multi-factorial and screening the elderly is challenging, NSTs use different combinations of indicators to assess malnutrition. For the purpose of this review these indicators are grouped as anthropometric measurements, biochemical, clinical, dietary assessment and psychological, social & physical indicators.

The review indicates a heavy reliance on anthropometric measurements with weight loss and BMI the most commonly used measures in NSTs. Weight loss among the elderly is predominantly associated with risk of malnutrition (11, 12, 15, 18, 20-22). However, weight loss is problematic from a measurement perspective particularly with regards to LTC residents. Regular weight monitoring is difficult in bedridden LTC residents and most elderly are unable to recall their habitual weight (23). The loss in body weight could also be indicative of poor health status rather than exclusively nutrition as in the case of the effects of certain medications and/or chronic diseases. Additionally, hydration status could incorrectly increase or decrease weight. In the LTC population, heavy reliance on weight loss is not appropriate (24). Identifying and treating other factors which make a person susceptible to weight loss and malnutrition could be more effective. Furthermore, given the absence of significant weight loss definition, there is lack of consensus on standard weight loss cutoff values. Cutoff values ranging from 1-10% weight loss in previous one week to six months are reported in the literature (15, 25). The present review identified eight different definitions of weight loss.

BMI is a measure of body fat which is derived by dividing the body mass by the square of the body height. The unit of BMI is kg/m². The purpose of attaining BMI is to categorize a person as underweight (BMI <18.5 kg/m²), normal weight (BMI 18.5-25 kg/m²), overweight (25-30 kg/m²) or obese (>30 kg/m²) (26). BMI has been extensively used as a surrogate marker of malnutrition (15, 18, 20). However, there

Table 2
Indicators used in NSTs to assess malnutrition among LTC residents (presented in alphabetical order of NSTs)

Author and Year	Nutrition Screening Tool	Total Items	Criteria for risk of malnutrition	Anthropometric	Bio Chemical	Clinical	Dietary	Psychological, Social & Physical
Lok et al., 2009 (38)	Chinese Nutrition Screen (CNS)	16	Overall score 0-32 ≥ 21: normal nutrition status ≤ 20: at risk of malnutrition	Decrease or increase in body weight in last 3 months		Acute illness, medication pressure sores, skin ulcers	Change in food intake, appetite, diet history, liquid intake, meals/day, feeding status	Happy, perception of health, live alone, activity level, management of daily activities
Cereda, 2011 (63)	Geriatric Nutritional Risk Index (GNRI)	5	>98: no risk 92 - ≤ 98: low risk 82 - <92: moderate risk <82: major risk	Weight, height GNRI=[1.489 x albumin(g/L)]+[41.7 x (weight/WL ₀)]	Albumin			
Isenring et al., 2009 (64)	Malnutrition Screening tool (MST)	2	Overall score 0-5 0-1: not at risk ≥ 2: at risk	Lose weight without trying			Low appetite	
Donini et al., 2016 (62)	Malnutrition Universal Screening tool (MUST)	5 steps	Overall Score: 0-6 0: low risk 1: medium risk >2: high risk	Unplanned weight loss in 3-6 months, BMI		Acute illness		
Crogan & Corbett., 2002 (65) Corbett et al., 2002 (66)	Minimum Data Set (MDS)	4	Resident assessment protocol trigger legend for revised raps	Height, weight, weight loss		Disease diagnoses, medication, health condition, skin condition, pressure ulcer	Altered diet, leave 20% or more food uneaten, complain about hunger & taste of food, tube or IV feeding, syringe/therapeutic diet	Psychosocial well-being, mood and behavior patterns, physical functioning, activity pattern
Robb et al., 2016 (67)	Mini Nutrition Assessment (MNA)	18: 6 for Screen	Overall Score: 0-30 ≥24: normal nutritional status 17-23.5: at risk of malnutrition <17: malnourished	Weight loss (kg), BMI, CC, MAC		Acute disease, GI problems, medication, pressure sores & skin ulcers	Dietary intake, appetite loss, feeding dependency, fruits, vegetables & protein intake, liquid Intake, swallowing difficulty	Neuro-psychological problems, self-view of health & nutrition status, living alone, mobility problems, physical activity
Donini et al., 2016 (62)	Mini Nutrition Assessment-Short Form (MNA-SF)	6	Overall score: 0-14 ≥12: normal nutritional status 8-11: At risk of malnutrition <7: malnourished	Weight loss, BMI		Acute disease	Appetite loss	Neuro-psychological problems, mobility problems
Simsek et al., 2014 (68)	Revised MNA-SF (MNA-SF-CC)	6	Overall score: 0-14 ≥12: normal nutritional status 8-11: At risk of malnutrition <7: malnourished	Weight loss, CC		Acute disease	Appetite loss	Neuro-psychological problems, mobility problems
Donini et al., 2016 (62)	Nutrition Risk Screening 2002 (NRS 2002)	4	Overall Score: 0-6 ≥3: nutritionally at risk <3: weekly rescreening	Weight loss (%), BMI		Severity of disease	Food intake	

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Table 2 (continued)
Indicators used in NSTs to assess malnutrition among LTC residents (presented in alphabetical order of NSTs)

Author and Year	Nutrition Screening Tool	Total Items	Criteria for risk of malnutrition	Anthropometric	Bio Chemical	Clinical	Dietary	Psychological, Social & Physical
Charlton et al., 2007 (69)	Nutrition Screening Initiative DETERMINE checklist (NSI-DETERMINE)	10	0-2: good 3-5: at moderate nutritional risk ≥ 6: at high nutritional risk	10 lb weight lost or gained in last 6 months		Illness, medication	Change in food, intake of fruits & vegetables or milk, < 2 meals/day, tooth/mouth problem, swallowing problems, > 3 drinks of alcoholic drinks	Eat alone, food affordability, poor physical ability to cook & shop
Rolland et al., 2012 (70); Iseing et al., 2012 (71)	Simplified Nutritional Appetite Questionnaire [SNAQ (US)]	4	Overall score: 0-20 ≤ 14; indicates risk of at least 5% weight loss within 6 months.				Appetite, satiety, food taste, meal/day	
Vandewoude & Van Gossuin., 2013 (59)	Short Nutritional Assessment Questionnaire [SNAQ (Dutch)]	3	Overall Score: 0-5 <2: well nourished 2: moderately malnourished ≥3: severely malnourished	Unintentional weight loss of 3 – 6 kg in last 1 or 6 months			Low appetite in the last month, tube feeding/Supplement drinks	
Kruizenga et al., 2010 (72)	Short Nutritional Assessment Questionnaire- Residential Care [SNAQ-RC (Dutch)]	5	Overall score: green, orange, red Green: not undernourished Orange: at risk of under nutrition Red: undernourished	Unintentional weight loss of 3 – 6 kg in last 1 or 6 months BMI			Low appetite, feeding dependency	
Laporte et al., 2000 (73) Laporte et al., 2001 (74)	Simple Screen Tool #1 (Simple ST #1)	2	Overall score: 0-4 0-1: low risk of PEM 2-4: high risk of PEM	Weight loss (%), BMI				
Laporte et al., 2000 (73) Laporte et al., 2001 (74)	Simple Screen Tool #2 (Simple ST #2)	2	Overall score: 0-4 0-1: low risk of PEM 2-4: high risk of PEM	BMI	Albumin			
Christensson et al., 1999 (75); Gaskill et al., 2008 (76)	Subjective Global Assessment (SGA)	6	Overall Score: A-C A: well nourished B: moderately malnourished C: severely malnourished	Weight change		Disease, GI Symptom, physical Symptoms, metabolic stress	Change in dietary intake	Functional capacity

Table 3
Prevalence of indicators in NSTs used to assess malnutrition in LTC residents

Indicators	NSTs	Prevalence
<i>Anthropometric</i>		
Weight loss	CNS, MDS, MNA, MNA_SF, MNA-SF-CC, MST, MUST, NRS 2002, NSI-DETERMINE, SGA, Simple ST #1 SNAQ(Dutch), and SNAQ-RC (Dutch)	81%
BMI	MNA, MNA-SF, , MUST, SNAQ-RC(Dutch), NRS 2002, and Simple ST #1&2	44%
Calf Circumference	MNA and MNA-SF	12%
Mid Arm Circumference	MNA	6%
<i>Bio Chemical</i>		
Albumin	GNRI and Simple ST #2	12 %
<i>Clinical</i>		
Acute Illness	MDS, MNA, MNA_SF, MNA_SF_CC, MUST, NSI-DETERMINE, NRS 2002 and SGA	56%
Medication	CNS, MDS, MNA and NSI-DETERMINE	25%
Pressure Sores	CNS, MDS and MNA	19%
Skin Ulcers	CNS and MNA	12%
GI problems	MNA and SGA	12%
<i>Dietary assessment</i>		
Low Appetite	CNS, MNA, MNA_SF, MNA-SF-CC, MST, SNAQ (Dutch), SNAQ –RC (Dutch), and SNAQ(US)	50%
Dietary Intake	MDS, MNA, MNA-SF, MNA-SF-CC, NRS 2002 and SGA	37%
Feeding Dependency/Assistance	CNS, MNA and SNAQ-RC(Dutch)	19%
Meals/Day	CNS, NSI-DETERMINE and SNAQ(US)	19%
Liquid Intake	CNS and MNA	12%
Food Taste	MDS and SNAQ(US)	12%
Tube Feeding	MDS and SNAQ (Dutch)	12%
Consumption of specific food	MNA and NSI- DETERMINE	12%
Mouth & Teeth problems	NSI-DETERMINE	6%
Diet history	CNS	6%
Alcohol	NSI-DETERMINE	6%
Therapeutic Diet	MDS	6%
Swallowing Problems	MNA	6%
Satiety	US-SNAQ	6%
<i>Psychological, social and physical factors</i>		
Mobility	MNA, MNA-SF, MNA-SF-CC and NRI-DETERMINE	25%
Neuro-psychological problems*	MNA, MNA-SF, and MNA-SF-CC	19%
Living alone	CNS and MNA	16%
Eat alone	NSI-DETERMINE	6%
Psychological wellbeing	MDS	6%
Perception of health	CNS	6%
Happiness	CNS	6%
Mood and behaviour problems	MDS	6%
Stress	SGA	6%
Self-view	MNA	6%
View of nutritional problems	MNA	6%
Activity level	CNS	6%
Functional capacity	SGA	6%
Physical functioning	MDS	6%
Activity pursuit pattern	MDS	6%

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Table 4
Weight loss values in NSTs used to assess malnutrition in LTC residents

Nutrition Screening Tools	Criteria	
CNS	Change in body weight in last 3 months	
	Body weight decreased	=0 points
	No change in body weight	=1 points
MDS	Body weight increased	=2 points
	Weight loss/gain $\geq 5\%$ in last 30 days	
MNA	Weight loss/ gain $\geq 10\%$ in last 180 days	
	Weight loss during last 3 months	
	Weight loss greater than 3 kg	= 0 points
MNA-SF	Does not know	= 1 point
	Weight loss between 1 and 3 kg	= 2 point
	No weight loss	= 3 point
	Weight loss during last 3 months	
MNA-SF-CC	Weight loss greater than 3 kg	= 0 points
	Does not know	= 1 point
	Weight loss between 1 and 3 kg	= 2 point
	No weight loss	= 3 point
MUST	Weight loss during last 3 months	
	Weight loss greater than 3 kg	= 0 points
	Does not know	= 1 point
	Weight loss between 1 and 3 kg	= 2 point
NSI-DETERMINE	No weight loss	= 3 point
	Unplanned weight loss in past 3-6 months (% of body weight)	
	> 10	= 2 Points
NRS 2002	5-10	= 1 Point
	<5	= 0 points
	Lost or gained 10 pounds in the last 6 months without trying	
SNAQ (Dutch)	Weight loss >5 % in 3 months	=1 points
	Weight loss >5% in 2 months	=2 points
	Weight loss >5% in 1 month	=3 points
SNAQ-RC (Dutch)	Did you lose weight unintentionally?	
	More than 6 kg in the last 6 months	=3 points
	More than 3 kg in the last month	=2 points
Simple Screen Tool 1	Did you lose weight unintentionally?	
	More than 6 kg in the last 6 months	= red
	More than 3 kg in the last month	= red
SGA	% of weight loss	1 point
	1 week	<1% - $\geq 1\% - 2\%$
	1 month	2% - $\geq 5\%$
	3 months	5% - $\geq 7.5\%$
	6 Months	7.5% - $\geq 10\%$
SGA	Unlimited Time Frame	<10% - $\geq 10\%$
	In the past 2 weeks, weight has: Increased/Decreased/Not changed	
	Overall weight loss in the past 6 months: _____ kg: _____%	

is an ongoing debate around whether it is a good indicator of malnutrition in the elderly or not (27, 28). A number of researchers considered BMI (sole marker) as a poor indicator of malnutrition risk in the elderly (15, 17, 18, 29, 30). Usually BMI is regarded as a measurement of fatness; conversely, it refers more to fat free mass (31). BMI is unable to take into account the changes occurring in the body composition as a result of aging (32-35). Age-related loss in lean body mass with the concomitant increase in fat mass has been well documented in the literature (1). Therefore, the same value of BMI in adults and the elderly indicates different body composition (36). In addition, height is a major component of BMI. However in the elderly, height decreases due to the vertebral compression, loss of muscle tone and other factors associated with aging (19). Incorrect measurement of height can lead to wrong BMI classification among LTC residents (37). Considering that presence of edema and dehydration can affect BMI reliability (38), other anthropometric measurements such as MAC and CC could be more accurate in estimating body muscle mass (39-41). The measures of MAC and CC are employed by many studies to measure fat stores and muscle mass. However, as with BMI, no universally accepted cutoff values of MAC or CC are available.

Table 5

BMI criteria and classification in NST used to assess malnutrition in LTC residents (presented in alphabetical order of NSTs)

Nutrition Screening Tools	Criteria	Classification
MNA	<19 kg/m ²	Undernutrition
	19-<21 kg/m ²	Normal Weight
	21-<23 kg/m ²	Overweight
	≥23 kg/m ²	Obese
MNA-SF	<19 kg/m ²	Underweight
	>25 kg/m ²	Overweight
MNA-SF-CC	<19 kg/m ²	Undernutrition
	19-<21 kg/m ²	Normal Weight
	21-<23 kg/m ²	Overweight
	≥23 kg/m ²	Obese
MUST	<18.5 kg/m ²	Underweight (probable)
	18.5-20 kg/m ²	Underweight (possible)
	20-25 kg/m ²	Desirable weight
	25-30 kg/m ²	Overweight
	>30 kg/m ²	Obesity
NRS 2002	<18.5 kg/m ²	Severe Nutritional Status
	18.5-20.5 kg/m ²	Moderate Nutrition Status
	>20.5 kg/m ²	Normal Nutrition Status
Simple screen tool #1&2,	<21.0 kg/m ²	High risk of PEM
	21.0-23.9 kg/m ²	Low risk of PEM
SNAQ-RC(Dutch)	≤20 kg/m ²	Severely malnourished
	20-22 kg/m ²	Moderately malnourished

Another problematic issue with using BMI to determine malnutrition in elderly is that the literature is inconclusive about the best lower cutoff values particularly with reference to the elderly (15, 18, 40, 42, 43). The NSTs employed to determine malnutrition in LTC residents use different BMI cutoff values. Consequently, the variation in the reported prevalence rate of malnutrition in the elderly can be attributed to the different BMI cutoff value used to define malnutrition. The literature suggests the use of higher than normal reference values for the elderly (18, 44, 45). Normally used BMI range for adults (18.5-24.9 kg/m²) as established by World Health Organization is considered inappropriate for older adults (46). Until evidence-based and consistently accepted cutoff points are established, the BMI classification in elderly should be pursued with caution.

Acute illness and underlying disease is often associated with aging. Therefore, more than half of the NSTs include acute illness as an indicator of malnutrition. However, NSTs do not provide a description about the nature of acute illness, they are all treated equally. The NSTs should be more specific about the nature of acute illness. Chronic illness is more prevalent as compared to acute illness among LTC residents (15). Given that chronic illness causes malabsorption and affects metabolism, gastrointestinal problems are considered a risk factor contributing to the malnutrition in this population (17). Furthermore, aging itself is accompanied by changes in the gastrointestinal tract hence hindering absorption of many nutrients. Malabsorption problems such as diarrhea and vomiting can cause weight loss and subsequently malnutrition. Similarly, co-morbidities in the elderly require them to take excessive medication, which also exacerbates their nutrition status (47). Medication can induce dry mouth, anorexia and GI disturbances (nausea, constipation and diarrhea), and alter the nutritional status. Therefore, instead of relying only on acute illness, other clinical indicators should be considered and included in the NSTs.

Serum proteins (albumin, pre albumin, transferrin and retinol binding protein) produced by the liver have been used as indicators of nutrition status. NSTs show limited reliance on biochemical indicators. Only two NSTs incorporated biochemical indicators and both of them use albumin. Given that serum albumin predicts mortality and other complications, it is widely used in elderly (17). However, there is no consensus in the literature about the reliability of albumin as an indicator of malnutrition (39, 48). Infection and inflammation influence the level of serum albumins and minimize their effectiveness as an indicator of malnutrition (7, 23). Furthermore, hypo albumin is associated with the aging process (49). In 2011, Miyake and colleagues (50) reported increases in hypo albumin in the elderly over the age of 75. Instead of malnutrition, albumin is a good marker of inflammation (39), therefore one should not be evaluated for another. No serum protein solely works as a screening test, and should be used in combination with other malnutrition risk indicators (7).

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As people grow older, appetite and food intake decreases (7), which, consequently affects their nutritional status (51). Low appetite is linked to malnutrition (22) and so many NSTs incorporated low appetite as an indicator of malnutrition. Inappropriate dietary intake is also associated with malnutrition in the elderly (18, 52). A comparison between recent intake and estimated requirement is another frequently used criterion to identify malnutrition. Dietary intake assessment in the elderly is a critical component, as there are many difficulties in estimating actual food intake. In addition, the nutrient requirements of very old are not explicitly defined (53). With regard to dietary assessment, it is evident that NSTs are too dependent on low appetite and dietary intake indicators while ignoring other indicators pertinent to LTC residents' nutritional status. Chewing & swallowing problems and feeding dependency both significantly affect elderly food intake. Studies suggest an association between swallowing difficulty and malnutrition (54-56). LTC residents who can take food independently have less chance of becoming malnourished in comparison to those who depend on staff to feed them (15). To counteract the vicious circle of feeding dependency leading to reduced intake, weight loss and eventually malnutrition, sustained optimal feeding assistance is recommended (57). Indicators such as feeding dependency, chewing and swallowing problems should be included in NSTs in order to identify malnutrition in elderly at an early stage (4, 54, 55).

Accumulating evidence confirmed that many psychological, social and physical factors are considered as risk factors for malnutrition in the elderly particularly living in LTC. Depression is prevalent in LTC residents and associated with malnutrition (55). Depressed people normally consume less food and consequently may suffer from malnutrition (6). Living without family and friends is a contributing factor in the advancement of poor health in the elderly (51). Self – perception of health status is interpretive of the physical and health state of an aging body (58). Similarly, physical and functional capacity is considered as contributing factors to malnutrition in the elderly (18, 55, 59). Physical activity leads to good physical and psychological health (51). Conversely, low physical activity is related to poor health and reduced physical functioning (47, 60, 61). The aging process leads to changes in body composition, which might lead to a decrease in body functions. Consequently, impairment in activities of daily life (ADL) is associated with malnutrition (54, 56). Physical functions are also affected by LTC residents' sedentary lifestyle and poor dietary habits. Regardless of these facts, few NSTs included psychological, social and physical indicators to assess malnutrition in the elderly. It appears that problems like weight loss and acute illness are more obvious therefore more consideration is given to them in the development of NST to identify malnutrition.

In an institutional context, there are additional factors associated with malnutrition. Recent studies have identified institutionalization itself as a risk factor of malnutrition among

LTC residents (47, 54). It emphasizes a need to identify where, when and which conditions in the LTC environment accelerate malnutrition. Future research should focus on the role of organizational structure (size, profit & Staffing level), the care process (staff at mealtime, monitoring of weight) and outcome (malnutrition).

NSTs could be more precise in assessing malnutrition and malnutrition risk if they incorporate more indicators including biological, psychological and physical risks (11, 62). Although, NSTs incorporated varied combinations of different indicators, none of them performed better than 'fair' in assessing malnutrition (11). This emphasizes a need to give serious consideration to the indicators used in NSTs among LTC residents. Most of these NSTs are not specifically developed for LTC population therefore may not have fully considered the indicators more pertinent to LTC residents in identifying malnutrition. Excluding relevant indicators compromise the effectiveness of NSTs in determining malnutrition. These NSTs rely on anthropometric measurements; some of these indicators are difficult to apply on LTC residents. Although, weight loss, BMI and dietary intake are alarming signs of malnutrition, other risk factors which are equally pertinent to LTC residents' nutritional status such as depression, functional status, chewing and swallowing problems should be included in NSTs for LTC residents (4, 54, 55). Furthermore, the absence of universally accepted reference values of indicators with reference to the elderly further limit their utility. The review calls attention to two main challenges. First, what is the optimal and best combination of indicators to assess malnutrition in LTC residents? Second, which are the best suitable cut off values for weight loss and BMI for LTC residents? These need further dialogue and research to improve on the current practice of screening for risk of malnutrition in the institutional context.

Conclusion

The review identified and summarized the indicators used in NSTs to assess malnutrition in LTC residents along with their merits and limitations. Due to its multi-factorial etiology, malnutrition cannot be diagnosed through a single measure. Therefore, use of a single measure to determine malnutrition is not sufficient/reliable. This paper showed that NSTs rely heavily on anthropometric measurements especially on body mass or weight based indicators (BMI, weight loss). Heavy reliance on certain indicators could compromise the effectiveness as a recent review showed none of the NST performed better than fair in identifying individuals with malnutrition or in predicting outcomes. NSTs, encompassing combinations of varied indicators, provides an alternate choice, however the optimal and best combination of these indicators has yet to be determined. To identify and address malnutrition in LTC residents, indicators which are more pertinent and indicative of malnutrition among LTC residents, at an earlier

stage should be incorporated in NSTs. Further studies are also needed to examine the effectiveness of these tools in accurately identifying stages of malnutrition and in predicting outcomes.

Ethical Standards: Ethical standards for research were applied. Research ethics board approval was not required for this study.

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