

Muscle mass assessment and definitions of sarcopenia

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In recent years, our understanding of age-related body changes has markedly advanced, techniques for measuring body composition have greatly improved, and large representative data sets on body composition have become widely available. Yet there is still no consensus definition of sarcopenia that can be applied across populations. For practical reasons, the age-related loss of skeletal muscle mass, named *sarcopenia*, is usually operationalized as low muscle mass or low muscle strength in old age. The challenge, however, is to build consensus on the best methods for quantifying muscle mass and muscle strength and to develop cutoff levels that represent an operational definition of sarcopenia. This presentation will review best-available methods for assessment of body composition with the goal of identifying people with, or at risk for developing, sarcopenia.

A wide range of methods have been used to evaluate body composition, particularly as relevant to sarcopenia. Changes in muscle have been estimated by anthropometric measurements, urine metabolite levels, and measures of whole body nitrogen; such determinations have limited sensitivity as markers of sarcopenia or require equipment that has limited availability. Reliable measures of body mass/muscle are based on dual-energy X-ray absorptiometry (DEXA) imaging (eg, for appendicular skeletal muscle mass) or magnetic resonance imaging (MRI) and computed tomography (CT) (eg, for mid-thigh cross-sectional area; Figure 1). DEXA imaging allows delineation of body mass as bone mineral, fat, and fat-free soft tissue; in the arms and legs, non-bone, non-fat tissues are assumed to be appendicular skeletal muscle mass (ASM).

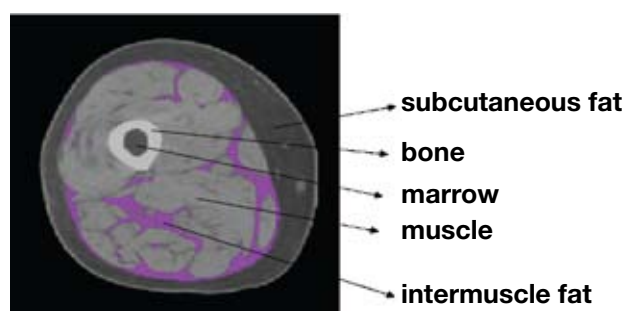


Figure 1. Computerized tomographic image (mid-thigh) showing evidence of fat infiltration into the muscle tissue of an older adult

About a decade ago, Janssen, Baumgartner et al used DEXA scanning to measure ASM, and defined skeletal muscle index (SMI) as $ASM/height^2$ (as kg/m^2); SMI levels 2 standard deviations below mean values for young reference populations were defined as cutoffs for sarcopenia ($7.26 kg/m^2$ and $5.45 kg/m^2$ for men and women, respectively).¹ Using this definition, sarcopenia occurred in >50 percent of persons over 80 years of age and was significantly associated with self-reported disability.¹ A more recent study by Janssen, et al, identified gender-specific SMI cutoffs for their direct correlation with presence of physical disability; cutoffs were $8.50 kg/m^2$ and $5.75 kg/m^2$ for men and women, respectively.² Since not only height but also fat mass influence the amount of skeletal muscle mass, a variation on the $ASM/height^2$ method uses residuals from linear regression on height and body fat mass to define sarcopenia cutpoints—a method simply referred to as residuals.³⁻⁴

Apart from sarcopenia definitions based on muscle mass, another operational definition of sarcopenia was based on an association between handgrip strength and mobility.⁵ Study results showed that low handgrip strength could be used as a clinical marker of poor mobility and was a better predictor compared to low muscle mass. This study defined cutoffs that could be used to screen for sarcopenia in older men and women.

In summary, a range of clinical assessments and cutpoints for sarcopenia have been developed over the last decade—skeletal muscle index, residuals, and handgrip strength. Moving forward, these clinical definitions need to be tested and verified in large-scale, longitudinal studies of aging populations. Some problems that must be addressed in the process of developing ideal clinical markers for sarcopenia are: (1) markers need to incorporate both body height and body fat, (2) low muscle strength seems to be more relevant for decline in physical function than low muscle mass in large cohort studies of older persons, and (3) in women, high body fat may be more relevant for decline in physical function than muscle parameters.

Take-home messages

- The condition of age-related muscle loss, called *sarcopenia*, is usually operationalized as low muscle mass or low muscle strength in old age, but there is not yet consensus on what methods and cutpoints to use as the definition of sarcopenia.
- Certain methods—skeletal muscle index, residuals, and handgrip strength—have been tested, and cutpoints have been designated for clinical definition of sarcopenia.
- Moving forward, clinical definitions need to be tested and verified in large-scale, longitudinal studies of aging populations.

References

1. Baumgartner R, Koehler K, Gallagher D, et al. Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol.* 1998;147:755-763.
2. Janssen I, Baumgartner R, Ross R, Rosenberg I, Roubenoff R. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. *Am J Epidemiol.* 2004;159:413-421.
3. Delmonico MJ, Harris TB, Lee JS, et al. Alternative definitions of sarcopenia, lower extremity performance, and functional impairment with aging in older men and women. *J Am Geriatr Soc.* 2007;55:769-774.
4. Newman A, Kupelian V, Visser M, et al. Sarcopenia: alternative definitions and association with lower extremity function. *J Am Geriatr Soc.* 2003;51:1602-1609.
5. Laurentani F, Russo C, Bandinelli S, et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. *AJ Appl Physiol.* 2003;95:1851-1860.

Discussion

Jean-Pierre Michel: You did not mention patients with cachexia in your presentation. Is it possible to differentiate between muscle loss due to disease-related wasting and muscle loss due to age-related sarcopenia with the measures used in those studies?

Marjolein Visser: No, these groups cannot be differentiated on the basis of muscle assessments.

Abellan van Kan Gabor: Chang divided appendicular mass by BMI. Where are we with this ratio? Is it relevant? Or should we continue to use the classical definitions?

Marjolein Visser: I think we need to consider fat in order to interpret the amount of skeletal muscle correctly. But I would not recommend using a ratio.

Abellan van Kan Gabor: In Europe, we have used the Baumgartner definition with a young US population as a reference. I don't know if we are doing right. Epidemiologically, I don't think we can use this population for all Europeans, but we are using it.

Marjolein Visser: I am not in favor of using a young reference group. The advantage of using 1 reference group is that data are comparable across studies. But I don't understand the argument about creating European reference data. Non-Hispanic whites in the US are the European people.

Jeffrey Stout: I am interested in the relationship between grip strength and predictors of functional tasks and muscle mass. Did you take the person's level of physical activity into account?

Marjolein Visser: It is very important for our future work; we should relate grip strength to outcomes. We don't know the answer yet. There might be some interaction with physical activity level. It is a very relevant comment.

Juergen Bauer: Handgrip strength has been criticized because lower muscles are more important than higher muscles; grip strength in older people measures small muscles, which are not as relevant as outcomes related to walking.

Marjolein Visser: Well, if you look at the data, it is surprising what grip strength can tell you about other parts of the body and future outcomes. Of course it's not perfect. But we definitely need simple, predictive tests.

Marjolein Visser: (comment) I really like to derive cutpoints from actual associations, because there you see at what level people start to have an increased risk. I would like to see these cutpoints based on relevant outcome measures.