

# Strengthening Muscle Health of Community-Dwelling Older Adults in Singapore: Evidence Towards Clinical Implementation

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## Abstract

The prevalence of sarcopenia will inevitably increase as the population ages in Singapore, rendering it a growing public health concern with a significant impact on healthcare resources. This article firstly summarizes the current understanding of the epidemiology, diagnosis and management of sarcopenia, focusing on community-dwelling older individuals. Early identification is key to preventing and minimizing muscle loss. Appropriate interventions, including resistance exercise training, nutritional interventions and prehabilitation program, should be tailored to each patient. We suggest several key actions to ultimately improve awareness and overcome challenges in identifying and managing sarcopenia to improve patient outcomes. A paradigm shift where muscle health is seen as an integral component to maintaining good health with longer lifespan is needed. Education – of healthcare professionals and the public – serves as the foundation to improving awareness of muscle health and sarcopenia, and to promoting physical exercise across the age spectrum for sarcopenia prevention. The use of cost-effective evidence-based modalities (e.g., calf circumference measurement, 5-times chair stand test or bioelectric impedance assessment) enable early identification of muscle loss in routine practice. Providing subsidies for nutritional interventions (e.g., oral nutritional supplements) and exercise (e.g., ActiveSG gym membership) would encourage uptake of and adherence to interventions. Further high-quality research on interventions and their outcomes is important to determine the optimal strategy in different patient populations and to demonstrate clinical significance and value of addressing sarcopenia. Having local champions within healthcare institution would facilitate the much-needed change in healthcare culture where muscle health is a part of routine clinical practice.

*Key words: Sarcopenia, muscles, aged, diagnosis, Singapore.*

## Introduction

Ageing is associated with progressive deterioration in physiological systems (1). For the musculoskeletal system, age-related changes include skeletal muscle cell atrophy and joint degeneration, which together cause declines in lean body mass and diminished functional ability. Muscle health is defined by the presence of adequate muscle mass and muscle function, and muscle function in itself is defined as having adequate muscle strength and physical performance (2). The presence of low skeletal muscle mass,

strength and/or physical performance in older individuals is defined as sarcopenia (3). Globally, sarcopenia affects approximately 10% of community-dwelling older adults (4, 5). Sarcopenia often coexists as comorbid disease (6) and with malnutrition (7, 8), and is now regarded as a precursor to frailty (9). It is a major determinant of falls and fractures (10), reduced ability to perform activities of daily living (ADLs) (11), poor health-related quality of life (HRQoL), poor post-operative outcomes (12, 13) and mortality (14–19).

The world population is aging rapidly – 1 in 6 people will be aged 60 years old or above by 2030 (20). In Singapore, about 1 in 4 people (23.8%) will be aged 65 and above by 2030 (21). Given the aging population worldwide and the inevitable increase in the prevalence of sarcopenia in the older population, skeletal muscle health will become a growing societal concern and a major source of healthcare utilization. Timely diagnosis, early intervention, and management of sarcopenia and associated risk factors are critical to improve patient outcomes. However, knowledge regarding sarcopenia is poor amongst older adults and healthcare providers (HCPs), thus accurately diagnosing and managing the condition has been underwhelming (22–24).

Early detection of sarcopenia in at-risk older adults with evidence-based targeted interventions is required to prevent and reverse progression throughout the continuum of care. In this context, the purpose of this review is to address these needs by summarizing the current understanding of the epidemiology, diagnosis, and management of sarcopenia, with a focus on community-dwelling older individuals. We also aim to provide a concerted approach to generate awareness, overcome diagnostic and interventional challenges, and to promote a holistic approach towards muscle health sustenance in Singapore.

## Epidemiology of sarcopenia

The prevalence of sarcopenia varies substantially, which may be attributed, at least in part, to the measurement scale used for assessment. In a meta-analysis of Asian and European adults 60 years and older, the prevalence of sarcopenia was 11% and 9% among community-dwelling men and women, respectively (5). The meta-analysis also reported a higher

**Table 1.** 2019 Asian Working Group for Sarcopenia consensus for diagnosis of sarcopenia in community-dwelling adults (3)

	Measurement	Criteria
<b>Case finding</b>		
	Calf circumference OR	Men: <34 cm Women: <33 cm
	SARC-F OR	≥4
	SARC-CalF	≥11
<b>Assessment</b>		
Muscle strength	Handgrip strength	Men: <28 kg Women: <18 kg
Physical performance	5-time chair stand test	≥12 seconds
<b>Confirmatory diagnosis</b>		
Muscle strength	Handgrip strength	Men: <28 kg Women: <18 kg
Physical performance	6-meter walk OR	<1.0 m/s
	5-time chair stand test OR	≥12 seconds
	Short Physical Performance Battery	≤9
Appendicular skeletal muscle mass	Dual-energy X-ray absorptiometry OR	Men: <7.0 kg/m <sup>2</sup> ; Women: <5.4 kg/m <sup>2</sup>
	Bioelectrical impedance analysis	Mean: <7.0 kg/m <sup>2</sup> ; Women: <5.7 kg/m <sup>2</sup>
<b>Severity classification</b>		
Sarcopenia		Low ASM + low muscle strength OR Low physical performance
Severe sarcopenia		Low ASM + low muscle strength AND Low physical performance

ASM, appendicular skeletal muscle mass.

prevalence of sarcopenia among hospitalized individuals (23% in men and 24% in women) and individuals living in nursing homes (51% in men and 31% in women) (5). In community-dwelling older adults (≥50 years) in Singapore, the reported prevalence of sarcopenia is 23%–46% (25–30). The prevalence may be as high as 76% in community-dwelling older adults (≥65 years) at risk of malnutrition, assessed using the Asian Working Group for Sarcopenia 2019 criteria (31).

The degree of sarcopenia depends on the presence of risk factors, including age, habitual levels of physical activity, malnutrition/malnutrition risk, and presence of comorbid diseases, such as cardiovascular disease, cognitive impairment and type 2 diabetes mellitus (T2DM) (32). Sarcopenia is highly prevalent in individuals with T2DM (31.1%) (6) and is associated with reduced energy and omega-3 fatty acid intake (33, 34) and lower participation rates in regular physical activity (35, 36). Low body mass index is also associated with sarcopenia in older patients with T2DM (37, 38). However, in a meta-analysis of individuals with T2DM of all age groups, those with T2DM showed lower muscle performance and strength, but comparable muscle mass, compared with those who are normoglycemic (39).

The association between sarcopenia, malnutrition, and frailty with poor post-operative outcomes is also increasingly recognized (12, 40, 41), with the prevalence of sarcopenia ranging between 25–42% among pre-operative individuals

(18, 42–44). Furthermore, low muscle mass is associated with higher adverse post-surgical outcomes and mortality among geriatric patients (13). Sarcopenia is also associated with decreased disease-free survival and overall survival of oncology patients (18, 44, 45). These highlight the importance of identifying and counteracting sarcopenia in the older pre-operative population as well as oncology patients.

### Sarcopenia definition and diagnosis

First introduced in 1988, sarcopenia was originally defined as loss of appendicular muscle mass in older individuals measured by dual energy x-ray absorptiometry (46). This definition was revised in 2010 to include both low muscle mass, muscle strength and/or physical performance, which was adopted by several consensus groups (3, 47). Subsequently, various cut-offs to define sarcopenia of aging have been employed, emphasizing the need for standardization and consideration of appropriate cut-offs for different ethnic groups. Notably, screening tools for sarcopenia, such as the SARC-F, are limited because of its low-to-moderate sensitivity (48), therefore necessitating the use of diagnostic criteria for sarcopenia without screening for identification in high-risk groups (3, 49).

The Asian Working Group for Sarcopenia 2019 (AWGS 2019) issued a consensus update on sarcopenia screening and

diagnosis (3), which is utilized in Singapore. The previous sarcopenia definition was maintained, but the diagnostic algorithm, protocols and some criteria were revised (Table 1). The AWGS 2019 consensus divides diagnosis into community and hospital settings, advocating for a case-finding approach based on risk factors, looking for symptoms when relevant symptoms are reported (e.g., falling, weakness, slowness, self-reported muscle wasting, difficulties carrying out ADLs). In the consensus, the presence of low muscle strength or poor physical performance is sufficient for diagnosis of probable sarcopenia and implementation of interventions. Diagnosis of sarcopenia requires the additional assessment and confirmation of low muscle mass, while the presence of all three of low muscle strength, low physical performance, and low muscle mass indicate severe sarcopenia. Diagnostic measures of sarcopenia have to be performed by trained HCPs, with the physician being the gateway to the diagnosis of sarcopenia.

## Sarcopenia interventions

### *Physical exercise*

Regular physical exercise can modulate the biological hallmarks of aging to delay age-related chronic diseases and maintain functional capacity (50). The mechanisms responsible for the effects of lifelong exercise that positively affect muscle health may act through the promotion of anti-inflammatory pathways in skeletal muscle, largely through the release of muscle-derived myokines (51–53). Exercise, including endurance training and resistance training, has been shown to improve muscle oxidative capacity in older adults (54, 55), which in turn improves muscle function.

From a public health perspective, a higher number of steps taken by an older individual has been demonstrated to be strongly and consistently associated with better clinical outcomes, including greater muscular strength (56). There is also consensus for resistance exercise training (RET) as a key approach to manage sarcopenia (57, 58). A meta-analysis found that the intensity of RET is positively associated with the degree of muscle strength improvement in older adults (57). Progressive RET is recommended to improve muscle strength in older adults; this involves the use of free-weight or machines, where multiple- and single-joint exercises are administered, with slow-to-moderate lifting velocity for 1–3 sets/exercise, at 60–80% of 1 repetition maximum, for 8–12 repetitions with 1–3 minutes of rest in between sets, and a frequency of 2–3 days/week (59, 60). Both the American College of Sports Medicine and World Health Organization (WHO) also recommends muscle-strengthening exercises at moderate or greater intensity involving all major muscle groups on 2 or more days a week for older adults (61, 62). In addition to the multiple metabolic and physiological aerobic benefits from RET, the improvement in muscle power in itself is important as it is a predictor of functional capacity, and hence may help prevent loss or decline in functional ability (59).

Physical exercise has also been shown to benefit muscle health in individuals with T2DM, including positive effects of resistance training on lower body strength (63), and structured

strength and balance training on functional status and balance confidence (64). Telerehabilitation is a useful alternative for improving physical fitness and muscle strength in older adults, particularly for those who face challenges in daily commuting (65).

### *Nutritional intervention*

The onset and progression of sarcopenia is multifactorial and includes reduced nutrient intake and absorption (66). The impact of malnutrition on muscle mass is recognised (8), and low muscle mass is now one of the criteria for the diagnosis of malnutrition based on the Global Leadership Initiative on Malnutrition consensus criteria (67). The recently published AWGS Expert Consensus on the role of nutrition in muscle health recommends that targeted nutritional requirements should primarily be met via regular dietary patterns prior to dietary enrichment or supplementation (68). The ESPEN clinical practice guidelines recommend an energy intake of 30 kcal/kg body weight/day and a daily protein intake of at least 1 g/kg body weight for older individuals; this should be adjusted according to individual nutritional status, levels of habitual physical activity, disease state and tolerance (69). Nutritional counselling and education should also be offered by HCPs to help older individuals achieve their nutritional intake goals (68, 69). Communal or social eating can also promote regular food intake among older individuals (68).

The benefits of nutritional supplementation to manage sarcopenia in older adults have been well described. A systematic review concluded that several nutritional interventions, including amino acids, creatine, beta-hydroxy-beta-methylbutyrate (HMB) and dietary protein with amino acids supplementation, contributed to improved muscle mass in older adults (70). In Singapore, the use of HMB in community-dwelling older adults at risk of malnutrition improved nutritional outcomes and reversed risk of malnutrition, leading to significant improvement in leg strength ( $12.85 \pm 0.22$  kg vs  $12.17 \pm 0.22$  kg at day 90) and handgrip strength ( $14.18 \pm 0.17$  kg vs  $13.70 \pm 0.17$  kg for females at day 180) compared to control group (71). Significantly greater calf circumference ( $30.64 \pm 0.17$  cm vs  $30.24 \pm 0.16$  cm at day 90) was also seen following HMB use among participants with low appendicular skeletal mass index (ASMI) at baseline (71). Vitamin D supplementation has been shown to have a beneficial effect on muscle strength (72). Furthermore, the AWGS Expert Consensus group recommends that vitamin D status should be assessed in patients at risk of malnutrition or sarcopenia (68). A vitamin D and leucine-enriched whey protein oral nutrition supplement (ONS) used for 13 weeks improved muscle mass and lower-extremity function in older adults with sarcopenia (66). A systematic review and meta-analysis showed that while leucine supplementation alone has no effect on muscle mass and strength, leucine-combined supplementation including with vitamin D demonstrated significant benefit for muscle strength and performance in older adults (73). As such, ONS and other specialized nutrients (e.g., HMB) can be added if nutritional requirements are still not met, or if deficiencies are identified in older adults (68).

## ***Combined physical exercise and nutritional intervention***

Combined interventions that include exercise and nutritional intervention significantly improve muscle health. Combined progressive RET and dietary protein intervention for 12 weeks was effective in improving lean body mass and muscle strength in community-dwelling older adults (74). Both protein supplementation and RET resulted in greater muscle mass (i.e., appendicular muscle mass and fat-free mass) and muscle strength (i.e., handgrip strength, knee extension strength and leg press strength) in older adults (75, 76). Combined vitamin D supplementation and RET also led to significant improvement in muscle strength of the lower limb when compared with the effects from each intervention alone (77). In older adults with T2DM, a multimodal training intervention, comprising of personalized RET, nutritional counselling and general health counselling demonstrated improvements in muscle health (78).

Guidelines have recommended such combined approaches for the management and prevention of sarcopenia, including the recently published Singapore Clinical Practice Guidelines for Sarcopenia (49, 68, 69). It is however important to ensure that older adults who exercise have adequate energy and protein intake to maintain body weight and maintain/improve muscle mass (69). The AWGS Expert Consensus recommends a combined approach using nutrition and resistance exercise interventions in a tailored and individualized manner for best outcomes (68). Recommended follow-up measures to assess response to interventions include nutritional, anthropometric, muscle health, functional, and HRQoL outcomes (68).

### ***Prehabilitation for patients with sarcopenia undergoing surgery***

Major surgical procedures can substantially reduce physiological and functional capacity, and the associated recovery process can lead to muscle atrophy and deterioration (79). As such, addressing sarcopenia prior to surgery through prehabilitation may help prepare individuals for their surgery by improving the functional capacity to tolerate stress from surgery thereby reducing complications and improving recovery (79). Studies assessing benefits of exercise and nutritional interventions are typically conducted over a long duration ( $\geq 10$  weeks) and yet, the lead up to major surgery is often only a few weeks long. There is thus a need for further study evaluating interventions that are impactful within a short intervention duration. The HEROS study (NCT05344313) is an ongoing study assessing the effect of ONS with HMB and 2–4 weeks RET prehabilitation on muscle quality in patients with sarcopenia undergoing surgery in Singapore; the outcome of this study will provide data on the optimal type and duration of intervention for this patient population.

Prehabilitation involves a multimodal approach encompassing physical exercises, nutritional optimization and psychological support (79). Prehabilitation physical exercises aim to improve aerobic capacity and develop lean muscle mass, while nutritional optimization aims to correct pre-operative

malnutrition and support exercise training (80). Psychological support during prehabilitation is important to improve anxiety and depression, and to help patients develop self-efficacy for prehabilitation and surgery (80). Data suggests the benefit of prehabilitation in older patients undergoing surgery (81, 82). Prehabilitation is associated with positive surgical, oncological, functional and patient-reported outcomes and improved healthcare cost savings (83, 84). In Singapore, a surgical prehabilitation program for older adults has been successfully implemented in Sengkang General Hospital. The program includes dietitian assessment and nutritional supplementation; physiotherapy assessment, RET and deep breathing exercise; and geriatric assessment – the program is completed within 2–4 weeks leading up to surgery.

### **Expert commentary: a call to action**

To optimize muscle health in older adults, improvements in awareness, diagnosis and management across the continuum of care is imperative. A paradigm shift is required where muscle health is seen as critical to good health, not only in avoiding adverse short term outcomes, but also in enabling and maintaining independent living for as long as possible and leading to high quality and meaningful life. In this context, we have provided several key priorities and potential actions for adoption within routine clinical care, with the ultimate goal of improving outcomes for patients.

### ***Increasing awareness of the adverse clinical impact of sarcopenia***

Key priorities for adoption of sarcopenia diagnosis and management initially require the recognition by both HCPs and the public of the importance of muscle health and the recognition of the impact sarcopenia can have. However, the concept of sarcopenia is not well recognized nor understood by either (85). Only half of HCPs across five continents involved in the care of older adults with musculoskeletal conditions measure at least one of the three domains of muscle mass, muscle strength, or physical performance in their clinical practice (86). Issues identified included a lack of standardization in the assessment tool and protocol, leading to difficulty in implementation and comparing results. In a study of Australian and New Zealand and Dutch HCPs, barriers to identification of sarcopenia included lack of awareness and knowledge, with engaging in continuous professional development to acquire up-to-date knowledge suggested as a means to overcome this issue (22, 23). Limitations in awareness of the health impact of sarcopenia by HCPs may be addressed, at least in part, through professional education and training. For instance, provision of training, webinars, awareness programs, and ‘toolkits’ comprising scientific information and illustrations for HCPs should be prioritized to explain assessment of muscle strength, muscle mass, and physical performance, and in prevention and management, as well as the differences in international guidelines and what is required for the local population across the continuum of care.



Patient awareness and knowledge is of utmost importance to improve muscle health and prevent sarcopenia, as ensuring adequate nutrition intake and regular RET requires patient active efforts. However, patient's lack of knowledge and poor/different understanding of sarcopenia (24, 85, 87) necessitates improving their awareness regarding the importance of muscle health, which can be done through health promotion advertisements, campaigns, and public forums. Promoting awareness and self-assessment of muscle health among older patients can be explored using simple-to-execute tests such as the 5-times Chair Stand Test (47), or through the use of mobile apps to screen for nutritional status and muscle health (88). HCPs should also be relied upon to implement educational strategies for patients, families and caregivers; this may include verbal/written advice and plain-language resources on muscle health, nutrition and physical activity (2). Furthermore, patients can be encouraged to ask questions to their HCPs.

With limited resources, it may be difficult to invest in measuring muscle health. However, because muscle health has multiple ramifications including falls prevention, reduction in disability and mortality from falls-related trauma, and decreases in disability and dependency, investing in measuring muscle health will ultimately lead to reduced healthcare spending (89, 90) and higher HRQoL (91). This benefit of measuring muscle health should be supported by high-quality population health and health economics studies to provide an evidence base supporting the projected improvements in population health and reduction in healthcare costs. This would require an increase in the scope of research, such as grants for capability developments and validation, and through higher hospital management buy-in. Because muscle health also impacts bone health, cardiovascular health, and cognitive wellbeing (92), incorporating muscle health as part of the current public health campaigns in these areas could minimize the costs of establishing a public health campaign highlighting muscle health (47).

### ***Improving identification and diagnosis of sarcopenia***

Early identification of patients at risk of sarcopenia is a key priority, to enable prevention and management strategies to be implemented in a timely manner and to improve outcomes (3). Although computed tomography (CT) scanning for diagnosis of sarcopenia may be costly, involves radiation, or may not be easily accessible, there are surrogate measures and other modalities which are cost effective and can be deployed in the clinical setting such as use of Bioelectric Impedance Assessment (BIA), calf circumference measurement, and use of 5-times Chair Stand Test for lower limb strength (93) or as a surrogate measure of gait speed (94). These are now also supported by consensus guidelines (3). More precise and clinically predictive tests for muscle mass such as the deuterated creatine dilution test may become more accessible in the near future and further enhance our ability to diagnose poor muscle health (2). Training for HCPs in sarcopenia diagnosis should also include understanding differences in cut-offs or

measurement criteria relevant to the local population based on available diagnostic tools. Newer technologies, such as ultrasound, need to be tested regarding their feasibility for sarcopenia diagnosis (95).

Population-specific data from a large and continuous database of muscle health measures (e.g., grip strength, knee extensor strength, calf circumference, gait speed and 5-times Chair Stand Test) in younger adults would also help establish appropriate cut-offs for poor muscle health in older adults.

### ***Establishing the optimal management of sarcopenia***

The pillars of improving muscle health in older individuals are nutritional interventions and RET, delivered in an integrated and tailored manner (47, 49, 68, 96). Although maintenance or improvement in both muscle mass and function should be the ultimate goal of sarcopenia management, all interventions must at least demonstrate improvements in nutritional status and muscle mass. Studies have shown that individuals with an energy deficient diet have a measurable reduction in their muscle protein synthesis rate (97). In a glycogen-depleted state, studies have also shown a doubling rate of muscle protein catabolism during increased physical activity (98). As such, identifying and treating any underlying concomitant protein and energy malnutrition is necessary before putting older adults into RET regimen. Once good nutritional health is achieved and muscle strength returned to normative values, increased muscle mass and quality can be additional outcome measures.

Management strategies should be tailored to each patient, according to underlying conditions (medical, physical and psychological) and individual circumstances that may act as barriers to the uptake and adherence to nutritional interventions and exercise regimen. Subsidies for nutritional interventions (e.g., ONS) and for exercise (e.g., ActiveSG gym membership) could help encourage uptake by older patients. Specific considerations regarding RET in older adults are also required, as they have different needs and require more individualization in terms of the training regimen as compared to young adults. Older adults may also have more intense delayed onset muscle soreness (DOMS) post-RET (99) and hence may require pre-training counselling and post-training mitigation strategies, such as allowing more recovery time and use of massage for relief (100, 101).

As with improving awareness and diagnosis of sarcopenia in older adults, resources for provision of evidence-based interventions for muscle health in older adults are also inadequate. Although global data is emerging of the substantial downstream benefits if muscle health and nutrition are managed, further good quality research is needed to demonstrate that management of sarcopenia makes a difference, including in a value-driven healthcare system such as that in Singapore. Such provision of evidence-based data would benefit from the sharing of resources and protocols, as well as collaboration. Similarly, high quality, prospective outcome measures built into intervention programs on nutritional, muscle health, clinical, functional outcomes, and HRQoL are required, including among particular patient subgroups, such as

those with T2DM and post-operative patients, to fine tune the interventions, leading to a virtuous circle.

### **Promoting lifelong commitment to physical activity for sarcopenia prevention**

A commitment to muscle health requires a lifelong dedication to physical activity participation. Considering the age spectrum through which sarcopenia presents, preventive efforts need to be enhanced to slow or prevent sarcopenia in the middle-aged, or even among younger populations, particularly if they have low skeletal muscle mass to begin with. With the current emphasis on physical activity as the cornerstone of health by the WHO (61, 102), the time is ripe to encourage and facilitate lifelong commitment to physical activity, not only in older adults but throughout the whole population starting from childhood into adulthood.

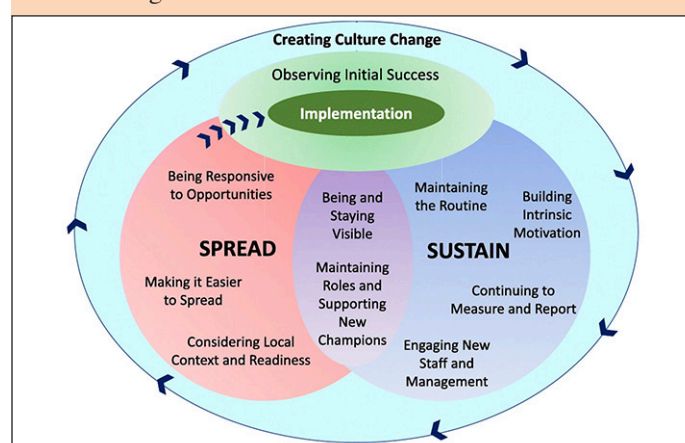
Physical activity participation rates in the older population (> 60 years) are low in Singapore. In a 2015 Sports and Physical Activity survey conducted in ~7500 households, it was reported that about 58% of Singaporeans aged > 60 years engaged in less than 3 days per week of leisure time physical activity or exercise (103), which is less than the minimum guidelines recommended by the WHO (150 minutes of moderate-intensity physical activity per week) (61). A cross-sectional study of multi-ethnic Asian aged ≥60 years in a Singapore public primary healthcare centre found that the physical activity of older adults decreased with increasing age and those with employment were twice as likely to have sedentary behaviour (104). More worryingly, ~76% of Singaporeans between the ages of 40-59 years also did not meet the minimum guideline recommended by the WHO (103). These statistics indicate that most middle-aged and older Singaporeans are not physically active – these are alarming because they reflect a relatively uninformed population regarding healthy lifestyle practices. The term ‘physical activity’ is broad and includes recreational, occupational and travel activities. Exercise training is a subset of physical activity that aims to improve cardiorespiratory and muscular fitness beyond what can be achieved with routine physical activity. The numbers for regular participation in exercise training focusing on improving cardiorespiratory and muscular fitness indicate poor uptake (105). Thus, there needs to be a greater emphasis on improving public awareness and uptake of exercise training. In other words, the quality of habitual physical activity matters – this should be part of the education of the general public and HCPs. More should be done at the policy level to improve organizational support at the workplace to enhance uptake amongst young and middle-aged individuals as the nation embraces healthier Singapore.

### **Creating and sustaining culture change to strengthen muscle health importance**

There is an urgent need for a change in the healthcare culture to incorporate muscle health as part of routine clinical practice. A framework such as ‘Sustain and Spread’ (Figure 1) can

be used to steer organizational culture change (106). Local champions within healthcare institutions would help enable, encourage and acknowledge the efforts in screening, assessment and management of sarcopenia so that these are sustained and embedded in daily practice. In this framework, once there is initial implementation success, several strategies are employed to sustain and spread the successful changes thereby leading to an overall culture change (106).

**Figure 1.** The Sustain and Spread Framework for creating a culture change



Reproduced from Figure 1, Laur C et al., published under the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>) (106).

## **Conclusion**

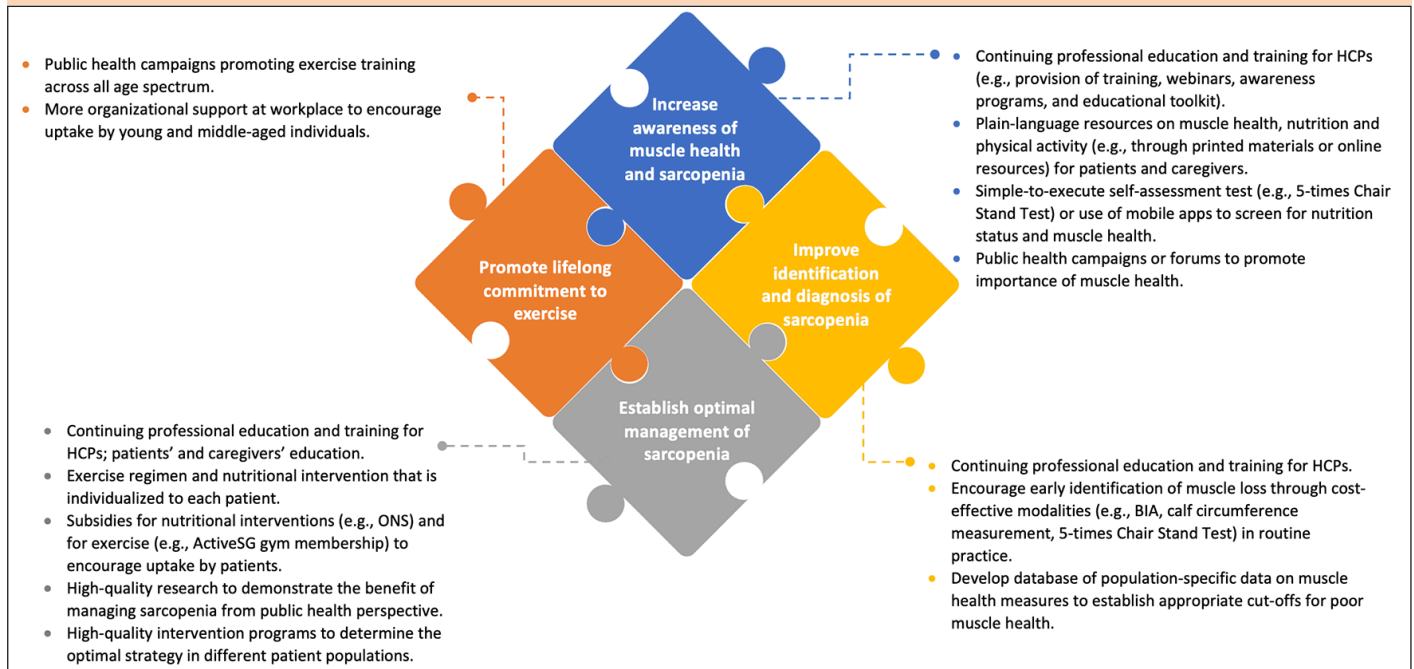
With the rapidly aging population in Singapore, muscle health is soon becoming a growing public health concern. Early identification of sarcopenia in at-risk older individuals along with evidence-based interventions are key to prevent and reverse the progression of sarcopenia. Therefore, urgent actions to increase awareness of muscle health and improve the diagnosis and management of sarcopenia across the continuum of care are imperative (Figure 2). To achieve these, there is a need for active dialogues and collaboration among various stakeholders (HCPs, professional societies, patients and their support networks, and policy makers).

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**Figure 2.** A call to action. Key priorities for action to strengthen muscle health in Singapore

Abbreviations: BIA, bioelectric impedance assessment; HCPs, healthcare providers; ONS, oral nutrition supplement.

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