



Definitions of Sarcopenia Across the World

2

Domenico Azzolino, Shaea Alkahtani, and Matteo Cesari

2.1 Introduction

The musculoskeletal system is pivotal for physical functioning. Advancing age is associated with several changes in body composition. The most evident of these changes (both phenotypically and functionally speaking) is probably the progressive loss of muscle mass and strength. In fact, after the age of 40, a progressive decline both in muscle mass (about 1–2% per year) and strength (about 1.5% per year, but even up to 3% per year after the sixth decade of life) is observed [1].

In 1988, during a meeting in Albuquerque (New Mexico, USA), Rosenberg explained that no change occurring with aging was more significant and clinically relevant than the progressive decline of the skeletal muscle. To give adequate recognition to this major feature of the aging process, he proposed using the term “sarcopenia” or “sarcomalacia.” Since then, sarcopenia, from the Ancient Greek σάρξ (sárx, “flesh”) and πενία (peniá, “poverty”), has been widely accepted and increasingly adopted [2].

The first studies on sarcopenia were focused mainly on the quantitative aspect of the skeletal muscle decline (i.e., the loss of muscle mass). Subsequently, evidence started to point out the prominent role of muscle quality (i.e., muscle strength) in the clinical characterization of the phenomenon. In particular, it became evident that muscle mass alone (at least as measured with the instruments available at that time)

D. Azzolino · M. Cesari (✉)

Department of Clinical Sciences and Community Health, University of Milan, Milan, Italy

Geriatric Unit, IRCCS Istituti Clinici Scientifici Maugeri, Milan, Italy

e-mail: domenico.azzolino@unimi.it

S. Alkahtani

Department of Exercise Physiology, King Saud University, Riyadh, Saudi Arabia

e-mail: shalkahtani@ksu.edu.sa

had a lower predictive capacity than muscle functioning for adverse clinical outcomes [3]. In this context, the term “dynapenia” was also proposed to capture the muscle strength abnormality [4].

It is also noteworthy the theoretical evolution of the sarcopenia concept over the years. If, at the beginning, sarcopenia was primarily considered as a geriatric syndrome [4], a specific International Classification of Diseases (ICD-10) code was applied to it in 2016, allowing to view it today as a formal disease [5]. This legitimation has substantially boosted the interest around it, and several molecules are in the pipeline of pharmaceutical industries for potentially treating sarcopenia in the next future [6, 7].

Over the past decade, several consensus definitions have been released by expert groups worldwide to (1) find an agreement on the definition, assessment, and diagnosis of sarcopenia and (2) stimulate research on this age-related condition globally impacting on our aging societies. Unfortunately, this field is still very debated and controversial. Several operational definitions have been proposed, frequently differing in the quality of the defining criteria and the cut-points setting the thresholds distinguishing normality from abnormality. Furthermore, it has been pointed out that body composition is substantially influenced by ethnicity. Therefore, the designing of diagnostic algorithms may need adaptations to the local context where these are applied. In this context, it is well-known how the scientific literature is strongly biased by the vast majority of evidence coming from high-income regions, in particular the United States and Europe. It is thus fully justified and meritorious the effort of many for adapting the concept of sarcopenia designed by task forces and expert groups to the reality of regions and countries which, despite being highly populated, are still not adequately represented in the literature [8]. In this chapter, we will present and discuss the main definitions and operationalizations of sarcopenia across the world.

2.2 Sarcopenia: Different Definitions Across the World

The first operational definition of sarcopenia was provided by Baumgartner and colleagues [9]. Low muscle mass was defined as the reduced amount (i.e., less than two standard deviations) of appendicular lean mass standardized by height in square meters. It is evident how the condition of interest was considered in a monodimensional way, exclusively looking at the skeletal muscle mass. Furthermore, the definition of the critical cut-points was based on the characteristics of the participants enrolled in the New Mexico Elder Health Survey 1993–1995.

A milestone in the field was subsequently set in 2010 when the European Working Group on Sarcopenia in Older People (EWGSOP) [10] released a well-known and highly cited consensus document. The recommendations have been recently revised and updated (in the so-called EWGSOP2 document) [11]. The first EWGSOP definition considered sarcopenia as the simultaneous presence of low muscle mass and poor muscle function (i.e., muscle weakness or physical performance impairment). In other words, the EWGSOP introduced the dimension of

muscle function into the definition of sarcopenia. The choice was mainly motivated by the fact that muscle strength had consistently been a better predictor of adverse health-related outcomes than muscle mass alone. Muscle strength is not dependent only on muscle mass, and the relationship between these two components is not linear. Furthermore, it could not be ignored that muscle weakness is more likely to be reported as a complaint by the older person than the reduction of muscle volume.

Interestingly, several consensus documents were released by different scientific societies and task forces at the same time [12–14]. They all presented the development of the sarcopenia condition into a bidimensional construct (i.e., mass and function reduction). However, probably because of its more accurate and detailed presentation, the EWGSOP definition became presumably the most widely adopted and largely contributed to increasing the recognition of sarcopenia. The cut-points proposed by the EWGSOP to define sarcopenia and the definition algorithm are presented in Table 2.1.

In 2013, members of the EWGSOP, together with the International Working Group on Sarcopenia (IWGS) [13] and several experts from Asia, met to discuss specific issues present with the construct of sarcopenia and to constitute the International Sarcopenia Initiative (ISI) [15]. The ISI agreed that the definitions of sarcopenia should include both muscle mass and function rather than muscle mass alone. Furthermore, it was recommended the use of standardized models and cut-points for each domain considered in the definition of sarcopenia.

In recognition of the impact that different ethnic backgrounds may have on body composition, the Asian Working Group on Sarcopenia (AWGS) [16] released a consensus in 2014 proposing specific cut-points for defining muscle mass and strength abnormalities in the Asian population (Table 2.1). The AWGS definition followed the same diagnostic approach of the EWGSOP (except for the recommendation of measuring muscle strength and gait speed as screening test). It can indeed be considered an adaptation of the EWGSOP to a different (i.e., non-European) population.

In parallel, using a completely different approach (i.e., data-driven instead of consensus statement), the Foundation for the National Institutes of Health-Sarcopenia Project (FNIH) [17] developed a new set of criteria to identify individuals with low appendicular lean mass and muscle weaknesses. The FNIH group conducted in-depth analyses taking advantage of several large cohort studies to determine the strongest predictors of mobility disability and the critical thresholds of risk. The analyses identified the low appendicular lean mass (both adjusted for body mass index and not adjusted) and poor grip strength as the most relevant criteria for capturing the two sarcopenia dimensions (Table 2.1).

More recently, the Sarcopenia Definition and Outcomes Consortium (SDOC) [18] published a position statement. Overall, the SDOC strongly agreed on the inclusion of low grip strength and slow gait speed in the definition of sarcopenia, while questioned on the use of the dual-energy X-ray absorptiometry (DXA) to assess muscle mass.

It is important to note that each definition impacts both case finding and prevalence of sarcopenia. The different diagnostic approaches, the various cut-points used to define sarcopenia, and the ethnic differences determine critical variations in

Table 2.1 Summary of different operational definitions of sarcopenia

Expert group	Cut-points for muscle mass	Cut-points for muscle strength	Cut-points for physical performance
EWGSOP1	ALM/height (m ²) using DXA: Men: <7.23 kg/m ² Women: <5.67 kg/m ² SMM/height (m ²) using BIA: Men: <8.87 kg/m ² Women: <6.42 kg/m ²	Men: <30 kg Women: <20 kg	Gait speed ≤0.8 m/s
EWGSOP2	ALM Men: <20 kg Women: <15 kg ALM/height (m ²) Men: <7 kg/m ² Women: <5.50 kg/m ²	Men: <27 kg Women: <16 kg	Gait speed ≤0.8 m/s, or Short Physical Performance Battery score ≤9, or Timed up and go ≥20 s, or 400 m walk test ≥6 min or non-completion
AWGS	ALM/height (m ²) using DXA Men: <7.0 kg/m ² Women: <5.4 kg/m ² SMM/height (m ²) using BIA Men: <7.0 kg/m ² Women: <5.7 kg/m ²	Men: <26 kg Women: <18 kg	Gait speed ≤0.8 m/s
AWGS2019	ALM/height (m ²) using DXA Men: <7.0 kg/m ² Women: <5.4 kg/m ² SMM/height (m ²) using BIA Men: <7.0 kg/m ² Women: <5.7 kg/m ²	Men: <28 kg Women: <18 kg	6-m walk <1.0 m/s, or Short Physical Performance Battery score ≤ 9, or 5-time chair stand test ≥12 s
IWGS	ALM/height (m ²) using DXA: Men: <7.23 kg/m ² Women: <5.67 kg/m ²	–	Gait speed <1 m/s
FNIH	ALM/BMI (kg/m ²) using DXA Men: <0.789 Women: <0.512	Men: <26 kg Women: <16 kg	Gait speed ≤0.8 m/s
SCWD	ALM/height (m ²) using DXA <2 SD lower than apparently healthy young adults of the same ethnic group	–	Gait speed <1.0 m/s, or < 400 m in the 6-minute walking test

EWGSOP1 European Working Group on Sarcopenia in Older People, *EWGSOP2* revised version of the European Working Group on Sarcopenia in Older People, *AWGS* Asian Working Group on Sarcopenia, *AWGS2019* revised version of the Asian Working Group on Sarcopenia, *IWGS* International Working Group on Sarcopenia, *FNIH* Foundation of the National Institute of Health-Sarcopenia Project, *SCWD* Society of Sarcopenia, Cachexia and Wasting Disorders, *ALM* appendicular lean mass, *DXA* dual X-ray absorptiometry, *BIA* bioimpedance analysis, *SMM* skeletal muscle mass, *BMI* body mass index

the epidemiology of sarcopenia. Whenever a different definition is applied, with consequently varying diagnostic tools and cut-points, inevitably, the results will change, increasing the diagnostic standardization.

2.3 EWGSOP1 vs. EWGSOP2: What Is Changed?

As mentioned above, in 2010, the EWGSOP released its first consensus defining sarcopenia as a bidimensional condition characterized by low muscle mass and poor muscle function (i.e., strength or physical performance). Furthermore, three different levels of sarcopenia severity were determined:

1. Presarcopenia (i.e., presence of low muscle mass alone).
2. Sarcopenia (i.e., presence of low muscle mass combined with reduced muscle strength or physical performance).
3. Severe sarcopenia (i.e., the simultaneous presence of low muscle mass, muscle weakness, and physical impairment).

In its original consensus document, the EWGSOP also distinguished between primary and secondary sarcopenia. Primary sarcopenia was defined as the age-related muscle decline in which no other causes than aging itself can be indicated. Secondary sarcopenia was defined as that condition due to other detectable causes (e.g., pathological conditions, physical inactivity, undernutrition). The cut-points for muscle mass, strength, and physical performance suggested in the recommendations were retrieved from the existing literature. However, at that time, most of the cut-points were still primarily defined from studies that had not been designed for proposing universally applicable thresholds of risk but instead identified on specific populations. In other words, they could be argued as not sufficiently data-driven [19].

The update EWGSOP2 document was justified by the need of implementing the emerging evidence in the field and to facilitate the implementation of the research findings into the clinical practice. In this context, it cannot be ignored the recognition of sarcopenia as a formal disease with its inclusion in the ICD-10 diagnosis codebook. In the EWGSOP2 consensus, the operational definition of sarcopenia was slightly modified. In fact, sarcopenia was here presented as “a progressive and generalized skeletal muscle disorder that is associated with an increased likelihood of adverse outcomes including falls, fractures, physical disability and mortality.” In other words, sarcopenia was tending to become a “disorder” (sometimes in the text “disease”), whereas it had before a rather syndromic profile [4]. The EWGSOP2 expert group also revised the cut-points for defining the abnormalities of muscle mass and strength (Table 2.1) and proposed a new algorithm for case finding. Interestingly, the proposed algorithm, identified by the acronym FACS (i.e., Find-Assess-Confirm-Severity), is structured around four steps:

1. Find. The use of the SARC-F questionnaire [20] or a clinical suspicion [21] is here recommended for detecting probable cases of sarcopenia. The SARC-F is a

screening questionnaire for sarcopenia consisting of five self-reported items (i.e., limitations in strength, walking ability, rising from a chair, climbing stairs, and history of falls). The SARC-F has been translated into many languages and has shown to be predictive of impaired physical function [22] as well as provided by excellent specificity at identifying people with sarcopenia (defined with the EWGSOP or AWGS criteria) [23].

2. **Assess.** The second part of the FACS is devoted to assessing muscle strength through the grip strength or chair stand tests in those previously screened as positive. At this step, the muscle weakness determines the condition of probable sarcopenia, which should pave the way towards the investigation of the underlying causes, and the design of an ad hoc intervention. Interestingly, the choice of prioritizing the assessment of muscle strength over the muscle mass quantification was motivated by the need of promoting the concept of sarcopenia in clinical practice. In fact, during the clinical routine, the evidence of muscle weakness is perceived as both more evident and relevant than the shrinking of the muscle.
3. **Confirm.** The next step is to confirm the diagnosis of sarcopenia through the formal assessment of the muscle quantity via DXA or bioelectrical impedance analysis (BIA, as lower level alternative) in clinical practice. The use of BIA is highly affected by the type and model of device, which requires population-specific cut off [24]. For research purposes and specialty care, the EWGSOP2 recommends the DXA, magnetic resonance imaging (MRI), and the computed tomography (CT) as standards.
4. **Severity.** For this final step, the EWGSOP2 explains that the assessment of physical performance (key defining criterion in the previous version of the recommendations) should determine the severity of the sarcopenia condition. For this purpose, the Short Physical Performance Battery was suggested.

In this new algorithm, it is evident how the process is redesigned, privileging the clinical implementation (as previously mentioned) and its cost-effectiveness (delaying to selected cases and specific settings the quantification of the muscle mass).

2.4 The Impact of Different Operational Definitions

The application of different operational definitions and cut-points to define sarcopenia over time has been inevitably resulting in a marked heterogeneity of the diagnostic process. Several authors reported considerable differences in both prevalence and risk factors associated with sarcopenia when different criteria are applied [23, 25–28]. In 2014, Dam et al. [25] reported that the sarcopenic condition defined according to the FNIH criteria was less prevalent (i.e., 1.3% in men and 2.3% in women) compared to the EWGSOP (i.e., 5.3% in men and 13.3% in women), and the IWGS (i.e., 5.1% in men and 11.8% in women). The authors also found a relatively low agreement among the different operational definitions. Lee et al. [28] similarly reported a higher prevalence of sarcopenia in

community-dwelling older people when the condition was assessed using the EWGSOP rather than the IWGS criteria. Several studies have described that applying different criteria determines discrepancies in both prevalence and outcomes, especially when the defining models developed in Western countries are used to other regions [28, 29]. As mentioned above, because of anthropometric, ethnic, genetic, and cultural backgrounds, the traditional cut-points working for Caucasian populations seem hardly applicable to Asian populations [8, 28]. For example, Asians may have substantially higher adiposity (also in terms of abdominal and visceral fat deposition) than Western counterparts for the same body mass index [30]. Indeed, given the differences in body composition across populations, it has been argued that the defining cut-points for sarcopenia might be adjusted to the local needs and characteristics [16].

In 2016, Bahat et al. [31] defined the alternative cut-points for determining low muscle mass (i.e., 9.2 kg/m² in men and 7.4 kg/m² in women), low muscle strength (i.e., 32 kg for men and 22 kg for women), and low calf circumference (i.e., 33 cm for both men and women) in the Turkish adaptation of the EWGSOP recommendations. The Australian and New Zealand Society for Sarcopenia and Frailty Research (ANZSSFR) [32] recently published a consensus about adopting the EWGSOP criteria and the future definition of modified cut-points specific for Australian and New Zealand populations. In 2019, the AWGS updated its consensus (i.e., AWGS 2019) [33] in which the diagnostic algorithm, the protocols, and some cut-points were revised. In particular, the cut-points for muscle strength were set out at 28 kg for men and 18 kg for women. At the same time, poor physical performance was defined by a 6-m walking speed lower than 1.0 m/s, a Short Physical Performance Battery score lower than 9, or a 5-time chair stand test equal to or higher than 12 s (Table 2.1). The AWGS in this revised consensus also revised the diagnostic algorithm, distinguishing a section for community care and another for the hospital setting. Both of these two sections propose the case finding via the measurement of the calf circumference (setting sex-specific thresholds at <34 cm for men and <33 cm for women), the SARC-F score (with the critical cut-point set at ≥ 4), or the SARC-CalF (abnormal results defined as ≥ 11). As done in the EWGSOP2, the AWGS 2019 also introduced the concept of possible sarcopenia defined by low muscle strength, independently from physical performance assessment.

Just recently, Yang et al. [34] compared the EWGSOP2 criteria with those of the EWGSOP, AWGS, IWGS, and FNIH in a sample of Chinese community-dwelling older persons in order to examine the prevalence and associated risk factors of sarcopenia. They found that the prevalence of sarcopenia defined by the EWGSOP2 criteria was lower than that measured using the EWGSOP and AWGS definitions. It was also reported that the FNIH criteria were more conservative than those of the EWGSOP, EWGSOP2, AWGS, and IWGS. In fact, the FNIH criteria consider the ASM adjusted for BMI for assessing the muscle mass, which results being more selective compared to ASM adjusted for height (m²). Hand-grip strength adjusted to body weight is also recommended to be superior to hand-grip strength in representing metabolic aspects of sarcopenia [35].

2.5 Conclusion

Over the last decade, several operational definitions for sarcopenia have been proposed across the world. The application of the different sarcopenia definitions has resulted in a marked heterogeneity in the literature, especially in studies reporting the prevalence and risk factors of sarcopenia. Given that ethnic differences determine a significant variability in body composition and lifestyle habits, it has been pointed out that unique cut-points for muscle parameters may not be readily applicable to everyone worldwide. If, on the one hand, the utility of having universal standards/targets cannot be overlooked, the need for a less stringent approach is reasonable for developing a person-centered approach, especially when dealing with the complexity of aging individuals.

References

1. Hughes VA, Frontera WR, Roubenoff R, Evans WJ, Singh MAF. Longitudinal changes in body composition in older men and women: role of body weight change and physical activity. *Am J Clin Nutr.* 2002;76(2):473–81.
2. Rosenberg IH. Sarcopenia: origins and clinical relevance. *J Nutr.* 1997;127(5 Suppl):990S–1S.
3. Delmonico MJ, Harris TB, Visser M, Park SW, Conroy MB, Velasquez-Mieryer P, et al. Longitudinal study of muscle strength, quality, and adipose tissue infiltration. *Am J Clin Nutr.* 2009;90(6):1579–85.
4. Cruz-Jentoft AJ, Landi F, Topinková E, Michel J-P. Understanding sarcopenia as a geriatric syndrome. *Curr Opin Clin Nutr Metab Care.* 2010;13(1):1–7.
5. Anker SD, Morley JE, von Haehling S. Welcome to the ICD-10 code for sarcopenia. *J Cachexia Sarcopenia Muscle.* 2016;7(5):512–4.
6. Molino A, Amabile MI, Rossi Fanelli F, Muscaritoli M. Novel therapeutic options for cachexia and sarcopenia. *Expert Opin Biol Ther.* 2016;16(10):1239–44.
7. Vellas B, Fielding RA, Bens C, Bernabei R, Cawthon PM, Cederholm T, et al. Implications of ICD-10 for sarcopenia clinical practice and clinical trials: report by the international conference on frailty and sarcopenia research task force. *J Frailty Aging.* 2018;7(1):2–9.
8. Chen L-K, Lee W-J, Peng L-N, Liu L-K, Arai H, Akishita M, et al. Recent advances in sarcopenia research in Asia: 2016 update from the Asian Working Group for Sarcopenia. *J Am Med Dir Assoc.* 2016;17(8):767.e1–7.
9. Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, et al. Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol.* 1998;147(8):755–63.
10. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on sarcopenia in older people. *Age Ageing.* 2010;39(4):412–23.
11. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing.* 2019;48(1):16–31.
12. Muscaritoli M, Anker SD, Argilés J, Aversa Z, Bauer JM, Biolo G, et al. Consensus definition of sarcopenia, cachexia and pre-cachexia: joint document elaborated by Special Interest Groups (SIG) ‘cachexia-anorexia in chronic wasting diseases’ and ‘nutrition in geriatrics’. *Clin Nutr.* 2010;29(2):154–9.
13. Fielding RA, Vellas B, Evans WJ, Bhasin S, Morley JE, Newman AB, et al. Sarcopenia: an undiagnosed condition in older adults. Current consensus definition: prevalence,

- etiology, and consequences. International Working Group on Sarcopenia. *J Am Med Dir Assoc.* 2011;12(4):249–56.
14. Morley JE, Abbatecola AM, Argiles JM, Baracos V, Bauer J, Bhasin S, et al. Sarcopenia with limited mobility: an international consensus. *J Am Med Dir Assoc.* 2011;12(6):403–9.
 15. Cruz-Jentoft AJ, Landi F, Schneider SM, Zúñiga C, Arai H, Boirie Y, et al. Prevalence of and interventions for sarcopenia in ageing adults: a systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). *Age Ageing.* 2014;43(6):748–59.
 16. Chen L-K, Liu L-K, Woo J, Assantachai P, Auyeung T-W, Bahyah KS, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. *J Am Med Dir Assoc.* 2014;15(2):95–101.
 17. Studenski SA, Peters KW, Alley DE, Cawthon PM, McLean RR, Harris TB, et al. The FNIH sarcopenia project: rationale, study description, conference recommendations, and final estimates. *J Gerontol A Biol Sci Med Sci.* 2014;69(5):547–58.
 18. Bhasin S, Travison TG, Manini TM, Patel S, Pencina KM, Fielding RA, et al. Sarcopenia definition: the position statements of the sarcopenia definition and outcomes consortium. *J Am Geriatr Soc.* 2020;68(7):1410–8.
 19. Marzetti E, Calvani R, Tosato M, Cesari M, Di Bari M, Cherubini A, et al. Sarcopenia: an overview. *Aging Clin Exp Res.* 2017;29(1):11–7.
 20. Malmstrom TK, Morley JE. SARC-F: a simple questionnaire to rapidly diagnose sarcopenia. *J Am Med Dir Assoc.* 2013;14(8):531–2.
 21. Beaudart C, Rolland Y, Cruz-Jentoft AJ, Bauer JM, Sieber C, Cooper C, et al. Assessment of muscle function and physical performance in daily clinical practice: a position paper endorsed by the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO). *Calcif Tissue Int.* 2019;105(1):1–14.
 22. Cao L, Chen S, Zou C, Ding X, Gao L, Liao Z, et al. A pilot study of the SARC-F scale on screening sarcopenia and physical disability in the Chinese older people. *J Nutr Health Aging.* 2014;18(3):277–83.
 23. Woo J, Leung J, Morley JE. Defining sarcopenia in terms of incident adverse outcomes. *J Am Med Dir Assoc.* 2015;16(3):247–52.
 24. Alkahtani SA. A cross-sectional study on sarcopenia using different methods: reference values for healthy Saudi young men. *BMC Musculoskelet Disord.* 2017;18(1):119.
 25. Dam T-T, Peters KW, Fragala M, Cawthon PM, Harris TB, McLean R, et al. An evidence-based comparison of operational criteria for the presence of sarcopenia. *J Gerontol A Biol Sci Med Sci.* 2014;69(5):584–90.
 26. Kim H, Hirano H, Eda Hiro A, Ohara Y, Watanabe Y, Kojima N, et al. Sarcopenia: prevalence and associated factors based on different suggested definitions in community-dwelling older adults. *Geriatr Gerontol Int.* 2016;16(Suppl 1):110–22.
 27. Han D-S, Chang K-V, Li C-M, Lin Y-H, Kao T-W, Tsai K-S, et al. Skeletal muscle mass adjusted by height correlated better with muscular functions than that adjusted by body weight in defining sarcopenia. *Sci Rep.* 2016;6:19457.
 28. Lee W-J, Liu L-K, Peng L-N, Lin M-H, Chen L-K, ILAS Research Group. Comparisons of sarcopenia defined by IWGS and EWGSOP criteria among older people: results from the I-Lan longitudinal aging study. *J Am Med Dir Assoc.* 2013;14(7):528.e1–7.
 29. Zeng Y, Hu X, Xie L, Han Z, Zuo Y, Yang M. The prevalence of sarcopenia in Chinese elderly nursing home residents: a comparison of 4 diagnostic criteria. *J Am Med Dir Assoc.* 2018;19(8):690–5.
 30. Wang J, Thornton JC, Russell M, Burastero S, Heymsfield S, Pierson RN. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparisons of anthropometric measurements. *Am J Clin Nutr.* 1994;60(1):23–8.
 31. Bahat G, Tufan A, Tufan F, Kilic C, Akpınar TS, Kose M, et al. Cut-off points to identify sarcopenia according to European Working Group on Sarcopenia in Older People (EWGSOP) definition. *Clin Nutr.* 2016;35(6):1557–63.

32. Zanker J, Scott D, Reijnierse EM, Brennan-Olsen SL, Daly RM, Girgis CM, et al. Establishing an operational definition of sarcopenia in Australia and New Zealand: delphi method based consensus statement. *J Nutr Health Aging*. 2019;23(1):105–10.
33. Chen L-K, Woo J, Assantachai P, Auyeung T-W, Chou M-Y, Iijima K, et al. Asian Working Group for Sarcopenia: 2019 consensus update on sarcopenia diagnosis and treatment. *J Am Med Dir Assoc*. 2020;21(3):300–307.e2.
34. Yang L, Yao X, Shen J, Sun G, Sun Q, Tian X, et al. Comparison of revised EWGSOP criteria and four other diagnostic criteria of sarcopenia in Chinese community-dwelling elderly residents. *Exp Gerontol*. 2020;130:110798.
35. Chun S-W, Kim W, Choi KH. Comparison between grip strength and grip strength divided by body weight in their relationship with metabolic syndrome and quality of life in the elderly. *PLoS One*. 2019;14(9):e0222040.