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Review

A review of nutrition screening tools used to assess the malnutrition-sarcopenia syndrome (MSS) in the older adult

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SUMMARY

Background: Malnutrition and sarcopenia are common in older adults. A new clinical syndrome has been suggested – the Malnutrition Sarcopenia Syndrome (MSS) - that may provide improved management, by highlighting two older adult conditions that can interact in a cumulative way to affect functional independence and health outcomes. This paper evaluates the published literature reporting data on both nutrition and sarcopenia evaluation simultaneously in the population studied, and creates a diagnostic algorithm.

Methods: An inclusive, systematic literature search was done for articles including a simultaneous standardised evaluation of sarcopenia and nutritional status, from 1990-date. Sarcopenic status needed to be evaluated using accepted guidelines published by international guideline committees which include a functional muscle evaluation and a quantitative evaluation using bioimpedence assay or dual energy X-ray absorptiometry. Nutritional status needed to evaluated with a standardised, validated nutritional screening tool that was not disease specific.

Results: 11 studies met these criteria. They differed in their methodology for screening both sarcopenia and nutritional issues. They differed as to the population studied (community versus institutionalised versus hospitalised).

Conclusions: No one methodology was consistent for evaluation of sarcopenia or malnutrition. The concept of the Malnutrition Sarcopenia Syndrome intuitively makes sense to clinicians. This opinion paper suggests a possible clinical approach. The management and interventions for both conditions are likely to have considerable overlap. There needs to be some consensus on how to evaluate it, in order to be able to accurately interpret the impact of interventions that may be undertaken for one or both conditions simultaneously.

Background

Older adults may be screened for sarcopenia or malnutrition, but rarely for both concomitantly. Increasing age is known to be a risk factor for both conditions. In isolation, malnutrition is associated with impaired quality of life, increased morbidity, increased mortality, increased hospital admissions, delayed discharges and increased dependence on health care [1]. Similarly, in isolation, sarcopenia is associated with increased length of stay, increased risk of hospital-acquired infections, decreased function relative to baseline, increased drug –related side effects, increased risk of falls, decreased function with respect to ADLs, increased hospitalizations, and increased mortality [2]. Less commonly known, sarcopenia is also associated with decreased hearing [3], sleep changes [4] and impaired swallowing [5]. Having both sarcopenia and malnutrition increases the risk of mortality in more than an additive way. Malnutrition may lead to sarcopenia, and nutritional factors contributing to sarcopenia were recently reviewed [6]. But sarcopenia may exacerbate malnutrition secondary to its effects on swallowing. This has been shown in hospitalized, cancer and institutionalized patients [7–9].

There is obviously considerable overlap in the consequences of these two conditions, with perhaps an overlap in their management, and this has led to a proposed clinical syndrome: Malnutrition Sarcopenia Syndrome (MSS) [10].

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Some authors believe it intuitively makes sense therefore to assess for both conditions concurrently, [10]. Others believe that malnutrition, fatigue, frailty, vulnerability, sarcopenia and cachexia are a continuum [11], although they acknowledge that not all will respond to simply providing nutrients.

Controversies

Multiple tools have been studied for malnutrition screening, some of which are the Malnutrition Screening Tool (MST), Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessment Short form (MNA-SF), Nutritional Risk Screening (NRS-2002), and Subjective Global Assessment (SGA). A recent meta-analysis [12] identified 32 screening tools. They concluded "none of the 32 screening and assessment tools performed consistently well on either screening/assessing patients' nutritional status or predicting (poor) nutrition related outcomes". None of the tools evaluated in their study were felt to be good enough to be advised as a screening tool in the elderly. Although the MNA is used widely, it did not perform consistently well, and the MNA-SF was found to overestimate the number of malnourished patients. They suggested that the Nutritional Form for the Elderly (NUFFE) seemed to be a valid tool in the elderly, but felt more validation studies are needed. They concluded to "never fully rely on one single tool to screen or assess patients' nutritional status". The recent Global Leadership Initiative on Malnutrition (GLIM) publication [13] has sought to develop a consensus for both risk screening and severity grading, For malnutrition diagnosis, they have recommended one phenotypic and one etiologic criteria. (Phenotypic: non-volitional weight loss; low body mass index; reduced muscle mass. Etiologic: reduced food intake or assimilation; disease burden/inflammatory condition). Hopefully this will now allow for more consistent assessment and diagnosis of malnutrition.

Similarly, there is ongoing debate about the definition of sarcopenia and the method for muscle mass evaluation. Initially sarcopenia was just defined on the basis of muscle mass [14,15], in spite of the advice of the originator of the term [16] declaring it was a change in body composition and function. Muscle mass alone has been shown to not predict disability or other outcomes [17]. In some populations, such as cancer, the focus has been on muscle mass primarily. The NIH in 2004 recognized the broader definition of muscle mass and function. In 2010 the European Working Group on Sarcopenia in Older People (EWGSOP) [18], published their consensus guidelines which included muscle mass and low muscle strength or low physical performance. This was revised in 2018 [19] with EWGSOP2 placing a greater emphasis on muscle strength as the key characteristic for sarcopenia, with low muscle mass and quality confirming the diagnosis, and being used to assess severity. There are also other guidelines from the International Working Group on Sarcopenia (IWGS), the European Union Geriatric Medicine Society (EUGMS), and the Asian Working Group for Sarcopenia (AWGS) [20]. These all recommend assessment of muscle mass plus some measure of measure strength and function (grip strength and/or gait speed). Sarcopenia can also be defined by anthropometric measures such as calf circumference [21]. Anthropometric measures found a significantly lower sarcopenia prevalence when compared to DXA or BIA, and are not felt to be a good measure of muscle mass, although calf muscle circumference can be used as a proxy if there are no other options [21]. A review of the different methodologies [22] showed variations in prevalence between men and women, and between countries, even when using the same methodology (two standard deviations below the mean for a young reference population). There were only two studies they identified that assessed muscle mass and function, with the other twenty six studies assessing muscle mass alone. Dual energy Xray absorptiometry (DXA) assessment of appendicular muscle mass index is felt to be precise and the recommended tool, but even for DXA the cut-off points need to be adjusted for the population being studied. Bioelectrical impedance assay (BIA) assessment, even adjusted for height and weight, showed a similar variation across studies and populations for the prevalence of sarcopenia. Interestingly, in that study, where 92.8% of the articles evaluated focused on muscle mass exclusively to define sarcopenia, they reported a high prevalence of sarcopenia in the elderly at 0–85.4% for men and 0.1–33.6% for women. A more recent review [23] differed in that they only included studies with assessment of function as well as muscle mass, in community based elderly. This produced thirty five papers. They found an overall prevalence of sarcopenia of 10%, similar in both sexes, and higher in non-Asian populations. They also confirmed that BIA tends to overestimate the prevalence of sarcopenia compared to DXA.

Objective

This paper's objective is to assess the impact of nutrition screening in people with sarcopenia (as evaluated by muscle mass and function), and to review nutritional screening tools that may help in sarcopenia assessment, or increase suspicion, thereby prompting a formal assessment of muscle mass and strength. As suggested by Vandewoude [10], "we need to develop a practical and reliable and valid toolkit to assess MSS that can be used in a variety of clinical conditions".

Methods

Medline, from 1999-date inclusive, was searched for articles mentioning both malnutrition and sarcopenia. All articles, even those not in English, were included in the search. These were screened for concomitant mention of nutrition and sarcopenia. Review articles and studies were evaluated for additional key references that may have been missed. Inclusion criteria required an article to feature: a clearly defined and validated assessment of sarcopenia (measure of both muscle mass and muscle strength or function); and a validated nutrition screening tool; and, in an older adult population (60yr or older). Figure 1 shows a flow chart of the search and selection procedure.

Results

This search generated 247 articles. Many articles focused on just sarcopenia assessment or just nutrition screening, few evaluated both. Very few mentioned MSS as such. The articles varied in country, population studied, tools used and outcomes of interest. This paper sought to narrow them down to those mentioning both syndromes, and with sound evaluation of sarcopenic status: EWGSOP guidelines using DXA or BIA [18]; Baumgartner's definition [14]; or, Asia Working Group (AWGS) [20] definition. The literature review revealed several screening methods used for malnutrition: serum albumin, serum cholesterol, age, weight, immunodeficiency, nutrient risk index score (NRI), Malnutrition Nutritional Assessment (MNA) (short form and long form), DXA appendicular lean mass^2 (alm^2), BMI <20 kg/m^2, loss of weight >10%, Malnutrition Screening Tool (MST), Malnutrition Universal Screening Tool (MUST), Nutrition Risk Screening NRS-2002, Subjective Global assessment (SGA), FQ-29 FFQ, DHD Index, Geriatric Nutrition Risk Index (GNRI), Instant Nutritional Assessment (INA), Detailed Nutritional Assessment (DNA), Malnutrition Inflammation Score (MIS), Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREEN II), Nursing Nutritional Screening Tool, and the Nutrition screening Initiative DETERMINE tool. Although the

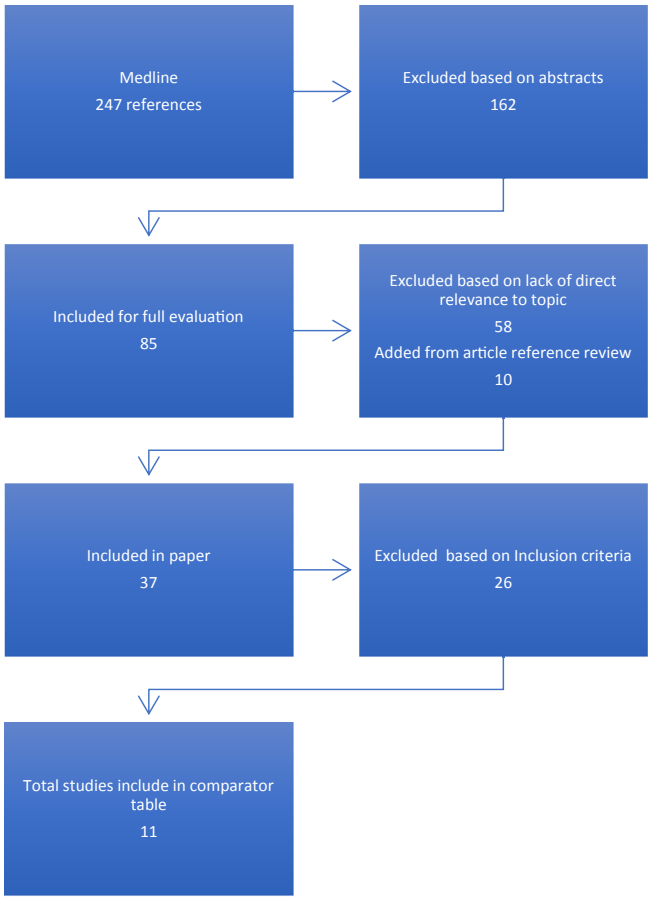

Fig. 1. Shows the flow chart of the article search and selection procedure.

majority of the studies identified used the MNA in some form (long or short), for this paper there was no article selection based on the nutrition screening tool used, only the concomitant evaluation of sarcopenia.

Table 1 shows the eleven studies meeting the inclusion criteria. Some of the studies showed a variable degree of association between nutrition and sarcopenia [4,24,25,27,31,33], with those having sarcopenia at greater risk for malnutrition. The interpretation column in Table 1 helps to explain the strength of the association between nutrition screening tools and sarcopenia for each study. Those with sarcopenic obesity were consistently shown to have the highest association with poor nutrition and poor outcomes [29]. In others, nutrition screening tools could NOT be relied upon to diagnose sarcopenia [28,30,32]. All the studies showed it was important to have an objective measure, not only of muscle mass, but also muscle function in order to diagnose sarcopenia. Anthropometric evaluation (using mid-arm circumference of calf circumference) can be used as an assessment of muscle mass when BIA, DXA or CT is unavailable or not feasible.

Discussion

This paper highlights the limited number of studies done combining formal nutrition screening with a standardized evaluation for sarcopenia. Munoz et al. [30] screened for sarcopenia using EWGSOP criteria, and malnutrition with MNA in a long term care population in Bogota and showed that the MNA was not a good tool to identify sarcopenia. Similarly, Sheean et al. [34] showed in intensive care patients with respiratory failure, 60% of those assessed as normally nourished by the SGA were actually sarcopenic when assessed by CT scan. 33% of those misclassified patients were overweight or obese. Most malnutrition tools only focus on factors associated with body composition and do not look at function, and so not surprisingly, can miss those with functional problems. The current study reinforces my clinical impression that it is inaccurate to assume that all malnourished elderly are sarcopenic and vice versa. In addition, both conditions are continually changing depending on other factors affecting health and social circumstances. Sarcopenia has been shown to be reversible [35]. Malnutrition reversibility results were equivocal in the recent review by Cruz-Jentoft and colleagues [36], although leucine and B-hydroxy-B-methylbutyrate (HMB) supplements showed some benefit in improving muscle mass and function.

As previously discussed, the assessment of muscle mass by BIA is the most susceptible to inaccuracies as precision and accuracy can be influenced by a number of factors [37]. Reiss and colleagues [41] showed that BIA systematically overestimated the prevalence of sarcopenia when compared to DXA as a gold standard. BIA misclassified 1 out of 6 patients. BIA cut-offs are also not standardized, and may need to vary depending on the population [38]. This must be considered when comparing the prevalence rates of the various studies reported in this paper. It will also therefore affect the association between the prevalence of malnutrition and sarcopenia being reported.

Only one study [27] used anthropometry and the Baumgartner criteria to assess appendicular skeletal mass (ASM) [14]. This calculates ASM using the following definition ASM(kg) = 0.2487 (weight)+0,0483(height)−0.1584(hip circumference)+0.0732 (grip strength)+2.5843 (sex)+5.8828. They used the height to further calculate the skeletal muscle index and used a cut-off of <5.45 kg/m^2 for women.

The present review further highlights the importance of looking at muscle function, as well as muscle mass, lest we make the same error we did with osteoporosis where the focus was for too long on bone mass and not bone quality. The role of muscle quality has also yet to be determined, especially with our awareness of the negative consequences on muscle function from increased intramuscular fat. With aging, the density of skeletal muscle decreases indicating lipid accumulation in the muscle. Excessive lipid infiltration in skeletal muscles is associated with low muscle strength and poor physical performance, independent of the cross-sectional area of the muscle [39]. Increasing evidence is showing that muscle strength and power are strongly related to mobility, functional status, and mortality in frail elderly even when adjusting for muscle mass [39]. Hence the need to assess muscle strength, as well as muscle mass. Interestingly, regular physical activity prevents both the age-associated loss of muscle strength and the increase in muscle fat infiltration, in older adults with moderate functional limitations [40].

Table 2 highlights the strengths and weaknesses of the main assessment parameters used in the eleven selected studies in this review. The studies meeting inclusion criteria in this article used a variety of nutrition screening tools, but the most common was the MNA (either SF or LF), which agrees with the meta-analysis by Zhang et al. [49] which found the MNA the most commonly studied tool, followed by the SGA and GNRI/NRI. The ESPEN guidelines [46] recommend MNA in the older adult.

Most of the studies had a 30–50% incidence of sarcopenia, except for the Netherlands study [25] which had a much lower sarcopenia rate, likely reflective of their community dwelling study population. Only the study by Oh et al. [29] showed the differences between men and women in terms of their prevalence of sarcopenia, but also the difference in biomarkers between men and women suggesting that the etiology of sarcopenia may differ between men and women.

Table 1
Comparison of malnutrition and sarcopenia criteria and results in selected articles meeting the inclusion criteria.

Study (year)	Study design	Country, subjects, number	Setting	Nutritional screening tools	Sarcopenia assessment tools	Main findings	Interpretation
Eglseer et al. (2016) [24]	Literature review (33 papers)	Worldwide, 48 −4000 per study (only 2 < 100)	Community dwelling elderly (majority)	BMI MNA MNA-SF MNA-LF SCREEN II	Anthropometry, BIA, CT, DXA, USS, hand grip, quadriceps strength, knee flexion/extension, SPPB, usual gait speed, TUG, PAQ	Higher anthropometric results associated with lower and higher risk of sarcopenia; lower nutrition screening scores associated with sarcopenia	Anthropometric measures are poor predictors of sarcopenia. Some association between poor nutrition and sarcopenia.
Reijnierse et al. (2015) [25]	Cross-sectional	The Netherlands, 185	Community dwelling elderly (all comers)	SNAQ BMI	BIA Handgrip 4 m walk test	16% malnourished (SNAQ ≥ 2), 1.2% low ALM/ht2, 8.4% low grip strength, 0.29% low walk speed. Risk of malnutrition associated with decreased ALM/ht2,	Very few subjects were malnourished or sarcopenic, however malnutrition still strongly associated with decreased relative and absolute muscle mass.
Cerri et al. (2015) [26]	Prospective	Northern Italy, 103 subjects	Hospitalised Acute Geriatric Unit. Men and women,>64yrs	MNF-SF albumin BMI	BIA (EWGSOP criteria) Grip strength 4 m gait speed	56.3% normal, 21.4% sarcopenic,22.3% “uncertain” (no grip strength or gait speed) However 45% had low Skeletal muscle index. 56% of total at risk for malnutrition (MNA>7), with 50% risk in sarcopenic group.	Prevalence of sarcopenia was low. However, difficulties using full EWGSOP criteria in hospitalised patients. (Handgrip done in only 51% subjects, gait speed in only 22%). This study therefore likely underestimated prevalence of sarcopenia. Sarcopenic patients died sooner
Alva et al. (2013) [27]	Cross-sectional	Mexico City, 90	Community dwelling female geriatric outpatients	MNA Height Weight	Anthropometric: Skin fold thickness Grip strength Hip, waist circumferences Calf/arm circumferences (Baumgartner criteria)	Undernutrition 15.5%, risk of undernutrition 72.2%, normal nutrition 12.2%. 41.1% sarcopenic overall, but in undernourished group 72.2% sarcopenic. The odds ratio for sarcopenia and undernutrition = 47.3	Undernutrition and risk of undernutrition was high in these women. The odds ratio of having sarcopenia in those undernourished was high.(47.3) Sarcopenia was associated with functional and activities of daily living limitations.
Ter Borg et al. (2016) [28]	Cross-sectional Maastrich Sarcopenia Study (MaSS)	Maastricht, The Netherlands. 227	Community geriatrics (includes LTC)	MNA-SF BMI FFQ-FQ29 Biomarkers	BIA (EWGSOP criteria) grip strength 4 m walk test	23.3% sarcopenic: of these 7 −20% had lower intake of 5 nutrients; 27% had high homocysteine; 25% low (<0.66 g/kg/d) protein intake; 51% low 25(OH)D levels (<50 nmol/l) MNA-SF: 5% at risk and 1% malnourished but no difference in sarcopenic subjects.	Low prevalence of sarcopenia in this study. No association found between MNA score and presence of sarcopenia.
Oh et al. (2015) [29]	National population Survey (KNHANES 2010)	Korea. 1433	Non-institutionalised adults >60 yrs.	Kcal CHO intake Protein intake Fat intake Micronutrient intake 24hr Dietary recall (calculated % Korean Dietary reference intake)	DXA BMI	22.7% were sarcopenic nonobese; 17.7% sarcopenic obese; 9.7% obese; and 41% were normal.	Body composition associated with lower intake of nutrients (worse in sarcopenic obese group), and higher inflammatory markers (highest in sarcopenic obesity group)

(*continued on next page*)

Table 1 (*continued*)

Study (year)	Study design	Country, subjects, number	Setting	Nutritional screening tools	Sarcopenia assessment tools	Main findings	Interpretation
Munoz et al. (2015) [30]	Cross-sectional	Bogota, Columbia. 108	Institutionalised, >64yrs	MNA-LF	EWGSOP (using calf circumference, 4 m walking speed, grip strength)	38.9% were sarcopenic. 33.3% had malnutrition with 2.8% at risk of malnutrition. 52.4% of sarcopenic subjects had a normal MNA vs 71,2% in nonsarcopenic. 47.6% sarcopenic had low or at risk MNA scores vs 28.8% in nonsarcopenic.	MNA showed mild concordance to identify sarcopenia.
Pierik et al. (2017) [31]	Prospective cohort study (EMPOWER)	Amsterdam. 374	In patients >69yrs	SNAQ	BIA Grip strength BMI	Low risk of malnutrition (SNAQ 0–1) in 65.2%, high risk (SNAQ >1) in 34.7%.	Malnutrition on admission associated with increased risk of decreased muscle mass {OR 0.9 (0.85-0.96)}, but not muscle strength
Verlaan et al. (2017) [32]	Matched case –control observational cohort (PROVIDE study population)	Netherlands and UK 66 sarcopenic, 66 non-sarcopenic	Community dwelling >64years	MNA 3 day food diary	DXA SPPB Grip strength PASE Barthel EQ-5D	MNA at risk 3% in non-sarcopenic and 6% sarcopenic (NSS)	Majority (93%) had normal MNA. No correlation between MNA and sarcopenic status. Sarcopenic subjects had lower QOL and activity scores.
Sakai et al. (2017) [33]	Cross-sectional	Tokyo, Japan 201	Rehabilitation hospital in patients >64years	MNA-SF	CC Grip strength (AWGS criteria for sarcopenia) Lip strength Tongue strength Barthel FOIS cRP	Malnutrition in 44.8%. Sarcopenia in 76%. Nutrition related sarcopenia (NRS) in 38.8%. Neither malnutrition or sarcopenia in 29.3%.	Significant association between sarcopenia and malnutrition. Tongue and lip strength significantly lower in NRS group
Hu et al. (2017) [4]	Prospective study	Chengdu, China. 453	Inpatient geriatrics (>60yrs)	MNA	Anthropometric (weight, height, MAC, CC) Hand grip strength. 4 m walk test {Sarcopenia calculated using AWGS algorithm}	18.3% sarcopenic. 41.3% at risk of malnutrition, 10.4% with malnutrition. Sarcopenic subjects compared to nonsarcopenic had higher risk of malnutrition (57.8% vs 37.7%) and malnutrition (25.3% vs 6.3%). Risk of sarcopenia based on MNA was 6.4% for normal, 25.7% for at risk and 44.7% for malnourished.	3yr mortality increased in MSS, or risk of MSS vs no sarcopenia, or no malnutrition (HR 4.78 and 4.25 respectively). MSS an important prognostic factor.

Abbreviations legend: BMI: body mass index, MNA, MNA-SF,MNA-LF Mini Nutritional Assessment, short form and long form, SCREEN II: Seniors in the Community Risk Evaluation for Eating and Nutrition, BIA,: bioelectrical impedance assay, CT: computerised tomography, DXA: Dual energy Xray absorptiometry, USS,: ultrasound scan, SPPB: short physical performance battery, TUG: timed up and go, PAQ: Physical Activity Questionnaire, SNAQ: Short Nutritional Assessment Questionnaire, EWGSOP: European Working Group on Sarcopenia in Older People, CC: Calf circumference, FFQ FQ 29: Food frequency Questionnaire, PASE: Physical Activity Scale for Elderly,EQ-5D: Euroqol quality of life tool, AWGS: Asian Working Group on Sarcopenia, FOIS: Functional Oral Intake Scale, MAC: mid-arm circumference.

We know that low protein intake is related to both malnutrition and sarcopenia. Food intake and physical activity are known to be key anabolic stimuli for muscle synthesis. Exercise can enhance muscle protein synthesis irrespective of age [50]. A review by Yanai [51] suggested an intake of 1.0–1.2 g/kg, in divided meals of 25–30 g, as optimal management for sarcopenia, in association with other micronutrients and exercise. Malnutrition is common in the elderly for a multitude of reasons. A simple screening tool ("Meals-on-wheels") [52] can draw attention to this issue and prompt appropriate management. However, many of the screening tools such as the MNA, MUST and SNAQ focus on weight loss and appetite. The MNA does ask about dysphagia, as does the PG-SGA and SCREEN II. We know dysphagia is exacerbated by sarcopenia, and further exacerbates nutrition problems. Sakai and colleagues [33] showed that not only dysphagia, but decrease in lip and tongue strength were associated with MSS. This can be caused by sarcopenia or malnutrition, but can also exacerbate it, and suggests there may be a role for oral resistance exercises. The low lip and tongue strength was associated with low food intake in the preceding three months, decreased mobility and low BMI on the MNA-SF screen. Their study was the first paper to investigate oral strength in relation to nutrition related sarcopenia. In addition, none of the screening tools available ask about the quality of food intake, such as protein, dairy or phytonutrients.

Weight loss exacerbates sarcopenia leading to a greater loss of lean muscle mass compared to fat mass. Any recovery of loss of weight usually comprises a greater proportion of fat [53], unless it is combined with resistance exercise [54]. Even in the most high

Table 2
Strengths and weaknesses of tools used in the reviewed articles.

	Strengths	Weaknesses
SARCOPENIA		
BIA vs DXA (using EWGSOP guidelines and DXA as gold standard)	- portable - more available - cheaper	- affected by hydration, food intake, and exercise - over-estimated muscle mass cf DXA. Agreement 80% of time in geriatric pts. Misclassified 1/6 pts [41]. - sarcopenic cut-offs vary between groups - sarcopenic cut-offs should also vary between populations [38]
EWGSOP criteria for sarcopenia	- can be calculated using BIA or DXA - uses muscle mass and function (strength and speed)	- gait speed assessment can be challenging - muscle mass and strength alone may suffice - gait speed <0.8 m/s cut-off may be too low [42]
Strength assessment - Handgrip strength - Quadriceps strength, knee flexion/extension	- portable, quick - easy to assess	- shown to not be valid to detect malnutrition in outpatients [43] - research tools only, not practical
Performance assessment - SPPB - 4 m walk test - TUG	- validated in the elderly	- require trained assessor - time consuming - patient must be mobile - change in muscle mass and gait speed non-linear [44]
MALNUTRITION		
BMI	- easy to calculate - familiar tool - good for population screening	- unable to discriminate sarcopenic obesity from obesity - jeopardises nutritional diagnosis of malnutrition [45]
MNA	- recommended in elderly by ESPEN [46] - most validated tool in elderly - identifies high risk individuals - valid in community dwelling	- includes BMI or calf circumference - includes risk questions but not the cause of under-nutrition itself - high sensitivity, but low specificity - requires an experienced rater - MNA-SF validated in hospital pts but over-includes those at risk - does not ask about food quality
SNAQ	- simple, easy to administer - 3 questions only - validated for community adults - associated with all cause mortality [47]	- developed for inpatient screening - fair validity in general population - does not ask about dysphagia - does not ask about food quality
SCREEN II	- valid, reliable - validated in community elderly - can be self administered - asks about dysphagia and oral issues - some questions related to food quality - significantly correlated with dietician nutrition risk rating [48]	- 17 questions, so takes longer than other screens

Abbreviations legend: BMI: body mass index, MNA, MNA-SF,MNA-LF Mini Nutritional Assessment, short form and long form, SCREEN II: Seniors in the Community Risk Evaluation for Eating and Nutrition, BIA,: bioelectrical impedance assay, DXA: Dual energy Xray absorptiometry, SPPB: short physical performance battery, TUG: timed up and go, SNAQ: Short Nutritional Assessment Questionnaire, EWGSOP: European Working Group on Sarcopenia in Older People.

risk group, those with sarcopenic obesity, resistance training has been shown to be of benefit in attenuating muscle mass loss [55]. Ultimately the treatment approach to both conditions in MSS may be the same.

Conclusions

MSS is a newly coined term for a clinical syndrome that highlights the co-existence of malnutrition and sarcopenia, especially in the older adult [10], and is associated with an increased risk of mortality compared to those with either condition alone [4]. Both problems: increase with age; increase mortality and morbidity; decrease quality of life; and increase healthcare utilization and cost. The problem is that there is no consensus on tools for malnutrition screening or sarcopenia assessment in general, or even in specific at-risk populations. Interestingly, the new GLIM consensus report includes a sarcopenic criteria in their recommendation for phenotypic assessment of malnutrition severity. (Either an objective measure of muscle mass or muscle strength) [13]. Their etiologic criteria, they hypothesise, will also help guide appropriate interventions. There is no agreement as to whom is most responsible for the screening, or what to do once the conditions are identified. Given that both conditions are dynamic, there also needs to be consensus on how to monitor these conditions over time. Concomitant assessment and targeted treatment of both may improve outcomes. As suggested by the GLIM group [13], creation of clear diagnostic criteria facilitate comparison of prevalence, interventions and outcomes across the globe. Perhaps for the MSS syndrome, the following criteria, as proposed by Vandewoude and colleagues [10] could be used as screening criteria with 4/5 required: reduced appetite, with decreased food intake; unintentional LOW >3 kg in 3 months; low muscle mass (measured by BIA, DXA, CT, MRI); decreased gait speed (<0.8 m/s); or decreased hand grip strength (based on age and gender). Identification of MSS needs to be followed by an assessment of the possible causes and intervention where possible [52]. Identification of sarcopenia or malnutrition would then require appropriate targeted interventions.

Recommendations

Inconsistencies in the literature have highlighted that we cannot use nutrition screening tools to accurately screen for sarcopenia. Likewise, positive screening for sarcopenia does not imply the presence of malnutrition. Both have to be addressed based on their own diagnostic criteria as they can coexist, and this coexistence produces an additive effect on morbidity and mortality. The new diagnostic criteria from EWGSOP2 focusing on grip strength [19],

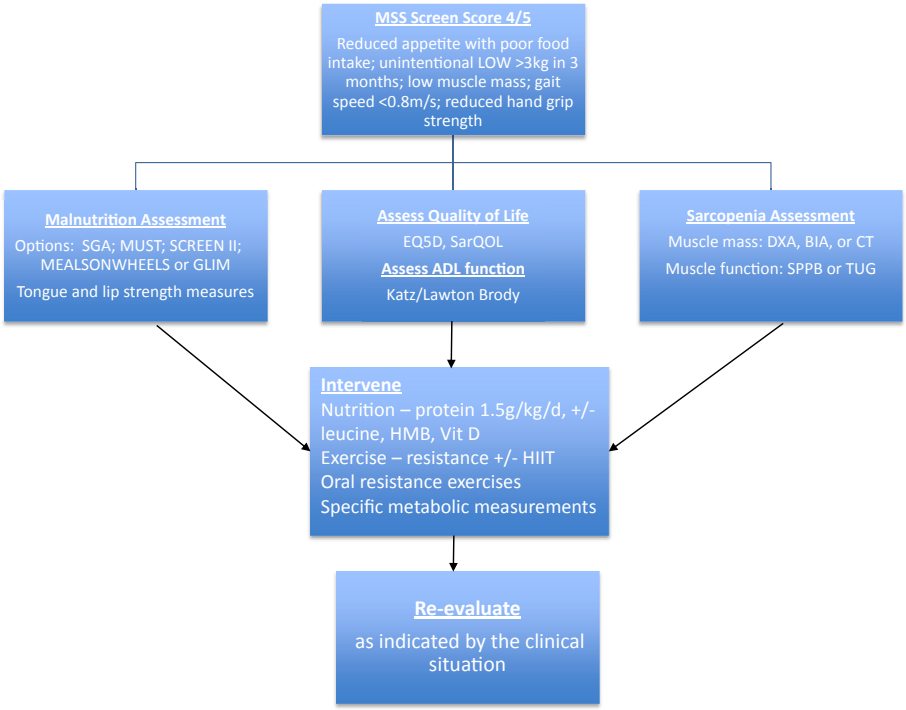

Fig. 2. Suggested model of MSS evaluation.

makes the assessment of sarcopenia more accessible and practical. The addition of a measure of physical performance can be used to assess severity. Perhaps also including the GLIM diagnostic criteria [13] would now be helpful in etiological identification and staging. Both malnutrition and sarcopenia are potentially preventable or modifiable and should NOT be considered a normal part of ageing. A suggested model of MSS evaluation is shown in Fig. 2. With the new sarcopenia guidelines [19], the model could be further simplified to using grip strength only for assessment of sarcopenia., In the model we have added Quality of Life (QOL) (EQ5D [56] or SarQOL [57]) and Activities of Daily Living (ADL) assessments [58,59], as we believe these are also important clinically relevant factors that are currently not being considered, identified or managed. Interestingly, they are not addressed in either the new EWGSOP2 [19] or GLIM [13] criteria, although the EWGSOP group does mention the existence of the SarQOL [57] QOL tool.

Further research

This could include use of the proposed MSS screening tool as shown in Fig. 2 in future studies. In our opinion, consensus of the best tools is the most pressing issue. We agree with the comment from van Bokhorst-de van der Schueren et al. [12] who suggest the "next steps for future research would be to apply different tools in the same patient population, allowing for comparisons between tools and pooling of results." With the most recent consensus publications on malnutrition [13] and sarcopenia [19] we may be on the road to achieving this goal, and in a better position to identify both conditions simultaneously.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2019.04.003.

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