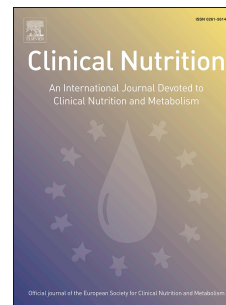


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Current application and future directions for the Sarcopenic Obesity Global Leadership Initiative (SOGLI) diagnostic algorithm

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1 **Current application and future directions for the Sarcopenic Obesity Global Leadership Initiative**
2 **(SOGLI) diagnostic algorithm**

3

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49

50 **Abstract**

51 **Background.** Sarcopenic obesity (SO) is characterized by excess adiposity and reduced muscle mass
52 and function. In 2022, the Sarcopenic Obesity Global Leadership Initiative (SOGLI) proposed a
53 diagnostic algorithm to standardize SO identification by integrating screening, diagnostic assessment,
54 and staging.

55 **Aim:** This review evaluates the application of the SOGLI algorithm, identifying strengths, limitations,
56 and potential areas for refinement.

57 **Methods.** A narrative review with systematic citation tracking was conducted (April 2022- August
58 2025). Literature searches in PubMed, Scopus, and Web of Science identified original studies in adults
59 (≥ 18 years) explicitly using the SOGLI algorithm. Data on screening, diagnostic tools, staging,
60 prevalence, and comorbidities were synthesized.

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

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

72

73 **Keywords:** sarcopenic obesity, ESPEN/EASO algorithm, Sarcopenic Obesity Global Leadership
74 Initiative, SOGLI

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

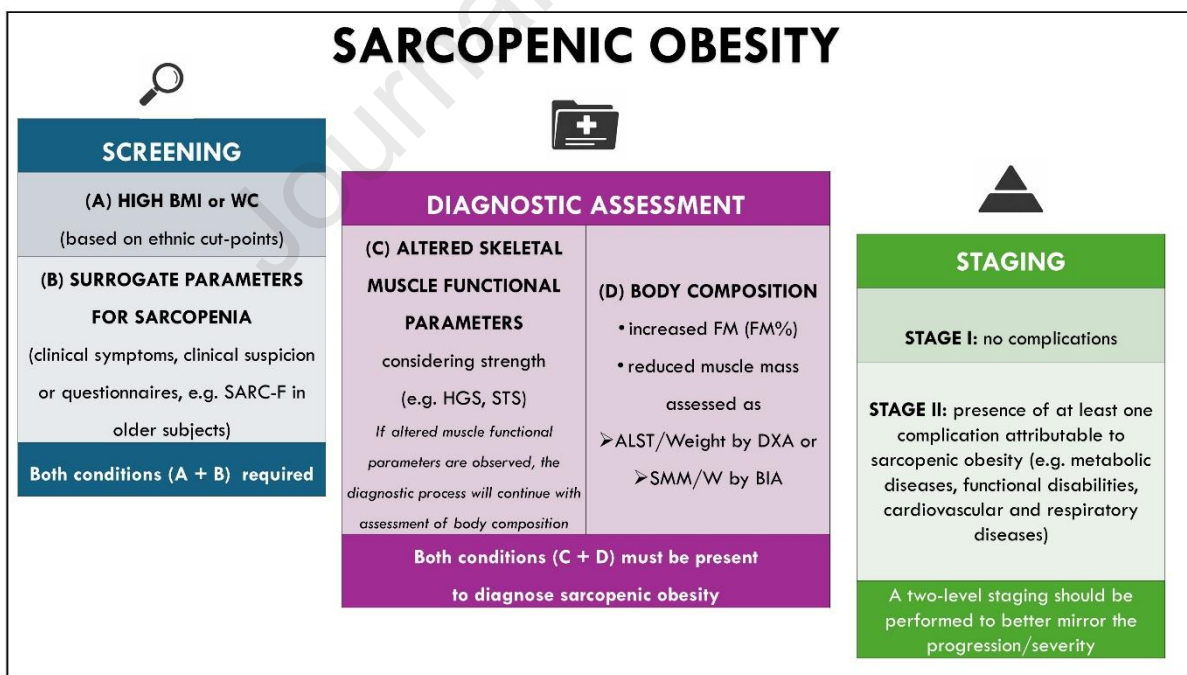
86 INTRODUCTION

87 Sarcopenic obesity (SO) is a condition characterized by the coexistence of excess adiposity
88 (obesity) and low muscle mass and function (sarcopenia)(1,2). The pathophysiology of SO is driven by
89 a complex interplay of hormonal, genetic, inflammatory, and myocellular mechanisms, influenced by
90 the cross-talk between adipose and muscle tissues (3). These interactions promote fat accumulation
91 while contributing to the loss of muscle mass and strength (4). A sedentary and inactive lifestyle,
92 excessive energy intake, and inadequate protein consumption further exacerbate this process, acting
93 both as a cause and a consequence of sarcopenia and obesity (1), which may reinforce each other in
94 a vicious cycle (5). As a result, individuals with SO tend to experience worse health outcomes than
95 those affected by either sarcopenia or obesity alone, including a higher risk of disability, loss of
96 independence, reduced quality of life, worsened outcome for many diseases and increased mortality
97 (3,6).

98 There is growing recognition of SO as an emerging public health concern, given its clinical and
99 functional implications, which adversely impact key patient-centered outcomes (1). Effective
100 identification and treatment of SO however has been until recently hampered by variability in its

101 assessment in clinical practice worldwide (7). To provide a standardized approach for SO identification
 102 and management, on behalf of the European Society for Clinical Nutrition and Metabolism (ESPEN)
 103 and the European Association for the Study of Obesity (EASO), the Sarcopenic Obesity Global
 104 Leadership Initiative (SOGLI) discussed, developed, and proposed a consensus-based diagnostic
 105 algorithm, which was published in 2022 (1,2) . This framework aimed at harmonizing clinical practice
 106 approaches to SO diagnosis and advancing research in this rapidly evolving field (1) **(Box 1 and figure**
 107 **1).**

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



114
 115 The current review with systematic citation tracking aims at evaluating the implementation of
 116 the SOGLI diagnostic algorithm by analyzing studies that explicitly reported its application up to August
 117 2025, in order to identify strengths, limitations, and potential misapplications that may guide its future

118 refinement and optimal utilization. In addition, we summarize recent developments and emerging
119 evidence on SO diagnosis, with a focus on prevalence estimates and clinical outcomes across different
120 populations.

121 **METHODS**

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

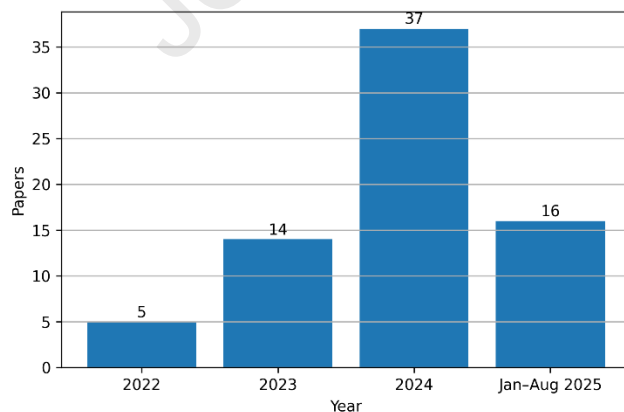
142 Relevant data were extracted by GP and MM, including publication details, sample size, participant
143 characteristics (sex, nationality, age), study setting, diagnostic criteria, SO prevalence rates, outcomes,

144 and limitations. Any disagreements were resolved by a third reviewer (LMD). We considered older
145 adults as persons aged ≥ 65 years, while study samples with mean ages below 65 were classified as
146 middle-aged populations, and those reporting wide or mixed ranges were categorized as mixed-age
147 populations. Also, to standardize the terminology in this work, we use appendicular lean soft tissue
148 (ALST) instead of appendicular lean mass (ALM)(8).

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

157 RESULTS

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



160

161 **Figure 2.** Original studies using the SOGLI algorithm as diagnostic criteria for Sarcopenic Obesity (SO)
162 published per year.

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

175 **1. SARCOPENIC OBESITY SCREENING**

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

180 **SARCOPENIA:** To screen for the presence of sarcopenia, 8 studies (11.1%) adopted the SARC-F
181 questionnaire; 11 studies (15.3%) assessed clinical symptoms for sarcopenia, while one (9) used both
182 SARC-F and clinical symptoms. Among the 8 studies applying SARC-F, 5 were conducted in older adult
183 populations, while 1 used the questionnaire in a younger population (10). Fonfría-Vivas et al.(9)
184 studied 95 community-dwelling women aged ≥ 70 years. They noted that women with SO exhibited
185 the highest SARC-F scores compared to women with sarcopenia alone or without sarcopenia. In 52
186 studies (72.2%) it was unclear which surrogate parameter for sarcopenia was used in the screening
187 phase.

188 Notably, Shimizu et al.(11) analyzed differences in SO prevalence with or without implementation
189 of the screening phase. In a sample of older Japanese adults, SO prevalence in a rehabilitation setting
190 was approximately 4% when the screening phase was applied (BMI \geq 25 kg/m² plus clinical symptoms
191 or suspected sarcopenia), while it increased to 20–30% when SO was directly assessed using bio-
192 impedance analysis (BIA) and handgrip-strength (HGS). However, it should be pointed out that by
193 definition, all individuals in the study should have been considered at risk for sarcopenia, since they
194 had suffered a recent stroke with acute disease, hospitalization and reduced mobility (1,2).

195 2. SARCOPENIC OBESITY DIAGNOSIS

196 72 studies used the SOGLI algorithm for the diagnosis of SO (**Figure 1**).

197 MUSCLE FUNCTION: 18 studies (25%) assessed both HGS and sit-to-stand (STS) (previously reported
198 as chair-stand test and including both the 5-time STS and the 30-STs), while 42 (58.3%) relied solely
199 on HGS. Only two studies(12,13) (2.8%) used STS alone, and 2 studies assessed the isokinetic strength
200 of quadriceps muscle (2.8%). Eight studies (11.1%) did not report how muscle function was assessed.
201 Pouget et al.(14) found in a population of 799 patients hospitalized for obesity in the Clinical Nutrition
202 Department of the University Hospital Center (CHU) of Clermont-Ferrand, France, between June 4,
203 2018, and March 29, 2022, that the prevalence of SO was low in their cohort but slightly different
204 according to functional tests: 5.4% and 3.2% for HGS and STS, respectively. Cook et al.(15) also
205 observed different prevalence of low muscle function in their sample (85 older adults with excess
206 adiposity from a rural community in New Hampshire) based on assessment method: 36 participants
207 completing the diagnostic step with SO (7 men and 29 women) had low HGS, 29 (9 men and 20 women)
208 were below the cut-point for the 30-Second STS, and 1 female participant showed low values for 5-
209 Times STS. 11 women and 2 men (15% of the sample) were below the cut-points in both HGS and the
210 STS (either the 30-second or 5-times).

211 BODY COMPOSITION: 4 studies(16–19) (5.6%) used both BIA and dual-energy X-ray absorptiometry
212 (DXA), while the majority (42=58.3%) relied solely on BIA, and 24 (33%) used only DXA. Two
213 studies(20,21) did not report how body composition was assessed (Table 1). Similar to muscle

214 function, some differences were also reported in SO prevalence when comparing different BC
215 assessment methods in the same cohort. Vieira et al.(19) observed prevalence of 7.9% and 23% in
216 their cohort using BIA and DXA, respectively. In the study by González-Arnáiz et al.(17), SO prevalence
217 ranged from 13% to 22% when using BIA with the skeletal muscle mass (SMM)/weight ratio, according
218 to Janssen et al.(22). When DXA was employed, prevalence ranged from 13% to 23% using the
219 ALST/weight ratio, following criteria described by Batsis et al(23). Different HGS cut-off points [e.g.
220 those proposed by Sánchez-Torralvo et al.(24), Dodds et al.(25) or a thresholds set at <-2 SD from a
221 healthy reference population] accounted for a large proportion of the variability in SO prevalence.
222 Danielewicz et al.(16) calculated the prevalence rates of SO using different tool combinations in their
223 study. Prevalence rates of SO were 23.3%, 25.5%, 31.1%, and 40.0% when using high fat mass (FM)
224 combined with STS+ALST/Weight (W), HGS+ALST/W, STS+SMM/W, and HGS+SMM/W, respectively.

225 **3. SARCOPENIC OBESITY STAGING**

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

235 **4. PREVALENCE of SARCOPENIC OBESITY**

236 Among the 72 studies that used the SOGLI algorithm, the reported prevalence of SO varied
237 widely, ranging from 1.1 (29) to 100% (30,31), expectedly reflecting broad heterogeneity in the
238 populations and settings studied. In the 6 studies that described all the steps (screening of both obesity
239 and sarcopenia, diagnosis and staging) and detailed how each step was performed (9,11,26,27,32,33),

240 SO prevalence ranged from 4% to 7.3% (3 of these studies were conducted in rehabilitations settings
241 for stroke, 2 in hospital patients with stroke or cancer, 1 in community dwelling older subjects). 5 of
242 these 6 studies were conducted in Asia. Among all studies and settings, higher prevalence of SO was
243 reported among patients with COVID-19 infection (from 34.5 to 56.7%) (34,35), nursing home
244 residents (43.5-45.3%)(36), and patients undergoing bariatric surgery (from 89.3 to 100%) (30, 31,37).
245 Nearly all studies reported a higher prevalence of SO in older individuals (16,27,29,36,38,39,
246 40,41,42,43,44). However, Booranasuksakul et al.(10) found a higher prevalence of SO in individuals
247 aged 50–59 years (18.1%) compared to individuals aged 60–85 years (14.2%) in a cohort of 2,356
248 community-dwelling adults. Regarding sex differences, Schluessels et al.(38), and Vieira et al.(19)
249 reported a higher prevalence of SO in men than in women (respectively 4 vs 5%; 21.7 vs 35.7%. On
250 the contrary, studies by Canello et al.(42) and Danielewicz et al.(16) documented a significantly higher
251 prevalence of SO in women (respectively 12.4 vs 10.7%; 55.3 vs 23.2%).

252 5. SARCOPENIC OBESITY AND CLINICAL OUTCOMES

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

255 5.1. Overall mortality and multimorbidity. Tseng et al.(29) examined a cohort of 1,779 community-
256 dwelling older adults in Taiwan, identifying a significantly higher 11-year mortality risk in those with
257 SO compared with those without SO. This was confirmed in a study conducted by Zhou et al.(45) and
258 also in a large-scale study by Benz et al.(46) on 5,888 individuals in the Netherlands.

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

265 5.2 Cardiometabolic risk profile

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

284 5.3 Cancer and other chronic diseases

285 - CANCER. Six studies have reported the clinical impact of SO in patients with cancer. Zhou et al.(53)
286 reported a 31.9% prevalence of SO in a cohort of 639 patients with advanced non-small cell lung
287 cancer, which was significantly associated with increased mortality. The link between SO and worse
288 survival in patients with cancer has been confirmed in multiple studies (54,55,56). Pedersini et al.(57)
289 examined a subgroup of women with early-stage breast cancer who had undergone surgery,
290 chemotherapy, and at least 18 months of therapy with aromatase inhibitor (AI). They found that 7.7%
291 of the patients developed SO following AI therapy. Furthermore, women with SO before AI therapy

292 were more likely to experience persistent SO after AI treatment. In a Chinese cohort of 6,790 patients
293 with cancer, Liu et al.(27) identified SO as most prevalent in breast cancer (5.9%), lung cancer (4.7%),
294 and colorectal cancer (4.6%), reinforcing its frequent occurrence across different tumor types.

295 - RESPIRATORY DISEASES. Among older individuals with chronic obstructive pulmonary disease
296 (COPD), Kaluźniak-Szymanowska et al.(58) observed that patients with SO undergoing a pulmonary
297 rehabilitation program required more prescription medications and had a more severe disease course.

298 Two studies specifically examined the impact of SO on COVID-19 outcomes. In a study including 30
299 post-critical patients suffering from COVID-19 infection, Cornejo-Pareja et al. reported that 56.7%
300 showed SO(34). Similarly, Zong et al.(35) reported a SO prevalence of 34.5% among 113 hospitalized
301 older adults with COVID-19. In this cohort, patients with SO were older, had a higher prevalence of
302 COPD, exhibited higher rates of malnutrition and frailty, and had a greater risk of requiring intubation
303 with overall poorer clinical outcomes.

304 - COGNITIVE IMPAIRMENT. Booranasuksakul et al.(10) examined 2,356 community-dwelling adults
305 (50–85 years old) and identified a significant association between SO and cognitive impairment,
306 particularly in those aged 60 and above. This association was further supported by Schluessels et
307 al.(38), who found a strong correlation between SO, disability, and cognitive decline.

308 5.4. Malnutrition, functional limitations and risk of falls

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

315 SO has been also consistently associated with an increased risk of falls in older adults. Montalvão-
316 Sousa et al.(62) found that SO was related to higher proportion of falls in the previous year in 232
317 community-dwelling older women. Li et al.(63) confirmed a significant association between SO and

318 increased risk of falls in a cohort of 1,353 community-dwelling older adults in Western China.
319 Consistent results were reported by Scott et al.(64), who examined 1,416 Australian older men and
320 found that SO was associated with higher fall rates. Consistent with these findings, poorer physical
321 performance was observed in subjects with SO based on Short Physical Performance Battery and
322 6MWT results in a cohort of hospitalized patients in a rehabilitation unit aged ≥ 60 years (13). On the
323 other hand, Cadvar et al.(65) reported no associations between SO (with muscle mass normalized for
324 body weight or BMI), and either impaired activities of daily living (ADL), instrumental activities of daily
325 living (IADL) or functional disability in 408 outpatients ≥ 65 years in Turkey.

326 5.5. Quality of life and sexual function

327 Several studies have highlighted the negative impact of SO on quality of life (QoL), emphasizing its
328 detrimental effects on overall well-being. Fonfría-Vivas et al.(9), in a study involving community-
329 dwelling older women, observed that those with SO had significantly lower SarQoL scores, indicating
330 a poorer QoL. SarQoL is a self-administered questionnaire that assesses 55 aspects of QoL across seven
331 domains, including physical and mental health, mobility, body composition, functionality, activities of
332 daily living, leisure activities, and fears (66). Consistent with these findings, Liu et al.(27) reported a
333 significant association between SO and lower QoL in a cohort of 6,790 Chinese patients with cancer.
334 Canello et al.(42) also found a strong correlation between SO and worsening QoL scores, further
335 emphasizing the negative impact of SO on both physical and psychological health. Finally, the
336 relationship between SO and sexual dysfunction (SD) remains an emerging but under-investigated
337 topic. Demirdağ et al.(67) investigated the prevalence of sexual dysfunction and its association with
338 SO in a cohort of 267 community-dwelling older adults (≥ 65 years). While SO was found to be
339 significantly associated with SD, the association was no longer significant after adjusting for sex,
340 marital status and comorbidities.

341 **6. ADDITIONAL ALTERNATIVE DIAGNOSTIC PARAMETERS**

342 Some studies employed alternative or additional methods for body composition assessment in the
343 general framework of the SOGLI algorithm [**Supplementary Table 2**]. Many studies [**Supplementary**

344 **Table 2]** collected additional parameters potentially related to SO, such as gait speed tests (e.g. Six-
345 Minute Walk Test, 4 meter gait speed)(68,69) and the Timed Up and Go test (TUG)(70). However,
346 these measures were not integrated into the diagnostic process of SO and will not be discussed in
347 detail.

348 6.1. Phase Angle (PhA)

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

356 6.2 Anthropometry

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

367 6.3 Muscle mass anthropometric adjustment

368 Some studies reported normalization of muscle mass by BMI instead of body weight and a few
369 compared SMM/BMI with SMM/W, reporting generally small differences. Cadvar et al.(65) found no

370 difference among the SOGLI-supported (SMM/W) and the alternative method (SMM/BMI). In one
371 study (72) SO prevalence was 16.4% and 15.0% when SMM was adjusted by weight or BMI
372 respectively. In the same study the authors also analyzed SMM adjusted by height² and they reported
373 that this adjustment may cause an underestimation of SO (prevalence of 1.9 compared to 16.4% when
374 SMM was adjusted by weight as proposed in the SOGLI algorithm). Li et al.(63) Tang et al. (36) and
375 Zhou et al. (53) all found only minimal differences in SO prevalence using SMM/W or SMM/BMI: 13.2
376 vs 11.4%; 43.5 vs 45.3%; 31.9 vs 28.2%, respectively.

377 **DISCUSSION**

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

384 Our review indicates a rapid uptake of the SOGLI algorithm in clinical research, as more than 70 studies
385 have applied it for the diagnosis of SO over a period of approximately two and a half years. BMI and
386 waist circumference were regularly used in the screening process, while SARC-F or symptom-based
387 screening for sarcopenia was reported less often. Muscle function was primarily assessed through
388 handgrip strength, while Sit-to-Stand test was less common. Body composition analysis is also
389 required for SO diagnosis, and it was most often based on BIA. Staging was reported in about one-fifth
390 of the studies, most often with patients classified as Stage II. Importantly, clinical findings confirm the
391 clinical relevance of the SOGLI algorithm with a strong association of SOGLI-diagnosed SO with
392 multimorbidity, functional impairment/decline, and mortality. SO prevalence expectedly varied across
393 studies, reflecting differences in populations and study design. In the six studies that explicitly
394 reported all phases of the algorithm (9,11,26,27,32,33), prevalence ranged from 4% to 7.3%. In
395 community-dwelling older adults, SO prevalence typically ranged from approximately 5% to 10%

396 across different studies, suggesting reasonable consistency when common diagnostic tools were used.
397 Higher SO prevalence was also consistently observed in high-risk groups such as COVID-19 survivors
398 (34,35), nursing home residents(36), cancer patients (27) and bariatric surgery candidates (30,37).
399 Such wide variability in prevalence estimates should therefore be interpreted primarily as a
400 consequence of population characteristics and methodological heterogeneity, rather than as an
401 intrinsic inconsistency of the SOGLI definition.

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

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

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

422 - Screening for excess adiposity. Vieira et al.(19) reported that the use of BMI alone may
423 underestimate excess adiposity: in their study population, BMI classified only 53.8% of
424 individuals as having obesity, whereas DXA identified 30% more cases. While the routine use
425 of DXA is unrealistic for screening purposes, BMI may need to be routinely combined with WC
426 or other measures of excess adiposity when feasible (74). Although 29 studies collected both
427 WC and BMI, none investigated potential differences in screening results between these
428 measures, which should be further explored in future research.

429 - Screening for low muscle mass and function. The use of SARC-F was infrequent and remains
430 under debate in the field of sarcopenia (75,76). Its low adoption may reflect practical barriers
431 such as time constraints, limited training or knowledge of this tool among physicians.
432 Importantly, the questionnaire was initially designed for use in geriatric population and may
433 require further validation in non-geriatric cohorts. Booranasuksakul et al.(10) applied SARC-F
434 to a middle-aged population and found a higher prevalence of SO in individuals aged 50–59
435 years compared with those aged 60–85 years, which may reflect early onset of SO but could
436 also indicate reduced specificity of SARC-F outside geriatric cohorts. Moreover, although
437 SARC-F is the most widely recommended screening tool for sarcopenia, it has low-to-
438 moderate sensitivity, which may limit its ability to detect early cases of sarcopenia and SO.

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

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

450 - Muscle function. Most studies measured muscle strength through HGS, while the STS test was
451 less frequently employed. Pouget et al. (14) suggested that obesity may differentially affect
452 upper and lower limb strength, and this issue may need to be addressed in further
453 investigations. Importantly, different methods for muscle function assessment may capture
454 distinct physiological domains, such as upper versus lower limb strength and function,
455 potentially leading to the identification of different patient subgroups. This heterogeneity may
456 contribute to variability in prevalence estimates and associations with clinical outcomes,
457 thereby affecting the comparability and interpretability of SO diagnosis across studies. As
458 mentioned in the paper published by Gortan Cappellari G et al (7) further research should
459 better define the validity of the skeletal muscle functional parameters considering other
460 criteria (e.g. gait speed), normative sex-, ethnicity- and age-specific cut points, the adjustment
461 of these parameters to BMI, height or weight, the opportunity to refer to lower as opposed
462 to upper limb strength).

463 - Normalized strength measurements have been also explored, such as HGS adjusted for fat-
464 free mass (FFM). Notably, the Global Leadership Initiative on Sarcopenia (GLIS) group has
465 recently proposed normalization of muscle strength for muscle mass, defined as muscle-
466 specific strength, as a diagnostic criterion for sarcopenia in its conceptual definition, although
467 its measurement has not been operationalized (77). Normalization of muscle strength
468 represents a potential future research direction, with more data needed before adjustments
469 (also including HGS/weight, HGS/BMI) can be recommended to improve diagnostic accuracy.
470 Also, the underutilization of STS may have affected detection of SO in some studies (16).

471 - Body composition and muscle mass. Despite methodological variability, a clear prevalence
472 was reported for use of BIA for body composition analysis. However, the use of different

473 measurement protocols and BIA equations may lead to variability in SO prevalence across
474 studies (17). DXA, while considered the reference method for body composition (78) was used
475 less frequently due to limited accessibility and higher costs. Importantly, BIA and DXA may
476 yield different estimates in individuals with obesity, underscoring the need for appropriate
477 predictive equations and their optimization in further studies to estimate body compartments
478 (8,79).

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

488 **Staging phase.** Staging was reported in only a minority of studies. When staging was implemented,
489 most patients were classified as Stage II, often due to the presence of complications such as stroke
490 (26), cancer (27), or metabolic syndrome (28). The predominance of Stage II classification across
491 studies likely reflects the clinical complexity of the investigated populations rather than a true
492 limitation of the staging framework itself; nevertheless, this pattern highlights the need for clearer
493 operational guidance on attribution of complications to sarcopenic obesity. It should be pointed out
494 that the algorithm indicates that staging assessment should be based on comorbidities directly related
495 to SO. These would directly include disabilities and metabolic diseases, whereas a direct pathogenetic
496 impact of SO, for instance, on cancer or kidney disease has not been demonstrated. Further
497 clarification and optimization of comorbidity patterns should help to guide the staging process. The
498 importance of staging in clinical practice should however be underscored: following SO diagnosis,

499 clinicians should be prompted to actively search for complications and accordingly tailor interventions
500 and their intensity. Given the consistent associations of SO with multimorbidity and mortality
501 (23,80,81,82,83,84,85), staging has indeed the potential to become a valuable tool for risk
502 stratification and individualized management.

503 **Additional alternative diagnostic parameters.** Some parameters not included in the diagnostic
504 algorithm have been suggested and investigated by different authors as potentially relevant to SO
505 assessment. Phase angle is generated by BIA, reflecting the capacitive and resistive properties of
506 human tissues as an indirect indicator of cell membrane integrity and intracellular function (86).
507 Elevated PhA values are typically correlated with better nutritional status, including adequate protein
508 reserves, muscle mass, and overall body composition. Lower PhA values have been conversely
509 associated with conditions such as metabolic syndrome, type 2 diabetes, and obesity (87). Future
510 research is warranted to determine the clinical applicability of PhA as a diagnostic and prognostic
511 biomarker for SO, including its potential role in monitoring disease progression and response to
512 interventions. Calf circumference (CC) is also an interesting clinical parameter that can be easily
513 assessed across different settings and may represent a proxy for whole-body skeletal muscle mass
514 (88) . However, it should be taken into account that obesity may lead to significant bias and error in
515 anthropometric lean mass assessment, due to subcutaneous fat depots. In community-dwelling
516 individuals, CC is higher in SO compared with non-sarcopenic non-obese subjects and may need to be
517 adjusted for body weight, BMI or FFM (40,51). Notably, none of the studies implementing the SOGLI
518 algorithm applied BMI-adjusted CC values for participants outside the normal-weight BMI range (89).
519 The WCR was also used in one study, representing a relatively new anthropometric index in obesity
520 research calculated by dividing WC by CC, both in centimeters. It may represent a useful indicator of
521 body composition, also taking into account abdominal fat distribution and peripheral muscle mass. In
522 previous studies, it has been shown that WCR is useful for assessing abdominal obesity and related
523 health risks, including metabolic conditions like insulin resistance and cardiovascular disease such as
524 carotid atherosclerosis in diabetic patients (90). Additionally, high WCR has been linked to cognitive

525 decline in older adults and increased frailty, highlighting its importance in evaluating overall health
526 (91). A high WCR may reflect an imbalance between appendicular muscle mass and central adiposity
527 (92), suggesting its potential as a predictive marker for SO. Finally, the application of the load-capacity
528 model of body composition has recently gained attention for its potential in identifying SO and
529 predicting cardiometabolic risk (93,94). This model, which is typically expressed as the ratio of
530 metabolic load (fat mass) to metabolic capacity (lean mass), relies on measurements obtained through
531 non-anthropometric techniques (93). All of the above parameters may be potentially considered for
532 integration of the SOGLI diagnostic algorithm, but more evidence data in this setting is needed.

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

546 **CONCLUSIONS**

547 In conclusion, the rising number of studies implementing the SOGLI algorithm highlights an increasing
548 interest in understanding SO prevalence and its clinical implications, as well as the applicability of the
549 algorithm in clinical research and potentially practice. Given the growing prevalence of SO in all
550 settings, and its high prevalence in patients with chronic disease, older adults and those recovering

551 from hospitalizations and acute diseases, early identification across primary care, hospital, and
552 rehabilitation environments should be prioritized to mitigate the risk of functional decline,
553 multimorbidity, and increased mortality. The use of the SOGLI algorithm is still in its early stages and
554 has been applied across heterogeneous clinical settings, with some expected discrepancies in practical
555 application emerging from the current review. Nevertheless, the algorithm is increasingly recognized
556 as the reference standard in SO diagnosis, as also demonstrated by high number of overall citations
557 (>880). Future efforts to optimize the algorithm and integrate emerging diagnostic models may
558 enhance its clinical utility, contributing to improved patient outcomes and more effective long-term
559 management of SO. As stated in the original ESPEN/EASO (SOGLI) consensus document(1), the expert
560 panel intended to re-evaluate the proposed procedures after a sufficient period of clinical research
561 implementation. At the same time, the present findings indicate that further refinement of
562 operational guidance and reporting standards will be essential to maximize the clinical and research
563 utility of the SOGLI algorithm. In this context, analyzing the studies that have adopted the algorithm
564 may help identify, over time, potential updates to the procedures and/or new cut-off values for the
565 diagnostic tools.

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652

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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 <i>N (min-max)</i>	Papers	Countries
ACUTE CARE	11,198 (30 – 6,790)	15	Austria, Belgium, Brazil, China, France, Italy, Japan, Poland, Spain, Taiwan
REHABILITATION UNITS	10,297 (84 – 3,858)	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

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) (**Figure 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.

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