

SARCOPENIC OBESITY: WHAT, WHEN, AND HOW

Dr Lee Phong Ching, Dr Tan Ying Tse Sarah, Dr Tham Kwang Wei

ABSTRACT

While obesity has garnered significant attention as one of the most common chronic diseases, the awareness and scientific understanding around sarcopenic obesity (SO) remains lacking. SO is characterised by the co-existence of sarcopenia (loss of skeletal muscle mass and function/strength) and obesity (excess or abnormally distributed body adiposity, which impairs health), which can impact people of all ages. SO warrants attention as it serves as an independent risk factor for poorer health and outcomes including increased frailty and mortality, and more adverse metabolic outcomes. With the increasing use of obesity management interventions that result in significant weight loss, SO can either develop in susceptible individuals or worsen in those with pre-existing SO. Management of SO poses unique challenges as it mandates a balance of adequate weight loss with the preservation of skeletal muscle mass and strength. This article provides an overview of SO and its management.

Keywords: Sarcopenia, obesity, prevention, diagnosis, management

SFP2025; 51(5): 54-62

INTRODUCTION

Sarcopenic obesity (SO) is the co-existence of sarcopenia (loss of skeletal muscle mass (SMM) and physical function or strength) and obesity (excess or abnormally distributed body adiposity, which impairs health).

With the advent of a rapidly ageing population, increasing life expectancy, and the rising prevalence of obesity in Singapore, SO warrants urgent attention as it is associated with poorer health outcomes for frailty and geriatric syndromes, for comorbidities of various chronic conditions and increased mortality, compared to either sarcopenia or obesity alone.¹⁻³ In Singapore, the prevalence of sarcopenia ranged from 13.6 percent to 25 percent among community-

dwelling older adults.⁴ The National Population Health Survey 2022 (Singapore) revealed that abdominal (central) obesity increased with age, particularly in women, with the highest prevalence (57.4 percent) among women aged 60–74 years old compared to women 18–29 years old (23.1 percent).⁵ In the Geri-LABS study, which studied Singapore adults 50 years and older, the prevalence of SO was 6.2 percent in men and 12.4 percent in women.⁶

SO can develop under various clinical scenarios. Sarcopenia develops typically as a consequence of ageing, which sees a paralleled change in body composition favouring relative or absolute body fat accrual, setting the metabolic milieu for the development of SO. Furthermore, adipose tissue-associated inflammation of muscle can exacerbate the process of sarcopenia. On the other hand, sarcopenia can develop in people with obesity due to changes in skeletal muscle metabolism, a very sedentary lifestyle, inadequate protein intake and malnourishment (e.g., from chronic dieting or after metabolic bariatric surgery), or after an acute illness that induces skeletal muscle loss. While SO is more common in people of older age, it is also highly prevalent in people with obesity across their lifespan.

In addition, with the availability and use of obesity treatments that can result in significant and rapid weight loss as seen with the newer incretin-based therapies and metabolic bariatric surgery, SO can worsen in those with undiagnosed and untreated SO or develop in at-risk individuals.

Primary care physicians play a pivotal role in the early detection and management of SO to reduce the risk of health sequelae from untreated SO. This article aims to provide an overview of the screening, diagnosis, mechanisms, and management of SO.

PREVALENCE OF SARCOPENIC OBESITY

The prevalence of SO is variable due to the inconsistencies in definitions used and populations studied, highlighting the challenges faced in the diagnostic criteria used for SO. In a study of 535 community-dwelling Singaporean adults aged 21–90 years (the Yishun study), the overall prevalence of SO ranged from 0.4 percent to 7.6 percent, when BMI and waist circumference (WC) were respectively used to define obesity.⁷ Among Singaporean adults aged 50 years and above (Geri-LABS study), the prevalence of SO was lowest for BMI (0.5 percent) compared to fat mass percentage (10.0 percent) and WC (10.5 percent), with WC correlating with worse functional outcomes, underscoring the need to prioritise assessment of central obesity over BMI for the diagnosis of obesity in Singaporeans.⁶

SO is highly prevalent among people with obesity and type 2 diabetes (T2D). Among Singaporean adults with a

DR LEE PHONG CHING

Obesity Centre, Singapore General Hospital, Singapore
Department of Endocrinology, Singapore General Hospital, Singapore

DR TAN YING TSE SARAH

Obesity Centre, Singapore General Hospital, Singapore
Department of Endocrinology, Singapore General Hospital, Singapore

DR THAM KWANG WEI

Senior Consultant
Endocrinology Services, Woodlands Health
National Healthcare Group, Singapore

mean age of 61 years and T2D, the prevalence of SO was nearly 20 percent.⁸ In a cohort of 599 people with obesity (mean age 51 years, mean BMI 43.1 kg/m²) presenting for obesity treatment, SO was present in nearly 50 percent. The prevalence increased with age, with 31 percent of those aged 18–40 years old having SO compared to ~60 percent in those 60 years and above, with SO being twice as prevalent among women (~51 percent) than in men, and in those with lower BMI.⁹ These variable prevalence rates inform us that we need to be vigilant with case-finding not just among people of older age but also among people with co-existing chronic diseases that can predispose to sarcopenia (e.g., T2D) and obesity.

DIAGNOSING SARCOPENIC OBESITY

The diagnosis of SO begins with high vigilance and an approach of case-finding (rather than universal screening).^{4,10,11} Locally, the Singapore Clinical Practice Guidelines for Sarcopenia 2022 recommends case-finding for sarcopenia in adults aged 65 years and above.⁴ In addition, screening for SO is recommended for all individuals with risk factors or with signs or symptoms of SO regardless of age (see **Table 1**).^{4,11}

Commonly encountered clinical scenarios include someone with a very high BMI who loses a disproportionately higher amount of SMM during weight loss (e.g., from physical inactivity and inadequate dietary protein intake) or someone with a pre-disposing chronic disease or frailty who gains weight mainly in ectopic sites and develops central obesity.

There is a lack of a universally established SO definition and diagnostic criteria especially among Asians. Regardless, the diagnosis of SO remains as the establishment of a loss of SMM coupled with reduction in muscle strength or function in people with obesity (including those with central obesity), based on ethnic/population-specific established criteria.¹²

For obesity, screening and diagnosis involve establishing the presence of excess adiposity using ethnic-specific BMI cutoffs (e.g., Asians in Singapore, BMI ≥ 27.5 kg/m²) and/or abnormally distributed adiposity using ethnic and gender-specific anthropometric measurements such as waist circumference (e.g., Asians in Singapore: males ≥ 90 cm; females ≥ 80 cm) or waist-hip ratio (e.g., Asians in Singapore: males ≥ 1.0 ; females ≥ 0.85). The use of BMI alone can often underdiagnose SO particularly in older adults and in Asians. Hence, adding a surrogate assessment of excess or abnormal distribution of adiposity is highly recommended.^{6,7} In addition to anthropometrics, measurement of percentage body fat has been advocated by some experts for diagnosis of obesity in SO although there is no standardisation at present.¹³ The WHO uses body fat cutoffs of >25 percent in males and >35 percent in females while recent studies use >30 percent and >40 percent in males and females respectively to define excess total body fat.^{6,14}

The presence of any of the following clinical conditions that predispose to sarcopenia (e.g., functional decline or limitation; recurrent falls; malnutrition or chronic conditions such as chronic heart, lung, liver, and kidney disease) serves as a positive screening and will warrant confirmation of sarcopenia with further assessments.

In the absence of clinical signs or symptoms of sarcopenia, the Singapore Clinical Practice Guidelines for Sarcopenia (2022) and the Asian Workgroup for Sarcopenia (AWGS) 2019 Consensus call for the adoption of a case-finding approach in adults ≥ 60 years old with the measurement of the calf circumference (in the standing position) or the use of questionnaires (e.g., SARC-F or SARC-CalF).¹⁰ If any of the following parameters are met—calf circumference (M: <34 cm, F: <33 cm) or SARC-F ≥ 4 or SARC-CalF ≥ 11 —further assessments must be carried out to confirm the diagnosis of sarcopenia. The SARC-CalF adds 10 points to the SARC-F scoring for calf circumference below cutoffs.

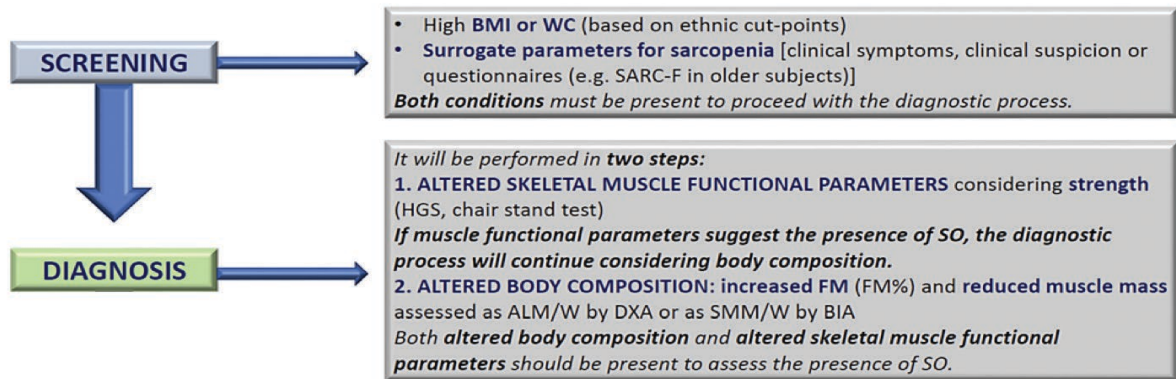
Table 1. Clinical Symptoms or Risk Factors for Sarcopenic Obesity

Age >70 years
Chronic disease diagnosis (e.g., inflammatory diseases and organ failure or chronic disease) including but not limited to:
Chronic heart failure
Chronic kidney disease (particularly renal replacement therapy)
Chronic bowel failure or dysfunction
Chronic liver disease (particularly NASH and liver cirrhosis)
Chronic respiratory disease
Chronic neurologic and neurodegenerative diseases
Chronic cognitive impairment
Depression
Organ transplantation
Endocrine diseases (e.g., metabolic syndrome, diabetes mellitus, hypercortisolism, hypogonadism and corticoid treatment)
Osteoarthritis
Cancer (especially but not limited to chemotherapy of breast or prostate cancer)
Recent acute disease/nutritional events:
Recent hospitalization (particularly but not limited to COVID-19, ICU stay, surgery)
Recent major surgery or trauma with/without complications
Recent sustained immobilization or reduced mobility (e.g., trauma, fracture, orthopaedic disease)
Recent history of reduced food intake (e.g., $<50\%$ for >2 weeks)
Recent weight loss (including diet-induced voluntary weight loss and weight cycling syndrome)
Recent rapid increase in weight
Long-standing restrictive diets and bariatric surgery
History – complaint of:
Repeated falls
Weakness, exhaustion
Fatigability
Perceived progressive movement limitations

Adapted from: Donini LM, Busetto L, Bischoff SC, et al. Definition and Diagnostic Criteria for Sarcopenic Obesity: ESPEN and EASO Consensus Statement. *Obes Facts*. 2022;15(3):321-335. doi: 10.1159/000521241. Epub 2022 Feb 23. PMID: 35196654; PMCID: PMC9210010.¹¹

Following a positive screening for sarcopenia, the diagnosis of sarcopenia requires the confirmation of both (1) reduced skeletal muscle function or strength and (2) reduced SMM, in a 2-stage approach (refer to **Figure 1**).

Figure 1. Diagnostic procedure for the assessment of sarcopenic obesity



Legend:

ALM/W: appendicular lean mass adjusted to body weight; bioelectrical impedance analysis

BMI: body mass index

DXA: dual X-ray absorptiometry

FM: fat mass

HGS: handgrip strength

SMM/W: total skeletal muscle mass adjusted by weight

SO: sarcopenic obesity

WC: waist circumference

SARC-F: strength, assistance with walking, rising from a chair, climbing stairs and falls.

Adapted from: Donini LM, Busetto L, Bischoff SC, et al. Definition and Diagnostic Criteria for Sarcopenic Obesity: ESPEN and EASO Consensus Statement. *Obes Facts.* 2022;15(3):321-335. doi: 10.1159/000521241. Epub 2022 Feb 23. PMID: 35196654; PMCID: PMC9210010.¹¹

For Asians, sarcopenia should be diagnosed using the AWGS 2019 criteria.¹⁰ Poor physical function (performance) is defined as 6-metre walk (gait speed) <1.0 m/s or 5-time chair stand test ≥12 seconds or Short Physical Performance Battery (SPPB) ≤9 while reduced muscle strength is defined as handgrip strength (HGS) of <28 kg and <18 kg for men and women respectively (refer to **Table 2**). However, the validation of these cutoffs is not available for younger people with obesity.

The assessment of muscle mass can be performed using dual energy X-ray absorptiometry (DEXA) for the analysis of appendicular skeletal mass (ASM) corrected for height (ASM/height²). A low ASM is defined as <7.0 and <5.4 kg/m² in men and women respectively, as measured by DXA (refer to **Table 2**).¹⁰ While DEXA is the recommended modality, it is not as accessible in the primary care setting and not every diagnostic facility has the capability to perform a body composition analysis with a DEXA scan. DEXA incurs higher cost (compared to bioelectrical impedance analysis (BIA)) and X-ray exposure, which may impose a barrier for the uptake of assessment. Recognising these challenges, some experts recommend the use of BIA, which is more readily available in most clinical settings. When performed under controlled conditions (e.g., fasted state with light clothing) and in subjects without fluid overload (or issues

with lower extremity swelling), BIA can be a practical and reproducible assessment for monitoring of treatment.

Table 2. Cutoffs for the Screening and Diagnosis of Sarcopenia in Asians¹⁰

Screening		
Clinical Situation	Measurements/Assessment	Positive Cutoff(s)
Presence of any clinical condition or, signs or symptoms of sarcopenia	Functional decline or limitation; unintentional weight loss; depressive mood; cognitive impairment; repeated falls; malnutrition OR Chronic conditions (as listed in Table 1)	Presence of any
Without clinical conditions, signs or symptoms of sarcopenia	Calf circumference or	M <34 cm, F <33 cm
	SARC-F or	≥4
	SARC-CalF	≥11
Diagnosis		
Muscle strength*	Handgrip strength	M <28 kg, F <18 kg
Physical performance (function)*	6-metre walk or	<1.0 m/s
	5-time chair stand test or	≥12 s
	Short Physical Performance Battery	≤9
Appendicular skeletal muscle mass (ASM)**	Dual-energy X-ray absorptiometry or	M <7.0 kg/m ² F <5.4 kg/m ²
	Bioelectrical impedance analysis	M <7.0 kg/m ² F <5.7 kg/m ²

M: males

F: females

*Assessments must be performed in sequence and all three must be present/positive for the diagnosis of sarcopenia

#Use of appendicular lean mass (ALM) or SMM corrected for weight (ALM/weight for DEXA or SMM/weight by BIA) has been alternatively recommended (cutoffs of 35.7% (M) and 30.7% (F) by BIA has been used for a predominantly East Asian population)¹⁵

In people with obesity in whom total body mass can be high, the use of ASM for SMM assessment can under-diagnose sarcopenia. Relatively reduced SMM in the presence of high fat and total body mass can have clinical implications including functional impact, even in the absence of absolute SMM loss. Hence, the use of appendicular lean mass (ALM) or SMM corrected for weight (ALM/weight for DEXA or SMM/weight by BIA) is recommended although this cutoff has not been determined in Asians.^{2,11} Cutoffs of 1–2 standard deviations corresponding to 31.5–37.0 percent (males) and 22.1–27.6 percent (females) have been recommended,¹⁶ while in the Korean SO Study, cutoffs of 35.7 percent (males) and 30.7 percent (females) by BIA have been used for a predominantly East Asian population.¹⁵

In the primary care setting, screening can be done using a case-finding approach with a BMI and waist circumference measurement followed by sarcopenia screening in those with signs or symptoms (refer to **Table 1**), a calf circumference measurement, or a SARC-F questionnaire in those with very high BMI or history of lower extremity oedema (in whom a calf circumference will not be accurate). Confirmation of sarcopenia can be easily carried out using a handheld dynamometer to measure handgrip strength repeated at least twice (for assessment of muscle strength) or the 5-time chair stand test or 6-metre walk test (for assessment of muscle function) followed by confirmation of reduced SMM (body composition) using a BIA scan, provided the patient does

not have fluctuating body fluid issues. not have fluctuating body fluid issues.

PATHOGENESIS AND AETIOLOGY OF SARCOPENIC OBESITY

The aetiology and pathophysiology of SO is complex. Different factors that can trigger the development of SO include ageing (age-related changes in body composition), hormonal imbalances, dietary and lifestyle factors (e.g., malnutrition, physical activity and mental stress), presence of co-existing acute or chronic conditions, and systemic inflammation to myocellular mechanisms (e.g., oxidative stress).^{2,11} Regardless of the metabolic scenario, the main mechanism of pathogenesis is the cross-talk between adipose tissue and skeletal muscle inflammation, and both weight gain and weight loss can contribute to the development of SO.

In people with obesity, the constellation of systemic inflammation, insulin resistance, and oxidative stress, systemically and within the muscles, can lead to a muscle-catabolic state, potentially promoting a “resistance to anabolism” in the skeletal muscle (i.e., reduced muscle protein synthesis in response to nutrients is blunted).^{2,17} In response to weight gain, this leads to a preferential increase in fat mass with proportionately reduced SMM accrual, favouring the development of SO.

Ectopic fat deposition in the muscle (myosteatosis), commonly seen in people with central obesity and insulin resistance, can lead to muscle oxidative stress with reduction in SMM and strength.¹ Reduced physical activity, a pertinent risk factor of weight gain and aetiology of obesity, can have further direct negative impact on muscle protein synthesis and muscle function. Obesity is associated with a myriad of other acute and chronic conditions/diseases (e.g., T2D, heart failure, chronic kidney disease, obstructive sleep apnoea, asthma, musculoskeletal conditions, prolonged hospital stays), which can perpetuate the process of SO either through further reduction in physical activity and/or through systemic inflammation and oxidative stress.^{2,11,13,14}

Weight loss (interventions) inevitably results in SMM loss, especially with rapid or large amounts of weight loss such as seen with metabolic bariatric surgery, very-low calorie diets, and when protein intake and physical activity are lacking during weight loss.¹¹ Body weight cycling and inadequate nutrition, as often seen in chronic dieting in the process of management of obesity, can lead to development of or perpetuate pre-existing SO.^{11,12} Hence, SO is rather prevalent even in younger individuals with obesity. Regardless, as people with obesity increase in age, the physiological changes in body composition favouring a loss in SMM and function with preferential fat mass gain and aggravate pre-existing SO, especially in the presence of risk factors (refer to **Table 1**).

Ageing is associated with physiologic body composition changes involving SMM loss (beginning in middle age) along with the development of myosteatosis and oxidative stress within the muscles, an increase in fat mass, and propensity for visceral adiposity, which favour the development of SO. These changes result from hormonal changes (e.g., reduced growth hormone, testosterone, and estrogen), low levels of physical activity, changes in energy metabolism, and diet (e.g., low protein, calcium, vitamin D intake). When older adults are afflicted with acute or chronic conditions, the above factors are augmented through increased inflammation, immobility, and changes in nutrition, which can lead to either weight gain or weight loss, triggering the onset or accelerating the development of SO.^{2,16}

CLINICAL IMPLICATIONS OF SARCOPENIC OBESITY

The co-existence of obesity and sarcopenia synergistically creates a vicious twin-cycling of SMM loss and adipose tissue gain with further aggravation of SO if untreated. Multiple studies demonstrate an increased risk of metabolic disorders, geriatric syndromes, morbidity, and mortality related to SO.

The clinical consequences of SO include worsening metabolic dysfunction with development of metabolic syndrome, T2D, increased risk of geriatric syndromes (further reduction in physical activity with functional limitation and disability, increased frailty, cognitive impairment and dementia, risk of falls and fractures, depression), prolonged hospital length

of stay, increased risk of all-cause mortality and mortality from various conditions such as cardiovascular disease, heart failure, post-hospitalisation, worse morbidity outcomes of various chronic diseases (e.g., stroke, lung diseases) and cancer outcomes (e.g., reduced overall disease-free survival), and development of various clinical conditions (e.g., hospitalisation, reduced quality of life, poor nutritional status).^{2,3,8,15,16}

MANAGEMENT OF SARCOPENIC OBESITY

Regardless of the phenotypic presentation or primary aetiology of SO, the overall management of SO requires an approach of vigilance and case-finding in susceptible individuals with early detection and halting of the process, along with management strategies which address fat loss without further SMM loss (preservation) and, where possible, increase in SMM.

However, the treatment of SO poses unique challenges. By reducing fat mass, intramyocellular inflammation can be reduced. Yet, with weight loss, there is inevitable concurrent muscle loss. Hence, effective management strategies of SO will need to focus on combining exercise and nutritional interventions targeted at reducing fat (weight) while preserving or increasing muscle mass and function. This approach aims to create a negative energy balance, leading to adipose tissue reduction, improved adipose markers, and decreased inflammation, while also enhancing muscle mass.

Exercise Interventions

Exercise is essential for the prevention and management of SO.¹⁸ Regular physical activity, particularly resistance and aerobic exercises, has been shown to improve muscle mass, strength, and overall physical function. Resistance training, in particular, is highly effective in enhancing muscle quality, function, strength, and flexibility in older adults, and it is recommended for at least two non-consecutive days per week, gradually increasing intensity and volume over time.^{19,20}

Aerobic exercise, such as walking, cycling, or swimming, is also important as it improves muscle aerobic capacity and cardiovascular function, increases insulin sensitivity, promotes mitochondrial adaptation, increases capillary density of muscle tissue, and reduces oxidative stress and adipose tissue.^{21,22} A combination of resistance and aerobic exercises is more effective in improving muscle mass and function and reducing fat than either form of exercise alone.² High-intensity interval training (HIIT), which alternates between short bursts of intense exercise and recovery periods, has been particularly noted for its ability to stimulate muscle protein synthesis and improve muscle function and insulin sensitivity.²³

The Singapore Physical Activity Guidelines (SPAG), developed by the Health Promotion Board and SportSG advises adults to engage in 150 to 300 minutes of moderate-intensity aerobic activity weekly, which can be spread across any duration throughout the week.²⁴ SPAG encourages

incorporating various activities, such as strength training and light-intensity exercises, to break up sedentary periods and enhance overall physical and mental well-being. For older adults, staying active while enhancing muscular strength and functional balance is crucial, as it aids in managing frailty and common chronic conditions like diabetes and hypertension.

Nutritional Interventions

Nutritional strategies play a vital role in preventing and treating SO. While hypocaloric diets can effectively reduce fat mass, they may also lead to muscle loss by downregulating muscle protein synthesis and increasing proteolysis. There is also a risk of micronutrient deficiencies and bone loss.²⁵ Currently, there is insufficient evidence regarding the impact of macronutrient manipulation (such as fat versus carbohydrate restriction) compared to conventional calorie restriction (total calorie intake) on weight loss and body composition, particularly in relation to the SO phenotype.²⁶

A modest reduction in calorie intake, typically between 200–700 kcal per day, is recommended to achieve gradual weight loss of 0.5–1 kg per week, while minimising muscle loss.²⁷ Protein intake is particularly important in preserving muscle mass, especially in older adults who are at higher risk of anabolic resistance. A daily protein intake of 1.0–1.2 g/kg body weight is generally recommended to maintain and recover muscle mass and function, with higher amounts (1.2–1.5 g/kg) suggested for individuals with multiple co-morbidities.^{28,29} Additionally, protein intake should be spread evenly across meals to optimise muscle protein synthesis, as no significant anabolic benefits have been observed with protein intake exceeding 30 grams per meal.³⁰

Apart from the quantity of protein, the source of protein may also be vital for preserving muscle mass. Animal-based proteins, particularly whey, are more effective at promoting muscle protein synthesis due to their higher leucine content and faster digestion and absorption rates.³¹ Supplementation with leucine, an essential amino acid, of 2.0–2.5 g per day has been associated with increased muscle protein synthesis in older adults, independent of other amino acid intake.³²

Time-restricted eating (TRE) involves limiting food intake to specific periods of the day (e.g., an 8-hour feeding window over a 24-hour period). Some studies have suggested that TRE can promote weight loss while preserving muscle mass and improving cardiovascular health and other physiological markers.³³ Hence, TRE could be an appealing, safe, and practical dietary approach for patients with SO, but more research is needed.

The combination of exercise and nutrition interventions offers the best outcomes for individuals with SO. Existing studies suggest that combining exercise with adequate protein intake can lead to significant reductions in fat mass, increases in muscle mass, and improvements in physical function, such as handgrip strength and gait speed.²

Role of Nutritional Supplements

Several nutrients and dietary components have been proposed to support muscle health due to their anabolic, anti-inflammatory, anticatabolic, and antioxidant properties. These include omega-3 fatty acids, β -hydroxy β -methylbutyrate (HMB), carotenoids, selenium, and vitamins D, E, and C. However, the evidence supporting these interventions is inconclusive and sometimes conflicting due to limited studies and small sample sizes.² Further research is needed to clarify their roles in the treatment of SO.

Impact of Novel GLP-1 Based Anti-Obesity Medications on Muscle Mass and Function

Newer glucagon-like peptide 1 (GLP-1) receptor agonist-based anti-obesity medications, such as semaglutide and tirzepatide, have garnered significant attention in recent years due to impressive weight loss of 17 percent with semaglutide and 21 percent with tirzepatide,^{34,35} along with substantial improvements in both subjective and objective measures of physical function. However, these AOMs have not been specifically studied in populations with SO, and existing clinical trials have often limited the enrolment of older adults and individuals with chronic diseases. While semaglutide and tirzepatide can lead to significant adipose tissue loss, they may also result in concomitant muscle loss. In the STEP 1 trial, semaglutide treatment led to lean mass loss of 5.26 kg, representing ~38 percent of total weight loss³⁴—exceeding the usual “quarter fat-free mass” rule.³⁶

Nevertheless, the extent of muscle mass loss relative to fat loss and the improvement in muscle composition, including reduction in myosteatosis and ectopic fat, remain unclear. These factors are crucial as they play a central role in the pro-inflammatory cycle driving SO.² Animal studies also suggest that GLP-1 may improve muscle cell function by enhancing blood flow and nutrient delivery, and even stimulating muscle growth through specific signalling pathways.³⁷

Bariatric Surgery

While bariatric surgery is highly effective in treating severe obesity, resulting in significant fat loss and relative improvements in physical function, it also causes substantial loss of muscle mass and strength.³⁸ Research specifically targeting individuals with SO is limited. In a study of 71 patients, sleeve gastrectomy was shown to better preserve bone and muscle compared to Roux-en-Y bypass.³⁹ However, remission rates for comorbidities were similar after surgery, regardless of sarcopenia.⁴⁰ Given the marked calorie deficit and weight loss in the first year after bariatric surgery, these patients should be managed at specialised multidisciplinary centres during this period, with a focus on nutrition, exercise, and additional medical support.

EMERGING MEDICAL THERAPIES

Myostatin Inhibitors

Myostatin inhibits skeletal muscle growth and development and elevated myostatin levels are observed in individuals with sarcopenia, making it a key target in SO treatment. Its inhibition leads to muscle cell hyperplasia and hypertrophy, suppresses irisin, and downregulates pro-inflammatory cytokines, with potential benefits on metabolism, adiposity, and insulin sensitivity.⁴¹ Interestingly, myostatin levels can be decreased following a DASH diet, with improved body composition and cardiometabolic biomarkers in older adults.⁴²

In a trial of the activin receptor type 2B inhibitor bimagrumab among 180 older adults with sarcopenia, it improved functional parameters and lean mass, although no specific subanalysis for those with obesity was conducted.⁴³ In another trial involving adults with type 2 diabetes and BMI 28–40 kg/m², bimagrumab, combined with diet and exercise, led to significant adipose tissue loss, increased lean mass, and metabolic improvements.⁴³ However, there was no distinct analysis for those with SO.

Case Study

Mdm H is a 61-year-old woman who was referred to Dr N for treatment of obesity. She describes a gradual increase in weight since her early thirties, with difficulty sustaining weight loss via lifestyle measures. Her current weight is 92 kg (BMI 33.8 kg/m²) and she has a waist circumference of 92 cm. She also has hypertension, type 2 diabetes (diagnosed four years ago; latest HbA1c 7.3%), and obstructive sleep apnoea. Her medications include metformin 1 g BD, empagliflozin 25 mg OM, and losartan 50 mg OM.

On further history, she describes that she has tried to control her weight by limiting caloric intake. As she is a vegetarian, her current dietary intake consists mainly of vegetables and rice or noodles. She shares that it has been difficult for her to exercise as she gets tired easily. She also describes muscle fatigue even when playing with or carrying her baby grandson. She works as a part-time administrator (sedentary) and spends the rest of her day caring for her grandson at home. She does not smoke or drink alcohol.

Suspecting sarcopenic obesity, Dr N conducted the SARC-F screening questionnaire:

Question	Response	Points
How much difficulty do you have in lifting or carrying 4.5 kg?	Some	1
How much difficulty do you have walking across a room?	None	0
Rising from a chair: How much difficulty do you have transferring from a chair or bed?	Some	1
How much difficulty do you have climbing a flight of 10 stairs?	A lot	2

How many times have you fallen in the past year?	None	0
Total		4

Individual Item Scoring:

None – 0 Some – 1 A lot – 2

A Total Score of ≥4 for SARC-F or ≥11 for SARC-CalF is a positive screening, which warrants confirmation of diagnosis of sarcopenia.

To confirm the diagnosis, further tests were performed:

Test	Result	Cutoff for Sarcopenic Obesity
Muscle Strength		
5 times chair stand test	16 seconds	≥12 seconds
Handgrip strength	15 kg	<18 kg (F)
Body Composition via Bioimpedance Analysis (BIA)		
Muscle mass (SMM/W)	26%	<30.7%(F)*
Fat mass	45%	>35% (F)

* via BIA based on an East Asian population

This confirms the diagnosis of sarcopenic obesity. Dr N explains to Mdm H that the treatment goals will focus on reducing fat mass, while improving her muscle mass and strength. She is started on obesity pharmacotherapy and referred to the dietitian and physiotherapist to guide her on increasing protein intake and resistance exercises.

CONCLUSION

Sarcopenic Obesity poses a real threat to the health of rapidly ageing populations especially with concurrent high prevalence of central obesity. Early detection through screening with a case-finding approach is key to breaking the vicious cycle of SO, which can occur throughout the entire life cycle. Despite challenges in diagnostic criteria, diagnosing SO involves the confirmation of excess or abnormal distribution of adiposity and loss of SMM and function/strength using the relevant population-specific cutoffs. The management of SO requires a multifaceted approach that includes exercise, nutrition, digital technology, and personalised care. Combining resistance and aerobic exercises with adequate protein intake and other nutritional strategies can effectively reduce fat, preserve or increase muscle mass, and improve overall physical function in individuals with SO. More research is needed to refine these interventions and explore the potential benefits of novel pharmacological agents and additional nutritional supplements to treat SO. In the meantime, it is essential to increase the awareness of SO and use simple screening tools in primary care to identify this important condition so

that at-risk individuals can receive appropriate treatments to improve their clinical outcomes.

REFERENCES

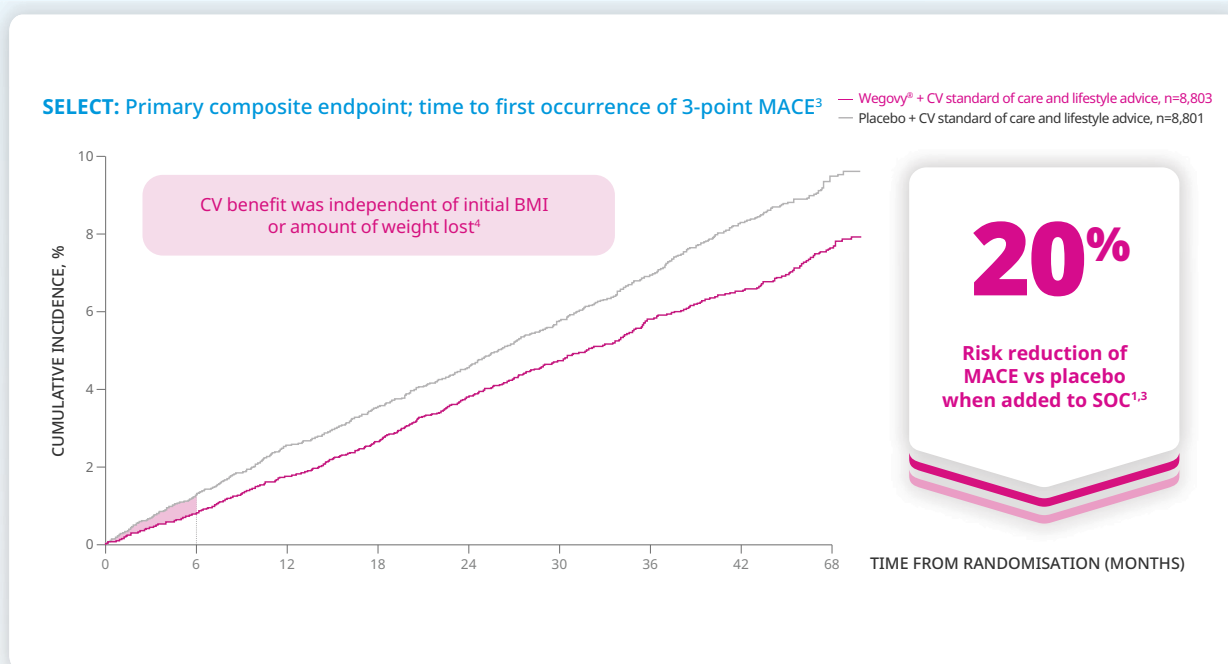
- Lim JP, Chong MS, Tay L, et al. Inter-muscular adipose tissue is associated with adipose tissue inflammation and poorer functional performance in central adiposity. *Arch Gerontol Geriatr.* 2019 Mar-Apr;81:1-7.
- Prado CM, Batsis JA, Donini LM, Gonzalez MC, Siervo M. Sarcopenic obesity in older adults: a clinical overview. *Nat Rev Endocrinol.* 2024 May;20(5):261-77.
- Stenholm S, Alley D, Bandinelli S, et al. The effect of obesity combined with low muscle strength on decline in mobility in older persons: results from the InCHIANTI study. *Int J Obes (Lond).* 2009 Jun;33(6):635-44.
- Lim WS, Cheong CY, Lim JP, et al. Singapore Clinical Practice Guidelines For Sarcopenia: Screening, Diagnosis, Management and Prevention. *J Frailty Aging.* 2022;11(4):348-69.
- National Population Health Survey 2022. Epidemiology & Disease Control Division and Policy, Research & Surveillance Group Ministry of Health and Health Promotion Board, Singapore
- Khor EQ, Lim JP, Tay L, et al. Obesity Definitions in Sarcopenic Obesity: Differences in Prevalence, Agreement and Association with Muscle Function. *J Frailty Aging.* 2020;9(1):37-43.
- Pang BWJ, Wee SL, Lau LK, et al. Obesity Measures and Definitions of Sarcopenic Obesity in Singaporean Adults - the Yishun Study. *J Frailty Aging.* 2021;10(3):202-10.
- Low S, Goh KS, Ng TP, et al. The prevalence of sarcopenic obesity and its association with cognitive performance in type 2 diabetes in Singapore. *Clin Nutr.* 2020 Jul;39(7):2274-81.
- Batsis JA, Gilbert-Diamond D, McClure AC, et al. Prevalence of Sarcopenia Obesity in Patients Treated at a Rural, Multidisciplinary Weight and Wellness Center. *Clin Med Insights Arthritis Musculoskelet Disord.* 2019;12:1179544119862288.
- Chen LK, Woo J, Assantachai P, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *J Am Med Dir Assoc.* 2020 Mar;21(3):300-7 e2.
- Donini LM, Busetto L, Bischoff SC, et al. Definition and Diagnostic Criteria for Sarcopenic Obesity: ESPEN and EASO Consensus Statement. *Obes Facts.* 2022;15(3):321-335. doi: 10.1159/000521241. Epub 2022 Feb 23. PMID: 35196654; PMCID: PMC9210010.
- Barazzoni R, Bischoff S, Boirie Y, et al. Sarcopenic Obesity: Time to Meet the Challenge. *Obes Facts.* 2018;11(4):294-305.
- Petroni ML, Caletti MT, Dalle Grave R, Bazzocchi A, Aparisi Gomez MP, Marchesini G. Prevention and Treatment of Sarcopenic Obesity in Women. *Nutrients.* 2019 Jun 8;11(6).
- Batsis JA, Villareal DT. Sarcopenic obesity in older adults: aetiology, epidemiology and treatment strategies. *Nat Rev Endocrinol.* 2018 Sep;14(9):513-37.
- Kim TN, Yang SJ, Yoo HJ, et al. Prevalence of sarcopenia and sarcopenic obesity in Korean adults: the Korean sarcopenic obesity study. *Int J Obes (Lond).* 2009 Aug;33(8):885-92.
- Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. *J Am Geriatr Soc.* 2002 May;50(5):889-96.
- Shou J, Chen PJ, Xiao WH. Mechanism of increased risk of insulin resistance in aging skeletal muscle. *Diabetol Metab Syndr.* 2020;12:14.
- Reiter L, Bauer S, Traxler M, et al. Effects of Nutrition and Exercise Interventions on Persons with Sarcopenic Obesity: An Umbrella Review of Meta-Analyses of Randomised Controlled Trials. *Curr Obes Rep.* 2023 Sep;12(3):250-63.
- Nelson ME, Rejeski WJ, Blair SN, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation.* 2007 Aug 28;116(9):1094-105.
- Groennebaek T, Vissing K. Impact of Resistance Training on Skeletal Muscle Mitochondrial Biogenesis, Content, and Function. *Front Physiol.* 2017;8:713.
- Lundby C, Jacobs RA. Adaptations of skeletal muscle mitochondria to exercise training. *Exp Physiol.* 2016 Jan;101(1):17-22.
- Di Donato DM, West DW, Churchward-Venne TA, Breen L, Baker SK, Phillips SM. Influence of aerobic exercise intensity on myofibrillar and mitochondrial protein synthesis in young men during early and late postexercise recovery. *Am J Physiol Endocrinol Metab.* 2014 May 1;306(9):E1025-32.
- Little JP, Safdar A, Bishop D, Tarnopolsky MA, Gibala MJ. An acute bout of high-intensity interval training increases the nuclear abundance of PGC-1alpha and activates mitochondrial biogenesis in human skeletal muscle. *Am J Physiol Regul Integr Comp Physiol.* 2011 Jun;300(6):R1303-10.
- Singapore Physical Activity Guidelines. Sport Singapore and Health Promotion Board; 2022 [cited 2024 14 September]; Available from: <https://ch-api.healthhub.sg/api/public/content/fc40f3e7c0da49b7809192e3ea76ec29?v=6aed8105>.
- Jiang BC, Villareal DT. Weight Loss-Induced Reduction of Bone Mineral Density in Older Adults with Obesity. *J Nutr Gerontol Geriatr.* 2019 Jan-Mar;38(1):100-14.
- Poggiogalle E, Migliaccio S, Lenzi A, Donini LM. Treatment of body composition changes in obese and overweight older adults: insight into the phenotype of sarcopenic obesity. *Endocrine.* 2014 Dec;47(3):699-716.
- Jensen MD, Ryan DH, Apovian CM, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation.* 2014 Jun 24;129(25 Suppl 2):S102-38.
- Schoufour JD, Tieland M, Barazzoni R, et al. The Relevance of Diet, Physical Activity, Exercise, and Persuasive Technology in the Prevention and Treatment of Sarcopenic Obesity in Older Adults. *Front Nutr.* 2021;8:661449.
- Weijts PJM, Wolfe RR. Exploration of the protein requirement during weight loss in obese older adults. *Clin Nutr.* 2016 Apr;35(2):394-8.
- Agergaard J, Bulow J, Jensen JK, et al. Effect of light-load resistance exercise on postprandial amino acid transporter expression in elderly men. *Physiol Rep.* 2017 Sep;5(18).
- Hector AJ, Marcotte GR, Churchward-Venne TA, et al. Whey protein supplementation preserves postprandial myofibrillar protein synthesis during short-term energy restriction in overweight and obese adults. *J Nutr.* 2015 Feb;145(2):246-52.
- Devries MC, McGlory C, Bolster DR, et al. Protein leucine content is a determinant of shorter- and longer-term muscle protein synthetic responses at rest and following resistance exercise in healthy older women: a randomized, controlled trial. *Am J Clin Nutr.* 2018 Feb 1;107(2):217-26.
- Kirkham AA, Parr EB, Kleckner AS. Cardiometabolic health impacts of time-restricted eating: implications for type 2 diabetes, cancer and cardiovascular diseases. *Curr Opin Clin Nutr Metab Care.* 2022 Nov 1;25(6):378-87.
- Wilding JPH, Batterham RL, Calanna S, et al. Once-Weekly Semaglutide in Adults with Overweight or Obesity. *N Engl J Med.* 2021 Mar 18;384(11):989-1002.
- Jastreboff AM, Aronne LJ, Ahmad NN, et al. Tirzepatide Once Weekly for the Treatment of Obesity. *N Engl J Med.* 2022 Jul 21;387(3):205-16.
- Heymsfield SB, Gonzalez MC, Shen W, Redman L, Thomas D. Weight loss composition is one-fourth fat-free mass: a critical review and critique of this widely cited rule. *Obes Rev.* 2014 Apr;15(4):310-21.
- Andreozzi F, Raciti GA, Nigro C, et al. The GLP-1 receptor agonists exenatide and liraglutide activate Glucose transport by an AMPK-dependent mechanism. *J Transl Med.* 2016 Jul 30;14(1):229.
- Ibache-Saavedra P, Martinez-Rosales E, Jerez-Mayorga D, Miranda-Fuentes C, Artero EG, Cano-Cappellacci M. Effects of bariatric surgery on muscle strength and quality: A systematic review and meta-analysis. *Obes Rev.* 2024 Sep;25(9):e13790.
- BaadVMA, Bezerra LR, de Holanda NCP, et al. Body Composition, Sarcopenia and Physical Performance After Bariatric Surgery: Differences Between Sleeve Gastrectomy and Roux-En-Y Gastric Bypass. *Obes Surg.* 2022 Dec;32(12):3830-8.

40. Mastino D, Robert M, Betry C, Laville M, Gouillat C, Disse E. Bariatric Surgery Outcomes in Sarcopenic Obesity. *Obes Surg.* 2016 Oct;26(10):2355-62.
41. Consitt LA, Clark BC. The Vicious Cycle of Myostatin Signaling in Sarcopenic Obesity: Myostatin Role in Skeletal Muscle Growth, Insulin Signaling and Implications for Clinical Trials. *J Frailty Aging.* 2018;7(1):21-7.
42. Perry CA, Van Guilder GP, Butterick TA. Decreased myostatin in response to a controlled DASH diet is associated with improved body composition and cardiometabolic biomarkers in older adults: results from a controlled-feeding diet intervention study. *BMC Nutr.* 2022 Mar 15;8(1):24.
43. Rooks D, Swan T, Goswami B, et al. Bimagrumab vs Optimized Standard of Care for Treatment of Sarcopenia in Community-Dwelling Older Adults: A Randomized Clinical Trial. *JAMA Netw Open.* 2020 Oct 1;3(10):e2020836.



Proven to reduce the risk of major CV events and treat obesity¹

Two thirds of deaths related to high BMI are attributed to CVD²



Adapted from Lincoff AM, *et al.* 2023.³

Data from SELECT: 3-point MACE included CV death, non-fatal MI or non-fatal stroke. Mean follow-up period of ~40 months (cumulative incidence of 6.5% with Wegovy[®] vs 8.0% with placebo). Mean change in body weight over the 104 weeks after randomisation was -9.4% with Wegovy[®] and -0.9% with placebo. Mean baseline body weight and BMI was 96.7 kg and 33.1 kg/m², respectively.³

Standard of care for CV risk included medical treatment that could be adjusted at the investigator's discretion for continued participation in the study and health lifestyle counselling.³

For healthcare professionals only.

BMI, body mass index; **CV**, cardiovascular disease; **MACE**, major adverse cardiovascular events; **MI**, myocardial infarction; **SOC**, standard of care.

References: 1. Wegovy[®] Singapore Prescribing Information, August 2025. 2. Koskinas KC, *et al.* *Eur Heart J.* 2024;45(38):4063–98. 3. Lincoff AM, *et al.* *N Engl J Med.* 2023;389:2221–32. 4. Ryan DH, *et al.* *Nat Med.* 2024;30:2049–57.

ONCE-WEEKLY
wegovy[®]
semaglutide injection 2.4 mg

Novo Nordisk Pharma (Singapore) Pte. Ltd. (199703791E)
150 Beach Road #19-01/08 Gateway West, Singapore 189720 | Tel: +65 6295 5518
2025 © Novo Nordisk Pharma (Singapore) | SG25SEMO00114

