DOI: https://doi.org/10.17816/DD110721

Саркопения: современные подходы к решению диагностических задач

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АННОТАЦИЯ

Саркопения является относительно новым диагнозом для медицинской статистики и системы здравоохранения, и тем не менее представляет социальное и экономическое бремя для системы здравоохранения из-за большого количества возможных неблагоприятных исходов, таких как повышение риска падений, физическая инвалидизация, увеличение времени пребывания в стационаре и увеличение смертности.

Несмотря на то, что узкоспециализированного медикаментозного лечения для саркопении не существует, профилактика и своевременное немедикаментозное лечение помогут снизить риск потенциальных неблагоприятных последствий.

Для установки диагноза саркопении необходимо подтверждение снижения не только мышечной силы, но и мышечной массы. Инструментальная диагностика включает в себя такие методы, как двухэнергетическая рентгеновская абсорбциометрия и биоимпедансометрия. Дополнением к этим методам могут быть алгоритмы искусственного интеллекта для автоматической сегментации мышечной и жировой ткани на компьютерно-томографических и магнитно-резонансных изображениях с последующим расчётом скелетно-мышечного индекса на уровне L3 позвонка. Такое программное обеспечение при его использовании в структурах, подобных Единому радиологическому информационному сервису Единой медицинской информационно-аналитической системы г. Москвы, открывает возможности для оппортунистического скрининга. Тем не менее общепризнанных количественных значений L3 скелетно-мышечного индекса для компьютерно-томографической и магнитно-резонансной диагностики саркопении пока не существует, несмотря на признание данных методик золотым стандартом Европейской рабочей группой по саркопении у пожилых людей. В дополнение к этому существует проблема унификации термина «скелетно-мышечный индекс».

При решении указанных проблем с помощью дальнейших популяционных исследований станет возможным получение новой методики инструментальной диагностики саркопении с последующим её применением для скрининга данного патологического состояния.

Ключевые слова: саркопения; старческая астения; искусственный интеллект; оппортунистический скрининг.

Как цитировать

Сморчкова А.К., Петряйкин А.В., Семёнов Д.С., Шарова Д.Е. Саркопения: современные подходы к решению диагностических задач // *Digital Diagnostics*. 2022. Т. 3, № 3. С. 196–211. DOI: https://doi.org/10.17816/DD110721

Рукопись получена: 31.08.2022 **Рукопись одобрена:** 19.09.2022 **Опубликована:** 27.09.2022

DOI: https://doi.org/10.17816/DD110721

Sarcopenia: modern approaches to solving diagnosis problems

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ABSTRACT

Although sarcopenia is a relatively new diagnosis for medical statistics and the healthcare system, it represents a social and economic burden on the healthcare due to the large number of possible adverse outcomes such as increased risk of falls, physical disability, longer hospital stays, and increased mortality. No specialized medical treatment is available for sarcopenia; however, prevention and timely nonpharmacological treatment can reduce the risk of potential adverse effects. To establish the diagnosis of sarcopenia, it is necessary to confirm the decrease in not only muscle strength but also muscle mass. Instrumental diagnostics includes methods such as dual-energy X-ray absorptiometry and bioimpedance analysis. These methods can be supplemented by artificial intelligence algorithms for the automatic segmentation of muscle and fat tissue on computed tomography and magnetic resonance images, followed by calculation of the skeletal muscle index at the level of the L3 vertebra (L3SMI). Such software, when used in systems such as the Unified Radiological Information Service of the Unified Medical Information and Analytical System of Moscow, opens up opportunities for opportunistic screening. However, despite the recognition of CT and MRI as the "gold standard" by the European Working Group on Sarcopenia in Older People, there are no generally accepted L3SMI cut-off values for CT and MR diagnostics of sarcopenia. Furthermore, there is the problem of unifying the term "skeletal muscle index." If these problems could be solved through further population studies, it will be possible to obtain a new method for the instrumental diagnosis of sarcopenia with its subsequent use for opportunistic screening.

Keywords: sarcopenia; frailty; artificial intelligence; mass screening.

To cite this article

Smorchkova AK, Petraikin AV, Semenov DS, Sharova DE. Sarcopenia: modern approaches to solving diagnosis problems. *Digital Diagnostics*. 2022;3(3):196–211. DOI: https://doi.org/10.17816/DD110721

Received: 31.08.2022 **Accepted:** 19.09.2022 **Published:** 27.09.2022

DOI: https://doi.org/10.17816/DD110721

肌肉减少症：解决诊断问题的现代方法。

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概要

肌肉减少症是医学统计和医疗保健系统的一个相对较新的诊断。然而，由于大量可能的不良后果，例如跌倒风险增加、残疾、住院时间延长和死亡率增加，它对医疗体系造成了社会和经济负担。虽然肌肉减少症没有高度专业化的药物疗法，但预防和及时的非药物治疗可以降低潜在不良反应的风险。诊断»肌肉减少症»不仅需要确认肌力下降，还需要确认肌肉质量下降。仪器诊断包括双能X光吸收测量 (DXA) 和生物阻抗测定法 (BIA)等方法。 这些方法可以辅以人工智能 (AI) 算法，用于在计算机断层扫描和磁共振图像上自动分割肌肉和脂肪组织，然后计算L3椎骨水平的肌肉骨骼指数。 此类软件在莫斯科市统一医疗信息和分析系统 (ERIS EMIAS)统一放射信息服务等系统中使用时，为机会性筛查提供了机会。然而，尽管欧洲老年人肌肉减少症工作组将CT和MRI技术认定为“金标准”，但仍然没有公认的用于诊断肌肉减少症的CT 和MR定量L3介质值。除此之外，还有统一术语“肌肉骨骼指数”的问题。如果这些问题通过进一步的人群研究得到解决，将有可能获得一种用于肌肉减少症的仪器诊断的新方法，并随后将其用于筛查这种疾病。

关键词：肌肉减少症； 老年虚弱；人工智能；机会性筛查。

To cite this article
Smorchkova AK, Petraikin AV, Semenov DS, Sharova DE. 肌肉减少症：解决诊断问题的现代方法。*Digital Diagnostics*. 2022;3(3):196–211. DOI: https://doi.org/10.17816/DD110721

收到： 31.08.2022 **接受：** 19.09.2022 **发布日期：** 27.09.2022

BACKGROUND

Increasingly more attention is currently paid to systemic diseases and conditions associated with a general change in the composition of the human body, including those due to the population aging. One of these nosologies is sarcopenia (sarcopenia, from the Greek sarx—*muscles*, *flesh* and penia—*lack*). This disease is included in the syndrome of senile asthenia or frailty syndrome.

The ICD-10 code for sarcopenia defined in 2016 is retained in ICD-11; the first working definition of sarcopenia was published in 2010. Therefore, this is a relatively new diagnosis for medical statistics and the health care system.

Sarcopenia is a progressive generalized skeletal muscle disease associated with an increased risk of adverse outcomes, including falls, fractures, physical disability, and mortality [1]. In geriatrics, the term "sarcopenia" implies primary sarcopenia, which is a condition characterized by a progressive generalized loss of strength, mass, and function of skeletal muscles due to aging without other causes [2].

Sarcopenia entails many negative consequences and outcomes in addition to adverse effects on the body, such as an increased risk of falls and, consequently, fractures [3] and physical disability [4]. Additionally, sarcopenia is associated with longer hospital stay and more severe outcomes in many diseases [5].

Timely diagnostics of sarcopenia and prevention of its consequences are relevant given the potential burden on the economy and health care system.

Our review aimed to assess the real significance of sarcopenia on the scale of a large metropolis (Moscow), as well as to determine methods for optimizing of diagnostics of this condition.

SARCOPENIA: METHODS OF OPTIMIZATION OF DIAGNOSTICS OF A PATHOLOGICAL CONDITION

Epidemiology

Older patients are most susceptible for primary sarcopenia since it is associated with aging. The literature provides data on the onset of loss of muscle tissue function as early as 50 years of age [6]. However, in a clinical context, it is customary to consider age groups of 60 years and older.

According to a number of reviews [7, 8], the prevalence of sarcopenia in the general population is 10% (inhabitants older than 60 years). In addition to gender and attitude to a particular social group [individually living (community-dwelling) older people; population of nursing homes and specialized clinics], differences in prevalence depend on the method of diagnostics of this condition, namely, tests, bioimpedancemetry, dual-energy X-ray absorptiometry (DXA), computed tomography (CT), and magnetic resonance imaging (MRI).

At the time of writing this article, no epidemiological studies with a large sample had been conducted in Russia. A study [9] was performed with a sample of 230 outpatients over the age of 65, where the prevalence of sarcopenia was estimated at 30% according to the criteria of the European Working Group on Sarcopenia in Older People (EWGSOP) and the International Working Group on Sarcopenia (IWGS), which is inconsistent with the above reviews. The discrepancies may be possibly due to the small sample size and its imbalance (95.6% of women). Therefore, the data needs to be clarified.

Impact of sarcopenia on the quality of life and health care system

Sarcopenia significantly reduces the quality of life, leading to a forced restriction of physical activity [10], which further aggravates the patient's situation. Both a healthy population and those with acute, chronic, and oncological diseases have a negative impact [11, 12]. Patients' quality of life is assessed using the Short Form-36 (SF-36)[1] and EuroQoL (EQ-5D)[2], general-purpose questionnaires, as well as using the effective specialized questionnaire SarQoL (Sarcopenia and Quality of Life) [13–16] available in Russian language [17]. When assessing the quality of life according to these questionnaires, a hundred-point system is used. The SF-36 presents a scale of values from 0 to 100, where 0 is the worst and 100 is the best quality of life. In EQ-5D, the result is also represented by a 100-point scale, but 0 implies the worst, and 100 is the best health state.

Sarcopenia not only reduces quality of life, but it also causes significant economic expenditures to the health care system. Studies on the financial costs for patients with and without sarcopenia have been conducted (median total hospitalization expenditures, average health care expenditures per person for 3 months, and costs for postoperative care for 90 days). For patients with sarcopenia, the average increase in total hospitalization expenditures can reach up to $14,322 per person [18]. It should be borne in mind that the available studies mainly consider the costs associated with hospitalization for surgical interventions (e.g., oncosurgery), use different diagnostic methods, and lack unified threshold values for confirming the diagnosis of sarcopenia [19]. Further studies using a more homogeneous sample and supplementing with other clinical scenarios (especially the analysis of outpatient expenditures) are required for more accurate estimation of the total expenditures of the health care system for patients with sarcopenia.

[1] 36-Item Short Form Survey Instrument (SF-36) [Electronic resource]. Access mode: https://www.rand.org/health-care/surveys_tools/mos/36-item-short-form/survey-instrument.html. Reference date: 06/06/2022.

[2] EuroQol Research Foundation. EQ-5D-5L User Guide, 2019 [Electronic resource]. Access mode: https://euroqol.org/publications/user-guides/. Reference date: 06/06/2022.

Treatment of sarcopenia

There is currently no unified and highly specific approach to the treatment of sarcopenia. Nevertheless, understanding the process pathophysiology enables to select possible options for therapy. For sarcopenia, there are both non-drug and drug treatments. The most effective non-drug methods are physical exercises, particularly strength exercises [20]. They currently represent the most cost-effective way not only for long-term prevention of sarcopenia, but also for maintaining and improving overall physical health [21]. Nutritional supplements, such as proteins (including whey), antioxidant agents, and long-chain polyunsaturated fatty acids, are used to improve and maintain muscle gain and strength [22]. For non-pharmacological therapy of sarcopenia, exercise is recommended because it has higher evidentiality than dietary changes [23]. Drugs, such as vitamin D [24], selective androgen receptor modulators, myostatin, and activin antagonists [25], are considered as drug therapy, but at the moment, their efficiency requires further confirmation due to more clinical studies.

Diagnostics of sarcopenia

Currently, the diagnosis of sarcopenia in clinical practice is often based on common anamnestic data, such as complaints about the symptoms and signs characteristic of the disease (falls, a feeling of weakness, slow walking speed, difficulty standing up from a sitting position) [26]. The EWGSOP recommends using the SARC-F (strength, assistance with walking, rising from a chair, climbing stairs, and falls) questionnaire [27] to objectify the diagnostics, and as screening, which considers both strength and assistance when walking, rising from a chair and stairs, and falling. However, due to the average sensitivity (25; 31.6; 50%) and high specificity (81.4; 82.4; 81.8%) of the test, according to the diagnosis criteria of EWGSOP, the Foundation for the National Institutes of Health, and the IWGS [30], respectively, the questionnaire in most cases tends to identify only severe cases of sarcopenia.

In Russia, sarcopenia is diagnosed not as a separate nosology but as a component of the senile asthenia syndrome; for primary screening, the "Age is not a problem" scale is used, and for further clarification of the diagnosis, a comprehensive geriatric assessment is used [2].

Instrumental diagnostic methods should be used for accurate diagnostics of sarcopenia. Measurement of two parameters is required, namely, muscle strength (including physical performance) and muscle mass [1]. Low muscle strength implies the possibility of sarcopenia; methods for assessing muscle mass are required to confirm the diagnosis [1].

The simplest and most accessible method to measure muscle strength is to assess grip strength using a hand dynamometer, followed by comparison of the data obtained with reference values in the population [1]. Although grip strength correlates well with overall muscle strength, different muscle groups should be considered for the most reliable results [29]. Standardized data for determining low muscle strength in carpal dynamometry are determined by gender and body mass index (BMI); for example, in men with a BMI of 24.1 to 28, the threshold value is the grip strength lower than 30 kg, and in women with a BMI of 23.1 up to 26, it is lower than 17.3 kg [2]. To assess performance, the chair rising test [2] is used, as well as the "Stand up and walk" tests, and the walking speed test included in the Short Physical Performance Battery (SPPB) can be used. When measuring walking speed, the patient is asked to walk 4 m at his usual speed, while the time of passing the distance is registered, and the speed is calculated (m/s) [30]. EWGSOP2 (2019) recommended a walking speed of 0.8 m/s or lower as the threshold for defining severe sarcopenia. In the "Stand up and walk" test, patients are asked to stand up from a chair, walk 3 m to the marker, turn around, walk back to the chair, and sit on it [31]. According to the EVGSOP2 recommendations, the threshold value of this test for the diagnosis of sarcopenia is 20 s or higher. The SPPB test is comprehensive and includes a walking speed assessment, a balance assessment, and a chair rising test. In this test, the maximum possible score is 12 points, with a score of 8 points or less indicating poor physical function [32].

To assess the human body composition and assess muscle mass, DXA, and bioimpedancemetry, bioelectrical impedance analysis are used. According to the EWGSOP, CT and MRI are the gold standard for assessing the mass and quality of muscle tissue [1]. EWGSOP recommends visualization at the level of the vertebra L3 using CT, measurement of muscle tissue in the middle third of the thigh, and assessment of muscle tissue using ultrasound [33]. Creatine dilution tests, a number of neuromuscular biomarkers, assessment of nonspecific inflammatory reactions, and hormonal and anabolic factors are used as methods for laboratory assessment of sarcopenia [1].

Methods of radiation diagnostics of sarcopenia

Radiation diagnostics of sarcopenia is based on an assessment of a decrease in the volume of muscle tissue and deterioration in its "quality." DXA is the most commonly used method for these purposes, due to its low radiation exposure and ability to obtain reproducible results. However, it has some drawbacks and limitations, namely, the study involves the measurement of lean body mass and not isolated muscle mass, which could lead to inaccurate results in patients with increased fluid intake and/or with a large amount of fibrous tissue. It is also impossible to assess the quality of muscle tissue due to the projection type of images [32]. The method limitation is the need for studies in dynamics on a single densitometer with regular calibration [34], and studies cannot be performed opportunistically.

According to the EWGSOP, CT and MRI represent the gold standard for noninvasive assessment of the amount of muscle tissue, although these methods are not widely

used due to some reasons, such as high cost of research/equipment, lack of clear diagnostic thresholds, and the need for segmentation to identify muscles and other anatomical structures [1, 32]. In contrast to DXA, CT and MRI often do not allow scanning of the entire body due to dose load (CT) or time constraints (MRI), and the study is limited to one anatomical region.

The measurement of axial slices at the level of the vertebra L3 is currently one of the most reliable and effective methods of CT assessment of muscle mass [35]. For a given anatomical location, the ratio of muscle mass to adipose tissue correlates well with the ratio for the whole body [36]. This anatomical landmark can be used to assess sarcopenia in patients regardless of BMI, while the parenchymal organs of the abdominal cavity, bone structures are the least represented on this section and make segmentation of muscle and adipose tissues less difficult [37, 38].

Diagnostics of sarcopenic obesity

Sarcopenic obesity is one of the most serious comorbidities in sarcopenia. The loss of muscle mass in sarcopenia is often (but not always) accompanied by an increase in adipose tissue. This process affects directly the quality of muscle tissue and, consequently, physical performance [39].

Similar to obesity, sarcopenia is characterized by subacute chronic proinflammation that impairs the function of muscle and adipose tissue [40]. Additional links of pathogenesis have also been identified, which determine the relationship between muscle and fat metabolism in sarcopenic obesity [41]. Thus, this comorbid condition in a patient increases the risks of adverse consequences [42].

The diagnostic capabilities of medical imaging used in sarcopenia are well suited for sarcopenic obesity; for example, DXA has been successfully used to determine body composition and tissue mass ratio (Fig. 1), while CT and MRI can visualize the area and distribution pattern of excess adipose tissues in the visceral organs and as part of the subcutaneous fat.

Quantitative criteria for diagnostics of sarcopenia

Total skeletal muscle mass and appendicular skeletal muscle mass (AMM) are the two parameters most commonly used to diagnose muscle loss. AMM is determined using DXA (the entire body of the patient is scanned, the upper and lower limbs, which are anatomical regions that do not contain parenchymal organs, are evaluated; Figure 1), while skeletal muscle mass is determined by bioimpedancemetry.

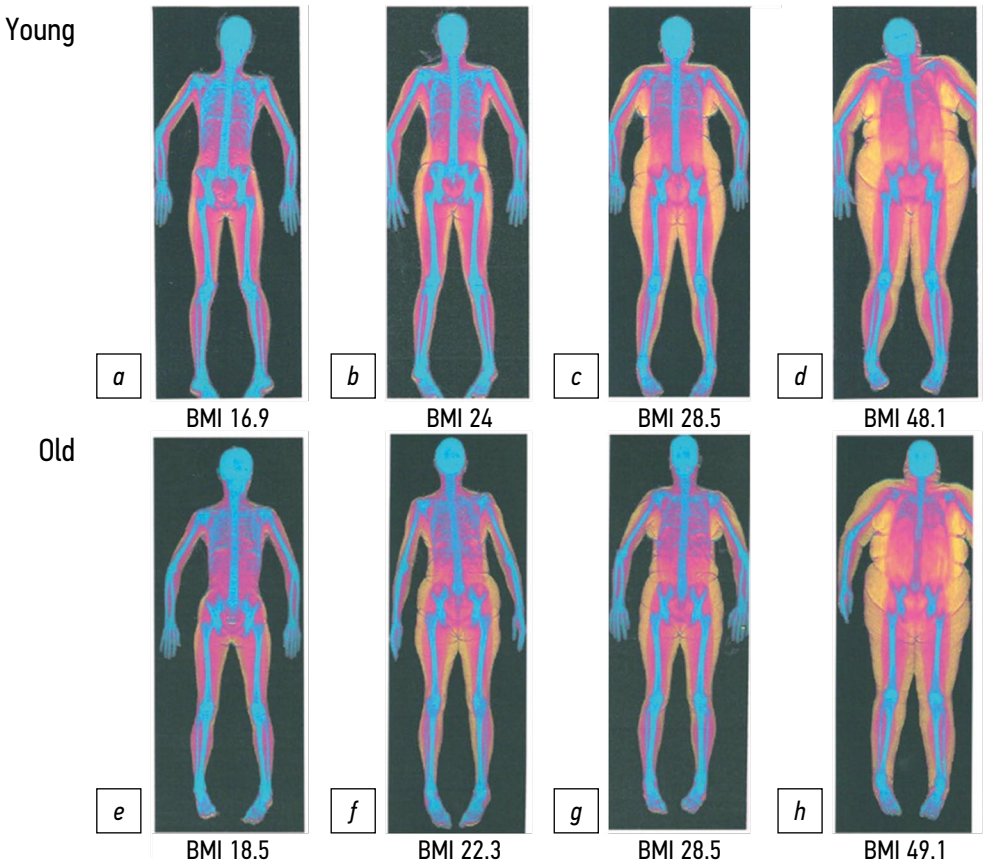


Fig. 1. An example of diagnostic images obtained using DXA (according to D.J. Tomlinson et al. [43]) at various body mass index (BMI) values in young (*a–d*) and elderly (*e–h*) women. Bone tissue is highlighted in blue, lean muscle tissue is highlighted in red, and adipose tissue is highlighted in yellow.

Table 1. EWGSOP2 consensus threshold quantitative indices for establishing the diagnosis of sarcopenia

Study method	Threshold for men	Threshold for women
EWGSOP2 quantitative criteria for low muscle strength		
Grip strength	<27 kg	<16 kg
Chair rising test	>15 s for 5 risings	
EWGSOP2 quantitative criteria for low muscle strength		
Appendicular muscle mass (AMM)	<20 kg	<15 kg
AMM/height^2, kg/m^2	<7,0 kg/m^2	<5,5 kg/m^2

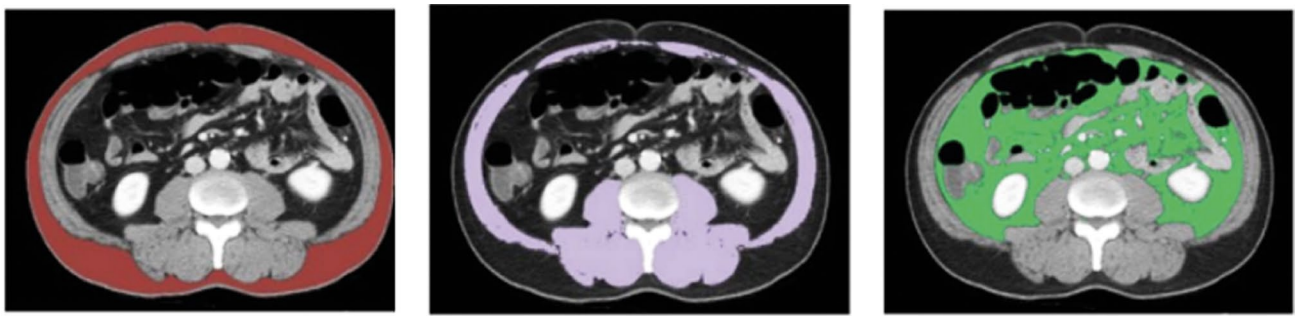
Table 2. AWGS consensus threshold quantitative indices for establishing the diagnosis of sarcopenia

Study method	Threshold for men	Threshold for women
AWGS quantitative criteria for low muscle strength		
Grip strength	<28 kg	<18 kg
Chair rising test	⩾12 s for 5 risings	
AWGS quantitative criteria for low muscle mass		
AMM/height^2, kg/m^2	<7,0 kg/m^2	<5,4 kg/m^2

As a derived parameter, the skeletal muscle index (SMI) is determined. There is an issue for terminology unification, since in works by various authors, different calculation equations are used for the same concept of "musculoskeletal index" [44]. For determining it, the ratio of AMM to height (AMM/m^2), the ratio of AMM to weight (AMM/kg), and the ratio of AMM to BMI (AMM/BMI) are used, depending on the adjustment for individual parameters. Each method has its advantages and disadvantages. Thus, SMI that has been adjusted for patient height (AMM/m^2) has a less reliable correlation with asthenia in women and does not take into account the distribution of adipose tissue [45]. There is evidence that the detection rate of severe sarcopenia when using BMI-adjusted SMI is twice as high as that of height-adjusted SMI [44]. The ratio of AMM to height (AMM/m^2) is the only SMI option with generally accepted threshold values for establishing a diagnosis of sarcopenia. They are enshrined in the consensus of the European (EWGSOP) and Asian (Asian Working Group on Sarcopenia) working groups on sarcopenia. These data, as well as quantitative criteria for establishing a diagnosis based on muscle strength, are presented in Tables 1 and 2. For other SMI options using other parameters for adjustment (BMI, weight), there are no generally accepted threshold values.

A variant of SMI for cross-sectional instrumental diagnostics using CT and MRI is the calculation of L3 SMI according to the equation $L3\text{SMI} = \frac{S}{h^2}$, where *L3* of SMI is the skeletal muscle index at the level of the L3 vertebra (cm^2/m); *S* is the area of all muscle groups in the section (cm^2); and *h* is human height (m).

Fig. 2 presents a variant of measuring the area of muscle tissue, subcutaneous adipose, and visceral adipose tissue in the section slice at the L3 level, using an artificial intelligence algorithm.



Subcutaneous fat area
112,4 см^2

Skeletal muscle area
139,2 см^2

Visceral fat area
146,7 см^2

Fig. 2. An example of measuring the area (cm^2) of muscle tissue, subcutaneous adipose, and visceral adipose tissue in the slice at the L3 level, using the L3SEG-net AI algorithm from the work by J. Ha et al. [46]. From left to right, subcutaneous adipose tissue is highlighted in red, skeletal muscle mass is highlighted in purple, and visceral adipose tissue is highlighted in green.

Despite the prospect of using and recognizing as the gold standard the assessment of sarcopenia according to CT data [1], there are still no unified threshold values for this indicator [44].

Various criteria are used to define sarcopenia by SMI defined for L3. Threshold values for sarcopenia are less than 55 cm^2/m^2 for men and less than 39 cm^2/m^2 for women [47], less than 53 cm^2/m^2 for BMI more than 25 and less than 43 cm^2/m^2 for BMI less than 25 for men, and less than 41 cm^2/m^2 regardless of BMI for women [48]. The lack of unification emphasizes again the need for further population studies to determine the correct L3 SMI values.

New approaches in radiation diagnostics of sarcopenia

The problem of using CT for a reliable assessment of the degree of muscle mass reduction is the need for manual segmentation of muscle tissue on a series of CT images, which is difficult with a large patient stream. However, the existing semi-automatic morphometric computer software for segmentation based on radiological density of muscle tissue (often in range from –29 to +150 Hounsfield units for muscle and from –30 to –190 Hounsfield units for fat) using masks has not yet been widely adopted. Examples of such software include Slice-O-Matic [49], AsanJ-Morphometry [50], and 3D Slicer [51].

It became possible to create software that more accurately segments various structures on CT and MRI images and has the ability to self-learn with the widespread advent of artificial intelligence technologies in medical imaging, in particular, machine learning, neural networks, and deep learning (deep learning). Despite the difficulties associated with the development and use of the technique, the literature presents relevant scientific papers covering the development and validation of machine learning segmentation algorithms, in particular, segmentation of skeletal muscles in CT studies of the abdominal organs in cancer patients [52–55]. U-Net, which was initially created for visualization in cell biology but is now successfully used in radiation diagnostics, is the most popular architecture used for model training [56]. The second most frequently used architecture is the fully connected neural network (FCNN) [57], which is applied for more general purposes and was originally created for semantic segmentation. The main parameter by which the performance of neural network segmenters is evaluated is the Dice coefficient, which indicates the percentage of correspondence of one data array to another, and in a given case, compliance of the predicted markup with the standard specified by the neural network developers. The literature now offers examples of algorithms that Dice coefficient exceeds 0.97 [58].

More and more often, researchers create complex models based on several architectures for several different subtasks, as seen, for example, in the work of J. Ha et al. [46], where the finished software uses two architectures, YOLOv3 and FCNN, where the former performs the task of searching for a specific object (in this case, the vertebra L3), and the latter performs direct segmentation. By utilizing deep learning, it is also possible to create maps that display the quality of skeletal muscle tissue based on the amount of intramuscular fat. This is presented in the work by D.W. Kim et al. [59], where the authors, based on a previously created algorithm with the FCNN architecture, created a web application that can be used to create labeled maps from CT slices at the vertebra L3 level, visually displaying the ratio of muscle tissue and intramuscular fat (Fig. 3). Currently, the main practical disadvantage of the work is the lack of appropriate boundary values or a special index that would enable to evaluate the quality of muscle tissue objectively rather than not subjectively. Nevertheless, given the importance of not only assessment of the strength and quantity, but also the quality of muscle tissue for a full-fledged diagnostics and prognosis of the course of sarcopenia, this direction is quite promising for future research.

It is noteworthy that the availability of specialized software based on deep learning technologies enables not only to solve the clinical and practical task of clarifying the diagnosis of sarcopenia, but also provides the possibilities for opportunistic screening of this condition.

Possibilities of opportunistic screening

As was mentioned earlier, the specificity of calculation of the L3 SMI indicator and obtaining it through instrumental diagnostics using X-ray methods enables to perform opportunistic CT screening using automatic segmentation software. This anatomical landmark is interesting because of its frequent occurrence in CT examinations, which is partly due to the standards of providing medical care, such as in oncological diseases when CT is required to search for distant metastases. As one of the evidence, L3 SMI calculation is often available in cancer patients and is used to assess cancer cachexia and its association with the disease outcomes [47, 48, 60]. The publication of P.M. Graffy et al. can be cited as an example of successful operation of the muscle tissue segmentation algorithm on a large retrospective screening sample [61]. The authors used a sample of 8,037 asymptomatic patients who underwent abdominal CT without contrast enhancement from April 2004 and December 2016. Given the fact that healthy patients constituted the majority of the sample, in addition to validating the algorithm, the authors also managed to obtain average values for a healthy population. According to the authors, the study limitations are the use of CT images of patients from only one medical institution, as well as the unsatisfactory performance of the algorithm on CT images with artifacts from hardware, motion artifacts, as well as on CT images obtained using low-dose scanning protocols. The last limitation is typical for any segmenter algorithms. Nevertheless, despite the disadvantages, it is difficult to overestimate one of the main advantages of opportunistic

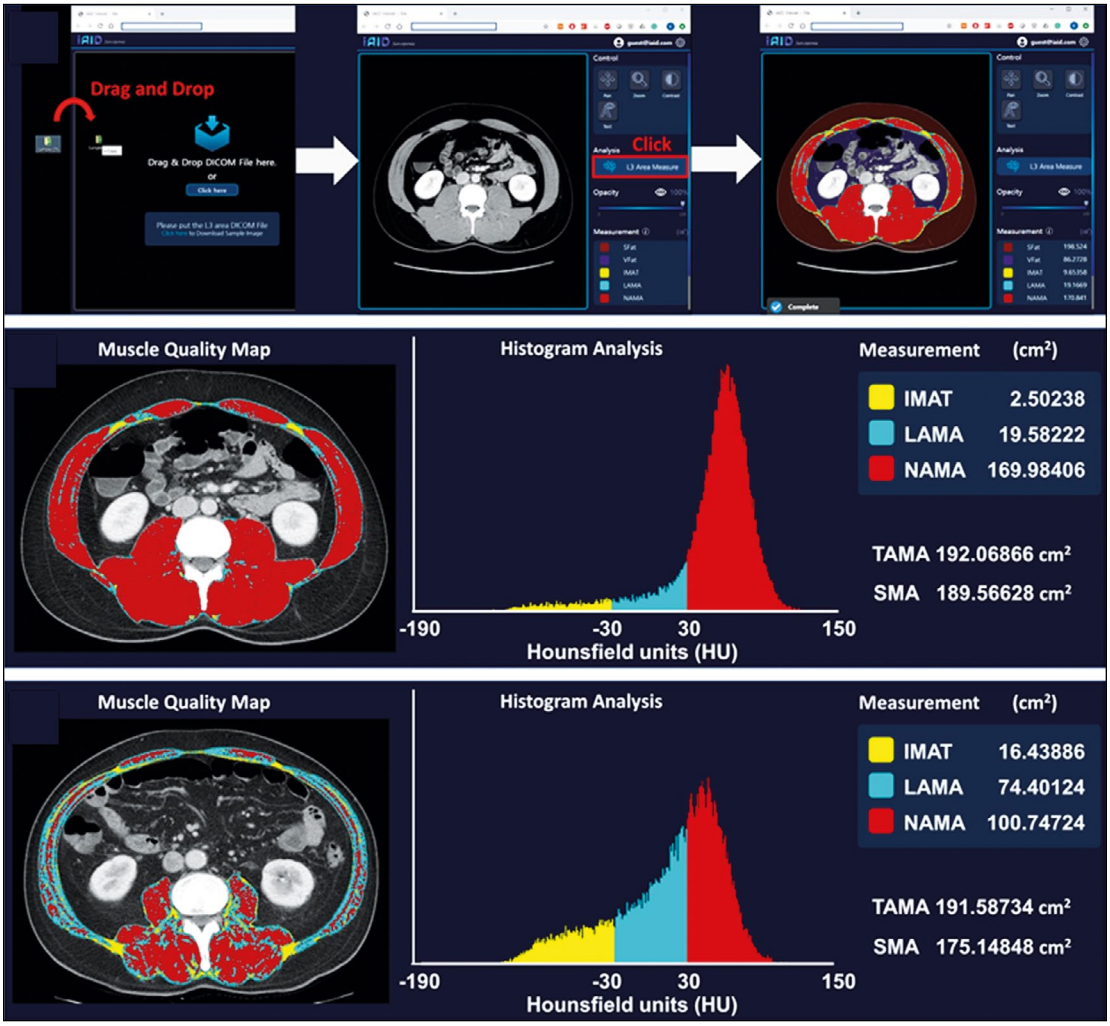


Fig. 3. Muscle tissue quality maps obtained using an automated web-based tool (according to D.W. Kim et al. [59]). IMAT, area of inter/intramuscular adipose tissue; LAMA, low-density muscle tissue area; NAMA, normal density muscle tissue area; SMA, skeletal muscle tissue area; TAMA, total abdominal muscle tissue area.

screening, which is the absence of the need to perform additional X-ray studies and, consequently, the reduction in the hypothetical dose of X-ray radiation received by the patient.

An example of the successful implementation of the opportunistic screening system in the Unified Radiological Information Service of the Unified Medical Information and Analytical System of Moscow (URIS UMIAS) is the project of opportunistic screening of osteoporosis [62] and a number of other diseases and conditions (aortic aneurysms, signs of pulmonary hypertension with determination of the pulmonary trunk diameter, lung cancer, signs of stroke, etc.) as part of an experiment on the use of innovative technologies in the field of computer vision for the analysis of medical images and further application in the health care system of Moscow[3] [63].

By analogy with the already implemented solution, as well as considering the experience of colleagues from other countries, we propose a possible option for organizing opportunistic screening of sarcopenia (including retrospective) with subsequent implementation in URIS UMIAS. The U-Net++ architecture can be used as a prototype for developing a tool for automatic segmentation of muscle and adipose tissue on CT images at the level of the vertebra L3 [64]. The advantage of this approach is the high values of the Dice coefficient for the neural network even with a very small size of the training sample (subcutaneous fat, 0.9706; muscles, 0.9312; intramuscular fat, 0.6465; visceral fat, 0.9609; training sample, 15 patients). The prospect of this direction includes the possibility of a rapid opportunistic assessment of the amount of muscle tissue, clarification of the boundary values for diagnosing sarcopenia, which will allow timely detection of the pathological condition, prediction and reduction of adverse outcomes in various invasive interventions, prevention of a progressive decline in

[3] Center for Diagnostics and Telemedicine [Internet]. Catalog of AI services. AI services in radiation diagnostics. Access mode: https://mosmed.ai/service_catalog/. Date of access: 08/26/2022.

the quality of life of this category of patients, and reduction the cost of health care system resources.

CONCLUSION

Sarcopenia is a disease that represents a social and economic burden on the health care system. Although sarcopenia does not have a highly specialized medical treatment, prevention and timely non-drug treatment through strength exercise can help reduce the risk of potential adverse effects. Timely diagnostics of a decrease in both muscle strength and muscle mass is required. A good addition to the already used methods of instrumental diagnostics (DXA and bioimpedancemetry) can be artificial intelligence algorithms for automatic segmentation of muscle and adipose tissue on CT and MR images with subsequent calculation of L3 SMI. Such software, when used in systems such as URIS UMIAS, provides possibility for opportunistic screening.

There are no generally accepted quantitative L3 SMI values for CT and MR diagnostics of sarcopenia, despite the recognition of EWGSOP as the gold standard for CT and MRI techniques. In addition, there is a problem of unifying the term "skeletal muscle index." When solving these problems by means of further population studies, it will be possible to obtain a new method for instrumental diagnostics of sarcopenia with its subsequent use for screening this condition.

ADDITIONAL INFORMATION

Funding source. This article was prepared by a group of authors as part of research (No. in the Unified State Information System for Accounting of Research, Development, and Technological Works (EGISU): AAAA-A21-121012290079-2) under the Program of the Moscow Healthcare Department "Scientific Support of the Capital's Healthcare" for 2020–2022.

Competing interests. The authors declare that they have no competing interests.

Authors' contribution. All authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work. A.S. Smorchkova — data sources collection and analysis, manuscript preparation; A.V. Petraikin — manuscript preparation, manuscript revision; D.S. Semenov, D.E. Sharova — review concept, manuscript preparation, final editing.

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