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Narrative Review

Current application and future directions for the sarcopenic obesity Global Leadership Initiative (SOGLI) diagnostic algorithm

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SUMMARY

Background: Sarcopenic obesity (SO) is characterized by excess adiposity and reduced muscle mass and function. In 2022, the Sarcopenic Obesity Global Leadership Initiative (SOGLI) proposed a diagnostic algorithm to standardize SO identification by integrating screening, diagnostic assessment, and staging.
Aim: This review evaluates the application of the SOGLI algorithm, identifying strengths, limitations, and potential areas for refinement.
Methods: A narrative review with systematic citation tracking was conducted (April 2022–August 2025). Literature searches in PubMed, Scopus, and Web of Science identified original studies in adults ($\geq$18 years) explicitly using the SOGLI algorithm. Data on screening, diagnostic tools, staging, prevalence, and comorbidities were synthesized.

Abbreviations: AG, Acylated ghrelin; ALM, Appendicular lean mass; ALST, Appendicular lean soft tissue; BIA, Bio-impedance analysis; BIVA, Bioelectrical Impedance Vector Analysis; BMI, Body mass index; BRI, Body roundness index; CC, Calf circumference; COPD, Chronic obstructive pulmonary disease; DXA, Dual-energy X-ray absorptiometry; EASO, European Association for the Study of Obesity; ESPEN, European Society for Clinical Nutrition and Metabolism; FFM, Fat-free mass; FM, Fat mass; FIM, Functional independence measure; FOIS, Functional oral intake scale; GNRI, Geriatric nutrition risk index; HGS, Hand-grip-strength; LAP, Lipid accumulation product; PhA, Phase angle; QoL, Quality of life; SMM, Skeletal muscle mass; SO, Sarcopenic obesity; SOGLI, Sarcopenic Obesity Global Leadership Initiative; STS, Sit-to-stand; TUG, Timed Up and Go test; TyG, Triglyceride-glucose index; UnAG, Unacylated ghrelin; WC, Waist circumference; WCR, Waist-to-Calf Ratio; WHtR, Waist-to-Height Ratio; W, Weight.

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Results: Seventy-two studies applied the SOGLI algorithm, showing heterogeneous approaches across clinical settings. For obesity screening, about half used both body mass index and waist circumference, while sarcopenia screening tools were less frequently reported. For SO diagnosis, bioelectrical impedance analysis was the most common method for body composition assessment, while muscle function was predominantly assessed via hand-grip strength. SO staging was reported in 19% of studies, most often as Stage II. Application of the algorithm consistently confirmed associations between SO and chronic disease burden, functional decline, and increased mortality.

Conclusions: The SOGLI algorithm represents a major advance, with 72 studies adopting it in two years. Some inconsistencies in screening and staging suggest opportunities for refinement. These findings support its validity, while further standardization and integration of novel biomarkers could enhance its clinical effectiveness.

1. Introduction

Sarcopenic obesity (SO) is a condition characterized by the coexistence of excess adiposity (obesity) and low muscle mass and function (sarcopenia) [1,2]. The pathophysiology of SO is driven by a complex interplay of hormonal, genetic, inflammatory, and myocellular mechanisms, influenced by the cross-talk between adipose and muscle tissues [3]. These interactions promote fat accumulation while contributing to the loss of muscle mass and strength [4]. A sedentary and inactive lifestyle, excessive energy intake, and inadequate protein consumption further exacerbate this process, acting both as a cause and a consequence of sarcopenia and obesity [1], which may reinforce each other in a vicious cycle [5]. As a result, individuals with SO tend to experience worse health outcomes than those affected by either sarcopenia or obesity alone, including a higher risk of disability, loss of independence, reduced quality of life, worsened outcome for many diseases and increased mortality [3,6].

There is growing recognition of SO as an emerging public health concern, given its clinical and functional implications, which adversely impact key patient-centered outcomes [1]. Effective identification and treatment of SO however has been until recently hampered by variability in its assessment in clinical practice worldwide [7]. To provide a standardized approach for SO identification and management, on behalf of the European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO), the Sarcopenic Obesity Global Leadership Initiative (SOGLI) discussed, developed, and proposed a consensus-based diagnostic algorithm, which was published in 2022 [1,2]. This framework aimed at harmonizing clinical practice approaches to SO diagnosis and advancing research in this rapidly evolving field [1] (Box 1 and Fig. 1).

The current review with systematic citation tracking aims at evaluating the implementation of the SOGLI diagnostic algorithm

Box 1

The SOGLI algorithm for the diagnosis of Sarcopenic Obesity

The proposed three-phase diagnostic algorithm consists of an initial screening step, followed by diagnostic confirmation in patients with a positive screening result, and staging for patients diagnosed with SO (Donini et al., 2022) (Fig. 1).

Screening is based on the presence of a high body mass index (BMI) within the obesity range or a waist circumference exceeding ethnicity-specific cut points, along with clinical suspicion of low muscle function. Key indicators of muscle dysfunction include being over 70 years of age, chronic diseases and organ failures, recent hospitalization, physical inactivity or immobility, history of repeated falls, weakness and easy fatigue, or a positive result on validated screening questionnaires such as SARC-F. The SARC-F questionnaire, recommended by the European Working Group on Sarcopenia in Older People (EWGSOP2), assesses sarcopenia risk in older persons based on five components: strength, assistance walking, rising from a chair, climbing stairs, and falls. A score of 4 or higher is considered indicative of sarcopenia risk.

The diagnostic phase involves assessing muscle function using validated tools such as handgrip strength (HGS) or the sit-to-stand test (STS), previously known as chair-stand test. HGS measures voluntary contraction force in the forearm and hand, offering a simple and quick functional assessment. STS evaluates lower limb strength, endurance, and balance, providing an additional practical measure of muscle function.

If muscle function impairment is detected, body composition analysis is required to confirm SO. Altered body composition is defined by an increased fat mass percentage, as per Gallagher et al., along with reduced muscle mass. This reduction is assessed using Batsis' definition of appendicular lean soft tissue adjusted by body weight (measured via dual-energy X-ray absorptiometry [DXA]) or Janssen's definition of total skeletal muscle mass adjusted by body weight (measured via bioelectrical impedance analysis [BIA]). While DXA is considered the gold standard for body composition assessment, its high cost and limited availability make BIA a more accessible alternative. However, BIA may overestimate fat-free mass and underestimate fat mass, particularly in individuals with obesity [1].

Following the SO diagnosis, **staging** is performed to determine the disease severity. Stage I SO is defined by the absence of complications related to body composition and muscle function impairments, whereas Stage II SO is characterized by the presence of complications, including functional disabilities and metabolic, cardiovascular, or respiratory diseases.

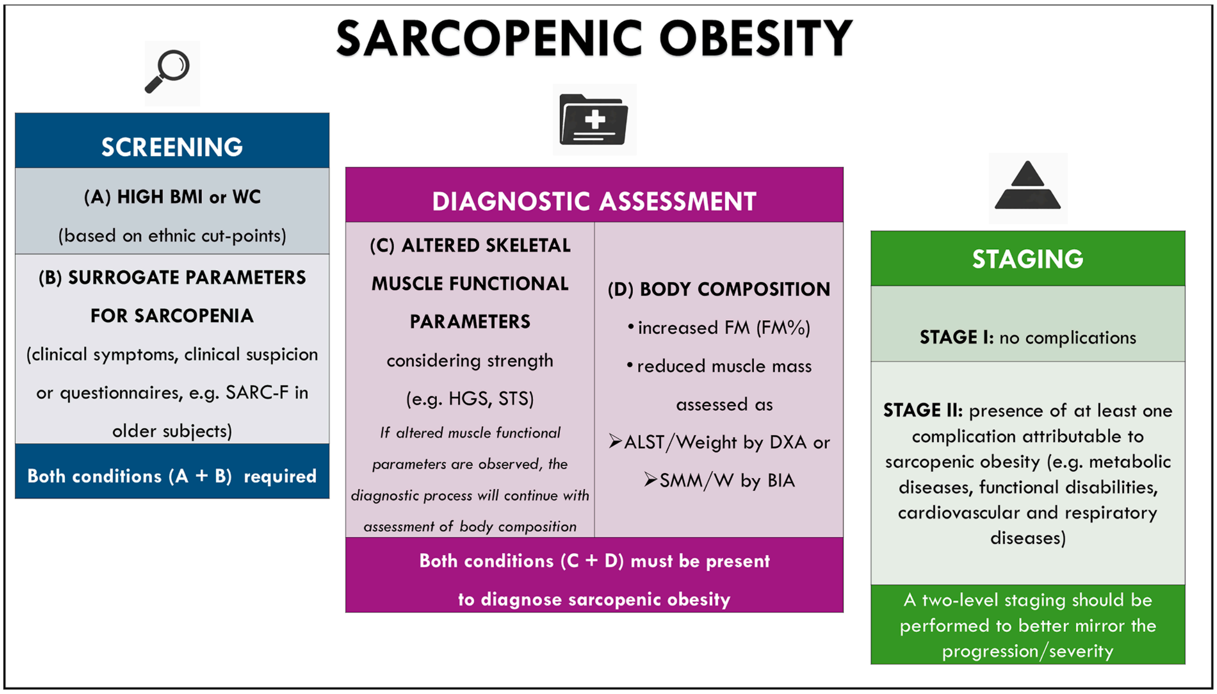

Fig. 1. Diagnostic procedure for the assessment of sarcopenic obesity. Adapted from [1] Donini et al. Obes Facts 2022; 15:321–335 and [2] Clin Nutr 2022 Apr; 41 (4):990–1000. ALST: appendicular lean soft tissue (previously reported as appendicular lean mass adjusted to body weight ALM/W); BIA: Bioelectrical impedance analysis; BMI: Body mass Index; DXA: Dual-energy X-ray absorptiometry; FM: Fat Mass; HGS: handgrip strength; SMM/W: skeletal muscle mass adjusted to body weight; STS: sit-to-stand test (previously reported as chair stand test); WC: Waist circumference.

by analyzing studies that explicitly reported its application up to August 2025, in order to identify strengths, limitations, and potential misapplications that may guide its future refinement and optimal utilization. In addition, we summarize recent developments and emerging evidence on SO diagnosis, with a focus on prevalence estimates and clinical outcomes across different populations.

2. Methods

A literature search was performed across PubMed, Scopus and Web of Science databases, with a specific focus on original research articles published between 2022 (following the release of the Consensus) and August 2025. The citation search was conducted using combinations of search strings {TITLE-ABS-KEY (ESPEN AND EASO) AND criteria AND sarcopenia AND obesity OR sarcopenic obesity AND definition} AND AUTHOR-NAME (Donini) to locate the source study. Additionally, a forward citation search was performed, focusing on the publication by Donini LM et al., titled “Definition and diagnostic criteria for SO: ESPEN and EASO consensus statement” [1,2]. Since the paper was published in two different journals (Obesity Facts and Clinical Nutrition), we checked for duplicates. To track the progression and recent findings in SO research, additional forward citation searches were performed to identify studies that cited the Consensus statement since its publication. Moreover, we aimed at identifying studies that used the SOGLI algorithm to diagnose SO in adults (age>18 years), irrespective of ethnicity and sex, across different clinical settings, including community-dwelling, acute care, and rehabilitation populations. We included original studies with any design in which the authors explicitly reported the use of the algorithm in the Methods section, regardless of whether it was properly applied. Only English-language publications were considered. The exclusion criteria included review articles, studies that did not explicitly use the SOGLI algorithm as diagnostic algorithm for SO, and studies with unavailable full texts. Titles and abstracts were independently screened by two reviewers (GP and MM) and full texts of eligible studies were then assessed for inclusion. A reference management software (EndNote 20.4.1) was used to organize the search results and remove duplicates.

Relevant data were extracted by GP and MM, including publication details, sample size, participant characteristics (sex, nationality, age), study setting, diagnostic criteria, SO prevalence rates, outcomes, and limitations. Any disagreements were resolved by a third reviewer (LMD). We considered older adults as persons aged $\geq$65 years, while study samples with mean ages below 65 were classified as middle-aged populations, and those reporting wide or mixed ranges were categorized as mixed-age populations. Also, to standardize the terminology in this work, we use appendicular lean soft tissue (ALST) instead of appendicular lean mass (ALM) [8].

To assess how the SOGLI algorithm was applied, we prepared a descriptive summary of individual diagnostic stages, identifying which tools were used at each phase (from screening to diagnosis to staging) to gain insight into the practical implementation of the algorithm in clinical research. Frequencies and percentages were calculated to summarize study characteristics and methodological approaches. As this work was conceived as a narrative review with systematic citation tracking rather than a full systematic review, no formal risk-of-bias assessment was performed. Consequently, findings should be interpreted with caution, particularly when comparing prevalence estimates and outcome associations across heterogeneous study designs.

3. Results

From the comprehensive list of studies retrieved, a total of 72 articles applied the SO algorithm between 2022 and August 2025 (Fig. 2).

Screening, diagnostic, and staging approaches in the 72 studies applying the SOGLI algorithm for SO have been summarized in

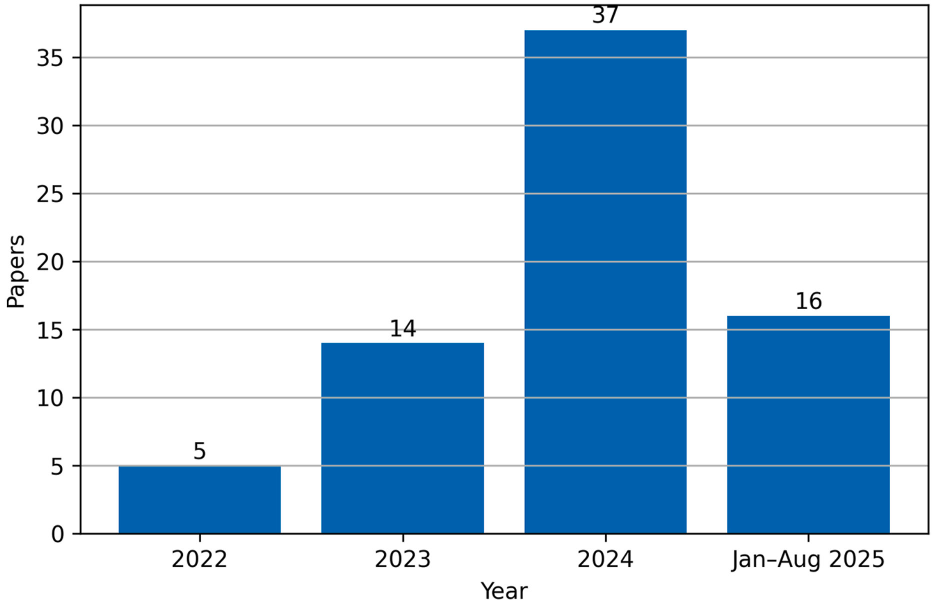

Fig. 2. Original studies using the SOGLI algorithm as diagnostic criteria for sarcopenic obesity (SO) published per year.

Table 1. The number of studies applying the algorithm, along with the number of individuals, categorized by setting, and the countries where these studies were conducted, is shown in Table 2. Across the 72 included studies, approximately 75,000 participants were evaluated. Sample sizes showed substantial variability, ranging from 30 to over 10,000 participants. Overall, 21 studies (29.2%) included more than 1000 participants, 28 studies (38.9%) enrolled between 100 and 1000 participants. Women accounted for approximately 60% of the overall sample, although 7 of 72 studies enrolled exclusively male or female participants. Additionally, the age of participants varied widely: 37 studies (51.4%) were conducted in older adults, with a mean age typically ranging from 70 to 75 years; 19 studies (26.4%) were conducted in middle-aged populations; and 16 studies (22.2%) included participants of mixed ages. Complete details on the studies are provided in Supplementary Table 1.

3.1. *Sarcopenic obesity screening*

OBESITY: 32 studies (44.4%) relied solely on body mass index (BMI) as a screening tool for the presence of obesity, while 35 (48.6%) used both BMI and waist circumference (WC) without analyzing potential differences in screening capacity. No studies used WC alone, and in five studies the screening procedure was not described.

SARCOPENIA: To screen for the presence of sarcopenia, 8 studies (11.1%) adopted the SARC-F questionnaire; 11 studies (15.3%) assessed clinical symptoms for sarcopenia, while one [9] used both SARC-F and clinical symptoms. Among the 8 studies applying SARC-F, 5 were conducted in older adult populations, while 1 used the questionnaire in a younger population [10]. Fonfría-Vivas et al. [9] studied 95 community-dwelling women aged ≥70 years. They noted that women with SO exhibited the

Table 1
Summary of screening, diagnostic, and staging approaches in the 72 studies applying the SOGLI algorithm for sarcopenic obesity (2022–2024). BIA: Bioelectrical Impedance Analysis; BMI: Body Mass Index; DXA: Dual-Energy X-ray Absorptiometry; HGS: Handgrip Strength; KES: Knee Extension Strength; SO: Sarcopenic Obesity; STS: Sit-to-Stand Test; WC: Waist Circumference.

SCREENING	Reported parameters	Number of studies (/72)
Surrogate parameters for obesity	Only BMI	32 (44.4%)
	Only WC	0
	BMI + WC	35 (48.6%)
	Not specified	5 (6.9%)
Surrogate parameters for sarcopenia	SARC-F	8 (11.1%)
	Clinical symptoms	11 (15.3%)
	SARC-F + clinical symptoms	1 (1.4%)
	Not specified	52 (72.2%)
DIAGNOSIS		
Body composition	Only BIA	42 (58.3%)
	Only DXA	24 (33.3%)
	BIA + DXA	4 (5.6%)
	Not specified	2 (2.8%)
Muscle function	Only HGS	42 (58.3%)
	Only STS	2 (2.8%)
	HGS + STS	18 (25%)
	KES	2 (2.8%)
	Not specified	8 (11.1%)
STAGING		
Studies that applied staging		14 (19.4%)
Studies with all patients classified as stage II		8 (57.1%)

Table 2
Number of studies applying the SOGLI algorithm as the diagnostic criteria for sarcopenic obesity.

Setting	Number of patients *N (min–max)*	Papers	Countries
ACUTE CARE	11,198 (30–6790)	15	Austria, Belgium, Brazil, China, France, Italy, Japan, Poland, Spain, Taiwan
REHABILITATION UNITS	10,297 (84–3858)	11	Italy, Japan, the Netherlands, Poland
COMMUNITY-DWELLING SUBJECTS	63,085 (35–10,043)	46	Australia, Brazil, China, France, Germany, Italy, the Netherlands, Poland, Portugal, Republic of Korea, Slovenia, Spain, Taiwan, Tunisia, Turkey, UK, USA

highest SARC-F scores compared to women with sarcopenia alone or without sarcopenia. In 52 studies (72.2%) it was unclear which surrogate parameter for sarcopenia was used in the screening phase.

Notably, Shimizu et al. [11] analyzed differences in SO prevalence with or without implementation of the screening phase. In a sample of older Japanese adults, SO prevalence in a rehabilitation setting was approximately 4% when the screening phase was applied (BMI $\geq$25 kg/m^2 plus clinical symptoms or suspected sarcopenia), while it increased to 20–30% when SO was directly assessed using bio-impedance analysis (BIA) and handgrip-strength (HGS). However, it should be pointed out that by definition, all individuals in the study should have been considered at risk for sarcopenia, since they had suffered a recent stroke with acute disease, hospitalization and reduced mobility [1,2].

3.2. Sarcopenic obesity diagnosis

72 studies used the SOGLI algorithm for the diagnosis of SO (Fig. 1).

MUSCLE FUNCTION: 18 studies (25%) assessed both HGS and sit-to-stand (STS) (previously reported as chair-stand test and including both the 5-time STS and the 30-STS), while 42 (58.3%) relied solely on HGS. Only two studies [12,13] (2.8%) used STS alone, and 2 studies assessed the isokinetic strength of quadriceps muscle (2.8%). Eight studies (11.1%) did not report how muscle function was assessed. Pouget et al. [14] found in a population of 799 patients hospitalized for obesity in the Clinical Nutrition Department of the University Hospital Center (CHU) of Clermont-Ferrand, France, between June 4, 2018, and March 29, 2022, that the prevalence of SO was low in their cohort but slightly different according to functional tests: 5.4% and 3.2% for HGS and STS, respectively. Cook et al. [15] also observed different prevalence of low muscle function in their sample (85 older adults with excess adiposity from a rural community in New Hampshire) based on assessment method: 36 participants completing the diagnostic step with SO (7 men and 29 women) had low HGS, 29 (9 men and 20 women) were below the cut-point for the 30-Second STS, and 1 female participant showed low values for 5-Times STS. 11 women and 2 men (15% of the sample) were below the cut-points in both HGS and the STS (either the 30-s or 5-times).

BODY COMPOSITION: 4 studies [16–19] (5.6%) used both BIA and dual-energy X-ray absorptiometry (DXA), while the majority (42 = 58.3%) relied solely on BIA, and 24 (33%) used only DXA. Two studies [20,21] did not report how body composition was assessed (Table 1). Similar to muscle function, some differences were also reported in SO prevalence when comparing different BC assessment methods in the same cohort. Vieira et al. [19] observed prevalence of 7.9% and 23% in their cohort using BIA and DXA, respectively. In the study by González-Arnáiz et al. [17], SO prevalence ranged from 13% to 22% when using BIA with the skeletal muscle mass (SMM)/weight ratio, according to Janssen et al. [22]. When DXA was employed, prevalence ranged from 13% to 23% using the ALST/weight ratio, following criteria described by Batsis et al. [23]. Different HGS cut-off points [e.g. those proposed by Sánchez-Torralvo et al. [24], Dodds et al. [25] or a threshold set at <–2 SD from a healthy reference population] accounted for a large proportion of the variability in SO prevalence. Danielewicz et al. [16] calculated the prevalence rates of SO using different tool combinations in their study. Prevalence rates of SO were 23.3%, 25.5%, 31.1%, and 40.0% when using high fat mass (FM) combined with STS + ALST/Weight (W), HGS + ALST/W, STS + SMM/W, and HGS + SMM/W, respectively.

3.3. Sarcopenic obesity staging

Once a diagnosis of SO was established, the staging step should be performed. Among the 72 selected studies, only 14 (19.4%) detailed the staging phase. Notably, 8 out of these 14 studies (57.1%) reported that all individuals with SO were classified as Stage II (presence of at least one complication attributable to SO) [1]. For example, Abe et al. [26] examined patients with stroke, all of whom were classified as Stage II due to their complications characterized by altered GNRI (geriatric nutrition risk index), FOIS (functional oral intake scale), and FIM (functional independence measure) scores. Similarly, Liu et al. [27] analyzed patients with cancer, who were likewise all assigned to Stage II. Additionally, Gortan Cappellari et al. [28] found that all individuals with SO were staged as Stage II due to the presence of metabolic syndrome.

3.4. Prevalence of sarcopenic obesity

Among the 72 studies that used the SOGLI algorithm, the reported prevalence of SO varied widely, ranging from 1.1 [29] to 100% [30,31], expectedly reflecting broad heterogeneity in the populations and settings studied. In the 6 studies that described all the steps (screening of both obesity and sarcopenia, diagnosis and staging) and detailed how each step was performed [9,11,26,27,32,33], SO prevalence ranged from 4% to 7.3% (3 of these studies were conducted in rehabilitation settings for stroke, 2 in hospital patients with stroke or cancer, 1 in community dwelling older subjects). 5 of these 6 studies were conducted in Asia. Among all studies and settings, higher prevalence of SO was reported among patients with COVID-19 infection (from 34.5 to 56.7%) [34,35], nursing home residents (43.5–45.3%) [36], and patients undergoing bariatric surgery (from 89.3 to 100%) [30,31,37]. Nearly all studies reported a higher prevalence of SO in older individuals [16,27,29,36,38,39,40,41,42,43,44]. However, Booranasuksakul et al. [10] found a higher prevalence of SO in individuals aged 50–59 years (18.1%) compared to individuals aged 60–85 years (14.2%) in a cohort of 2356 community-dwelling adults. Regarding sex differences, Schluessels et al. [38], and Vieira et al. [19] reported a higher prevalence of SO in men than in women (respectively 4 vs 5%; 21.7 vs 35.7%. On the contrary, studies by Cancello et al. [42] and Danielewicz et al. [16] documented a significantly higher prevalence of SO in women (respectively 12.4 vs 10.7%; 55.3 vs 23.2%).

3.5. Sarcopenic obesity and clinical outcomes

The following paragraphs describe the outcomes and clinical consequences associated to SO diagnosis according to the SOGLI algorithm as reported in the 72 included studies.

3.5.1. Overall mortality and multimorbidity

Tseng et al. [29] examined a cohort of 1779 community-dwelling older adults in Taiwan, identifying a significantly higher 11-year mortality risk in those with SO compared with those without SO. This was confirmed in a study conducted by Zhou et al. [45] and also in a large-scale study by Benz et al. [46] on 5888 individuals in the Netherlands.

Beyond mortality, SO has been consistently associated with increased multimorbidity and polypharmacy across different studies performed in diverse countries. A study on 998 older adults in Germany found that SO was associated with presence of $\geq$2 comorbidities and the use of $\geq$5 medications [38]. In Poland, Murawiak et al. [40] reported that SO was associated with the highest levels of morbidity and medications in a cohort of 211 older adults. Similarly, in Turkey Güner et al. [39] noted a higher prevalence of arterial hypertension and multimorbidity in patients with SO.

3.5.2. Cardiometabolic risk profile

The relationship between SO and cardiometabolic risk factors was more extensively investigated. Almost all the studies indicated an association between SO and cardiometabolic risk as well as cardiovascular disease. Fantin et al. [47] described a strong association between SO and increased arterial stiffness in 77 older hospitalized patients, indicating a potential link between SO and more advanced cardiovascular disease. Zhang et al. explored the association between SO and insulin resistance [48], showing significant correlations between SO and the triglyceride-glucose index (TyG) as well as its combinations with anthropometric parameters, and lipid accumulation product (LAP). Gortan Cappellari et al. [28] also reported that individuals with SO had higher insulin resistance, along with elevated acylated ghrelin (AG) levels and an increased AG/UnAG plasma ratio that might exert a negative impact on insulin action and skeletal muscle mass [28]. Frigerio et al. [49] further demonstrated that SO was associated with a worse serum lipid profile compared to patients with obesity without sarcopenia. Hu et al. [50] reported that individuals with SO diagnosed by the SOGLI algorithm were more likely to exhibit unfavourable metabolic and inflammatory profiles. Finally, in a cohort of 322 older adults with type 2 diabetes Hafızoğlu et al. [51] reported a higher rate of microvascular complications in SO patients, also associated with significantly lower phase angle. Only in the study conducted by Gregori et al. [52] in a cohort of 189 community-dwelling older adults metabolic syndrome was present in 76% of SO patients and 75% of non-SO individuals, suggesting similar prevalence in the two groups.

3.5.3. Cancer and other chronic diseases

- CANCER. Six studies have reported the clinical impact of SO in patients with cancer. Zhou et al. [53] reported a 31.9% prevalence of SO in a cohort of 639 patients with advanced non-small cell lung cancer, which was significantly associated with increased mortality. The link between SO and worse survival in patients with cancer has been confirmed in multiple studies [54–56]. Pedersini et al. [57] examined a subgroup of women with early-stage breast cancer who had undergone surgery, chemotherapy, and at least 18 months of therapy with aromatase inhibitor (AI). They found that 7.7% of the patients developed SO following AI therapy. Furthermore, women with SO before AI therapy were more likely to experience persistent SO after AI treatment. In a Chinese cohort of 6790 patients with cancer, Liu et al. [27] identified SO as most prevalent in breast cancer (5.9%), lung cancer (4.7%), and colorectal cancer (4.6%), reinforcing its frequent occurrence across different tumor types.
- RESPIRATORY DISEASES. Among older individuals with chronic obstructive pulmonary disease (COPD), Kaluźniak-Szymanowska et al. [58] observed that patients with SO undergoing a pulmonary rehabilitation program required more prescription medications and had a more severe disease course. Two studies specifically examined the impact of SO on COVID-19 outcomes. In a study including 30 post-critical patients suffering from COVID-19 infection, Cornejo-Pareja et al. reported that 56.7% showed SO [34]. Similarly, Zong et al. [35] reported a SO prevalence of 34.5% among 113 hospitalized older adults with COVID-19. In this cohort, patients with SO were older, had a higher prevalence of COPD, exhibited higher rates of malnutrition and frailty, and had a greater risk of requiring intubation with overall poorer clinical outcomes.
- COGNITIVE IMPAIRMENT. Booranasuksakul et al. [10] examined 2356 community-dwelling adults (50–85 years old) and identified a significant association between SO and cognitive impairment, particularly in those aged 60 and above. This association was further supported by Schluessels et al. [38], who found a strong correlation between SO, disability, and cognitive decline.

3.5.4. Malnutrition, functional limitations and risk of falls

Malnutrition and sarcopenia share pathophysiological mechanisms related to nutritional state and muscle metabolism. Several studies confirmed an association between SO and malnutrition diagnosed using the GLIM criteria [59] in different settings (community-dwelling older adults, subjects with idiopathic pulmonary fibrosis) [45,60,61]. Sanmartin-Sanchez et al. [60] observed that 100% of patients with SO were malnourished according to GLIM criteria in a cohort of patients with idiopathic pulmonary fibrosis.

SO has been also consistently associated with an increased risk of falls in older adults. Montalvão-Sousa et al. [62] found that SO was related to higher proportion of falls in the previous year in 232 community-dwelling older women. Li et al. [63] confirmed a significant association between SO and increased risk of falls in a cohort of 1353 community-dwelling older adults in Western China. Consistent results were reported by Scott et al. [64], who examined 1416 Australian older men and found that SO was associated with higher fall rates. Consistent with these findings, poorer physical performance was observed in subjects with SO based on Short Physical Performance Battery and 6MWT results in a cohort of hospitalized patients in a rehabilitation unit aged $\geq$60 years [13]. On the other hand, Cadvar et al. [65] reported no associations between SO (with muscle mass normalized for body weight or BMI), and either impaired activities of daily living (ADL), instrumental activities of daily living (IADL) or functional disability in 408 outpatients $\geq$65 years in Turkey.

3.5.5. Quality of life and sexual function

Several studies have highlighted the negative impact of SO on quality of life (QoL), emphasizing its detrimental effects on overall well-being. Fonfría-Vivas et al. [9], in a study involving community-dwelling older women, observed that those with SO had significantly lower SarQol scores, indicating a poorer QoL. SarQol is a self-administered questionnaire that assesses 55 aspects of QoL across seven domains, including physical and mental health, mobility, body composition, functionality, activities of daily living, leisure activities, and fears [66]. Consistent with these findings, Liu et al. [27] reported a significant association between SO and lower QoL in a cohort of 6790 Chinese patients with cancer. Cancello et al. [42] also found a strong correlation between SO and worsening QoL scores, further emphasizing the negative impact of SO on both physical and psychological health. Finally, the relationship between SO and sexual dysfunction (SD) remains an emerging but under-investigated topic. Demirdağ et al. [67] investigated the prevalence of sexual dysfunction and its association with SO in a cohort of 267 community-dwelling older adults (≥65 years). While SO was found to be significantly associated with SD, the association was no longer significant after adjusting for sex, marital status and comorbidities.

3.6. *Additional alternative diagnostic parameters*

Some studies employed alternative or additional methods for body composition assessment in the general framework of the SOGLI algorithm [Supplementary Table 2]. Many studies [Supplementary Table 2] collected additional parameters potentially related to SO, such as gait speed tests (e.g. Six-Minute Walk Test, 4 m gait speed) [68,69] and the Timed Up and Go test (TUG) [70]. However, these measures were not integrated into the diagnostic process of SO and will not be discussed in detail.

3.6.1. *Phase angle (PhA)*

In the context of BIA, Hafızoğlu et al. [51] found that PhA values were lower in individuals with SO in a cohort of 322 older adults with type 2 diabetes. Yoshimura et al. [33] reported that SO was significantly and negatively associated with PhA in 760 patients with stroke in a post-acute care hospital in Japan, also reporting cutoff values. Marini et al. [18] aimed to establish a method for detecting bioelectrical characteristics through specific Bioelectrical Impedance Vector Analysis (BIVA). In 915 community-dwelling Italian adults, those suffering from SO had longer vectors (indicating greater FM%) and lower PhA (indicating lower muscle mass and quality).

3.6.2. *Anthropometry*

Among the 72 published studies using the SOGLI algorithm, calf circumference was reported in 10 studies; however, only four studies, demonstrated a significantly lower calf circumference in individuals with SO compared with patients with obesity without sarcopenia. Three studies [27,39,40] reported that calf circumference was significantly lower in patients with SO compared with patients with obesity without sarcopenia, although differences with other comparison groups (non-sarcopenic non-obese or sarcopenic non-obese) were less consistent. In addition, Xu et al. [71] reported that neck circumference predicted SO beyond WC and BMI and suggested that it could be considered as a possible new anthropometric measurement for SO screening [71]. Finally, in community dwelling older adults from Turkey, Güner et al. [39] reported that the Waist-to-Calf Ratio (WCR) was significantly higher in patients with SO, proposing its potential role as SO predictor in this setting.

3.6.3. *Muscle mass anthropometric adjustment*

Some studies reported normalization of muscle mass by BMI instead of body weight and a few compared SMM/BMI with SMM/W, reporting generally small differences. Cadvar et al. [65] found no difference among the SOGLI-supported (SMM/W) and the alternative method (SMM/BMI). In one study [72] SO prevalence was 16.4% and 15.0% when SMM was adjusted by weight or BMI respectively. In the same study the authors also analyzed SMM adjusted by height^2 and they reported that this adjustment may cause an underestimation of SO (prevalence of 1.9 compared to 16.4% when SMM was adjusted by weight as proposed in the SOGLI algorithm). Li et al. [63] Tang et al. [36] and Zhou et al. [53] all found only minimal differences in SO prevalence using SMM/W or SMM/BMI: 13.2 vs 11.4%; 43.5 vs 45.3%; 31.9 vs 28.2%, respectively.

4. Discussion

The SOGLI algorithm represents a significant step forward in the standardization of SO screening, diagnosis, and staging, offering a consensus-based structured and clinically relevant approach to identify this complex condition. The number of studies adopting the SOGLI algorithm for the diagnosis of SO has rapidly increased over time, along with its citations in scientific literature. This trend reflects the growing recognition of the algorithm as a valuable effort to standardize procedures and create a shared framework for studying pathophysiology and therapeutic approaches.

Our review indicates a rapid uptake of the SOGLI algorithm in clinical research, as more than 70 studies have applied it for the diagnosis of SO over a period of approximately two and a half years. BMI and waist circumference were regularly used in the screening process, while SARC-F or symptom-based screening for sarcopenia was reported less often. Muscle function was primarily assessed through handgrip strength, while Sit-to-Stand test was less common. Body composition analysis is also required for SO diagnosis, and it was most often based on BIA. Staging was reported in about one-fifth of the studies, most often with patients classified as Stage II. Importantly, clinical findings confirm the clinical relevance of the SOGLI algorithm with a strong association of SOGLI-diagnosed SO with multimorbidity, functional impairment/decline, and mortality. SO prevalence expectedly varied across studies, reflecting differences in populations and study design. In the six studies that explicitly reported all phases of the algorithm [9,11,26,27,32,33], prevalence ranged from 4% to 7.3%. In community-dwelling older adults, SO prevalence typically ranged from approximately 5%–10% across different studies, suggesting reasonable consistency when common diagnostic tools were used. Higher SO prevalence was also consistently observed in high-risk groups such as COVID-19 survivors [34,35], nursing home residents [36], cancer patients [27] and bariatric surgery candidates [30,37]. Such wide variability in prevalence estimates should therefore be interpreted primarily as a consequence of population characteristics and methodological heterogeneity, rather than as an intrinsic inconsistency of the SOGLI definition.

Despite its strengths, this review highlights relevant areas for improvement in real-world application of the algorithm, which will be discussed in the following sections.

4.1. *Screening phase*

The screening phase of the algorithm is designed to ensure that diagnostic procedures are applied to individuals at risk for SO. However, its implementation was not consistently reported across studies. This heterogeneity may partly reflect true variability in practice, but also the fact that many included cohorts (such as adults >70 years, hospitalized patients, or those with chronic disease) would already be considered screening-positive according to the SOGLI consensus [1,28,73]. In these cases, conditions for positive screening may have been implicit and therefore not explicitly described in the methods. An interesting example comes from the study by Shimizu et al. [11], that investigated SO in stroke survivors. Recent stroke represents a risk factor fulfilling the screening condition of recent hospitalization and neurological disease, also listed in the original ESPEN-EASO (SOGLI) paper. All patients should have been considered positive and submitted to the diagnostic procedure, but the authors failed to consider stroke as a risk condition, resulting in reported variability in SO prevalence. In some studies, such as Marini et al. [18], the focus was specifically on diagnostic techniques, hence omission of the screening step. The frequent lack of explicit reporting of the screening phase represents a relevant methodological limitation, as it hampers the ability to determine whether deviations from the SOGLI algorithm reflect true clinical adaptations or incomplete methodological reporting.

In general, emerging results suggest that choice of screening parameters may however influence prevalence estimates. In particular:

- Screening for excess adiposity. Vieira et al. [19] reported that the use of BMI alone may underestimate excess adiposity: in their study population, BMI classified only 53.8% of individuals as having obesity, whereas DXA identified 30% more cases. While the routine use of DXA is unrealistic for screening purposes, BMI may need to be routinely combined with WC or other measures of excess adiposity when feasible [74]. Although 29 studies collected both WC and BMI, none investigated potential differences in screening results between these measures, which should be further explored in future research.
- Screening for low muscle mass and function. The use of SARC-F was infrequent and remains under debate in the field of sarcopenia [75,76]. Its low adoption may reflect practical barriers such as time constraints, limited training or knowledge of this tool among physicians. Importantly, the questionnaire was initially designed for use in geriatric population and may require further validation in non-geriatric cohorts. Booranasuksakul et al. [10] applied SARC-F to a middle-aged population and found a higher prevalence of SO in individuals aged 50–59 years compared with those aged 60–85 years, which may reflect early onset of SO but could also indicate reduced specificity of SARC-F outside geriatric cohorts. Moreover, although SARC-F is the most widely recommended screening tool for sarcopenia, it has low-to-moderate sensitivity, which may limit its ability to detect early cases of sarcopenia and SO.

Looking ahead, a general important question is whether the screening phase should be omitted in settings where direct assessment of muscle mass and strength is available, or when the population has a general high risk of SO and could be directly included in the diagnostic step. The recent 5-year update of the Global Leadership Initiative on Malnutrition (GLIM) [59] raised a similar question regarding the role of malnutrition screening and announced that updated recommendations on how, when, and if screening should be used will soon be provided. Likewise, future work by the SOGLI consortium should further define recommendations for the use of screening across clinical settings, balancing feasibility, and diagnostic accuracy.

4.2. Diagnostic phase

The SOGLI diagnosis of SO requires both muscle function and body composition analysis, which were implemented using different approaches across studies, with most common utilization of BIA for body composition and handgrip strength for muscle function.

- Muscle function. Most studies measured muscle strength through HGS, while the STS test was less frequently employed. Pouget et al. [14] suggested that obesity may differentially affect upper and lower limb strength, and this issue may need to be addressed in further investigations. Importantly, different methods for muscle function assessment may capture distinct physiological domains, such as upper versus lower limb strength and function, potentially leading to the identification of different patient subgroups. This heterogeneity may contribute to variability in prevalence estimates and associations with clinical outcomes, thereby affecting the comparability and interpretability of SO diagnosis across studies. As mentioned in the paper published by Gortan Cappellari G et al. [7] further research should better define the validity of the skeletal muscle functional parameters considering other criteria (e.g. gait speed), normative sex-, ethnicity- and age-specific cut points, the adjustment of these parameters to BMI, height or weight, the opportunity to refer to lower as opposed to upper limb strength).
- Normalized strength measurements have been also explored, such as HGS adjusted for fat-free mass (FFM). Notably, the Global Leadership Initiative on Sarcopenia (GLIS) group has recently proposed normalization of muscle strength for muscle mass, defined as muscle-specific strength, as a diagnostic criterion for sarcopenia in its conceptual definition, although its measurement has not been operationalized [77]. Normalization of muscle strength represents a potential future research direction, with more data needed before adjustments (also including HGS/weight, HGS/BMI) can be recommended to improve diagnostic accuracy. Also, the underutilization of STS may have affected detection of SO in some studies [16].
- Body composition and muscle mass. Despite methodological variability, a clear prevalence was reported for use of BIA for body composition analysis. However, the use of different measurement protocols and BIA equations may lead to variability in SO prevalence across studies [17]. DXA, while considered the reference method for body composition [78] was used less frequently due to limited accessibility and higher costs. Importantly, BIA and DXA may yield different estimates in individuals with obesity, underscoring the need for appropriate predictive equations and their optimization in further studies to estimate body compartments [8,79].

In general, different combinations of muscle function and body composition assessment methods could also lead to variability, as suggested by one study in 90 patients involved in a rehabilitation program for severe obesity [16]. Taken together, these observations suggest that while the SO algorithm provides clear guidance, further standardization of procedures will strengthen its implementation and comparability across diverse settings. Future harmonization of methods, and potential optimization in different settings and cohorts could also help reduce variability in prevalence and outcome predictive ability. While the SOGLI algorithm provides a clear conceptual framework, its real-world implementation would benefit from further methodological harmonization, particularly regarding measurement protocols and cut-off selection.

4.3. Staging phase

Staging was reported in only a minority of studies. When staging was implemented, most patients were classified as Stage II, often due to the presence of complications such as stroke [26], cancer [27], or metabolic syndrome [28]. The predominance of Stage II classification across studies likely reflects the clinical complexity of the investigated populations rather than a true limitation of the staging framework itself; nevertheless, this pattern highlights the need for clearer operational guidance on attribution of complications to sarcopenic obesity. It should be pointed out that the algorithm indicates that staging assessment should be based on comorbidities directly related to SO. These would directly include disabilities and metabolic diseases, whereas a direct pathogenetic impact of SO, for instance, on cancer or kidney disease has not been demonstrated. Further clarification and optimization of comorbidity patterns should help to guide the staging process. The importance of staging in clinical practice should however be underscored: following SO diagnosis, clinicians should be prompted to actively search for complications and accordingly tailor interventions and their intensity. Given the consistent associations of SO with multimorbidity and mortality [23,80–85], staging has indeed the potential to become a valuable tool for risk stratification and individualized management.

4.4. Additional alternative diagnostic parameters

Some parameters not included in the diagnostic algorithm have been suggested and investigated by different authors as potentially relevant to SO assessment. Phase angle is generated by BIA, reflecting the capacitive and resistive properties of human tissues as an indirect indicator of cell membrane integrity and intracellular function [86]. Elevated PhA values are typically correlated with better nutritional status, including adequate protein reserves, muscle mass, and overall body composition. Lower PhA values have been conversely associated with conditions such as metabolic syndrome, type 2 diabetes, and obesity [87]. Future research is warranted to determine the clinical applicability of PhA as a diagnostic and prognostic biomarker for SO, including its potential role in monitoring disease progression and response to interventions. Calf circumference (CC) is also an interesting clinical parameter that can be easily assessed across different settings and may represent a proxy for whole-body skeletal muscle mass [88]. However, it should be taken into account that obesity may lead to significant bias and error in anthropometric lean mass assessment, due to subcutaneous fat depots. In community-dwelling individuals, CC is higher in SO compared with non-sarcopenic non-obese subjects and may need to be adjusted for body weight, BMI or FFM [40,51]. Notably, none of the studies implementing the SOGLI algorithm applied BMI-adjusted CC values for participants outside the normal-weight BMI range [89]. The WCR was also used in one study, representing a relatively new anthropometric index in obesity research calculated by dividing WC by CC, both in centimeters. It may represent a useful indicator of body composition, also taking into account abdominal fat distribution and peripheral muscle mass. In previous studies, it has been shown that WCR is useful for assessing abdominal obesity and related health risks, including metabolic conditions like insulin resistance and cardiovascular disease such as carotid atherosclerosis in diabetic patients [90]. Additionally, high WCR has been linked to cognitive decline in older adults and increased frailty, highlighting its importance in evaluating overall health [91]. A high WCR may reflect an imbalance between appendicular muscle mass and central adiposity [92], suggesting its potential as a predictive marker for SO. Finally, the application of the load-capacity model of body composition has recently gained attention for its potential in identifying SO and predicting cardiometabolic risk [93,94]. This model, which is typically expressed as the ratio of metabolic load (fat mass) to metabolic capacity (lean mass), relies on measurements obtained through non-anthropometric techniques [93]. All of the above parameters may be potentially considered for integration of the SOGLI diagnostic algorithm, but more evidence in this setting is needed.

4.5. Clinical outcomes

A most important emerging finding is that SOGLI-diagnosed SO was associated with increased mortality risk, multimorbidity, functional decline, and reduced quality of life across diverse populations in most studies. Associations were also observed with chronic diseases such as diabetes and COPD, as well as with a higher risk of falls and disability. Few studies have however quantified the importance of SO-particularly when compared with the presence of only sarcopenia or obesity [95]. The findings regarding the clinical consequences of SO reinforce the value of the SOGLI algorithm not only for diagnosis but also for staging, since documenting complications is crucial to risk stratification and to tailoring clinical interventions. Although most evidence derives from observational studies, the consistency of associations with clinically relevant outcomes supports the construct validity of the SOGLI algorithm, while underscoring the need for prospective and interventional validation. At the same time, it should be acknowledged that the exclusive inclusion of studies explicitly applying the SOGLI algorithm may introduce selection bias, as studies adopting alternative diagnostic criteria for SO were not included, potentially leading to an overestimation of its clinical relevance.

5. Conclusion

In conclusion, the rising number of studies implementing the SOGLI algorithm highlights an increasing interest in understanding SO prevalence and its clinical implications, as well as the applicability of the algorithm in clinical research and potentially practice. Given the growing prevalence of SO in all settings, and its high prevalence in patients with chronic disease, older adults and those recovering from hospitalizations and acute diseases, early identification across primary care, hospital, and rehabilitation environments should be prioritized to mitigate the risk of functional decline, multimorbidity, and increased mortality. The use of the SOGLI algorithm is still in its early stages and has been applied across heterogeneous clinical settings, with some expected discrepancies in practical application emerging from the current review. Nevertheless, the algorithm is increasingly recognized as the reference standard in SO diagnosis, as also demonstrated by high number of overall citations (>880). Future efforts to optimize the algorithm and integrate emerging diagnostic models may enhance its clinical utility, contributing to improved patient outcomes and more effective long-term management of SO. As stated in the original ESPEN/EASO (SOGLI) consensus document [1], the expert panel intended to re-evaluate the proposed procedures after a sufficient period of clinical research implementation. At the same time, the present findings indicate that further refinement of operational guidance and reporting standards will be essential to maximize the clinical and research utility of the SOGLI algorithm. In this context, analyzing the studies that have adopted the algorithm may help identify, over time, potential updates to the procedures and/or new cut-off values for the diagnostic tools.

Authors' contribution

All the Authors were involved in: 1) the conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; 3) final approval of the final version to be published; 4) agreement to be accountable for all aspects of the work, thereby ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. No one eligible for authorship has been excluded from the list of authors.

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Conflict of interest

The other authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

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