American College of Radiology
ACR Appropriateness Criteria®
Diagnosis and Monitoring of Sarcopenia

Variant: 1 Adult 60 years of age and older with suspected sarcopenia. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
DXA total body composition	Usually Appropriate	☢
US thigh	May Be Appropriate	O
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without and with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 2 Adult with cancer and suspected sarcopenia. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
DXA total body composition	Usually Appropriate	☢
US thigh	May Be Appropriate	O
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without and with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 3 Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
DXA total body composition	Usually Appropriate	☢
US thigh	May Be Appropriate	O
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without and with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 4 Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
DXA total body composition	Usually Appropriate	☢
US thigh	May Be Appropriate	O
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without and with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 5 Adult with known sarcopenia. Surveillance.

Procedure	Appropriateness Category	Relative Radiation Level
DXA total body composition	Usually Appropriate	☢
US thigh	May Be Appropriate	O
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢

CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without and with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Panel Members

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Summary of Literature Review

Introduction/Background

Sarcopenia is a generalized disease of skeletal muscle characterized by reduced muscle mass and weakness [1]. Weakness may be "muscle specific", defined as the ratio of muscle strength to muscle quantity (eg, muscle cross-sectional area measured in cm^2) [2]. In clinical practice and clinical research, muscle weakness is most commonly evaluated by measuring grip strength or with the chair stand test.

Sarcopenia is consistently associated with adverse clinical outcomes, including outcomes related to health-related quality of life, activities of daily living, physical performance, falls, fractures, and premature mortality [3]. Similar adverse outcomes have been reported when sarcopenia is diagnosed using clinical and imaging methods.

Sarcopenia is more common with aging, and the prevalence may vary depending on the diagnostic criteria utilized (eg, diagnostic method, cut points) and the study population (eg, age, comorbidities). For example, sarcopenia prevalence is lower among community-dwelling older adults (10%), compared to hospitalized patients (23%-24%) and nursing home residents (31%-51%) [4]. Comorbidities also affect the prevalence of sarcopenia, varying from 18% with diabetes to 66% with unresectable esophageal cancer [5].

Muscle depletion is a hallmark of four related conditions that are common in clinical practice: cancer, malnutrition, cachexia, and physical frailty. All of these clinical conditions have individual ICD codes and are associated with adverse outcomes, including hospitalization and excess mortality [6]. Cancer and other conditions can result in muscle depletion that may not be obvious clinically, especially in obese patients. Malnutrition is diagnosed when two conditions are satisfied: one etiologic condition (inflammation or reduced food intake/assimilation) and one phenotypic

condition (low muscle mass that can be identified with imaging, low body mass index (BMI), or nonvolitional weight loss) [7]. Cachexia is a subtype of malnutrition characterized by involuntary loss of muscle associated with a chronic disease (eg, malignancy, chronic obstructive pulmonary disease (COPD), congestive heart failure, or chronic kidney disease). Patients with cancer may have muscle depletion owing to age-related sarcopenia or secondary to cancer cachexia. Frailty is characterized by low physiologic reserve, low adaptive capacity, and vulnerability to stressors [8, 9].

Despite the high prevalence and burden of adverse outcomes, sarcopenia is underdiagnosed and undertreated [10]. Currently, knowledge of sarcopenia is low among many patients and medical providers, but both groups indicate willingness to start treatment [11-13]. The unmet need for sarcopenia detection and education may be partially addressed by quantitative imaging as a biomarker of muscle depletion. Standardized measurements with AI tools are increasingly enabling automated ("opportunistic") analysis of imaging examinations that are already acquired for other routine indications. For example, if there is suspected sarcopenia, clinical CT or MRI scans can be used secondarily to screen for quantitative imaging findings associated with sarcopenia, namely myopenia (low muscle mass) and myosteatosis (high muscle fat) [14, 15]. Such an opportunistic evaluation is generally performed when a referring provider requests this secondary analysis owing to clinically suspected sarcopenia. Myopenia and myosteatosis identified by imaging are characteristic of sarcopenia, but are not sufficient in isolation to diagnose the clinical disease of sarcopenia.

Sarcopenia may be suspected when predisposing risk factors are present, including low muscle strength (eg, grip strength), physical frailty, recurrent falls, major health conditions, hospitalization, and residency in a long-term care facility [16, 17]. Screening for sarcopenia also has been recommended on an annual basis in older adults at risk, particularly those with low physical activity levels [18-20].

Sarcopenia is a potentially reversible disease [21]. Beyond prevention, exercise and proper nutrition are the mainstays of sarcopenia treatment that can be tailored to individual patients [22-24]. There is no approved pharmacologic treatment for sarcopenia, but numerous drugs are currently under evaluation in clinical trials [25-27]. For malnutrition, management may include nutritional counseling supplemented by oral, enteral, or parenteral nutrition [28]. For cachexia, interventions also include targeted pharmacological and psychosocial therapies, in addition to treatment of the underlying disease process [29].

Special Imaging Considerations

Dual-energy X-ray absorptiometry (DXA) uses two X-ray energies with differential absorption that allows measurement of bone mineral density, fat mass, and lean mass. DXA measurements of lean mass in the upper and lower extremities are summed to yield the appendicular lean soft tissue mass, with reference values generally adjusted or "indexed" using patient height or BMI. Although widely used in research, the value of DXA in the evaluation of muscle mass has been increasingly questioned. There are four main concerns: 1) DXA measures "lean mass" (all tissue that is not fat or bone), and therefore does not directly measure muscle mass; 2) as a projectional technique, DXA also does not measure muscle quality features directly, such as myosteatosis; 3) measurements may be influenced by patient fluid status; and 4) there is limited comparability between different scanner manufacturers and models.

CT, MRI, and ultrasound (US) allow measurement of features associated with muscle quantity and tissue quality. With CT and MRI, proxies for muscle mass include cross-sectional areal measurements of muscle size. CT and MRI tissue quality proxies aim to assess noncontractile components within muscle, such as adipose tissue. With US, muscle quantity parameters measured most commonly are muscle thickness and cross-sectional area (eg, quadriceps musculature in the thigh). The muscle quality parameter measured most commonly is echo intensity (associated with fat content). US potential limitations include intra- and interuser variability. Recent meta-analysis of US studies with 2,143 participants found low-to-moderate accuracy for sarcopenia diagnosis depending on different US parameters, measured muscles, reference standards, and study populations [30]. The Sarcopenia through Ultrasound (SARCUS) Working Group has provided a framework to standardize appendicular muscle measurements [31]. Ongoing work includes further validating of optimal cutoff points to indicate sarcopenia in diverse populations (including adjustments for patient height and weight), understanding the impact of fluid status on US assessment, and documenting the added clinical value of US in predicting patient outcomes are still works in progress [32-34].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.

When sarcopenia is suspected clinically, various imaging techniques have been validated to confirm the diagnosis of sarcopenia by showing low muscle quantity or quality, particularly with CT, MRI, DXA, or US [16, 35].

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.
A. Bone scan whole body

There is no relevant literature to support the use of whole body bone scan for initial imaging of suspected sarcopenia because these scans primarily assess bone metabolism rather than muscle mass and quality.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.
B. CT abdomen with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT with intravenous (IV) contrast. However, if abdominal CT with IV contrast is already being obtained for a routine clinical indication (eg, abdominal surgery [44, 45]), a

secondary quantitative analysis of muscle is usually appropriate for initial imaging evaluation in a patient with suspected sarcopenia [46]. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Of note, the presence of IV contrast tends to result in a small increase in measured muscle quantity (≤1.1 cm^2/m^2, 2.6%) at the L3 level [47]. Muscle density measurements increase variably after IV contrast administration [48, 49], but a simplified correction factor of 7.5 Hounsfield units has been recommended at the L3 level for venous and delayed phase contrast scans [50, 51]. Compared to noncontrast abdominal CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. C. CT abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without and with IV contrast. However, if abdominal CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle is usually appropriate for initial imaging evaluation in a patient with suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. D. CT abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without IV contrast. However, if abdominal CT without IV contrast is already being obtained for a routine clinical indication [52-54], a secondary quantitative analysis of the muscle is usually appropriate for initial imaging evaluation in a patient with suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. E. CT chest with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT with IV contrast. However, if chest CT with IV contrast is already being obtained for a routine clinical indication (eg, COVID-19 [55], transcatheter aortic valve replacement [56, 57], or admission to the intensive care unit [58]), a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation in a patient with suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Of note, contrast-enhanced and noncontrast data should not be used interchangeably, although correction modeling can be performed for varying chest CT protocols [59].

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. F. CT chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without and with IV contrast. However, if chest CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation in a patient with suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than

re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. G. CT chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without IV contrast. However, if chest CT without IV contrast is already being obtained for a routine clinical indication (eg, in older hospitalized patients [60], lung cancer screening [61, 62]), a secondary quantitative analysis of the muscle may be appropriate for initial imaging evaluation in a patient with suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. H. DXA total body composition

DXA is usually appropriate for imaging of suspected sarcopenia. Most expert working groups recommend DXA as a technique to confirm the imaging features of sarcopenia, with specific cutoff thresholds and wide adoption in research settings [16, 17, 36-38].

Given recent studies indicating that DXA associations with sarcopenia-related clinical outcomes are weak or inconsistent [1, 39, 40], combining clinical evaluation with secondary analysis of muscle on an available recent CT scan may be more appropriate than performing a new DXA scan.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. I. FDG-PET/CT whole body

There is insufficient evidence to support the use of whole body FDG-PET/CT for initial imaging of suspected sarcopenia. There is a paucity of literature to support secondary quantitative analysis of muscle on CT scans routinely performed with PET (eg, cardiac PET/CT in patients with cardiometabolic syndrome [71]).

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. J. FDG-PET/MRI whole body

There is no relevant literature to support the use of whole body fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/MRI for initial imaging of suspected sarcopenia.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. K. MRI abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without and with IV contrast is already being obtained for a routine clinical indication (eg, Crohn disease [64, 65], chronic liver disease [66, 67]).

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging. L. MRI abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without IV contrast is already being obtained for a routine clinical indication. On abdomen and chest scans covering the L1 level (level of the superior

mesenteric artery), there is a high intraindividual correlation between MRI and CT for biomarkers of muscle quantity and quality [68].

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.
M. MRI chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without and with IV contrast is already being obtained for a routine clinical indication (eg, cardiomyopathy [69], aortic valve replacement [70]).

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.
N. MRI chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.
O. Radiography chest

There is insufficient evidence to support the use of chest radiography for initial imaging of suspected sarcopenia [63].

Variant 1:Adult 60 years of age and older with suspected sarcopenia. Initial imaging.
P. US thigh

Thigh US, performed in conjunction with clinical history and physical examination, may be useful for the evaluation of suspected sarcopenia. US is not routinely used for evaluating sarcopenia. Some studies have found sonographic muscle measurements for muscle depletion can help stratify mortality risk (eg, patients hospitalized with COVID-19 [41]), and should be used increasingly in the future [42]. More research in various settings is needed to clarify the value of muscle US in clinical practice [43].

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.

Patients with cancer may have muscle depletion owing to age-related sarcopenia or secondary to cancer cachexia. This muscle depletion may be occult clinically, particularly in obese patients.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
A. Bone scan whole body

There is no relevant literature to support the use of whole body bone scan for initial imaging of suspected sarcopenia in adults with cancer because these scans primarily assess bone metabolism rather than muscle mass and quality.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
B. CT abdomen with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT with IV contrast. However, if abdominal CT with IV contrast is already being obtained for a routine clinical indication (eg, malignancy [78-82]), a secondary quantitative analysis of muscle is usually appropriate for initial imaging evaluation in an adult patient with suspected sarcopenia [46]. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Compared to noncontrast abdominal CT, contrast-

enhanced CT does not provide added information with regard to sarcopenia.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
C. CT abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without and with IV contrast. However, if abdominal CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle is usually appropriate for initial imaging evaluation in an adult with cancer and suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
D. CT abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without IV contrast. However, if abdominal CT without IV contrast is already being obtained for a routine clinical indication, a secondary quantitative analysis of the muscle is usually appropriate for initial imaging evaluation in an adult with cancer and suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
E. CT chest with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT with IV contrast. However, if chest CT with IV contrast is already being obtained for a routine clinical indication (eg, prior to thoracic surgery in the setting of lung cancer [83-86]), a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation in an adult with cancer and suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Of note, contrast-enhanced and noncontrast data should not be used interchangeably, although correction modeling can be performed for varying chest CT protocols [59].

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
F. CT chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without and with IV contrast. However, if chest CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation in an adult with cancer and suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
G. CT chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT. However, if chest CT without IV contrast is already being obtained for a routine clinical indication (eg, non–small-cell lung cancer [87]), a secondary quantitative analysis of the

muscle may be appropriate for initial imaging evaluation in an adult with cancer and suspected sarcopenia. Based on currently available evidence, muscle quantification is best done using existing images rather than re-scanning.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
H. DXA total body composition

DXA is usually appropriate for imaging of suspected sarcopenia. Most expert working groups recommend DXA as a technique to confirm the imaging features of sarcopenia, with specific cutoff thresholds and wide adoption in research settings [16, 17, 36-38]. If DXA is being performed for evaluation of bone density, DXA for total body composition could potentially be performed contemporaneously. However, given that DXA associations with some sarcopenia-related clinical outcomes are weak or inconsistent, combining clinical evaluation with secondary analysis of muscle on a recent CT scan may be more appropriate than performing a new DXA scan. Of note, DXA and CT are not interchangeable in the evaluation of sarcopenia; there can be poor agreement between the two modalities for sarcopenia diagnosis in patients with cancer [72].

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
I. FDG-PET/CT whole body

There is insufficient evidence to support the use of FDG-PET/CT as a stand-alone indication for diagnosing sarcopenia. There is a paucity of literature to support secondary quantitative analysis of muscle if FDG-PET/CT is already being obtained for a routine clinical indication (eg, esophageal adenocarcinoma [93, 94], multiple myeloma [95], lymphoma [96], neck cancer [97], non–small-cell lung cancer [98]).

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
J. FDG-PET/MRI whole body

There is no relevant literature to support the use of FDG-PET/MRI for initial imaging of suspected sarcopenia.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
K. MRI abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without and with IV contrast is already being obtained for a routine clinical indication (eg, hepatocellular carcinoma [88-90], pancreatic cancer [91]).

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
L. MRI abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
M. MRI chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without and with IV contrast is already being obtained

for a routine clinical indication (eg, breast cancer [92]).

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
N. MRI chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
O. Radiography chest

There is insufficient evidence to support the use of chest radiography for initial imaging of suspected sarcopenia.

Variant 2:Adult with cancer and suspected sarcopenia. Initial imaging.
P. US thigh

Thigh US, in conjunction with patient history and physical examination, is sometimes useful the evaluation of suspected sarcopenia [73, 74]. US is not routinely used for evaluating sarcopenia. Some studies have found sonographic thigh measurements for muscle depletion can help stratify risk of adverse outcomes (eg, neutropenia after chemotherapy) [75, 76]. Combining thigh and arm US measurements may result in improved diagnostic results [77].

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging.

Patients with cancer may have muscle depletion owing to age-related sarcopenia or secondary to cancer cachexia. This muscle depletion is often occult clinically, particularly in obese patients. Muscle depletion may be clinically occult in patients with cachexia or malnutrition, particularly in early stages or in the setting of obesity. Not only is malnutrition strongly associated with sarcopenia, the combination of malnutrition and sarcopenia are associated with increased mortality rates [99].

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging.
A. Bone scan whole body

There is no relevant literature to support the use of whole body bone scan for initial imaging of suspected sarcopenia in adults with cancer because these scans primarily assess bone metabolism rather than muscle mass and quality.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging.
B. CT abdomen with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT with IV contrast. However, if abdominal CT with IV contrast is already being obtained for a routine clinical indication [100, 101], a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation in an adult with cachexia/malnutrition and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning. Compared to noncontrast abdominal CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging.
C. CT abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the

use of abdominal CT without and with IV contrast. However, if abdominal CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation in an adult with cachexia/malnutrition and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. D. CT abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without IV contrast. However, if abdominal CT without IV contrast is already being obtained for a routine clinical indication, a secondary quantitative analysis of the muscle may be appropriate for initial imaging evaluation in an adult with cachexia/malnutrition and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. E. CT chest with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT with IV contrast. If chest CT with IV contrast is already being obtained for a routine clinical indication, a secondary quantitative analysis of muscle may occasionally be appropriate for initial imaging evaluation in an adult with cachexia/malnutrition and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning. Of note, contrast-enhanced and noncontrast data should not be used interchangeably, although correction modeling can be performed for varying CT protocols [59].

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. F. CT chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without and with IV contrast. If chest CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle may occasionally be appropriate for initial imaging evaluation in an adult with cachexia/malnutrition and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. G. CT chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without IV contrast. If chest CT without IV contrast is already being obtained for a routine clinical indication, a secondary quantitative analysis of the muscle may occasionally be appropriate for initial imaging evaluation in an adult with cachexia/malnutrition and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. H. DXA total body composition

DXA is usually appropriate for imaging of suspected sarcopenia. Most expert working groups recommend DXA as a technique to confirm the imaging features of sarcopenia, with specific cutoff

thresholds and wide adoption in the research settings [16, 17, 36-38]. Given recent studies indicating that DXA associations with some sarcopenia-related clinical outcomes are weak or inconsistent, combining clinical evaluation with secondary analysis of muscle on a recent available abdominal CT scan may be more appropriate than performing a new DXA scan.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. I. FDG-PET/CT whole body

There is insufficient evidence to support the use of FDG-PET/CT as a stand-alone indication for suspected sarcopenia. If FDG-PET/CT is already being obtained for a routine clinical indication, a secondary quantitative analysis of existing FDG-PET/CT data may occasionally be appropriate for initial imaging evaluation in a patient with cachexia/malnutrition and suspected sarcopenia, but there is not substantial evidence to support this in the literature.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. J. FDG-PET/MRI whole body

There is no relevant literature to support the use of FDG-PET/MRI for initial imaging of suspected sarcopenia.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. K. MRI abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without and with IV contrast is already being obtained for a routine clinical indication.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. L. MRI abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. M. MRI chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without and with IV contrast is already being obtained for a routine clinical indication.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. N. MRI chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging. O. Radiography chest

There is no relevant literature to support the use of chest radiography for initial imaging of

suspected sarcopenia.

Variant 3:Adult with cachexia or malnutrition and suspected sarcopenia. Initial imaging.
P. US thigh

Thigh US, in conjunction with patient history and physical examination, is sometimes useful the evaluation of suspected sarcopenia [73, 74]. US is not routinely used for evaluating sarcopenia.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.

Adults with frailty or multiple comorbidities are at increased risk for sarcopenia. Comorbidities commonly associated with sarcopenia include chronic diseases such as diabetes, chronic kidney disease, cardiovascular disease, neurological disease, and bone and joint disease [102, 103]. The frequency of sarcopenia increases with the number of chronic diseases. For example, the risk of sarcopenia for older hospitalized patients with >6 chronic diseases is >5 times higher than for 2 to 3 chronic diseases [103]. Patients with a greater comorbidity burden are also more likely to undergo CT and MRI [104], which can be used for secondary analysis for sarcopenia [15].

Specific phenotypes evaluated with imaging of sarcopenia include obesity ("sarcopenic obesity" [105, 106]) and osteoporosis ("osteosarcopenia" [107]). Sarcopenic obesity (compared to patients without sarcopenia and obesity) is associated with functional dependence (3.8×) and mortality (2.8×) [108]. Osteosarcopenia is associated with an increased risk of fall (1.5×), fracture (2.1×), and mortality (1.8×) [109]. Screening and treatment protocols for older adults have been suggested to mitigate adverse health outcomes [108]. Imaging evaluation of body composition may be appropriate in some patients to inform clinical decision-making and identify patients who may benefit from rehabilitation interventions [110].

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
A. Bone scan whole body

There is no relevant literature to support the use of whole body bone scan for initial imaging of suspected sarcopenia in adults with cancer because these scans primarily assess bone metabolism rather than muscle mass and quality.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
B. CT abdomen with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT with IV contrast. However, if abdominal CT with IV contrast is already being obtained for a routine clinical indication (eg, in the setting of trauma [117], emergency laparotomy [118], chronic limb-threatening ischemia [119], liver transplantation [120], surgical oncology [121], frail older adults with cancer [122]), then a secondary quantitative analysis of muscle may be complementary for initial imaging evaluation in an adult with clinical frailty and suspected sarcopenia. Muscle quantification is best done using existing images rather than re-scanning. Compared to noncontrast abdominal CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
C. CT abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without and with IV contrast. However, if abdominal CT without and with IV contrast is obtained for another clinical indication, then a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation for suspected sarcopenia in an adult with clinical frailty or multiple comorbidities. Muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
D. CT abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal CT without IV contrast. However, if abdominal CT without IV contrast is already being obtained for a routine clinical indication, then a secondary quantitative analysis of the muscle may be appropriate for initial imaging evaluation for suspected sarcopenia in an adult with clinical frailty or multiple comorbidities. For example, in a study of patients with acute kidney injury (n = 2,200, mostly >65 years of age, with multiple comorbidities), noncontrast abdominal CT evaluation of muscle at the L3 level showed strong protective effects of muscle mass on short-term mortality [123]. Muscle quantification is best done using existing images rather than re-scanning.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
E. CT chest with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT with IV contrast. If chest CT with IV contrast is already being obtained for a routine clinical indication in older patients (eg, burn patients [124], in the setting of transcatheter aortic valve replacement [125], cardiac surgery with cardiopulmonary bypass [126], hip fracture [127]), then a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation for suspected sarcopenia in an adult with clinical frailty or multiple comorbidities. Muscle quantification is best done using existing images rather than re-scanning. Of note, contrast-enhanced and noncontrast data should not be used interchangeably, although correction modeling can be performed for varying CT protocols [59].

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
F. CT chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without and with IV contrast. However, if chest CT without and with IV contrast is obtained for another clinical indication, then a secondary quantitative analysis of muscle may be appropriate for initial imaging evaluation for suspected sarcopenia in an adult with clinical frailty or multiple comorbidities. Muscle quantification is best done using existing images rather than re-scanning. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information with regard to sarcopenia.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
G. CT chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without IV contrast. However, if chest CT without IV contrast is already being obtained for a routine clinical indication in older patients (eg, in the setting of hip fracture [128], idiopathic pulmonary fibrosis [129], hemodialysis [130]), then a secondary quantitative analysis of the muscle may be appropriate for initial imaging evaluation for suspected sarcopenia in an adult with clinical frailty or multiple comorbidities. Muscle quantification is best done using existing images rather than re-scanning.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
H. DXA total body composition

DXA is usually appropriate for imaging of suspected sarcopenia. Most expert working groups recommend DXA as a technique to confirm the imaging features of sarcopenia, with specific cutoff thresholds and wide adoption in research settings, including for suspected sarcopenia in adults with clinical frailty or comorbidities [111, 112]. Given that DXA associations with some sarcopenia-related clinical outcomes are weak or inconsistent, combining clinical evaluation with secondary analysis of muscle on a recent CT scan may be more appropriate than performing a new DXA scan.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
I. FDG-PET/CT whole body

There is insufficient evidence to support the use of FDG-PET/CT as a stand-alone indication for suspected sarcopenia. There is a paucity of literature to support secondary quantitative analysis of muscle if FDG-PET/CT is already being obtained for a routine clinical indication.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
J. FDG-PET/MRI whole body

There is no relevant literature to support the use of FDG-PET/MRI for initial imaging of suspected sarcopenia.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
K. MRI abdomen without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without and with IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without or with IV contrast is already being obtained for a routine clinical indication.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
L. MRI abdomen without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of abdominal MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if abdominal MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
M. MRI chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI. There is a paucity of literature to support secondary quantitative analysis of muscle in this setting.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
N. MRI chest without IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest MRI without IV contrast. There is a paucity of literature to support secondary quantitative analysis of muscle if chest MRI without IV contrast is already being obtained for a routine clinical indication.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
O. Radiography chest

There is no relevant literature to support the use of chest radiography for suspected sarcopenia.

Variant 4:Adult with frailty or multiple comorbidities and suspected sarcopenia. Initial imaging.
P. US thigh

Thigh US, in conjunction with patient history and physical examination, is sometimes useful the evaluation of suspected sarcopenia in an adult with clinical frailty or comorbidities [113-116]. US is not routinely used for evaluating sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.

Sarcopenia prevalence increases with age but wide variations in the "normal range" of muscle on imaging have been observed, even in young healthy individuals [131]. In order to better characterize muscle status in an individual patient, it may be helpful to evaluate muscle mass and quality for any longitudinal changes. By analyzing muscle at two or more time points, the rate of change over time may be determined. However, there is no consensus regarding specific intervals for repeated imaging in adult patients with known sarcopenia.

Accurate monitoring of established sarcopenia may aid in optimizing individual patient management plans and assessing efficacy of interventions [132]. Accelerated patient-specific muscle changes may have more profound implications for management and prognosis than using a single time point and a general population-based threshold. When evaluating for meaningful changes in the time interval between comparison examinations for a patient, attention to technical factors is essential because measurement precision (ie, measurement reproducibility) varies with different imaging techniques. The concept of least significant change (LSC) is most developed with DXA and refers to a minimum change that can be considered statistically significant. If a change in muscle is less than the LSC, it may simply reflect measurement variability. As with any imaging evaluation at a single timepoint, the clinical context for longitudinal changes in muscle is important.

Variant 5:Adult with known sarcopenia. Surveillance.
A. Bone scan whole body

There is no relevant literature to support the use of whole body bone scan for surveillance of sarcopenia because these scans primarily assess bone metabolism rather than muscle mass and quality.

Variant 5:Adult with known sarcopenia. Surveillance.
B. CT abdomen with IV contrast

There is insufficient evidence to support sarcopenia surveillance as a stand-alone indication for the use of abdominal CT with IV contrast. However, if abdominal CT with IV contrast is already being obtained for a routine clinical indication, a secondary quantitative analysis of the muscle may be appropriate for imaging follow-up of sarcopenia (rather than additional re-scanning). For example, with immune checkpoint inhibitor therapy for various neoplasms, progressive decreases in both muscle mass and radiodensity metric at L3 on serial CT scans are associated with worse survival [146]. Furthermore, longitudinal muscle loss may predict worse survival with colorectal cancer [147-149] and decreasing muscle density during treatment for endometrial cancer is associated with worse survival [150]. Temporal changes in muscle; however, do not always predict clinical outcomes. For example, overall survival may be predicted by lower baseline muscle mass and density in studies of sepsis [151] and metastatic pancreatic cancer [152], respectively, but longitudinal changes in muscle metrics may not be. Compared to noncontrast abdominal CT, contrast-enhanced CT does not provide added information.

Variant 5:Adult with known sarcopenia. Surveillance.
C. CT abdomen without and with IV contrast

There is insufficient evidence to support sarcopenia surveillance as a stand-alone indication for the use of abdominal CT without and with IV contrast. However, if abdominal CT without and with IV contrast is obtained for another clinical indication, a secondary quantitative analysis of muscle may be appropriate for imaging follow-up in a patient with sarcopenia (rather than additional re-scanning). For example, patients with liver cirrhosis [159], both persistent sarcopenia and new onset sarcopenia defined by a low skeletal muscle index at the L3 level [160] have been associated with higher risk of death. Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information.

Variant 5:Adult with known sarcopenia. Surveillance.
D. CT abdomen without IV contrast

There is insufficient evidence to support sarcopenia surveillance as a stand-alone indication for the use of abdominal CT without IV contrast. However, if abdominal CT without IV contrast is already being obtained for a routine clinical indication, a secondary quantitative analysis of the muscle may be appropriate for imaging follow-up of sarcopenia (rather than additional re-scanning). For example, in a study of 101 patients with colorectal cancer [153], there was not a significant association of baseline muscle mass and attenuation on CT with clinical outcomes, but the interval decrease in these CT metrics within a 1-year period after the diagnosis of colorectal cancer was associated with decreased survival.

Variant 5:Adult with known sarcopenia. Surveillance.
E. CT chest with IV contrast

There is insufficient evidence to support sarcopenia surveillance as a stand-alone indication for the use of chest CT with IV contrast. However, if chest CT with IV contrast are already being obtained for a routine clinical indication, a secondary quantitative analysis of muscle may be appropriate for imaging follow-up of sarcopenia (rather than additional re-scanning) (eg, after lobectomy for lung cancer [154], advanced stage lung cancer [155]). Of note, contrast-enhanced and noncontrast data should not be used interchangeably, although correction modeling can be performed for varying chest CT protocols.

Variant 5:Adult with known sarcopenia. Surveillance.
F. CT chest without and with IV contrast

There is insufficient evidence to support suspected sarcopenia as a stand-alone indication for the use of chest CT without and with IV contrast. However, if serial chest CT without and with IV contrast are obtained for another clinical indication, a secondary quantitative analysis of muscle may be appropriate for imaging follow-up of sarcopenia (rather than additional re-scanning). Noncontrast images are preferred for measurements due to the variable influence of IV contrast. Compared to noncontrast CT, contrast-enhanced CT does not provide added information.

Variant 5:Adult with known sarcopenia. Surveillance.
G. CT chest without IV contrast

There is insufficient evidence to support sarcopenia surveillance as a stand-alone indication for the use of chest CT without IV contrast. However, if serial chest CT without IV contrast are already being obtained for a routine clinical indication (eg, COPD), a secondary quantitative analysis of muscle may be appropriate for imaging follow-up of sarcopenia (rather than additional re-scanning). For example, in patients with COPD already undergoing chest CTs, the longitudinal decrease in the pectoralis muscle area has been associated with mortality risk (independent of baseline muscle status, BMI, and COPD severity) [156]. However, an association between CT muscle metrics and clinical outcomes has not been established in all studies [62, 157], and deserves further study [158].

Variant 5:Adult with known sarcopenia. Surveillance.
H. DXA total body composition

DXA is usually appropriate for imaging surveillance of sarcopenia and is widely used in research settings. DXA has several advantages, including positive correlation with CT and MRI measurements in cross-sectional clinical trials. In longitudinal studies; however, DXA has not been reliable in detecting muscle changes over time when compared with CT or MRI [133-135].

For monitoring changes in lean mass with whole body DXA, consecutive-day analysis of precision error and LSC values is advocated to assess for meaningful measurement changes. Although there is limited literature on these values when surveilling patients with sarcopenia in clinical practice, the consecutive-day precision error for whole body lean mass can average approximately 925 g, with an LSC of 3.2%, in young adult resistance-trained athletes [136]. Worse precision tends to occur with longer-term follow-up [137].

Greater decline in DXA lean mass has been associated with modest increased mortality risk, but may not be associated with recurrent falls or hospital admissions [138]. Furthermore, whole body DXA measurements of lean mass declines more slowly than muscle strength [139, 140]. Currently available data suggests that combining clinical evaluation with secondary analysis of muscle on an available recent CT scan may be more appropriate than performing a new DXA scan.

Variant 5:Adult with known sarcopenia. Surveillance.
I. FDG-PET/CT whole body

There is insufficient evidence to support the use of whole body FDG-PET/CT for surveillance imaging of sarcopenia. However, CT scans are routinely performed with PET, and therefore potentially valuable CT body composition data may be extracted, such as in patients >65 years of age with Hodgkin lymphoma [161], but further research is warranted. In patients with breast cancer, for example, CT-derived metrics for muscle mass at baseline are associated increased

mortality and severe neutropenia, but there is not currently a proven association between follow-up body composition measurements and clinical outcomes [162].

Variant 5:Adult with known sarcopenia. Surveillance.
J. FDG-PET/MRI whole body

There is no relevant literature to support the use of whole body FDG-PET/MRI for surveillance imaging of sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.
K. MRI abdomen without and with IV contrast

There is no relevant literature to support the use of abdominal MRI without and with IV contrast for surveillance imaging of sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.
L. MRI abdomen without IV contrast

There is no relevant literature to support the use of MRI of the abdomen without IV contrast for surveillance imaging of sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.
M. MRI chest without and with IV contrast

There is no relevant literature to support the use of chest MRI without and with IV contrast for surveillance imaging of sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.
N. MRI chest without IV contrast

There is no relevant literature to support the use of chest MRI without IV contrast for surveillance imaging of sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.
O. Radiography chest

There is no relevant literature to support the use of chest radiography for surveillance imaging of sarcopenia.

Variant 5:Adult with known sarcopenia. Surveillance.
P. US thigh

Thigh US, in conjunction with clinical history and physical examination, may be useful for the surveillance of sarcopenia. US is not routinely used in most practices for evaluating sarcopenia, and further standardization and validation of clinical usefulness is warranted. However, for assessment of malnutrition, US evaluation is supported by the Global Leadership Initiative on Malnutrition, particularly for repeated measurements of muscle thickness and cross-sectional area [141]. Thigh US can show dynamic changes of muscle atrophy and edema acutely during hospitalization that may be associated with poor clinical outcomes [142, 143]. Chronic longitudinal deterioration in muscle thickness and echo intensity can be observed in stroke survivors, and may help guide appropriate prescription of physical therapy [144, 145]. More research in various settings is needed to clarify the value of muscle longitudinal changes in clinical practice.

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variants 1-5**: DXA is usually appropriate. Thigh US, performed in conjunction with clinical history and physical examination, may be useful. There is insufficient evidence to support a stand-alone indication for the use of CT of the abdomen (with or without IV contrast) or chest (with, without and with, without IV contrast), but a secondary quantitative analysis of muscle may be appropriate using examinations obtained for another clinical indication.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

References

1. Kirk B, Cawthon PM, Arai H, et al. The Conceptual Definition of Sarcopenia: Delphi Consensus from the Global Leadership Initiative in Sarcopenia (GLIS). Age Ageing. 2024 Mar 01;53(3):afae052.
2. Cawthon PM, Visser M, Arai H, et al. Defining terms commonly used in sarcopenia research: a glossary proposed by the Global Leadership in Sarcopenia (GLIS) Steering Committee. Eur Geriatr Med. 2022 Dec;13(6):1239-1244.
3. Beaudart C, Alcazar J, Aprahamian I, et al. Health outcomes of sarcopenia: a consensus report by the outcome working group of the Global Leadership Initiative in Sarcopenia (GLIS). Aging Clin Exp Res. 2025 Mar 22;37(1):100.
4. Papadopoulou SK, Tsintavis P, Potsaki P, Papandreou D. Differences in the Prevalence of Sarcopenia in Community-Dwelling, Nursing Home and Hospitalized Individuals. A Systematic Review and Meta-Analysis. J Nutr Health Aging. 2020;24(1):83-90.
5. Yuan S, Larsson SC. Epidemiology of sarcopenia: Prevalence, risk factors, and consequences. Metabolism. 2023 Jul;144():S0026-0495(23)00136-1.
6. Jensen GL, Cederholm T. Exploring the intersections of frailty, sarcopenia, and cachexia with malnutrition. Nutrition in Clinical Practice. 39(6):1286-1291, 2024 Dec.Nutr Clin Pract. 39(6):1286-1291, 2024 Dec.

7. Cederholm T, Jensen GL, Correia MITD, et al. The GLIM consensus approach to diagnosis of malnutrition: A 5-year update. Clin Nutr. 2025 Jun;49():S0261-5614(25)00086-X.

8. Lenchik L, Mazzoli V, Cawthon PM, Hepple RT, Boutin RD. Muscle Steatosis and Fibrosis in Older Adults, From the AJR Special Series on Imaging of Fibrosis. [Review]. AJR. American Journal of Roentgenology. 222(5):e2329742, 2024 05.AJR Am J Roentgenol. 222(5):e2329742, 2024 05.

9. Kim DH, Rockwood K. Frailty in Older Adults. N Engl J Med. 2024 Aug 08;391(6):538-548.

10. Zambrano Chaves JM, Hom J, Lenchik L, Chaudhari AS, Boutin RD. Sarcopenia, Obesity, and Sarcopenic Obesity: Retrospective Audit of Electronic Health Record Documentation versus Automated CT Analysis in 17?646 Patients. Radiology. 2025 Apr;315(1):e243525.

11. Guralnik JM, Cawthon PM, Bhasin S, et al. Limited physician knowledge of sarcopenia: A survey. J Am Geriatr Soc. 2023 May;71(5):1595-1602.

12. Verstraeten LMG, Mashni A, van Wijngaarden JP, Meskers CGM, Maier AB. Sarcopenia knowledge of geriatric rehabilitation patients is low while they are willing to start sarcopenia treatment: EMPOWER-GR. J Cachexia Sarcopenia Muscle. 2024 Feb;15(1):352-360.

13. Lewis EG, Hurst C, Errington L, Sayer AA. Perceptions of sarcopenia in patients, health and care professionals, and the public: a scoping review of studies from different countries. Eur Geriatr Med. 2025 Feb;16(1):99-113.

14. Winder C, Clark M, Frood R, et al. Automated extraction of body composition metrics from abdominal CT or MR imaging: A scoping review. Eur J Radiol. 2024 Dec;181():S0720-048X(24)00480-7.

15. Christensen EW, Drake AR, Lenchik L, Boutin RD. Sarcopenia Diagnosis Trends and Opportunistic Use of Abdominal CT Among Medicare Beneficiaries. J Am Coll Radiol. 2025 Apr 09;():S1546-1440(25)00184-X.

16. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019 Jan 01;48(1):16-31.

17. 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):S1525-8610(19)30872-2.

18. Dent E, Morley JE, Cruz-Jentoft AJ, et al. International Clinical Practice Guidelines for Sarcopenia (ICFSR): Screening, Diagnosis and Management. Journal of Nutrition, Health & Aging. 22(10):1148-1161, 2018.J Nutr Health Aging. 22(10):1148-1161, 2018.

19. Zanker J, Sim M, Anderson K, et al. Consensus guidelines for sarcopenia prevention, diagnosis and management in Australia and New Zealand. Journal of Cachexia, Sarcopenia and Muscle. 14(1):142-156, 2023 02.J Cachexia Sarcopenia Muscle. 14(1):142-156, 2023 02.

20. Zhang Y, Guo JY, Wang F, Li CW, Yu K. Start with muscle mass or muscle strength in diagnosis and management of sarcopenia? A systematic review of guidance documents. Asia Pac J Clin Nutr. 2024 Jun;33(2):247-271.

21. Kirk B, Cawthon PM, Arai H, et al. An executive summary on the Global conceptual definition of Sarcopenia. Aging Clin Exp Res. 2024 Jul 27;36(1):153.

22. Dent E, Woo J, Scott D, Hoogendijk EO. Toward the recognition and management of

sarcopenia in routine clinical care. Nat Aging. 2021 Nov;1(11):982-990.

23. Volkert D, Delzenne N, Demirkan K, et al. Nutrition for the older adult - Current concepts. Report from an ESPEN symposium. Clin Nutr. 2024 Aug;43(8):S0261-5614(24)00212-7.

24. Izquierdo M, de Souto Barreto P, Arai H, et al. Global consensus on optimal exercise recommendations for enhancing healthy longevity in older adults (ICFSR). J Nutr Health Aging. 2025 Jan;29(1):S1279-7707(24)00489-5.

25. Cesari M, Bernabei R, Vellas B, et al. Challenges in the Development of Drugs for Sarcopenia and Frailty - Report from the International Conference on Frailty and Sarcopenia Research (ICFSR) Task Force. J Frailty Aging. 2022;11(2):135-142.

26. Rolland Y, Dray C, Vellas B, Barreto PS. Current and investigational medications for the treatment of sarcopenia. Metabolism. 2023 Dec;149():S0026-0495(23)00201-9.

27. Alorfi NM, Alshehri FS, Ashour AM. Therapeutics for Sarcopenia and Functional Disabilities in Older Adults: A Review of Phase 4 Clinical Trials. Drug Des Devel Ther. 2025;19():2307-2314.

28. Cederholm T, Bosaeus I. Malnutrition in Adults. N Engl J Med. 2024 Jul 11;391(2):155-165.

29. Brown LR, Sousa MS, Yule MS, et al. Body weight and composition endpoints in cancer cachexia clinical trials: Systematic Review 4 of the cachexia endpoints series. J Cachexia Sarcopenia Muscle. 2024 Jun;15(3):816-852.

30. Fu H, Wang L, Zhang W, Lu J, Yang M. Diagnostic test accuracy of ultrasound for sarcopenia diagnosis: A systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2023 Feb;14(1):57-70.

31. Perkisas S, Bastijns S, Baudry S, et al. Application of ultrasound for muscle assessment in sarcopenia: 2020 SARCUS update. Eur Geriatr Med. 2021 Feb;12(1):45-59.

32. Wang JC, Wu WT, Chang KV, et al. Ultrasound Imaging for the Diagnosis and Evaluation of Sarcopenia: An Umbrella Review. [Review]. Life. 12(1), 2021 Dec 22.Life (Basel). 12(1), 2021 Dec 22.

33. Stanley B, Greig C, Jackson T, et al. Investigating the impact of fluid status on the ultrasound assessment of muscle quantity and quality in the diagnosis of sarcopenia - a multidimensional cross-sectional study. BMC Geriatr. 2023 Aug 15;23(1):493.

34. Yoshida T, Watanabe Y, Yokoyama K, Kimura M, Yamada Y. Thigh muscle thickness on ultrasonography for diagnosing sarcopenia: The Kyoto-Kameoka study. Geriatr Gerontol Int. 2024 Mar;24 Suppl 1():156-161.

35. Ang SW, Liew J, Dharmaratnam VM, et al. Diagnostic performance of various radiological modalities in the detection of sarcopenia within Asian populations: a systematic review. Ann Coloproctol. 2025 Feb;41(1):27-39.

36. Sousa-Santos AR, Barros D, Montanha TL, Carvalho J, Amaral TF. Which is the best alternative to estimate muscle mass for sarcopenia diagnosis when DXA is unavailable?. Arch Gerontol Geriatr. 2021;97():S0167-4943(21)00180-1.

37. Westbury LD, Beaudart C, Bruyère O, et al. Recent sarcopenia definitions-prevalence, agreement and mortality associations among men: Findings from population-based cohorts. J Cachexia Sarcopenia Muscle. 2023 Feb;14(1):565-575.

38. Stuck AK, Tsai LT, Freystaetter G, et al. Comparing Prevalence of Sarcopenia Using Twelve Sarcopenia Definitions in a Large Multinational European Population of Community-Dwelling Older Adults. J Nutr Health Aging. 2023;27(3):205-212.

39. Bhasin S, Travison TG, Manini TM, et al. Sarcopenia Definition: The Position Statements of the Sarcopenia Definition and Outcomes Consortium. J Am Geriatr Soc. 2020 Jul;68(7):1410-1418.

40. Cawthon PM, Manini T, Patel SM, et al. Putative Cut-Points in Sarcopenia Components and Incident Adverse Health Outcomes: An SDOC Analysis. J Am Geriatr Soc. 2020 Jul;68(7):1429-1437.

41. Kremer WM, Labenz C, Kuchen R, et al. Sonographic assessment of low muscle quantity identifies mortality risk during COVID-19: a prospective single-centre study. J Cachexia Sarcopenia Muscle. 2022 Feb;13(1):169-179.

42. Kremer WM, Schwarz A, Schepers M, et al. Evaluation of Sonographic Muscle Measurement Using Established Muscle Markers. J Ultrasound Med. 2024 Dec;43(12):2385-2397.

43. Nagae M, Umegaki H, Yoshiko A, et al. Muscle changes on muscle ultrasound and adverse outcomes in acute hospitalized older adults. Nutrition. 2022 Oct;102():S0899-9007(22)00111-3.

44. Shafaat O, Liu Y, Jackson KR, et al. Association between Abdominal CT Measurements of Body Composition before Deceased Donor Liver Transplant with Posttransplant Outcomes. Radiology. 2023 Mar;306(3):e212403.

45. Fumagalli IA, Le ST, Peng PD, et al. Automated CT Analysis of Body Composition as a Frailty Biomarker in Abdominal Surgery. JAMA Surg. 2024 Jul 01;159(7):766-774.

46. Bedrikovetski S, Seow W, Kroon HM, Traeger L, Moore JW, Sammour T. Artificial intelligence for body composition and sarcopenia evaluation on computed tomography: A systematic review and meta-analysis. Eur J Radiol. 2022 Apr;149():S0720-048X(22)00068-7.

47. Lortie J, Gage G, Rush B, Heymsfield SB, Szczykutowicz TP, Kuchnia AJ. The effect of computed tomography parameters on sarcopenia and myosteatosis assessment: a scoping review. J Cachexia Sarcopenia Muscle. 2022 Dec;13(6):2807-2819.

48. Boutin RD, Kaptuch JM, Bateni CP, Chalfant JS, Yao L. Influence of IV Contrast Administration on CT Measures of Muscle and Bone Attenuation: Implications for Sarcopenia and Osteoporosis Evaluation. AJR Am J Roentgenol. 2016 Nov;207(5):1046-1054.

49. Brath MSG, Kristensen SV, Sahakyan M, et al. Influence of weight-adjusted contrast enhancement on computed tomography-derived skeletal muscle measures: a retrospective proof-of-concept comparative study between Danish females and males. Am J Clin Nutr. 2024 Sep;120(3):S0002-9165(24)00578-1.

50. Moeller AR, Garrett JW, Summers RM, Pickhardt PJ. Adjusting for the effect of IV contrast on automated CT body composition measures during the portal venous phase. Abdom Radiol (NY). 2024 Jul;49(7):2543-2551.

51. Lortie J, Ufearo D, Hetzel S, Pickhardt PJ, Szczykutowicz TP, Kuchnia AJ. Validating a Practical Correction for Intravenous Contrast on Computed Tomography-Based Muscle

Density. J Comput Assist Tomogr. ;49(3):480-485.

52. Lenchik L, Lenoir KM, Tan J, et al. Opportunistic Measurement of Skeletal Muscle Size and Muscle Attenuation on Computed Tomography Predicts 1-Year Mortality in Medicare Patients. J Gerontol A Biol Sci Med Sci. 2019 Jun 18;74(7):1063-1069.

53. Lee MH, Zea R, Garrett JW, Graffy PM, Summers RM, Pickhardt PJ. Abdominal CT Body Composition Thresholds Using Automated AI Tools for Predicting 10-year Adverse Outcomes. Radiology. 2023 Feb;306(2):e220574.

54. Nachit M, Horsmans Y, Summers RM, Leclercq IA, Pickhardt PJ. AI-based CT Body Composition Identifies Myosteatosis as Key Mortality Predictor in Asymptomatic Adults. Radiology. 2023 Jun;307(5):e222008.

55. Wen Z, Wang T, Luo S, Liu Y. CT scan-derived pectoralis muscle parameters are closely associated with COVID-19 outcomes: A systematic review and meta-analysis. PLoS One. 2025;20(1):e0316893.

56. Persits I, Mirzai S, Sarnaik KS, et al. Low Muscle Mass by Preprocedural Computed Tomography Is Associated With Worse Short-Term Outcomes in Transcatheter Aortic Valve Replacement Recipients. Am J Cardiol. 2024 Apr 15;217():S0002-9149(24)00150-4.

57. Soh S, Suh YJ, Lee S, Roh YH, Kwak YL, Kim YJ. Prognostic value of CT body composition analysis for 1-year mortality after transcatheter aortic valve replacement. Eur Radiol. 2025 Jan;35(1):244-254.

58. Moon SW, Kim SY, Choi JS, et al. Thoracic skeletal muscle quantification using computed tomography and prognosis of elderly ICU patients. Sci Rep. 2021 Dec 06;11(1):23461.

59. Lortie J, Rush B, Gage G, et al. Correcting Posterior Paraspinal Muscle Computed Tomography Density for Intravenous Contrast Material Independent of Sex and Vascular Phase. J Thorac Imaging. 2023 Nov 01;38(6):367-373.

60. Shen Y, Luo L, Fu H, et al. Chest computed tomography-derived muscle mass and quality indicators, in-hospital outcomes, and costs in older inpatients. J Cachexia Sarcopenia Muscle. 2022 Apr;13(2):966-975.

61. Lenchik L, Barnard R, Boutin RD, et al. Automated Muscle Measurement on Chest CT Predicts All-Cause Mortality in Older Adults From the National Lung Screening Trial. J Gerontol A Biol Sci Med Sci. 2021 Jan 18;76(2):277-285.

62. Wang M, Tang H, Chen X, et al. Opportunistic Muscle Evaluation During Chest CT Is Associated With Vertebral Compression Fractures in Old Adults: A Longitudinal Study. J Gerontol A Biol Sci Med Sci. 2024 Feb 01;79(2):glad162.

63. Ryu J, Eom S, Kim HC, et al. Chest X-ray-based opportunistic screening of sarcopenia using deep learning. J Cachexia Sarcopenia Muscle. 2023 Feb;14(1):418-428.

64. Grova M, Crispino F, Maida M, et al. Sarcopenia is a negative predictive factor for endoscopic remission in patients with Crohn's disease treated with biologics. Dig Liver Dis. 2023 Jul;55(7):S1590-8658(23)00482-6.

65. Blagec P, Sara S, Tripalo Batoš A, et al. Magnetic Resonance Imaging Can Be Used to Assess Sarcopenia in Children with Newly Diagnosed Crohn's Disease. Nutrients. 2023 Sep 02;15(17):3838.

66. Beer L, Bastati N, Ba-Ssalamah A, et al. MRI-defined sarcopenia predicts mortality in

patients with chronic liver disease. Liver Int. 2020 Nov;40(11):2797-2807.

67. Nakamura A, Yoshimura T, Sato T, Ichikawa T. Diagnosis and Pathogenesis of Sarcopenia in Chronic Liver Disease Using Liver Magnetic Resonance Imaging. Cureus. 2022 May;14(5):e24676.

68. Faron A, Sprinkart AM, Kuetting DLR, et al. Body composition analysis using CT and MRI: intra-individual intermodal comparison of muscle mass and myosteatosis. Sci Rep. 2020 Jul 16;10(1):11765.

69. Drucker Iarovich M, Matos JF, Lowes WH, et al. Cardiac MRI Pectoralis Muscle Thickness as a Measure of Sarcopenia: Prognostic Significance, Interreader Agreement, and Physiologic Correlation. Radiol Cardiothorac Imaging. 2024 Dec;6(6):e240147.

70. Mirzai S, Aleixo GFP, Mazumder S, et al. Sarcopenia evaluation on cardiac magnetic resonance imaging in older adults for outcomes prediction following surgical aortic valve replacement. Int J Cardiol. 2023 Nov 15;391():S0167-5273(23)01059-8.

71. Miller RJH, Yi J, Shanbhag A, et al. Deep learning-quantified body composition from positron emission tomography/computed tomography and cardiovascular outcomes: a multicentre study. Eur Heart J. 2025 Jun 23;46(24):2336-2347.

72. Simonsen C, Kristensen TS, Sundberg A, et al. Assessment of sarcopenia in patients with upper gastrointestinal tumors: Prevalence and agreement between computed tomography and dual-energy x-ray absorptiometry. Clin Nutr. 2021 May;40(5):S0261-5614(21)00161-8.

73. Casey P, Alasmar M, McLaughlin J, et al. The current use of ultrasound to measure skeletal muscle and its ability to predict clinical outcomes: a systematic review. J Cachexia Sarcopenia Muscle. 2022 Oct;13(5):2298-2309.

74. de Luis Roman D, García Almeida JM, Bellido Guerrero D, et al. Ultrasound Cut-Off Values for Rectus Femoris for Detecting Sarcopenia in Patients with Nutritional Risk. Nutrients. 2024 May 21;16(11):1552.

75. Güner G, Özçakar L, Baytar Y, et al. Sonographic Measurements of Rectus Femoris Muscle Thickness Strongly Predict Neutropenia in Cancer Patients Receiving Chemotherapy. Cancers (Basel). 2024 Mar 05;16(5):1061.

76. Abdulsalam AJ, Merza AH, Kara M. Evaluating sarcopenia in cancer patients: focus on the rectus femoris muscle. Support Care Cancer. 2024 May 15;32(6):350.

77. Sousa IM, Pereira JPDC, Rüegg RAB, et al. Comparing A-mode ultrasound and computed tomography for assessing cancer-related sarcopenia: A cross-sectional study. Nutr Clin Pract. 2025 Jun;40(3):699-708.

78. Albano D, Dondi F, Ravanelli M, et al. Prognostic Role of "Radiological" Sarcopenia in Lymphoma: A Systematic Review. Clin Lymphoma Myeloma Leuk. 2022 May;22(5):S2152-2650(21)02438-1.

79. Lee MH, Pickhardt SG, Garrett JW, et al. Utility of Fully Automated Body Composition Measures on Pretreatment Abdominal CT for Predicting Survival in Patients With Colorectal Cancer. AJR Am J Roentgenol. 2023 Mar;220(3):371-380.

80. Anabtawi NM, Pasala MS, Grimshaw AA, et al. Low skeletal muscle mass and treatment outcomes among adults with haematologic malignancies: A systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2024 Jun;15(3):1084-1093.

81. Meerkerk CDA, Bruijnen CP, van den Bos F, Emmelot-Vonk MH, de Bree R. The geriatric assessment and sarcopenia to assess frailty in older patients with cancer. J Geriatr Oncol. 2024 Jul;15(6):S1879-4068(24)00074-2.

82. Láinez Ramos-Bossini AJ, Gámez Martínez A, Luengo Gómez D, et al. Computed Tomography-Based Sarcopenia and Pancreatic Cancer Survival-A Comprehensive Meta-Analysis Exploring the Influence of Definition Criteria, Prevalence, and Treatment Intention. Cancers (Basel). 2025 Feb 11;17(4):607.

83. Troschel FM, Jin Q, Eichhorn F, et al. Sarcopenia on preoperative chest computed tomography predicts cancer-specific and all-cause mortality following pneumonectomy for lung cancer: A multicenter analysis. Cancer Medicine. 10(19):6677-6686, 2021 10.

84. Kaltenhauser S, Niessen C, Zeman F, et al. Diagnosis of sarcopenia on thoracic computed tomography and its association with postoperative survival after anatomic lung cancer resection. Sci Rep. 2023 Oct 27;13(1):18450.

85. Sun C, Hirata Y, Kawahara T, et al. Diagnosis of Respiratory Sarcopenia for Stratifying Postoperative Risk in Non-Small Cell Lung Cancer. JAMA Surg. 2025 Jan 01;160(1):e244800.

86. Mantz L, Mercaldo ND, Simon J, et al. Preoperative Chest CT Myosteatosis Indicates Worse Postoperative Survival in Stage 0-IIB Non-Small Cell Lung Cancer. Radiology. 2025 Feb;314(2):e240282.

87. Huang Y, Cun H, Mou Z, et al. Multiparameter body composition analysis on chest CT predicts clinical outcomes in resectable non-small cell lung cancer. Insights Imaging. 2025 Feb 06;16(1):32.

88. Guichet PL, Taslakian B, Zhan C, et al. MRI-Derived Sarcopenia Associated with Increased Mortality Following Yttrium-90 Radioembolization of Hepatocellular Carcinoma. Cardiovasc Intervent Radiol. 2021 Oct;44(10):1561-1569.

89. Rao C, Chen J, Xu K, et al. Association of magnetic resonance imaging-derived sarcopenia with outcomes of patients with hepatocellular carcinoma after hepatectomy. Abdom Radiol (NY). 2024 Jul;49(7):2272-2284.

90. Cespiati A, Smith D, Lombardi R, Fracanzani AL. The Negative Impact of Sarcopenia on Hepatocellular Carcinoma Treatment Outcomes. Cancers (Basel). 2024 Jun 24;16(13):2315.

91. Wang Z, Zhu L, Wang Y, Han X, Xu Q, Dai M. Looking at or beyond the tumor - a systematic review and meta-analysis of quantitative imaging biomarkers predicting pancreatic cancer prognosis. Abdom Radiol (NY). 2025 Apr 08;().

92. Rossi F, Valdora F, Barabino E, Calabrese M, Tagliafico AS. Muscle mass estimation on breast magnetic resonance imaging in breast cancer patients: comparison between psoas muscle area on computer tomography and pectoralis muscle area on MRI. Eur Radiol. 2019 Feb;29(2):494-500.

93. Zhou C, Foster B, Hagge R, et al. Opportunistic body composition evaluation in patients with esophageal adenocarcinoma: association of survival with 18F-FDG PET/CT muscle metrics. Ann Nucl Med. 2020 Mar;34(3):174-181.

94. Zhou Y, Zhou J, Cai X, et al. Integrating 18F-FDG PET/CT radiomics and body composition for enhanced prognostic assessment in patients with esophageal cancer. BMC Cancer. 2024 Nov 14;24(1):1402.

95. Umit EG, Korkmaz U, Baysal M, et al. Evaluation of Sarcopenia with F-18 FDG PET/CT and relation with disease outcomes in patients with multiple myeloma. Eur J Cancer Care (Engl). 2020 Nov;29(6):e13318.

96. Abdallah NH, Nagayama H, Takahashi N, et al. Muscle and fat composition in patients with newly diagnosed multiple myeloma. Blood Cancer J. 2023 Dec 12;13(1):185.

97. Zwart AT, Cavalheiro VJ, Lamers MJ, et al. The validation of low-dose CT scans from the [18F]-FDG PET-CT scan to assess skeletal muscle mass in comparison with diagnostic neck CT scans. Eur J Nucl Med Mol Imaging. 2023 May;50(6):1735-1742.

98. Yuan H, Tan X, Sun X, He L, Li D, Jiang L. Role of 18F-FDG PET/CT and sarcopenia in untreated non-small cell lung cancer with advanced stage. Jpn J Radiol. 2023 May;41(5):521-530.

99. Prokopidis K, Testa GD, Giannaki CD, et al. Prognostic and Associative Significance of Malnutrition in Sarcopenia: A Systematic Review and Meta-Analysis. Adv Nutr. 2025 May;16(5):100428.

100. Lai JC, Tandon P, Bernal W, et al. Malnutrition, Frailty, and Sarcopenia in Patients With Cirrhosis: 2021 Practice Guidance by the American Association for the Study of Liver Diseases. Hepatology. 2021 Sep;74(3):1611-1644.

101. Khristenko E, Sinitsyn V, Rieden T, et al. CT-based screening of sarcopenia and its role in cachexia syndrome in pancreatic cancer. PLoS One. 2024;19(1):e0291185.

102. Pacifico J, Reijnierse EM, Lim WK, Maier AB. The Association between Sarcopenia as a Comorbid Disease and Incidence of Institutionalisation and Mortality in Geriatric Rehabilitation Inpatients: REStORing health of acutely unwell adulTs (RESORT). Gerontology. 2022;68(5):498-508.

103. Xia W, Luo K, Gu Z, Hu J, Liu X, Xiao Q. Correlational analysis of sarcopenia and multimorbidity among older inpatients. BMC Musculoskelet Disord. 2024 Apr 22;25(1):309.

104. Pelzl CE, Drake A, Rosenkrantz AB, Rula EY, Christensen EW. External Validation of the Neiman Imaging Comorbidity Index in Medicare, Medicaid, and Private Payer Claims Data. J Am Coll Radiol. 2025 Apr;22(4):S1546-1440(24)00917-7.

105. Donini LM, Busetto L, Bischoff SC, et al. Definition and diagnostic criteria for sarcopenic obesity: ESPEN and EASO consensus statement. Clin Nutr. 2022 Apr;41(4):S0261-5614(21)00523-9.

106. Molina-Baena B, Alvarez-Bustos A, Carnicero JA, Garcia-Garcia FJ, Rodriguez-Manas L. The Performance and Associated Risks of the Criteria for Sarcopenic Obesity Proposed by the European Association for the Study of Obesity in a Geriatric Population. Nutrients. 16(19), 2024 Sep 30.Nutrients. 16(19), 2024 Sep 30.

107. Veronese N, Ragusa FS, Sabico S, et al. Osteosarcopenia increases the risk of mortality: a systematic review and meta-analysis of prospective observational studies. Aging Clin Exp Res. 2024 Jun 18;36(1):132.

108. Zhou Y, Sun C, Zhao R, Dong C, Gu Z, Gao J. The association between sarcopenic obesity, sarcopenia and functional dependence, malnutrition, and mortality: the phenomenon of obesity paradox in sarcopenic obesity. Eur Geriatr Med. 2025 Feb;16(1):89-97.

109. Chen S, Xu X, Gong H, et al. Global epidemiological features and impact of

osteosarcopenia: A comprehensive meta-analysis and systematic review. J Cachexia Sarcopenia Muscle. 2024 Feb;15(1):8-20.

110. Solla-Suarez P, Arif SG, Ahmad F, et al. Osteosarcopenia and Mortality in Older Adults Undergoing Transcatheter Aortic Valve Replacement. JAMA Cardiology. 9(7):611-618, 2024 Jul 01.JAMA Cardiol. 9(7):611-618, 2024 Jul 01.

111. Benz E, Pinel A, Guillet C, et al. Sarcopenia and Sarcopenic Obesity and Mortality Among Older People. JAMA Network Open. 7(3):e243604, 2024 03 04.JAMA netw. open. 7(3):e243604, 2024 03 04.

112. Kinoshita K, Matsui Y, Hirano Y, et al. Association between the presence or absence of muscle mass assessment in sarcopenia diagnosis and poor health outcomes: A follow-up study of older outpatients at a frailty clinic. Geriatr Gerontol Int. 25(4):553-559, 2025 Apr.

113. Canales C, Mazor E, Coy H, et al. Preoperative Point-of-Care Ultrasound to Identify Frailty and Predict Postoperative Outcomes: A Diagnostic Accuracy Study. Anesthesiology. 2022 Feb 01;136(2):268-278.

114. Anderson BM, Wilson DV, Qasim M, et al. Ultrasound quadriceps muscle thickness is variably associated with frailty in haemodialysis recipients. BMC Nephrol. 24(1):16, 2023 01 18.

115. Prell T, Grimm A, Axer H. Uncovering sarcopenia and frailty in older adults by using muscle ultrasound-A narrative review. Front Med (Lausanne). 2024;11():1333205.

116. Yang F, Zhu L, Cao B, et al. Accuracy of Ultrasound Measurements of Muscle Thickness in Identifying Older Patients With Sarcopenia and Its Impact on Frailty: A Systematic Review and Meta-Analysis. [Review]. Journal of the American Medical Directors Association. 26(2):105419, 2025 Feb.J AM MED DIR ASSOC. 26(2):105419, 2025 Feb.

117. Shear BM, Chiu AK, Stombler A, et al. Comparison of Sarcopenia With Frailty and Area Deprivation Index for Predicting Postoperative Mortality and Complications in Thoracolumbar Trauma. Clin Spine Surg. 2025 Apr 07;().

118. Park B, Vandal A, Welsh F, et al. Sarcopenia, myosteatosis, and frailty parameters to predict adverse outcomes in patients undergoing emergency laparotomy: prospective observational multicentre cohort study. BJS Open. 2025 Mar 04;9(2):zraf016.

119. Bradley NA, Walter A, Roxburgh CSD, McMillan DC, Guthrie GJK. The Relationship between Clinical Frailty Score, CT-Derived Body Composition, Systemic Inflammation, and Survival in Patients with Chronic Limb-Threatening Ischemia. Ann Vasc Surg. 2024 Jul;104():S0890-5096(23)00339-4.

120. Liu D, Ji D, Garrett JW, et al. Automated abdominal CT imaging biomarkers and clinical frailty measures associated with postoperative deceased-donor liver transplant outcomes. Eur Radiol. 2025 Mar 23.

121. Weerink LBM, van Leeuwen BL, Kwee TC, Lamoth CJC, van Munster BC, de Bock GH. Co-occurrence of CT-based radiological sarcopenia and frailty are related to impaired survival in surgical oncology. Br J Radiol. 2025 Apr 01;98(1168):607-613.

122. Tolonen A, Kerminen H, Lehtomäki K, et al. Association between Computed Tomography-Determined Loss of Muscle Mass and Impaired Three-Month Survival in Frail Older Adults with Cancer. Cancers (Basel). 2023 Jun 28;15(13):3398.

123. Jung J, Lee J, Lim JH, et al. The effects of muscle mass and quality on mortality of patients with acute kidney injury requiring continuous renal replacement therapy. Sci Rep. 2023 May 05;13(1):7311.

124. Romanowski KS, Fuanga P, Siddiqui S, Lenchik L, Palmieri TL, Boutin RD. Computed Tomography Measurements of Sarcopenia Predict Length of Stay in Older Burn Patients. J Burn Care Res. 2021 Feb 03;42(1):3-8.

125. Persits I, Mirzai S, Sarnaik KS, et al. Sarcopenia and frailty in patients undergoing transcatheter aortic valve replacement. Am Heart J. 2024 Oct;276():S0002-8703(24)00173-X.

126. Wang X, Wang Z, Cheng Y, Chen X. Effects of sarcopenia on postoperative recovery in elderly patients after cardiac surgery with cardiopulmonary bypass. BMC Geriatr. 2025 Apr 30;25(1):295.

127. Boutin RD, Bamrungchart S, Bateni CP, et al. CT of Patients With Hip Fracture: Muscle Size and Attenuation Help Predict Mortality. AJR Am J Roentgenol. 2017 Jun;208(6):W208-W215.

128. Li EL, Hu JS, Chen ZH, et al. Based on CT scans at the 12th thoracic spine level, assessing the impact of skeletal muscle and adipose tissue index on one-year postoperative mortality in elderly hip fracture patients: a propensity score-matched multicenter retrospective study. BMC Musculoskelet Disord. 2025 Jan 06;26(1):21.

129. Çinkooglu A, Bayraktaroglu S, Ufuk F, et al. Reduced CT-derived erector spinae muscle area: a poor prognostic factor for short- and long-term outcomes in idiopathic pulmonary fibrosis patients. Clin Radiol. 2023 Dec;78(12):S0009-9260(23)00372-0.

130. Liu J, Ye Z, Xiang J, et al. Association of muscle mass and radiodensity assessed by chest CT with all-cause and cardiovascular mortality in hemodialysis patients. Int Urol Nephrol. 2024 Nov;56(11):3627-3638.

131. Ju C, Yao L, Yoon SY, et al. Defining Reference Values for Skeletal Muscle Metrics on Abdominal CT Using Data From Healthy Young Adult Populations: A Systematic Review and Meta-Analysis. AJR Am J Roentgenol. 2025 May 07;().

132. Bennett JP, Ford KL, Siervo M, et al. Advancing body composition assessment in patients with cancer: First comparisons of traditional versus multicompartment models. Nutrition. 2024 Sep;125():S0899-9007(24)00143-6.

133. Basty N, Thanaj M, Whitcher B, Bell JD, Thomas EL. Comparing DXA and MRI body composition measurements in cross-sectional and longitudinal cohorts. medRxiv. 2024:2024-12.

134. Tavoian D, Ampomah K, Amano S, Law TD, Clark BC. Changes in DXA-derived lean mass and MRI-derived cross-sectional area of the thigh are modestly associated. Sci Rep. 2019 Jul 11;9(1):10028.

135. Otsuka Y, Yamada Y, Maeda A, et al. Effects of resistance training intensity on muscle quantity/quality in middle-aged and older people: a randomized controlled trial. J Cachexia Sarcopenia Muscle. 2022 Apr;13(2):894-908.

136. Zemski AJ, Hind K, Keating SE, Broad EM, Marsh DJ, Slater GJ. Same-Day Vs Consecutive-Day Precision Error of Dual-Energy X-Ray Absorptiometry for Interpreting Body

Composition Change in Resistance-Trained Athletes. J Clin Densitom. 2019;22(1):S1094-6950(18)30171-9.

137. Powers C, Fan B, Borrud LG, Looker AC, Shepherd JA. Long-term precision of dual-energy X-ray absorptiometry body composition measurements and association with their covariates. J Clin Densitom. 2015;18(1):S1094-6950(13)00172-8.

138. Westbury LD, Syddall HE, Fuggle NR, et al. Relationships Between Level and Change in Sarcopenia and Other Body Composition Components and Adverse Health Outcomes: Findings from the Health, Aging, and Body Composition Study. Calcif Tissue Int. 2021 Mar;108(3):302-313.

139. Goodpaster BH, Park SW, Harris TB, et al. The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. J Gerontol A Biol Sci Med Sci. 2006 Oct;61(10):1059-64.

140. Santanasto AJ, Miljkovic I, Cvejkus RK, Boudreau RM, Wheeler VW, Zmuda JM. Body Composition Across the Adult Lifespan in African Caribbean Men: The Tobago Longitudinal Study of Aging. J Frailty Aging. 2022;11(1):40-44.

141. Barazzoni R, Jensen GL, Correia MITD, et al. Guidance for assessment of the muscle mass phenotypic criterion for the Global Leadership Initiative on Malnutrition (GLIM) diagnosis of malnutrition. Clin Nutr. 2022 Jun;41(6):S0261-5614(22)00044-9.

142. Fuest KE, Lanz H, Schulz J, et al. Comparison of Different Ultrasound Methods to Assess Changes in Muscle Mass in Critically ill Patients. J Intensive Care Med. 2023 May;38(5):431-439.

143. López Jiménez E, Neira Álvarez M, Menéndez Colino R, et al. Muscle mass loss measured with portable ultrasound in hospitalized older adults: The ECOSARC study. J Nutr Health Aging. 2024 Jan;28(1):S1279-7707(23)01270-8.

144. Akazawa N, Harada K, Okawa N, Kishi M, Tamura K, Moriyama H. Changes in Quadriceps Thickness and Echo Intensity in Chronic Stroke Survivors: A 3-Year Longitudinal Study. J Stroke Cerebrovasc Dis. 2021 Mar;30(3):S1052-3057(20)30961-7.

145. Monjo H, Fukumoto Y, Asai T, et al. Changes in Muscle Thickness and Echo Intensity in Chronic Stroke Survivors: A 2-Year Longitudinal Study. J Clin Neurol. 2022 May;18(3):308-314.

146. Loosen SH, van den Bosch V, Gorgulho J, et al. Progressive Sarcopenia Correlates with Poor Response and Outcome to Immune Checkpoint Inhibitor Therapy. Clin. Med.. 10(7), 2021 Mar 25.

147. Brown JC, Caan BJ, Meyerhardt JA, et al. The deterioration of muscle mass and radiodensity is prognostic of poor survival in stage I-III colorectal cancer: a population-based cohort study (C-SCANS). J Cachexia Sarcopenia Muscle. 9(4):664-672, 2018 08.

148. Hopkins JJ, Reif R, Bigam D, Baracos VE, Eurich DT, Sawyer MM. Change in Skeletal Muscle Following Resection of Stage I-III Colorectal Cancer is Predictive of Poor Survival: A Cohort Study. World Journal of Surgery. 43(10):2518-2526, 2019 10.World J Surg. 43(10):2518-2526, 2019 10.

149. Kurk SA, Peeters PHM, Dorresteijn B, et al. Loss of skeletal muscle index and survival in patients with metastatic colorectal cancer: Secondary analysis of the phase 3 CAIRO3 trial.

Cancer Med. 9(3):1033-1043, 2020 02.

150. Lee J, Lin JB, Wu MH, et al. Muscle radiodensity loss during cancer therapy is predictive for poor survival in advanced endometrial cancer. J Cachexia Sarcopenia Muscle. 2019 Aug;10(4):814-826.

151. Cox MC, Booth M, Ghita G, et al. The impact of sarcopenia and acute muscle mass loss on long-term outcomes in critically ill patients with intra-abdominal sepsis. J Cachexia Sarcopenia Muscle. 2021 Oct;12(5):1203-1213.

152. Lee MW, Jeon SK, Paik WH, et al. Prognostic value of initial and longitudinal changes in body composition in metastatic pancreatic cancer. J Cachexia Sarcopenia Muscle. 2024 Apr;15(2):735-745.

153. Deng CY, Lin YC, Wu JS, et al. Progressive Sarcopenia in Patients With Colorectal Cancer Predicts Survival. AJR Am J Roentgenol. 2018 Mar;210(3):526-532.

154. Kuboi R, Tsubokawa N, Kamigaichi A, et al. Impact of pectoralis major muscle mass decrease after lobectomy on the prognosis of lung cancer. Jpn J Clin Oncol. 2025 Aug 03;55(8):941-946.

155. Lee J, Kim EY, Kim E, et al. Longitudinal changes in skeletal muscle mass in patients with advanced squamous cell lung cancer. Thorac Cancer. 2021 Jun;12(11):1662-1667.

156. Mason SE, Moreta-Martinez R, Labaki WW, et al. Longitudinal Association Between Muscle Loss and Mortality in Ever Smokers. Chest. 2022 Apr;161(4):S0012-3692(21)04290-2.

157. Pishgar F, Shabani M, Quinaglia A C Silva T, et al. Quantitative Analysis of Adipose Depots by Using Chest CT and Associations with All-Cause Mortality in Chronic Obstructive Pulmonary Disease: Longitudinal Analysis from MESArthritis Ancillary Study. Radiology. 2021 Jun;299(3):703-711.

158. Nicholson JM, Orsso CE, Nourouzpour S, et al. Computed tomography-based body composition measures in COPD and their association with clinical outcomes: A systematic review. Chron Respir Dis. 2022;19():14799731221133387.

159. Jiang M, Hua X, Wu M, et al. Longitudinal changes in sarcopenia was associated with survival among cirrhotic patients. Front Nutr. 2024;11():1375994.

160. Nishikawa H, Shiraki M, Hiramatsu A, Moriya K, Hino K, Nishiguchi S. Japan Society of Hepatology guidelines for sarcopenia in liver disease (1st edition): Recommendation from the working group for creation of sarcopenia assessment criteria. Hepatol Res. 2016 Sep;46(10):951-63.

161. Albano D, Dondi F, Treglia G, et al. Longitudinal Body Composition Changes Detected by [18F]FDG PET/CT during and after Chemotherapy and Their Prognostic Role in Elderly Hodgkin Lymphoma. Cancers (Basel). 2022 Oct 20;14(20):5147.

162. Kang H, Kim I, Park H, Ahn W, Kim SK, Lee S. Prognostic value of body composition measures in breast cancer patients treated with chemotherapy. Sci Rep. 2024 Oct 07;14(1):23309.

Disclaimer

condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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