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REVIEW

A critical analysis of the methodological processes applied in the studies using the Global Leadership Initiative on Malnutrition

Global Leadership Initiative on Malnutrition: uma análise crítica de estudos a respeito dos processos metodológicos utilizando a ferramenta

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ABSTRACT

Although hospital malnutrition is highly prevalent worldwide, it is difficult to compare the data due to the different nutritional assessment tools used. The Global Leadership Initiative on Malnutrition, which aims to operationalize malnutrition diagnosis, consists of five criteria: three phenotypic and two etiological criteria. Many researchers have studied the applicability and clinical relevance of Global Leadership Initiative on Malnutrition, and methodological standards have been established by the Global Leadership Initiative on Malnutrition commission for the application and possible validation of the tool. This study aimed to analyze the methodological processes of the studies that compared the Global Leadership Initiative on Malnutrition with a test tool. A literature review was conducted by the *Portal Periódicos* from *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* between November 2020 and January 2021. This review included articles published in English between 2016 and 2021 that compared the Global Leadership Initiative on Malnutrition with another tool used for diagnosing malnutrition. The sample had 13 articles, of which 11 did not adequately describe how the Global Leadership Initiative on Malnutrition criteria were applied. Only two studies utilized a combination of the phenotypic and etiological criteria. Some studies differed from the methodological recommendations of the Global Leadership Initiative on Malnutrition commission. Thus, it seems that applying the Global Leadership Initiative on Malnutrition in a manner different from the original framework elicited limited results regarding the applicability and reliability of the tool. Therefore, more studies should be conducted on the

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application of the GLIM Global Leadership Initiative on Malnutrition in different populations and contexts as per the patterns suggested to determine its actual applicability and reliability.

Keywords: Malnutrition. Nutritional assessment. Nutritional status.

RESUMO

Apesar de a desnutrição hospitalar ter alta prevalência mundial, é difícil comparar os dados devido à utilização de diferentes ferramentas de avaliação nutricional. O Global Leadership Initiative on Malnutrition *visa operacionalizar o diagnóstico de desnutrição e consiste em cinco critérios: três fenotípicos e dois etiológicos. Muitos pesquisadores têm estudado a aplicabilidade e relevância clínica do Global Leadership Initiative on Malnutrition e os padrões metodológicos para aplicação e possível validação da ferramenta foram estabelecidos pela comissão que o organizou para a aplicação e possível validação da ferramenta. O objetivo do presente estudo foi analisar os processos metodológicos de estudos que comparam o* Global Leadership Initiative on Malnutrition GLIM *a uma ferramenta teste. Entre novembro de 2020 e janeiro de 2021 realizou-se uma busca no Portal Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior por artigos publicados em inglês entre 2016 e 2021 que comparavam o Global Leadership Initiative on Malnutrition à outra ferramenta para diagnóstico de desnutrição. A revisão incluiu artigos publicados em inglês entre 2016 e 2021 e que comparavam o* Global Leadership Initiative on Malnutrition *à outra ferramenta para diagnóstico de desnutrição. A amostra contou com 13 artigos, dos quais 11 não descreveram detalhadamente como foi realizada a aplicação dos critérios* Global Leadership Initiative on Malnutrition*. Somente dois estudos realizaram a combinação de critérios fenotípicos e etiológicos. Alguns estudos se diferem das recomendações metodológicas feitas pela comissão do Global Leadership Initiative on Malnutrition. Nesse sentido, parece que ao aplicar o* Global Leadership Initiative on Malnutrition *de maneira divergente do recomendado pela proposta original tem apresentado obtém-se resultados limitados sobre a aplicabilidade e confiabilidade da ferramenta. Assim, é necessário que mais estudos com o* Global Leadership Initiative on Malnutrition *sejam realizados em diferentes populações e contextos, seguindo os padrões sugeridos, para que seja possível determinar sua real aplicabilidade e confiabilidade.*

Palavras-chave: *Desnutrição. Avaliação nutricional. Estado nutricional.*

INTRODUCTION

Malnutrition is a nutritional status resulting from low intake and reduced absorption of nutrients in the body, with or without inflammation, which causes changes in the body composition and body cell mass, leading to decreased physical and mental function and negative outcomes [1]. The main adverse events related to hospital malnutrition are reduced physical and immunological functionality, difficulty in healing wounds, prolonged hospitalization, increased risk of hospital readmission, increased risk of infection, insulin resistance, sarcopenia, and increased mortality [2-10]. Early detection of hospital malnutrition is related to an appropriate therapeutic plan and early initiation of nutritional therapy for the patients [1,11,12].

Besides, its impact on the patient's prognosis related to increased morbidity and mortality, length of stay, and hospital costs, hospital malnutrition has a high prevalence worldwide [12-16]. However, there is still a lot of disparity regarding the prevalence rates and difficulty in comparing the malnutrition data worldwide, which could be attributed to the use of different nutritional assessment tools [17].

The nutritional assessment method used has an impact on the prevalence of malnutrition and the evaluation of the patients' nutritional status, diagnosis, and interventions. Currently, there are several nutritional assessment tools for evaluating hospitalized patients, such as the Subjective Global Assessment (SGA) [18], as well as those for specific groups, such as the Mini Nutritional Assessment (MNA) [19] that targets the elderly. These instruments are considered as reference or standard tools for target populations [20]. Nutritional assessment tools perform differently depending on the parameters considered and the characteristics of the population assessed. Therefore, the global clinical nutrition societies' experts met in

2016 and proposed a tool to operationalize malnutrition diagnosis in clinical practice [12,21]. This framework is called the Global Leadership Initiative on Malnutrition (GLIM).

The GLIM is a specific tool for the adult population and includes five criteria: three phenotypic criteria (unintentional weight loss, low Body Mass Index, and reduced muscle mass) and two etiological criteria (reduced food intake and disease burden/inflammation). Malnutrition diagnosis using the GLIM requires the presence of at least one phenotypic criterion and one etiological criterion. Malnutrition severity is determined based on the phenotypic criteria [12].

Hospital malnutrition is a risk factor for adverse outcomes. Therefore, it is important to evaluate the efficacy of the GLIM criteria in the early detection of malnutrition in hospitalized patients [22].

Several researchers have evaluated the applicability and reliability of the GLIM in diagnosing malnutrition [23-35], and methodological standards have been established by the GLIM commission for the application and possible validation of the tool. The purpose of validation is to determine how effectively the GLIM criteria can identify malnutrition [36]. There are several validation methods [37-39]. One of these methods is validation by the concurrent criteria that compares a test tool and a gold or semi-gold standard, such as the SGA [20], which is the most commonly used tool. The validation of the GLIM criteria can be assessed by conducting retrospective and prospective studies, and the design of each type of study should consider specific aspects to identify the GLIM variables that contribute the most to the malnutrition prevalence in different populations [36].

Recently published papers evaluating the applicability and clinical relevance of the GLIM have used methodological processes different from the one suggested by the commission, which can lead to wrong conclusions about the use of the tool. Therefore, this study aimed to analyze the methodological processes used and the results found by researchers in studies that compared the GLIM with a test tool.

METHODS

This is a narrative review of the studies published between November 2020 and January 2021 through the *Portal Periódicos* from *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (Capes). The search terms associated with Boolean operators were used (Chart 1).

The guiding question underlying the bibliographic search was directed at finding studies that compared the GLIM with other nutritional assessment tools in determining the prevalence of malnutrition. Therefore, the inclusion criteria were publications in English between 2016 (the year the proposal was published) and January 2021 and compatibility with the guiding question. Studies that were not entirely in English, those not specifically addressing the comparison between the tools, and duplicate studies were excluded. The bibliographic search process is shown in Figure 1.

In the initial research, 27 articles were identified, and 13 studies were included in the narrative review after the evaluation process. The included articles were analyzed by an evaluator who compared the findings with the recommendations of the "Guidance On Validation" proposed by the GLIM commission experts [20]. The details of the studies are described in Table 1, including the authors, study design, sample, methods, and main findings.

RESULTS AND DISCUSSION

Prospective observational studies were common among the selected studies, whose sample size, adopted methodology, and main findings are described in Table 1.

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Chart 1 – Search strategy used in the narrative review.

Search terms *Portal Periódicos* from Capes
#1 "Malnutrition"
#2 "Nutritional assessment"
#3 "Nutritional status"
#4 "GLIM"
#5 "Global Leadership Initiative on Malnutrition"
#6 "Validation"
#7 "Protein-energy malnutrition"
#8 "GLIM criteria"
#9 "Nutritional assessment tool"
#10 "Subjective Global Assessment"
#11 "Malnutrition" AND "nutritional assessment"
#12 "Malnutrition" AND "nutritional assessment" OR "nutritional status"
#13 "Malnutrition" AND "Global Leadership Initiative on Malnutrition" OR "GLIM"
#14 "Malnutrition" AND "nutritional assessment" AND "GLIM"
#15 "Malnutrition" AND "GLIM" OR "validation"
#16 "Malnutrition" AND "GLIM" OR "GLIM criteria"
#17 "Nutritional assessment" OR "nutritional status" AND "GLIM"
#18 "Nutritional assessment" AND "validation" AND "GLIM"
#19 "Protein-energy malnutrition" AND "GLIM"
#20 "Protein-energy malnutrition" AND "nutritional assessment"
#21 "Nutritional assessment tool" AND "validation"
#22 "Nutritional assessment tool" AND "validation" AND "GLIM"
#23 "Subjective Global Assessment" AND "GLIM"
#24 "Subjective Global Assessment" AND "GLIM" OR "validation"
#25 "Subjective Global Assessment" AND "nutritional assessment" AND "validation"

Note: Capes: *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*; GLIM: Global Leadership Initiative on Malnutrition.

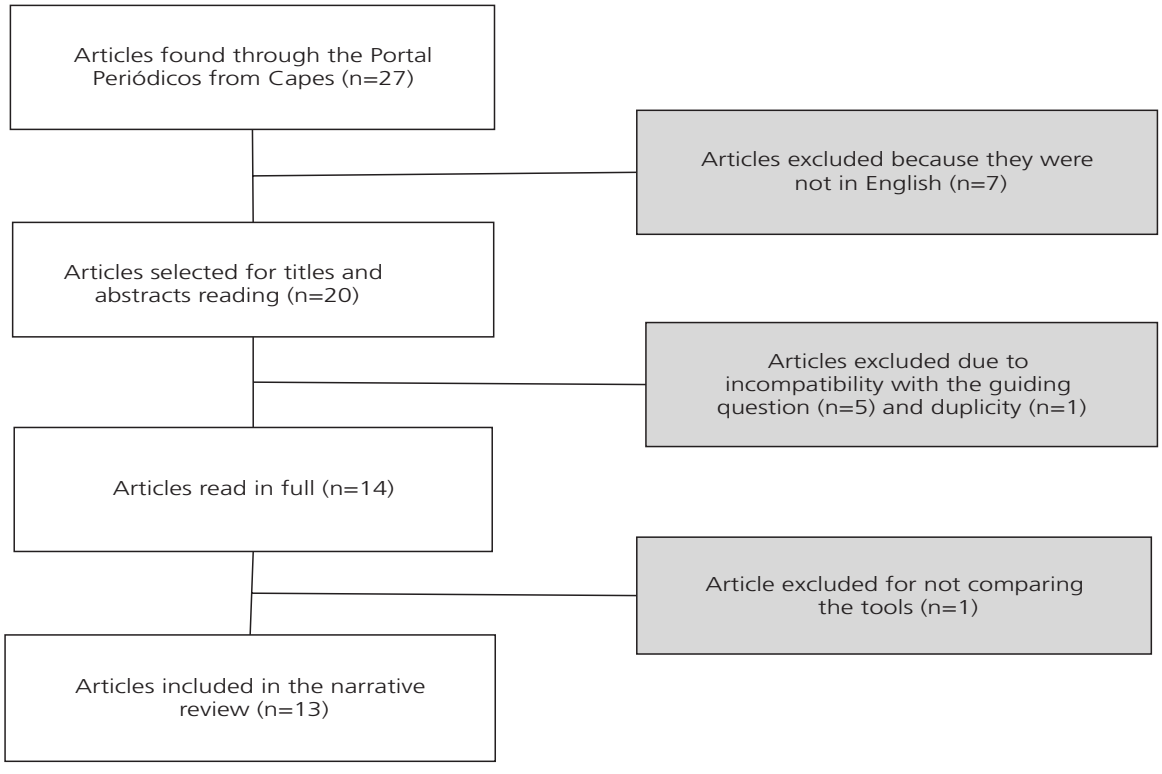

Figure 1 – Bibliographic search flowchart.
Note: Capes: *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*.

Table 1 – Details of the studies comparing the Global Leadership Initiative on Malnutrition with a test tool.

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Authors	Study design	Sample	Tools used	Methods	Main findings
Allard *et al*. [23]	Retrospective prospective cohort analysis	N=784 adults	SGA, CNST, and GLIM	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). Four combinations of phenotypic and etiological criteria were made, and each combination was compared to the SGA.	SGA malnutrition prevalence = 45.2% GLIM malnutrition prevalence = 33.3% The GLIM that combined weight loss or low BMI as the phenotypic criteria and low food intake or CRP as the etiological criteria (A, B, C, and D) showed poor sensitivity (61.3%) and fair specificity (89.8%) as compared to the SGA.
Bellanti *et al*. [28]	Prospective	N=152 elderly patients	SGA, GLIM, MUST, and NRS2002	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	Malnutrition according to GLIM = 46% MUST showed greater agreement with the GLIM in detection of malnutrition in this population. Sensitivity was 64%, 96%, and 47% and specificity was 82%, 15%, and 76% with MUST, SGA, and NRS2002, respectively.
Boulhosa *et al*. [24]	Prospective cross	N=166 chronic liver disease patients	GLIM, NRS2002, and RFH-NPT	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	The nutritional risk identified by RFH-NPT showed greater sensitivity and greater agreement with the malnutrition diagnosis made using the GLIM. According to the GLIM, 42.80% were classified as nourished and 57.20% as malnourished. None of the screening tools reported such a significant number of individuals at nutritional risk. It was noted that 45.26% and 20% of patients at a low risk according to the NRS2002 and RFH-NPT, respectively, were malnourished by the GLIM.
Clark *et al.* [35]	Retrospective analysis of prospective cohort	N=693 elderly patients	ESPEN, GLIM, and MST	Different phenotypes were created based on 3 different tools (ESPEN, GLIM, and MST), and the characteristics were compared between 8 phenotypes: GLIM, GLIM/ESPEN, GLIM/MST, GLIM/ESPEN/MST, ESPEN, ESPEN/MST, MST, and not malnourished according to all 3 tools. The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	Only a small proportion of patients were identified as malnourished or at risk of malnutrition by all the tools (7.2%). There was slight agreement regarding the prevalence and risk of malnutrition between the GLIM, ESPEN (k=0.30), and MST (k=0.26). The accuracy of the MST was low as compared to the GLIM and ESPEN criteria. The 91.0% of patients considered malnourished by the ESPEN were similarly diagnosed by the GLIM. The malnutrition prevalence determined by GLIM was 52.0%. According to the ESPEN and MST, 44.4% of patients were at nutritional risk.
Fierini, Madill [33]	Retrospective analysis of prospective cohort	N=264 hospitalized patients	CNST and GLIM	Patients were screened by CNST, and those at risk were evaluated using the GLIM. The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	According to the CNST, 38% of patients were at malnutrition risk, and 25% of patients at risk were considered malnourished by the GLIM.

Table 1 – Details of the studies comparing the Global Leadership Initiative on Malnutrition with a test tool.

Authors	Study design	Sample	Tools used	Methods	Main findings
Groot *et al.* [25]	Prospective cross	N=246 adults with CA	GLIM, MST, PG-SGA, and PG-SGA-SF	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria. The data reported by the GLIM and PG-SGA-SF were compared to the PG-SGA data.	The GLIM assessment showed a higher percentage of malnutrition as compared to the PG-SGA assessment (35% *vs.* 16%). Compared to PG-SGA, malnutrition diagnosis by GLIM had a sensitivity of 76%, specificity of 73%, and poor agreement (k=0.323).
Henrique *et al.* [26]	Prospective cross	N=206 adults with GID admitted for surgery	SGA and GLIM	A combination of a phenotypic criterion and an etiological criterion of the GLIM was used to categorize the patients as malnourished. Ten different combinations of phenotypic and etiological criteria were made, and each combination was compared to the SGA.	The several combinations of GLIM criteria provided different malnutrition rates. GLIM 1 (weight loss % and low food intake) and 6 (weight loss % and inflammation) showed greater agreement with SGA as compared to the other combinations. Malnutrition prevalence: SGA=50.0%, GLIM 1=31.6%, and GLIM 6=41.3%.
Matsumoto *et al.* [29]	Prospective cross	N=490 hospitalized patients	GLIM and MNA-SF	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	About 33% of patients were considered malnourished by the GLIM. The GLIM criteria for malnutrition were fulfilled by 98% of patients screened for risk by MNA-SF.
Rigler *et al.* [27]	Prospective cross	N=150 hospitalized patients	SGA and GLIM	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	There was a significant correlation between the GLIM and SGA assessment of the malnutrition diagnosis (R=0.353).
Steer *et al.* [32]	Retrospective analysis of prospective cohort	N=188 HNC patients	GLIM and MST	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). Subsequently, the malnutrition diagnosis was determined without metastatic disease (inflammation) as an etiological criterion. There was no mention of utilizing combinations of the GLIM criteria.	The GLIM determined that 20.0% of HNC patients undergoing treatment were malnourished and 42.0% were considered at nutritional risk. The malnutrition prevalence determined by the GLIM was 22.6%.
Theila *et al.* [34]	Prospective cross	N=84 critical patients	SGA, PA, GLIM, FFMI, and PANDORA	The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). All patients were defined as having an acute disease. There was no mention of utilizing combinations of the GLIM criteria.	There was a high correlation between PA, FFMI, and PANDORA and the GLIM in this population. The SGA validated the GLIM criteria combined with two diagnostic criteria (PA and FFMI) for diagnosing malnutrition with a high level of accuracy. The GLIM malnutrition assessment appears to be acceptable in the ICU setting. Sensitivity was 85% and specificity 79% for the GLIM stratified by the SGA results.

Table 1 – Details of the studies comparing the Global Leadership Initiative on Malnutrition with a test tool.

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Authors	Study design	Sample	Tools used	Methods	Main findings
Xu *et al.* [31]	Prospective cross	N=6519 hospitalized elderly patients	GLIM, MNA-SF, MUST, and NRS2002	Nutritional risk patients underwent nutritional assessment by the GLIM. The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). There was no mention of utilizing combinations of the GLIM criteria.	The GLIM associated with the MNA-SF seems to be the first choice for the malnutrition diagnosis, as they detected a greater number of malnourished patients than the other tools did. Malnutrition prevalence by GLIM = 35.0%; Malnutrition prevalence by GLIM and MNA-SF = 32.6%
Xu *et al.* [30]	Retrospective analysis of prospective cohort	N=1831 hospitalized patients	GLIM and NRS2002	Patients at nutritional risk underwent nutritional assessment by the GLIM. The minimum criteria of GLIM were used for the diagnosis (at least 1 phenotypic criterion + 1 etiological criterion). Patients were divided into 4 groups: negative NRS2002 (NRS-), positive NRS2002 (NRS+), malnutrition (NRS+/GLIM+), and positive NRS2002 but no malnutrition (NRS+/GLIM-). There was no mention of utilizing combinations of the GLIM criteria.	Malnutrition prevalence: (NRS+/GLIM+) = 21.40% NRS+ = 45.17% NRS+/GLIM- = 33.40% About 47% of the NRS+ patients were neglected by the GLIM. Nutritional risk determined by the NRS2002 seems to be a better indicator for starting nutritional support than malnutrition diagnosis.

Note: BMI: Body Mass Index; CNST: Canadian Nutritional Screening Tool; CA: Cancer; CRP: C-Reactive Protein; ESPEN: European Society of Parenteral and Enteral Nutrition; FFMI: Fat-Free Mass Index; GID: Gastrointestinal Disease; GLIM: Global Leadership Initiative on Malnutrition; HNC: Head and Neck Cancer; ICU: Intensive Care Unit; MST: Malnutrition Screening Tool; MUST: Malnutrition Universal Screening Tool; MNA-SF: Mini Nutritional Assessment Short Form; NRS: Nutritional Risk Screening; PANDORA: Patient and Nutrition Derived Outcome Risk Assessment; PG-SGA: Patient-Generated Subjective Global Assessment; PA: Phase Angle; RFH-NPT: Royal Free Hospital Nutritional Prioritizing Tool; SGA: Subjective Global Assessment.

In the analysis of the articles, a difference was observed in the sample size, which ranged from 84 to 6,519 patients, and in the characteristics of the population studied, wherein three studies evaluated only the elderly [28,31,35], one evaluated only adults [23], and the others evaluated only adult and elderly sick patients (with different comorbidities). Heterogeneity and the application of GLIM in the elderly may limit the extrapolation of the results, since GLIM is a specific tool for the adult population and its performance as a nutritional assessment tool varies according to the target population.

Regarding the methodological processes, all the included studies compared the GLIM with a test tool. However, most studies used screening and nutritional assessment tools that were not gold/semi-gold standards for comparison [24,25,28-35]. The most commonly used test tool was the SGA (n=5), which is considered a semi-gold standard [20].

Most of the articles were published in 2020 (n=11), demonstrating that research using GLIM has increasingly intensified in recent months. It was observed that the malnutrition prevalence determined by the SGA was higher than that determined by the GLIM in two studies [23,26]. Some test tools (SGA, Malnutrition Universal Screening Tool [MUST], and Royal Free Hospital Nutritional Prioritizing Tool [RFH-NPT]) showed a malnutrition prevalence similar to that determined by the GLIM [24,27,28,34].

Generally, it was observed that most articles (n=11) did not describe in detail how the application of the GLIM criteria was performed, which measures were recorded to assess each criterion, and what were the cutoff points used. This made the analysis of the applied methodology difficult. Only two studies [23,26] described that they utilized a combination of phenotypic and etiological criteria and compared each GLIM model to the semi-gold standard (SGA) as suggested by the GLIM commission [36]. Nevertheless, both studies used a combination of only one phenotypic criterion and one etiological criterion.

Comparing the GLIM with a test tool can be considered a method of validation by the concurrent criteria, which compares a test tool with a standard of nutritional assessment. This method consists of understanding malnutrition and allows this outcome to be measured in a valid and reliable way [20].

Currently, no tool is considered as the gold standard for assessing the nutritional status. Nevertheless, the GLIM commission emphasizes that the SGA and MNA (for the elderly) are considered "diffuse semi-gold" standards [20]. In fact, the most commonly used test tool among the selected studies was the SGA (n=5). These data are relevant because they show that the SGA is a well-known and widely used tool, and they indicate that the authors chose a standard tool, as suggested by the GLIM commission.

On the other hand, several studies compared the GLIM with screening tools [24,28,30,32,33,35]. Screening tools are not used to diagnose nutritional status but to identify nutritional risks. Therefore, it is not plausible to compare a nutritional assessment tool, which diagnoses malnutrition, with screening tools [40]. Furthermore, the GLIM commission suggests that these tools are used in association with the GLIM to identify the need for patient evaluation according to the GLIM criteria [20].

Only two studies utilized a combination of the GLIM criteria and compared the malnutrition prevalence determined by the SGA and the different GLIM criteria combinations [23,26]. The other studies did not report utilizing the combination criteria; they only mentioned that the minimum criterion used to diagnose malnutrition using GLIM was to have at least one phenotypic criterion and one etiological criterion. According to Allard *et al.* [23], using only the minimum criteria may not be sufficient to diagnose malnutrition, because when a combination of several criteria are used, the sensitivity of the tool seems to increase.

According to the commission, a combination of criteria is recommended to test and refine the GLIM. The malnutrition prevalence determined using the GLIM criteria combinations should be compared with the standard (gold or semi-gold) used in the study. Moreover, it is recommended to use at least 21 combinations of the criteria to categorize a patient as malnourished or nourished. In addition to comparing the prevalence, these combinations are important to determine which GLIM parameters and cutoff points are more sensitive for identifying malnourished patients, predicting associated outcomes, and/or predicting which patients may benefit from nutritional interventions according to the present criteria [20].

Thus, the analysis of the studies that did not use the GLIM criteria combinations is limited, since the use of the minimum criteria may not express the actual malnutrition prevalence of the analyzed population. Therefore, it is not possible to distinguish which criteria can or cannot determine a malnutrition prevalence that is similar to that determined by the standard tool, which makes it difficult to interpret and extrapolate the results found. In addition, not utilizing the combinations affects the comparison of the prevalence and interpretation of the results, as well as makes decision-making regarding the therapeutic plan difficult [20]. Choosing the most suitable nutritional therapy for each case depends on the knowledge of the specific deficiencies of each patient. All malnourished patients are not the same and should not receive the same treatment.

In some studies, nutritional screening was performed separately [23,30,31,33], and only patients at a nutritional risk were evaluated using the GLIM criteria recommended by the GLIM commission. It should

be emphasized that participants should be included in these studies regardless of their nutritional status to ensure that there is no bias in the results [37].

Furthermore, it is necessary to be cautious about the results, as the GLIM is based on expert consensus and further evidence may be needed to validate and test the reliability of the tool. Therefore, studies that evaluate and compare the GLIM to standard tools using large databases are encouraged, as they can help refine the criteria [20].

Notably, with the currently available information, the GLIM does not compare nor replace the complete nutritional assessment in clinical care. This is not the purpose of this framework. The GLIM minimum criteria are intended to establish a global language for understanding the variation in the malnutrition prevalence between regions and populations and to support the development of an updated International Classification of Diseases for malnutrition [12,21].

Among the selected studies, two were called validation studies [27,34], and one study was called a pilot validation study [26]. As explained above, with respect to the methodological processes, most studies deviate from the recommendations of the GLIM commission and would not be considered as validation studies. The pilot validation study [26] methodology is similar to that suggested by the commission, although it used combinations of just one phenotypic criterion and one etiological criterion. However, it is important to highlight that the two validation studies [27,34] did not describe the methodology adopted in detail, limiting the critical analysis of the methodological processes used.

According to the commission, a study that proposes to apply, compare, and validate the GLIM must at least inform how the criteria were evaluated and whether there is reliability in determining the criteria. For example, it is necessary to detail the body composition parameters and cutoff points used to determine low muscle mass [20].

Regarding the heterogeneity of the studies, it was possible to observe that the studies diverged significantly in terms of the methodological processes, which made it difficult to compare the studies and extrapolate the results. Additionally, the populations studied were heterogeneous, as there were studies conducted only on the elderly, only on elderly and adults, and only on adults. The heterogeneity of age of the sample, and consequently the organic characteristics, can be an important limitation because the GLIM is a tool proposed for the adult population [12]. Furthermore, the changes in the body composition caused by the malnutrition process (as well as the tools and cutoff points used) differ between the adults and elderly [41,42]. Some studies evaluated hospitalized patients in general without differentiating the underlying disease, while others chose to study a population with specific comorbidities (*e.g.*, those with head and neck cancer). Therefore, not considering the different organic and clinical changes resulting from the underlying disease can be a selection bias and may influence the sample, as some diseases are known to be more catabolic as compared to others and have different impacts on the parameters evaluated by the GLIM.

This study has some limitations. The first is related to the fact that a single evaluator performed the bibliographic search. However, it is important to highlight that the evaluation of the studies and the discussion of data were performed by the authors of the manuscript. Another limitation is that only articles in English were selected, limiting the inclusion of the articles in other languages. Nevertheless, this selection decision was made, because the English language is the universal language for scientific publication.

CONCLUSION

Papers that assess the applicability and clinical relevance of GLIM can make important contributions to the literature. However, 11 of the 13 selected studies deviated from the recommendations made by

the GLIM commission regarding the methodological processes. Thus, the critical analysis of the selected studies showed that the extrapolation of the results is limited. Furthermore, applying the GLIM in a way different from that recommended by the original framework and comparing the malnutrition prevalence determined by the GLIM to that of non-standard tools does not seem to contribute to relevant findings on the applicability and reliability of the tool, as these results are questionable. Therefore, it is necessary that studies that evaluate the application of the GLIM and its comparison with standard tools be conducted in different populations and contexts, as per the recommendations suggested by the commission in order to determine the actual applicability and reliability of the tool.

CONTRIBUTORS

ALF FONSECA worked on the conception, literature review, study design, data extraction and discussion, manuscript writing, and review. LG FERREIRA worked on the conception, study design, data extraction and discussion, and manuscript review.

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