

Diagnostic techniques in research and clinical practice

Juergen M. Bauer, *Department of Geriatric Medicine, Friedrich-Alexander University of Erlangen-Nuremberg, Germany*

Age-related sarcopenia is a condition of declining muscle mass and muscle strength with increasing age. Changes in muscle mass can be assessed by measuring biomarkers or by using imaging methods; muscle strength can be rated using various functional tests. However, experts have not yet agreed on which measurements should be included in an operational diagnosis of sarcopenia. This presentation will discuss various techniques for evaluating muscle with the aim of helping build practical definitions for the diagnosis of sarcopenia in research and clinical settings. Assessment techniques include anthropometric measures, biochemical markers, various body scanning methods, bioimpedance analysis, and measures of physical function.

Anthropometric measures. Mid upper arm circumference and skinfold thickness have been used to estimate muscle mass in ambulatory settings. Calf circumference correlates positively with muscle mass; calf circumference < 31 cm has been associated with disability.¹ However, age-related changes in fat deposits and loss of skin elasticity contribute to errors of estimation in older people. There are few studies validating anthropometric measures in older and obese people; these and other confounders make anthropometric measures vulnerable to error.²

Biochemical measures. Muscle metabolites (eg, creatinine and 3-methylhistidine) in urine may indicate low muscle mass, but these measures are neither sensitive nor reliable. In addition they are difficult to perform accurately because they rely on precisely timed urine collection, consumption of a meat-free diet, physical activity, and renal clearance.³

Body imaging techniques. Three imaging techniques have been used for estimating muscle mass or lean body mass—computed tomography (CT) scan, magnetic resonance imaging (MRI), and dual energy X-ray absorptiometry (DEXA). CT and MRI are considered to be very precise imaging systems that can separate fat from other soft tissues of the body. High cost, no access to equipment at some elder care sites, and concerns about radiation exposure limit the use of these whole-body imaging methods.⁴ Dual energy X-ray absorptiometry (DEXA) is an attractive alternative method for clinical use. The relative attenuation of two X-ray beams of different energy levels is used to distinguish fat, bone mineral and lean tissues. This whole-body scan exposes the patient to minimal radiation. The drawback is that the equipment is not portable, which may preclude its use in large-scale epidemiologic studies.⁴

Bioimpedance analysis. BIA uses the varying conductivity of body tissues to estimate the volume of fat and lean body mass. The test itself is inexpensive, easy to use, readily reproducible, and appropriate for both ambulatory and bedridden patients. BIA measurement techniques have been standardized for over 10 years,⁵ and BIA results under standard conditions have been found to correlate well with magnetic resonance imaging (MRI) predictions.⁶ Prediction equations have been validated for multiethnic adults⁶ and reference values established for adult white men and women.⁷

Physical functional tests. While there is an association between loss of muscle mass and loss of strength, it does not explain the latter sufficiently.⁸⁻⁹ Therefore, most experts in the field see the necessity of including a functional test in the operational diagnosis of sarcopenia. In addition, certain functional measures can reliably predict outcomes critical to quality of life, and can gauge the impact of an intervention on these important areas of general health. However, the measured physical function may not be influenced solely by the presence or absence of sarcopenia but also by additional factors beyond the studied intervention.¹⁰

The Short Physical Performance Battery (SPPB) is a reliable measure able to predict a number of adverse outcomes, including mortality and the onset of new disability,¹⁰ and is appropriate for research settings. Gait speed has been shown to capture nearly all the predictive ability of the SPPB, and is well-suited for clinical use.¹⁰⁻¹¹

What diagnostic techniques should be used?

Table 1 provides recommendations for muscle mass and strength evaluations in clinical and research settings. For clinical use, a single-frequency arm-to-leg BIA measurement is proposed for the estimation of muscle mass. Patients who fall at or below 2 standard deviations from the young adult mean of a reference population are defined as having low muscle mass, i.e., being sarcopenic, while those being 1 to 2 standard deviations below are considered *at risk* for low muscle mass.⁹ The same skeletal muscle thresholds are appropriate in research settings, but the more advanced whole-body scan techniques of DEXA, CT, or MRI should be considered. Gait speed measures and SPPB offer reliable assessment of physical function; SPPB is suggested for use in research settings.

Table 1. Recommendations for diagnostic techniques

Measure of:	Clinical setting	Research setting
Muscle mass	BIA (single frequency arm-to-leg BIA)	Consider DEXA, CT or MRI
Physical function	4 m walking speed (gait speed)	SPPB (short physical performance battery)

In conclusion, it is important for geriatricians and gerontologists to achieve consensus on what techniques to use for assessment of muscle mass and strength in different settings, how to standardize use of these techniques, and what cutpoints to use for different levels of severity. Such advances will help improve diagnosis and treatment of sarcopenia, in turn enhancing the quality of life for the large and ever-growing population of older people.

Take-home messages

- The range of methods that will facilitate diagnosis and treatment of sarcopenia is wide—including anthropometric measures, biochemical markers, various body scanning methods, bioimpedance analysis, and tests of physical function.
- To make a consistent and reliable diagnosis, it is important to achieve consensus on what techniques to use in different settings, how to standardize use of these techniques, and what cutpoints to use for operational diagnosis of sarcopenia.

References

1. Rolland Y, Lauwers-Cances V, Cournot M, et al. Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. *J Am Geriatr Soc.* Aug 2003;51(8):1120-1124.
2. Rolland Y, Czerwinski S, Abellan Van Kan G, et al. Sarcopenia: its assessment, etiology, pathogenesis, consequences and future perspectives. *J Nutr Health Aging.* Aug-Sep 2008;12(7):433-450.
3. Morley JE. Sarcopenia: diagnosis and treatment. *J Nutr Health Aging.* Aug-Sep 2008;12(7):452-456.
4. Chien MY, Huang TY, Wu YT. Prevalence of sarcopenia estimated using a bioelectrical impedance analysis prediction equation in community-dwelling elderly people in Taiwan. *J Am Geriatr Soc.* Sep 2008;56(9):1710-1715.
5. NIH. Bioelectrical impedance analysis in body composition measurement: National Institutes of Health Technology Assessment Conference Statement. *Am J Clin Nutr.* Sep 1996;64(3 Suppl):524S-532S.
6. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. *J Appl Physiol.* Aug 2000;89(2):465-471.
7. Kyle UG, Genton L, Slosman DO, Pichard C. Fat-free and fat mass percentiles in 5225 healthy subjects aged 15 to 98 years. *Nutrition.* Jul-Aug 2001;17(7-8):534-541.
8. Clark BC, Manini TM. Sarcopenia \neq dynapenia. *J Gerontol A Biol Sci Med Sci.* Aug 2008;63(8):829-834.
9. 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.* May 2002;50(5):889-896.
10. Working Group on Functional Outcome Measures for Clinical Trials. Functional outcomes for clinical trials in frail older persons: time to be moving. *J Gerontol A Biol Sci Med Sci.* Feb 2008;63(2):160-164.
11. Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *J Gerontol A Biol Sci Med Sci.* Apr 2000;55(4):M221-231.

Discussion

Irit Hermesh: You suggest using BIA, and you showed how it correlates with hand grip. Professor Visser just showed that handgrip strength correlates with outcomes, so why not just use hand grip? It's easy and cheap.

Juergen M. Bauer: Here it comes to the point—why care about muscle mass at all? We are interested in function, so maybe we should go for functional tests, with hand grip being one of the key opportunities to measure function. However, is it sensitive to change after interventions?

Pilar Garcia: This situation seems to be parallel to our strategy for nutritional assessment. In our hospitals, we use simple screening techniques to identify patients who need more complicated assessments of nutritional status.

Alfonso Cruz: Yes, for clinical use, we could also borrow a model from dementia. We screen prior to doing more extensive diagnostic testing. Among patients at risk for Alzheimer's, a simple test as the mini-mental test is used—somewhat like BIA could be used for sarcopenia screening.