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INVITED REVIEW

GLIM consensus approach to diagnosis of malnutrition: A 5-year update

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Abstract

Background: The Global Leadership Initiative on Malnutrition (GLIM) introduced an approach for malnutrition diagnosis in 2019 that comprised screening followed by assessment of three phenotypic criteria (weight loss, low body mass index [BMI], and low muscle mass) and two etiologic criteria (reduced food intake/assimilation and inflammation/disease burden). This planned update reconsiders the GLIM framework based on published knowledge and experience over the past 5 years.

Methods: A working group (n = 43 members) conducted a literature search spanning 2019–2024 using the keywords "Global Leadership Initiative on Malnutrition or GLIM." Prior GLIM guidance activities for using the criteria on muscle mass and inflammation were reviewed. Successive rounds of revision and review were used to achieve consensus.

Results: More than 400 scientific reports were published in peer-reviewed journals, forming the basis of 10 systematic reviews, some including meta-analyses of GLIM validity that indicate strong construct and predictive validity. Limitations and future priorities are discussed. Working group findings suggest that assessment of low muscle mass should be guided by experience and available technological resources. Clinical judgment may suffice to evaluate the inflammation/disease burden etiologic criterion. No revisions of the weight loss, low BMI, or reduced food intake/assimilation criteria are suggested. After two rounds of review and revision, the working group secured 100% agreement with the conclusions reported in the 5-year update.

Conclusion: Ongoing initiatives target priorities that include malnutrition risk screening procedures, GLIM adaptation to the intensive care setting, assessment in support of the reduced food intake/assimilation criterion, and determination of malnutrition in obesity.

KEYWORDS
assessment, inflammation, malnutrition, muscle, screening

INTRODUCTION

In 2016 the Global Leadership Initiative on Malnutrition (GLIM) was founded. GLIM builds on efforts to address the priority for the development of a consensus approach for diagnosis of malnutrition and to consolidate consensus around nutrition concepts and terminology.[1,2] The lack of consensus has hindered the development of a common nutrition language to support sharing of meaningful prevalence data, the testing of targeted interventions, and the monitoring of outcomes across the globe. Breakthroughs in our understanding of malnutrition in settings of disease/inflammation have supported a changing paradigm in how we fundamentally characterize malnutrition in clinical settings. These insights culminated in the 2019 GLIM consensus papers that provided a framework for a globally accepted diagnostic process that should be valid for adults in most settings, irrespective of methodological availability and resources.[3–5]

Four major clinical nutrition societies—the American Society for Parenteral and Enteral Nutrition (ASPEN); the European Society for Clinical Nutrition and Metabolism (ESPEN); Federación Latinoamericana de Terapia Nutricional, Nutrición Clinica Y Metabolismo (FELANPE); and the Parenteral and Enteral Nutrition Society of Asia (PENSA)—convened in 2016 to establish a core leadership committee composed of two representatives of each society and an expert working group composed of 24 physicians and dietitians.

A modified Delphi process was used, which included several ballots, biannual meetings during the ASPEN and ESPEN congresses, and email communications. After 3 years, consensus was reached, and the GLIM diagnostic model was published in three nutrition-related journals.[3–5]

The consensus process arrived at a two-step GLIM procedure that starts with nutrition screening followed by diagnostic assessment for confirmation of malnutrition. In patients identified as being

at risk of malnutrition, all five GLIM criteria should be assessed to confirm the presence of malnutrition. Three phenotypic and two etiologic criteria were selected from existing widely accepted approaches to diagnosis. All chosen criteria are well-established nutrition-related variables that, in their own capacity, have well-validated prognostic value for negative clinical outcomes—ie, mortality. The three phenotypic criteria are nonvolitional weight loss, low body mass index (BMI), and low muscle mass, whereas the two etiologic criteria are reduced food intake/food assimilation and disease burden/inflammation. To confirm a malnutrition diagnosis, at least one phenotypic and one etiologic criterion must be present. Still, in occasional cases, it will not be possible to assess all five criteria. When assessment of one or more criteria is not possible for compelling practical reasons, the diagnosis of malnutrition will still be possible if, among those available, one phenotypic and one etiologic criterion are fulfilled. For exclusion of the diagnosis, all five criteria need to be assessed. Further, the severity grading of malnutrition is based solely on the phenotypic criteria. When the criteria assessment confirms the diagnosis of malnutrition, the patient should undergo a comprehensive nutrition assessment, according to available resources, to establish a treatment plan. However, it should be noted that the GLIM Consortium advises against using hypoalbuminemia as an indicator of malnutrition because of its limited sensitivity and specificity when used for this purpose.[6]

The new approach to malnutrition diagnosis uses variables similar to those of other validated tools to provide an opportunity to standardize language about the condition. The intention is also to offer a simplified version for use by clinicians with less nutrition expertise and to serve settings with limited staffing and measurement resources. The GLIM approach was primarily intended not to supplant other diagnostic methods in use by nutrition experts but rather to integrate the shared variables when possible. The original consensus document stated, "The GLIM consensus should be re-evaluated based upon review of new studies and advances in screening and assessment every 3–5 years." The aim of this paper is to report the current consensus of the GLIM Consortium and to share discussions on possible revisions and amendments.

METHODS—THE CONSENSUS PROCEDURE

The GLIM Core Committee—that is, two representatives from ASPEN (GLJ, CC), ESPEN (TC, RB), FELANPE (MITDC, MCG), and PENSA (RF, VP), respectively—supervised the overall process. A GLIM working group (n = 43 participants) with broad global and professional representation was instituted based on the suggestions from the GLIM Core Committee. A literature search was conducted using the keywords "Global Leadership Initiative on Malnutrition or GLIM" between 2019 and May 2024. Ten systematic reviews (SRs) and meta-analyses of GLIM validation studies were evaluated that were published up to March 5, 2024. Results from ongoing working group activities on implementation and integration, guidance for the GLIM criteria on muscle mass and inflammation, and recently started review activities (ie, procedures for malnutrition risk screening and food intake/assimilation assessment) are reported.

A first draft of the consensus document was provided by TC and GLJ, in close consultation with the GLIM Core Committee. This draft was then circulated among participants of the working group, and the text went through two rounds of revision until a consensus was reached at a threshold level of at least 75% agreement.

VALIDATION STUDIES BETWEEN 2019 AND 2024 AND GLIM BIBLIOMETRIC AFTER 5 YEARS

Because the phenotypic and etiologic criteria were selected from widely accepted diagnostic models introduced over the past 50 years, the GLIM Consortium decided in 2019 to recommend immediate implementation while promoting ongoing validation studies. To support the performance of sound validation studies, the GLIM Consortium provided a guidance paper[7,8] on how to perform studies targeting construct or criterion validity (ie, to assure that the model identifies malnutrition) and predictive validity (ie, that the model identifies cases with adverse clinical outcomes).

A literature search of PubMed used "Global Leadership Initiative on Malnutrition or GLIM" as the search term for the period of 2019 to May 2024. The search identified >400 validity and feasibility studies, not taking reviews or commentaries into account. These publications provide evidence that GLIM has good concurrent criterion validity when compared with established models—ie, Subjective Global Assessment (SGA),[9] Mini Nutritional Assessment-Short Form (MNA-SF),[10] and the Academy of Nutrition and Dietetics and ASPEN Indicators to Diagnose Malnutrition (AAIM).[11] Likewise, predictive validity is comparable to other malnutrition diagnostic instruments.

During the same period (2019 to May 2024), the three original GLIM consensus papers have been cited >5000 times in Google Scholar, >2300 times in Scopus, and >3000 times in Web of Science.

SRs and meta-analyses of validation studies

The large number of individual validation studies has provided the basis for 10 SRs, some including meta-analyses, exploring different aspects and settings of GLIM (Table 1) published through March 5, 2024.[12–21] We elected to focus on the SRs and meta-analyses rather than attempt analyses of the multiple individual studies. The SRs are based on major validation studies and include studies from diverse regions of the world. Eight focus on predictive validity and encompass approximately 100 studies with >100,000 patients.

Criterion validity

Two meta-analyses focus on criterion validity.[12,13] One included a general sample (mixed settings) of 20 studies with 10,781 patients

from 13 countries, showing a sensitivity of 72% with a range of 51%–92% (ie, capacity to identify true positive cases) and a specificity of 82% with a range of 73%–98% (ie, capacity to identify true negative cases) relative to SGA or Patient-Generated SGA as the mainly used semi-gold standard.[7,8] With an area under the curve of 0.82, the authors stated that GLIM has good diagnostic accuracy. Malnutrition prevalence was 44% in the total sample.[12] A smaller meta-analysis that included five intensive care unit studies concluded that the small sample of 337 patients and the heterogeneity limited the resulting sensitivity to 65.5% (95% CI, 35%–86.8%). Specificity was 86.9% (95% CI, 59.3%–96.9%).[13]

Predictive validity

Concurrently, eight SRs, some with meta-analyses, of predictive validity (mainly mortality as the outcome) were published (Table 1).[14–21] The largest meta-analysis was performed in general hospitalized patients, with 47,654 participants.[14] Among the 64 articles, 34 were from Asia, 20 from Europe, nine from the Americas, and one from Oceania. Many diagnoses were included: cancer, COVID-19, renal failure requiring hemodialysis, inflammatory bowel disease, and cerebrovascular accident.[14] Increased 1-year mortality in patients diagnosed with malnutrition by the GLIM approach was indicated by hazard ratio (HR) of 2.62 (95% CI, 1.95–3.52). Heterogeneity was managed by random-effects models. The corresponding HR for "beyond 1-y mortality" was 2.04 (95% CI, 1.70–2.45). Malnutrition prevalence was 40%–50% on average.[14]

The SRs included studies conducted in hospital settings,[14] among community-dwelling older adults,[15] and in nursing homes.[15] Malnourished patients diagnosed by the GLIM approach had a consistent increase in mortality. Among hospitalized patients with malnutrition, there was a 1.2- to 7.2-fold increase in mortality over 4 months; among nursing home patients with malnutrition, there was a 1.3- to 4.7-fold increase in mortality over 1 or 2 years; and finally, among patients in community settings with malnutrition, there was a 1.6- to 4.4-fold increase in mortality over 2–14 years.[15]

The largest SR/meta-analysis, focused on patients with cancer, included 21 cohort studies with 28,726 patients (14 from China, two from Spain, two from Australia, one from Greece, one from Turkey, and one from Japan).[16] Many types of cancer were included. Mortality and disease-free survival were consistently worse among those diagnosed with malnutrition by the GLIM approach, and these clinical outcomes were even worse for those patients with severe compared with moderate malnutrition.

TABLE 1 Summary of systematic reviews, some including meta-analyses, evaluating the GLIM (2019–2024) criterion or predictive validity.

First author	Purpose	Sample size
Huo[12]	Assess criterion validity of GLIM criteria for diagnosing malnutrition	20 studies with 10,781 patients
Díaz[13]	Assess criterion validity of GLIM criteria in patients admitted to the intensive care unit	5 studies with 337 patients
Bian[14]	Prevalence of malnutrition by GLIM criteria with and without a screening step; assess risk of mortality with malnutrition	64 studies with 47,654 patients
Brown[16]	Assess risk of survival and disease-free survival in adults with cancer and malnutrition	21 studies with 28,726 patients
Sánchez-Rodríguez[15]	Assess risk of all-cause mortality in older adults with malnutrition; describe how muscle mass was assessed	17 studies (15 cohort, 2 cross-sectional) with data from 10,671 hospitalized patients, 485 nursing home patients, and 8096 community-dwelling adults
Yin[17]	Assess risk of overall survival in patients with cancer and malnutrition	9 studies with 8829 patients
Lidoriki[18]	Assess risk of postoperative complications and survival in patients with gastrointestinal cancer surgery and malnutrition	7 studies with data from 3662 patients
Matsui[19]	Assess the risk of mortality and complications in patients with cancer and malnutrition	10 studies with 11,700 patients
Peng[20]	Assess the risk of mortality and complications in patients with cancer and malnutrition	15 studies with data from 14,573 patients
Xu[21]	Assess the risk of mortality and complications in patients with cancer and malnutrition	12 studies with 6799 patients

Note: Search is through March 5, 2024. See the long version of this table (Table S1) for additional study details.

A limitation of these reviews is that some of the same studies are included in multiple reviews. Three reviews did not include information on whether all five GLIM criteria were addressed by every included study. Overall, approximately 80% of the included individual studies reported an assessment of muscle mass.

EFFORTS TO FACILITATE THE IMPLEMENTATION AND INTEGRATION OF GLIM

To better understand how the GLIM consensus has been implemented since its introduction, the GLIM Implementation, Dissemination, and Integration Working Group conducted a global survey in early 2023 to evaluate the implementation of the GLIM approach, including barriers and enablers to implementation in both practice and research. General results from >1500 respondents indicated either the GLIM consensus had been implemented (25%) or its implementation was in process (20%).[22,23]

Of those who had implemented GLIM or were in progress, 63% reported to be in hospital settings, 19% in private practice or primary care, and 5% in long-term care (total of 100% included "other" workplace settings; $n = 574$ respondents). Respondents indicating GLIM implementation or progress were from the following continents: Europe (40%), North America (24%), South America (21%), Africa (7%), Asia (6%), and Oceania (2%) ($n = 631$ respondents). These results were surprising, as the adoption and implementation of new practices have generally been shown to take from 17 to 20 years.[24] The next steps will include seeking publication of survey findings and using these results to provide practical tips for implementing GLIM and overcoming barriers. An opinion paper has been published describing the rationale for implementing the GLIM framework in clinical dietetic practice.[25] Dissemination of GLIM activities has been ongoing, with dedicated educational sessions held at several nutrition society conferences. These sessions have provided updates for attendees, including "guidance for muscle mass assessment," "inflammation position statements," GLIM survey data, and methods to integrate the GLIM consensus with other malnutrition diagnostic approaches. Examples of successful integration with the AAIM approach were presented at the recent ASPEN 2024 Nutrition Science and Practice Conference in Tampa, Florida.[26] The participating GLIM societies have also included invited presentations of national or regional GLIM experiences at their annual meetings. A significant advancement in GLIM implementation is the endorsement of the GLIM consensus for reimbursement by the Ministry of Health, Labor and Welfare of Japan,[27] as well as the acknowledgment of the GLIM criteria for the diagnosis of disease-related malnutrition by the World Health Organization (WHO) Regional Office for Europe in its manual on brief interventions for noncommunicable disease risk factors in primary care.[28] WHO Europe has also published, in collaboration with ESPEN, two fact sheets on disease-related malnutrition[29] and tuberculosis,[30] both quoting the GLIM criteria as a suggested malnutrition diagnostic tool.

REEVALUATION PROCESS

A final round of revision resulted in 100% of the working group supporting the conclusions of the update. Figure 1 summarizes the updates performed after the reevaluation process. Figure 1 is adapted from the original GLIM consensus papers.[3–5] In this update, each step and suggested amendments are discussed based on new experience and knowledge accrued over the past 5 years.

IS THERE A NEED TO CLARIFY THE MALNUTRITION SCREENING PROCEDURE AFTER THE INTRODUCTION OF GLIM?

The international clinical nutrition community has, until recently, focused on the introduction of procedures for nutrition screening into regular clinical practice in hospitals, outpatient care, primary care, and other care settings. This is intended to identify individuals at a higher risk for malnutrition who require nutrition assessment and intervention. Many validated screening tools are now available,[31,32] with most focusing on the identification of individuals who already have signs of malnutrition, whereas others identify risk factors for developing malnutrition.[33–36] Tools focusing on identifying existing malnutrition mostly use similar sets of variables (weight loss, low BMI, and disease burden), but these variables are combined in various manners and applied with different cutoff values.

The experience collected after the introduction of the GLIM procedure indicates that the screening tool selected—ie, tools that identify "risk of malnutrition" vs tools that identify "malnutrition"—affects the prevalence of malnutrition diagnosed by GLIM.[37,38] In addition, conservative screening methods with limited specificity might result in false negative diagnosis outcomes.

Global consensus to define the "risk of malnutrition" is not established. For this reason, a new GLIM working group initiative is ongoing with the aim to provide clarity on how, when, and if screening should be used within the GLIM approach.[31,32] Results from this initiative are expected in 2025. In the meantime, the GLIM Consortium continues to recommend using existing screening procedures.

WHAT HAVE WE LEARNED ABOUT THE FEASIBILITY OF THE PHENOTYPIC CRITERIA?

Nonvolitional weight loss

In general terms, weight loss is perhaps the most widely accepted variable for nutrition assessment. In the GLIM original paper, the decisions on cutoffs for weight loss were based on a consensus process accounting for recommendations from the major established screening and diagnostic instruments. The cutoff recommendations, considering both acute and chronic weight loss, were >5% weight

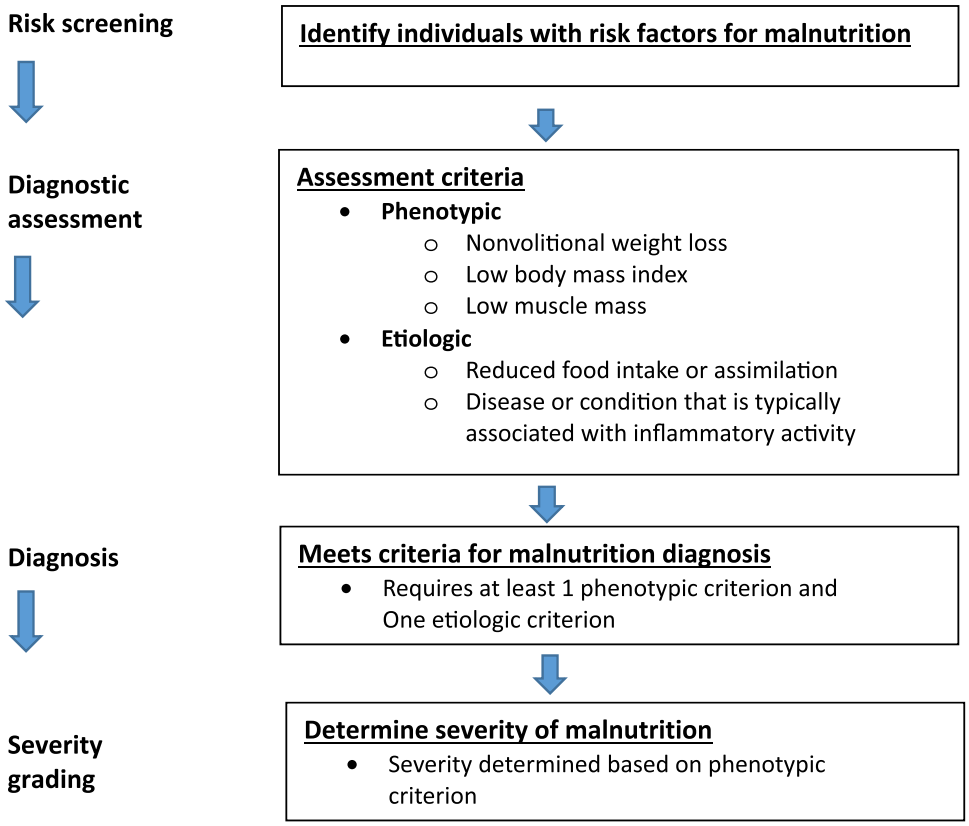

FIGURE 1 GLIM diagnostic scheme for screening, diagnostic assessment and grading of malnutrition. First, identify subjects with risk factors for malnutrition. Second, apply the two etiologic criteria and the three phenotypic criteria. When at least one of each set of criteria is fulfilled, the diagnosis of malnutrition is confirmed. Third, determine severity, i.e., moderate or severe malnutrition based on the degree of aberration in the phenotypic criteria. This figure is adapted from the original 2019 consensus paper.[3–5]

loss within the past 6 months or >10% weight loss beyond 6 months. There appears to be no indication to change this recommendation at this time.

Low BMI

The utility of BMI as an indicator of malnutrition has been questioned in regions of the globe where obesity is common. However, low BMI/underweight is a common global indicator of malnutrition associated with unfavorable outcomes. This is especially true for those with chronic starvation or advanced chronic illness and among some older adults. Thus, it is important to obtain BMI for all individuals, irrespective of their size. Determination of BMI is an established and easily performed practice for most clinical encounters. Additionally, obtaining BMI, concurrent with weight loss history, will help to promote understanding among practitioners that even among those who are overweight or obese, malnutrition is increasingly prevalent.[39] Furthermore, determination of BMI is advocated to identify overweight and obesity because of their associations with increased risk of comorbidities such as diabetes mellitus and heart disease. Such individuals may be evaluated readily for malnutrition by meeting the GLIM phenotypic criterion for nonvolitional weight loss or when appropriate expertise and resources are available by determination of low muscle mass (see the next section on the low muscle mass criterion). For patients with fluid overload (ie, in noncompensated heart, renal, and liver failure), BMI and weight loss may be difficult criteria to apply for malnutrition diagnosis. However, weight loss history may be obtained verbally from the patient or surrogate or from medical records.

The suggested BMI cutoffs are <20 and <22 in people <70 and ≥70 years old, respectively. For people of Asian origin, the corresponding recommended cutoffs for those aged <70 and ≥70 years are 18.5 and 20, respectively. Consideration of specific BMI cut points and their application across the globe is subject to continued investigation and discussion. There appears to be no compelling information to warrant a change of the low BMI criterion at this time.

Low muscle mass

The skeletal muscles constitute the largest organ of the body and provide the major prerequisites for protein regulation, physical function, and activities of daily living. Muscle size and function are deeply dependent on an adequate and sufficient nutrient intake,

including protein and energy, and loss of muscle mass is a devastating component of malnutrition. This loss may be especially profound in the malnourished patient with significant inflammation, as muscle catabolism is usually elevated in cases of severe illness or injury.

The original GLIM consensus did not provide detailed information on how to measure muscle mass or how to define low muscle mass. For this reason, a GLIM working group later published such guidance.[40,41] Because the availability of specific methods and the feasibility of implementing them in clinical practice are highly prioritized by the GLIM framework, a range of methods was recommended. The choice of method should be based on the availability of expertise, resources, and valid applicable cutoffs for the intended population. Magnetic resonance imaging (MRI) can be considered a gold-standard method for accuracy,[42] but MRI is not routinely available for the assessment of muscle mass.[40–42] Thus, the working group recommended for GLIM implementation the use of dual-energy x-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), computed tomography (CT), or ultrasound. CT evaluation of muscle mass can be an opportunity when the examination is performed for other indications, such as abdominal CT scans for oncologic or gastrointestinal disease purposes. In the absence of knowledge and availability of advanced technical devices, acceptable methods for GLIM implementation also include calf or arm anthropometry and subjective muscle mass assessment by trained health professionals conducting nutrition-focused physical examinations. However, irrespective of the method used, markedly elevated BMI and fluid accumulation may confound accurate assessment of muscle mass.

The guidance papers clarified that low muscle strength, although often closely associated with loss of muscle mass and included in full nutrition assessment after malnutrition diagnosis, is not a component of the GLIM diagnostic algorithm.[40,41] For this reason, it should not be used as a surrogate for muscle mass assessment.[43] Still, muscle strength testing—ie, hand dynamometry—is vital if sarcopenia is a diagnostic consideration.

Most body composition assessment tools have limitations in their application to adults living with obesity and may need specific adjustments for muscle mass assessment. Calf circumference with BMI adjustments has been proposed for use in clinical practice and could represent an appealing approach once additional validation is available.[44] DXA and BIA with population-specific equations are also options for muscle mass assessment in patients with obesity that is not severe.[45] A recent consensus initiative on sarcopenic obesity proposed to normalize muscle mass for total body weight.[46] Validation of this approach to diagnose sarcopenic obesity and its relevant clinical outcomes is underway, and it could represent a potential future refinement for muscle mass assessment in persons with obesity and malnutrition.

Preliminary recommendations on cutoffs for muscle mass, using various methods, are provided in Table 2. Cutoffs should be specific to sex, ethnicity, and device. As different approaches can be used to establish cutoffs for low muscle mass definition, concurrent global consensus initiatives on sarcopenia and sarcopenic obesity are underway.[46,57] The GLIM Consortium has appointed a working group to consider this criterion, including an SR and modified Delphi procedure. The GLIM network also considers it of strategic importance to promote agreement and consensus between the relevant global initiatives.

TABLE 2 Examples of recommended thresholds for low muscle mass or its surrogate markers.

	Men	Women
ALMI (DXA)[47,48,a,b]	<7	<5.5
ASMI or ALMI[49,a,c]		
BIA[50,c]	<7	<5.7
DXA[51,c]	<7	<5.4
FFMI (BIA)[52,53]	<17	<15
ALM/weight (%) (DXA)[54,d]	<25.7	<19.4
ALM/BMI (DXA)[55,d]	<0.827	<0.518
Calf circumference, cm[e,f,44]	<33	<32

Abbreviations: ALM, appendicular lean mass; ALMI, ALM index; ASMI, appendicular skeletal muscle mass index; BIA, bioelectrical impedance analysis; BMI, body mass index; DXA, dual-energy x-ray absorptiometry; FFMI, fat-free mass index.

[a]ALMI should alternatively (and more correct) be called appendicular lean soft tissue index.[56]

[b]Recommendation from The European Working Group on Sarcopenia in Older People 2 (for White populations).[47]

[c]Recommendation from The Asian Working Group for Sarcopenia (for Asian populations).[49]

[d]ALM/weight (%) should alternatively (and more correctly) be called appendicular lean soft tissue/weight (%).[56]

[e]The recommended cutoffs of <33 and <32 cm in men and women, respectively, were in the original Global Leadership Initiative on Malnutrition (GLIM) paper based on consensus within the GLIM working group. The cutoffs refer to the NHANES data[44] and correspond to the figures in between −1 and −2 SD—ie, 32 and 34 cm (men) and 31 and 33 cm (women). Cutoffs for muscle mass are currently under discussion within a GLIM working group and within the scientific community. The cutoffs will likely be updated in the near future. For this reason, the GLIM calf circumference cutoffs are not changed at this time.

[f]In adults with obesity, decrease the measured value by 3 cm (BMI 25–30) or 7 cm (BMI 30–40) (recommended thresholds for low muscle mass or its surrogate markers).[44] Adjustments should be made by square height, weight, or BMI (for use in persons with obesity). The recommendations are feasible for adults.[40,41]

WHAT HAVE WE LEARNED ABOUT THE FEASIBILITY OF THE ETIOLOGIC CRITERIA?

Reduced food intake/assimilation

There are numerous causes for reduced food intake and assimilation. Food insecurity under low-income circumstances or famine

during war and natural catastrophes is still afflicting millions of people across the globe. A variety of disease conditions and medications often cause appetite loss. "Anorexia of aging" may explain the loss of appetite experienced by some persons of advanced age who do not appear to have known disease conditions that affect appetite and are not receiving known appetite-suppressing treatments. Such individuals do appear to have low-grade inflammation and associated hunger-satiety imbalance.[58,59] Psychiatric conditions, such as depression and anorexia nervosa, are also associated with reduced food intake. Chewing and swallowing problems occur in older ages and in some disease conditions, such as neurological diseases and various dementia disorders. Gastrointestinal disturbances such as inflammatory bowel disorders, malabsorptive disorders, or postsurgical short bowel may also contribute to impaired assimilation of nutrients. A list of conditions was provided in the original guidance[3–5] that could be used to determine assimilation challenges. However, severity and duration were not considered at that time. The original GLIM paper stated, in accordance with current practice, that this GLIM criterion is fulfilled by a food intake of <50% of calculated energy requirement for >1 week, any reduction in food intake for >2 weeks, or any chronic gastrointestinal condition that adversely affects food assimilation or absorption.

As there is no standardized approach for assessment or interpretation of inadequate intake/assimilation, the GLIM Consortium has appointed a working group to consider this criterion. The process includes a scoping review and a modified Delphi procedure. Until this process is completed, there is no indication to change the current recommendation.

Inflammation/disease burden

There is a strong consensus that many diseases or conditions are of inflammatory origin and/or elicit inflammatory responses. Malnutrition may result from inflammation-driven catabolic muscle loss, anorexia, altered metabolism, and associated micronutrient deficiencies. However, the original GLIM consensus papers did not provide the detailed guidance needed to assess inflammation in support of malnutrition diagnosis.

A GLIM working group, therefore, undertook a robust modified Delphi process to provide comprehensive guidance.[59,60] Seven statements were developed (Table 3) that conclude that the occurrence of acute or chronic disease, infection, or injury that is often/usually associated with inflammatory activity may fulfill the GLIM disease burden/inflammation criterion, and confirmation by laboratory markers is not always necessary. Examples of acute and chronic conditions are provided. In cases of uncertainty, confirmation by C-reactive protein (CRP) analysis is recommended. Serial measurements of CRP are recommended, and repeated measures higher than the upper cutoff level of the selected clinical laboratory support the presence of chronic inflammation. Application of clinical judgment is encouraged (Table 3).

SEVERITY GRADING

The original consensus paper recommended severity grading (moderate or severe malnutrition) based on any of the three phenotypic criteria. Unfortunately, it is not currently possible to broadly attempt a distinction between moderate and severe reductions of muscle mass because only some of the current methodological approaches allow for this level of differentiation. Further research is needed to inform severity grading in muscle mass assessment. The GLIM Consortium does not currently identify a rationale to warrant changes in the recommendations for severity grading for any of the phenotypic criteria (Table 4).

WHAT HAVE WE LEARNED ABOUT GLIM INTEGRATION WITH OTHER NUTRITION DIAGNOSTIC TOOLS?

The implementation survey identified that having another malnutrition diagnostic approach in place that was fully endorsed at the institutional or regional level was a barrier to the use of GLIM.[22,23] However, the GLIM consensus approach was mainly intended to provide a feasible alternative for clinicians in clinical sites with more limited nutrition knowledge and resources rather than to displace other valid methods used by nutrition experts. The GLIM approach endorses core phenotypic and etiologic criteria that are already in widespread use throughout the world. GLIM promotes the global use of these criteria that may, in turn, be readily used with other approaches.

Some centers have harmonized the GLIM approach with preexisting methods, such as the AAIM and SGA. Because GLIM, AAIM, and SGA use similar variables, having staff members gather data using these established AAIM or SGA frameworks enables a crosswalk to the GLIM structure. Depending on the degree of regional investment in preexisting validated approaches to malnutrition diagnosis like AAIM or SGA, either adoption of GLIM or integration with GLIM may be considered.

CONCLUSIONS AND PERSPECTIVES

1. The GLIM approach has found a positive reception within the global clinical nutrition community; ie, GLIM appears to have the potential to become widely adopted as a practical framework for the diagnosis of malnutrition in diverse clinical settings with widely variable resource availability.
2. The growing number of validation and feasibility studies have formed the basis for SRs and meta-analyses on criterion and predictive validity. The results indicate that GLIM has undergone extensive validation and has a well-established evidence base. Variations in prevalence, sensitivity, and specificity between studies may possibly relate to the fact that some of the studies did not use all five GLIM criteria or that the populations evaluated

TABLE 3 Guidance statements for assessment of the GLIM etiologic criterion of inflammation.[59,60]

Statement 1: Fulfillment of the GLIM inflammation criterion	The occurrence of acute or chronic disease, infection, or injury that is often/usually associated with inflammatory activity may fulfill the GLIM disease burden/inflammation criterion; ie, confirmation by laboratory markers is not always necessary. When testing is available, we recommend that laboratory markers be measured in uncertain cases to help confirm the inflammatory character of the underlying disease or condition.
Statement 2: Conditions with severe/moderate acute inflammation	Confirmation of the presence of severe or moderate acute inflammation should be guided by clinical judgment based on underlying diagnosis or condition, clinical signs, or laboratory markers. Examples of acute diseases or conditions that may be associated with acute inflammation of severe/moderate degree include critical illness or sepsis and exacerbations of COPD or Crohn's disease.
Statement 3: Conditions with mild to moderate chronic inflammation	Confirmation of the presence of mild to moderate chronic inflammation should be guided by clinical judgment based on underlying diagnosis or condition, clinical signs, or laboratory markers. Examples of diseases that may be associated with chronic inflammation of mild/moderate degree include congestive heart failure, cancer, and chronic kidney disease.
Statement 4: Conditions with no clear or perceptible inflammation	Disease conditions that have no clear or perceptible inflammatory components will not fulfill the disease burden/inflammation criterion unless confirmed by laboratory analyses. Examples include anorexia nervosa, depression, dysphagia, and nondisease conditions that are associated with limited resources or environments that compromise food security, access, or intake, including poverty, famine, and war.
Statement 5: Laboratory markers indicating inflammation	The documentation of laboratory markers indicating inflammation may support confirmation of the inflammation criterion. Use of CRP is recommended in cases of clinical uncertainty.
Statement 6: Application of CRP testing	For acute conditions, CRP levels ≥10 times higher than the upper reference value for the methodology of the selected clinical laboratory can be used to support the presence of moderate to severe acute inflammation. For chronic conditions, serial measures of CRP higher than the upper reference value for the methodology of the selected clinical laboratory support the presence of the chronic inflammation criterion.
Statement 7: Application of clinical judgment	Clinical judgment based on integration of underlying diagnosis or condition, clinical signs, and/or laboratory markers should guide confirmation of the presence of inflammatory disease or condition. The sound interpretation of some of these indicators requires clinical training and expertise.

Abbreviations: COPD, chronic obstructive pulmonary disease; CRP, C-reactive protein.

TABLE 4 Thresholds for severity grading of malnutrition into stage 1 (moderate) and stage 2 (severe) malnutrition.[3–5]

	Phenotypic criteria[a]		
	Weight loss	**Low BMI[b]**	**Low muscle mass**
Stage 1/moderate malnutrition (requires 1 phenotypic criterion that meets this grade)	5%–10% within the past 6 mo, or 10%–20% beyond 6 mo	<20 if <70 y old, <22 if ≥70 y old	Data for severity grading are not available
Stage 2/severe malnutrition (requires 1 phenotypic criterion that meets this grade)	>10% within the past 6 mo, or >20% beyond 6 mo	<18.5 if <70 y old, <20 if ≥70 y old	Data for severity grading are not available

Abbreviation: BMI, body mass index.

[a]Severity grading is based upon the noted phenotypic criteria.

[b]Further research is needed to secure consensus reference BMI data for Asian populations in clinical settings.

vary. To exclude the diagnosis of malnutrition, all five criteria need to be measured. Making it a practice point to assess all five GLIM criteria in prospective studies may help to resolve the discrepancies in research to date. Statistical modeling based on large available databases may allow for estimation of the individual weights of the GLIM criteria and reassessment of the actual cutoff value. Furthermore, application of the formal methods used for the development of scoring systems may allow for increased precision of the GLIM approach and integration of the interactions between risk indicators.

3. Another key observation since the two-step GLIM procedure was launched is that the choice of malnutrition risk screening tool results in variations in malnutrition prevalence. A GLIM working group is currently performing two modified Delphi studies to provide further guidance for screening within the GLIM framework.

TABLE 5 Summary of the phenotypic and etiologic criteria for the diagnosis of malnutrition.

Phenotypic criteria[a]			Etiologic criteria[a]	
Weight loss	**Low BMI**	**Low muscle mass[b]**	**Reduced food intake or assimilation[c,d]**	**Inflammation[e,f,g]**
>5% within past 6 mo, or >10% beyond 6 mo	<20 if <70 y old, or <22 if ≥70 y old Asia: <18.5 if <70 y old, or <20 if ≥70 y old	Determined by validated body composition measuring techniques[b]	≤50% of ERs for >1 week, or any reduction for >2 weeks, or any chronic GI condition that adversely impacts food assimilation or absorption[c,d]	Occurrence of acute[e] or chronic[f] disease, infection, or injury that is often/usually associated with inflammatory activity[g]

Note: Adapted from the 2019 consensus papers.[3–5] The table and the recommended cutoffs remain largely unchanged.

Abbreviations: BMI, body mass index; ER, energy requirement; GI, gastrointestinal.

[a]All five criteria should be assessed. At least one phenotypic criterion and one etiologic criterion are required for the diagnosis of malnutrition.

[b]Bioelectrical impedance analysis, dual-energy x-ray absorptiometry, computed tomography, magnetic resonance imaging, and ultrasound are methods that can be used when experience and relevant reference values are available. When not available or by regional preference, physical examination or standard anthropometric measures such as calf circumference or mid-arm muscle circumference may be used. Thresholds for reduced muscle mass need to be adapted to race (Asia).

[c]Consider gastrointestinal symptoms as supportive indicators that can impair food intake or absorption (dysphagia, nausea, vomiting, diarrhea, constipation, or abdominal pain).

[d]Reduced assimilation of food/nutrients is associated with malabsorptive disorders such as short bowel syndrome, pancreatic insufficiency, and after bariatric surgery. It is also associated with disorders such esophageal strictures, gastroparesis, and intestinal pseudo-obstruction.

[e]Acute disease/injury-related severe inflammation is likely to be associated with major infection, burns, trauma, or closed head injury. Other acute disease/injury-related conditions are likely to be associated with mild to moderate inflammation.

[f]Chronic disease-related inflammation is generally mild to moderate and often recurrent and is likely to be associated with malignant disease, chronic obstructive pulmonary disease, congestive heart failure, chronic renal disease, or any disease with chronic or recurrent inflammation. Note that transient inflammation of a mild degree does not meet the threshold for this etiologic criterion.

[g]C-reactive protein may be used as a supportive laboratory measure.

4. In the original consensus publication, there remained uncertainties as how to assess the phenotypic criterion on low muscle mass and the etiologic criterion on inflammation/high disease burden. Two GLIM working groups have since provided more detailed guidance; ie, calf circumference may be considered in the absence of machine-based techniques to evaluate muscle mass,[40,41] and clinical judgment of inflammatory disease burden may only require laboratory confirmation (by CRP) in cases of uncertainty.[59,60] For the phenotypic criteria of nonvolitional weight loss and low BMI, no new data justify any changes from the original recommendations.
5. Malnutrition is a common occurrence among individuals living with obesity, especially in the form of deficiencies of protein, essential nutrients, and micronutrients. The assessment of muscle mass in the setting of obesity is particularly challenging. Parallel initiatives within the scientific community are seeking to address this issue.[46] The GLIM Consortium is an active participant in these efforts. Testing the validity of the GLIM approach to identify malnutrition in patients with obesity is a further challenge that will be addressed.
6. Other ongoing GLIM working group initiatives include the evaluation of the etiologic food intake and assimilation criterion, as well as how to adapt the GLIM framework for use in the intensive care setting, and guidance on cutoffs for low muscle mass.
7. In 2019, the GLIM Consortium foresaw securing endorsements from leading nutrition professional societies and set priorities to promote dissemination, validation testing, and feedback. More recently, a discussion has been opened with the International Classification of Diseases (ICD) group at WHO in Geneva with the aim of modernizing the ICD codes for malnutrition through the use of common key variables that are shared across the leading approaches to malnutrition diagnosis.[61] As the current *ICD-11* edition does not have a code for malnutrition/undernutrition in adults, this revision is a high priority because the ICD scheme guides clinical diagnosis and reimbursement across much of the world.
8. The current phenotypic and etiologic criteria for the diagnosis of malnutrition are summarized in Table 5.
9. The GLIM consensus should continue to be reevaluated based on review of new studies and advances in the field at least every 5 years.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception of the project and to writing, review, and editing. Gordon L. Jensen and Tommy Cederholm led the project from inception to completion. They as well as Charlene Compher and Rocco Barazzoni contributed data curation, formal analysis, writing of the original and subsequent drafts, methodology, investigation, supervision, project administration, and validation. All authors agree to be fully accountable for ensuring the integrity and accuracy of the work, and all authors affirm that they have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

Tommy Cederholm disclosed receiving lecture honoraria from Fresenius-Kabi, Nutricia/Danone, and Nestlé. M. Isabel T. D. Correia reported support from Abbott, Baxter, Danone, Fresenius, and Nestlé for lectures and educational materials. David C. Evans disclosed support from Abbott Nutrition for consulting and speaking honoraria, Fresenius Kabi for consulting and speaking honoraria, and Alcresta Therapeutics for consulting and speaking honoraria. M. Cristina Gonzalez disclosed receiving honoraria and/or paid consultancy from Abbott Nutrition, Nutricia, and Nestlé Health Science Brazil. Jeanette M. Hasse disclosed serving on the speakers bureau for Alcresta Therapeutics. Ainsley Malone disclosed that she is an employee of ASPEN. Kris M. Mogensen disclosed serving as an advisory board member for American Regent. Manpreet Mundi disclosed research

grants from Nestlé and Northsea as well as service on the advisory boards of Baxter, NutriShare, and Otsuka. Alison Steiber reported that she is an employee of the Academy of Nutrition and Dietetics and that she has received grant funding from the Academy of Nutrition and Dietetics Foundation and the Administration for Community Living. The remaining authors declare no conflicts of interest.

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SUPPORTING INFORMATION

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

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