

Impact of Muscle Mass Gain and Loss Assessed by Bioimpedance in the Treatment of Lung Cancer

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<https://doi.org/10.17925/USPRD.2025.10.1.5>

Lung cancer is the leading cause of cancer-related deaths and the second-most common cancer worldwide. Body composition, including muscle mass and body fat distribution, may significantly influence patient outcomes. Bioelectrical impedance analysis (BIA) offers a simple and affordable method to assess body composition; yet, it remains underutilized in lung cancer treatment protocols. This article explores how BIA could serve as a valuable tool in lung cancer care, enabling more effective assessment of body composition. It also highlights the critical role of maintaining muscle mass during treatment, as greater muscle reserves have been associated with fewer chemotherapy side effects, prolonged survival and improved quality of life. Recognizing the importance of body composition in lung cancer management could refine treatment strategies and enhance patient care.

Keywords

Body composition, cachexia, lung cancer, lung neoplasms, nutritional status, sarcopenia, skeletal muscle, quality of life

Disclosures: Rafael Alvim Pereira, Milena Tumelero, Wallace Schwengber, Fernanda Bortolon, Leonardo Stone Lago and Gabriel Lenz have no financial or non-financial relationships or activities to declare in relation to this article.

Review process: Double-blind peer review.

Compliance with ethics: This article involves a review of the literature and did not involve any studies with human or animal subjects performed by any of the authors.

Data availability: Data sharing is not applicable to this article as no datasets were generated or analysed during the writing of this article.

Authorship: All named authors meet the criteria of the International Committee of Medical Journal Editors for authorship for this manuscript, take responsibility for the integrity of the work as a whole and have given final approval for the version to be published.

Access: This article is freely accessible at touchRESPIRATORY.com. © Touch Medical Media 2025.

Received: 4 July 2025

Accepted: 9 September 2025

Published online: 29 September 2025

Citation: touchREVIEWS in Respiratory & Pulmonary Diseases. 2025;10(1):Online ahead of journal publication

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Support: No funding was received for the publication of this article.

Lung cancer remains the leading cause of cancer mortality and the second-most common cancer globally. In the USA, there were 238,340 new cases of lung cancer in 2023, according to the American Cancer Society.¹ Worldwide, 2.2 million new cases were reported in 2020.² Although lung cancer incidence is declining in some regions, due to smoking cessation efforts, it remains a major public health concern.³

Multiple risk factors contribute to lung cancer, with smoking responsible for 90% of cases in regions where it is prevalent.⁴ Other risk factors include socioeconomic status, measured by the Human Development Index (HDI) and Socio-Demographic Index (SDI). Clinical evidence shows that higher HDI and SDI are associated with increased lung cancer incidence, partly due to greater exposure to smoking habits, including both direct tobacco use and secondhand smoke.³ Environmental factors, such as asbestos and air pollution, also contribute to higher incidence rates.⁵

Body composition, measured by body mass index (BMI) and other metrics, interacts with factors such as smoking, socioeconomic status, geographic location, environmental exposures, demographic factors and tumour characteristics.⁶ For example, women who are underweight or obese and have a history of smoking tend to have worse outcomes compared with those with a normal BMI. This is especially true among White patients, while Black patients often show better outcomes even at BMI extremes.⁶ This raised the question of whether body composition interacts with factors like race to influence treatment response.

Beyond BMI, factors such as fat distribution (especially visceral fat) and muscle mass also play a role in lung cancer outcomes. Higher muscle mass is linked to better survival and physical function, while increased intermuscular fat raises the risk of mortality.⁷ Additionally, muscle loss during treatment often signals worse outcomes, particularly in men.⁸

Bioelectrical impedance analysis (BIA) helps overcome this limitation by providing a more comprehensive assessment of body composition, including fat-free mass, muscle mass and hydration status.⁶ This enables more accurate evaluation of nutritional and metabolic status, potentially improving treatment response and prognosis.⁶

BIA is a simple and affordable method to measure body composition, including muscle mass. It works by sending a small electrical current through the body and measuring how different tissues slow it down. Since tissues like muscle and fat conduct electricity differently based on their water and electrolyte content, BIA can estimate total body water (TBW) and, from that, calculate muscle and fat mass.⁹ Different approaches to BIA exist, including single-frequency, multifrequency, bioelectrical impedance spectroscopy (BIS) and segmental BIA. These approaches differ in both complexity and clinical utility. Single-frequency BIA is the most straightforward and widely available,

while multifrequency devices can separate intra- and extracellular water with greater detail. BIS offers higher precision across a spectrum of frequencies, and segmental BIA makes it possible to evaluate specific regions of the body rather than relying only on whole-body estimates. When interpreting results in oncology, especially across different studies or patient populations, it is essential to keep these methodological differences in mind.^{10,11}

Using BIA to assess body composition in patients with lung cancer is important for identifying those at risk of malnutrition and cachexia, both of which are common in cancer and can negatively impact recovery. BIA is especially useful for tracking changes in muscle mass over time, providing clinicians with valuable insights for adjusting nutrition and treatment plans.⁹

The objective of this article is to provide a comprehensive evaluation of the role of nutritional interventions in patients with cancer, approached from both a clinical oncology and nutrition perspective. We aim to offer valuable insights that can help oncologists, dietitians and other healthcare professionals refine supportive care by integrating the latest research and highlighting areas of clinical significance. To ensure that nutritional strategies are successfully integrated into multidisciplinary cancer care, this article aims to bridge the gap between research findings and routine clinical practice.

The role of bioelectrical impedance analysis in lung cancer

Muscle depletion, or sarcopenia, is a significant concern in lung cancer, with a prevalence ranging from 42.8 to 45.0%.¹² Sarcopenia can be assessed through various methods, including dual-energy X-ray absorptiometry (DEXA), BIA, computed tomography (CT), magnetic resonance imaging (MRI), arm dimensions, handgrip strength, skinfold thickness, tumour staging via the TNM system and functional status measured by the Eastern Cooperative Oncology Group (ECOG) Performance Status Scale.¹² However, these methods have limitations, such as sensitivity primarily in advanced cancer stages and subjective evaluations dependent on the assessor. As a result, ongoing studies aim to identify more reliable prognostic indicators beyond weight loss.¹³

Radiological method: The gold standard

The gold standard for assessing body composition includes radiological methods such as MRI and CT.¹⁴ These imaging techniques can distinguish fat from other soft tissues and simultaneously quantify both the quantity and quality of muscle.¹⁵ Both methods do have drawbacks, including the need for qualified professionals to conduct the examination, radiation exposure, lack of portability and space requirements.¹⁶ Crucially, routine CT scans for staging and follow-up in patients with advanced-stage cancer can be used to evaluate sarcopenia without adding to the expense.

CT is particularly useful for estimating skeletal muscle mass (SMM) in clinical practice. Cross-sectional image analysis at the level of the third lumbar vertebra is the current gold standard for inferring total SMM using CT. However, this method depends on the availability of abdominal images, which are not routinely performed. Therefore, muscle mass assessment is particularly important for patients at higher risk of developing sarcopenia, such as those with head and neck cancer.^{17,18}

DEXA is another widely used imaging technique for measuring body composition, including the total body mass, SMM and body fat

percentage. It can also calculate skeletal muscle area and skeletal muscle index (SMI) in the lower limb. While DEXA is accurate, it has limitations, such as cost, radiation exposure and the need for specialized equipment. Additionally, DEXA cannot assess muscle quality, as it cannot detect adipose tissue within muscles.¹⁸ Despite these limitations, DEXA is the predominant imaging technique for identifying sarcopenia, offering established cutoff points and low radiation exposure. Its clinical applications are widespread, particularly in primary care, geriatric medicine and metabolic diseases.^{19,20}

Ultrasound has gained popularity in clinical and research settings due to its cost-effectiveness, availability and lack of ionizing radiation. While it shows good validity compared with other imaging techniques such as DEXA, CT and MRI, the European Working Group on Sarcopenia in Older People (EWGSOP2) considers ultrasound valid for assessing muscle mass but does not provide specific cutoff values. Conversely, the Asian Working Group for Sarcopenia (AWGS2) does not recommend its use due to a lack of supporting studies.²¹

Measuring the mid-arm muscle circumference (MAMC) is another technique for evaluating muscle loss; it works even better when paired with BIA. One of its primary benefits is that it is easy to use, can be used at the patient's bedside and is appropriate for a variety of clinical settings. The Global Leadership Initiative on Malnutrition (GLIM) criteria, which aid in diagnosing malnutrition and predicting survival in patients with cancer, still include MAMC despite its lower sensitivity.²²⁻²⁴ Table 1 below summarizes the main diagnostic methods for sarcopenia, outlining their advantages, limitations and common applications in oncology.

Bioelectrical impedance analysis: A practical alternative

In contrast to radiological methods, BIA offers a practical alternative for measuring body composition in clinical settings. BIA is non-invasive, easy to use, portable, inexpensive and provides quick results.^{15,25,26} It estimates TBW by measuring impedance (Z), which results from resistance (R) and reactance (Xc). This relationship is expressed by the equation $Z^2 = R^2 + Xc^2$.^{10,27} In clinical oncology, BIA is useful for evaluating nutritional status, hydration, symptoms and survival in patients with advanced cancer through bioelectrical impedance vector analysis and phase angle (PhA), converting results into z-scores.¹¹

BIA has proven effective in providing important data on malnutrition and body composition in various patients with oncological diagnosis. In head and neck cancer, a prospective study found a strong correlation between BIA measurements and CT-based estimates, with over 90% sensitivity and specificity in identifying sarcopenia.²⁸ In oesophageal cancer, BIA has been shown to identify patients at risk of postoperative morbidity.²⁹ However, in lung cancer, a study by Hansen et al. found that BIA overestimated SMM and underestimated muscle strength.²⁶ Despite this, BIA has demonstrated clinical advantages in pancreatic, colorectal, lung and skin cancer, serving as a prognostic indicator and a valid tool for assessing muscle mass and strength, as well as monitoring malnutrition and cachexia.¹⁰

Bioelectrical impedance analysis in clinical practice: Advantages and limitations

Two studies showed that BIA is comparable to gold-standard methods (CT, MRI and DEXA) in detecting sarcopenia, leading to its acceptance in European and Asian sarcopenia guidelines.^{16,30} This is particularly important when gold-standard imaging methods are not readily available

Table 1: Diagnostic methods for sarcopenia: Main advantages, limitations and common applications in oncology

Method	Main advantages	Limitations	Typical use in oncology
CT	Gold standard; high accuracy; can quantify both muscle mass and quality (fat infiltration) and also often available from staging scans	Radiation exposure; requires software and abdominal imaging not always available	Widely used in research and repurposed from routine CT scans in advanced cancer
MRI	High accuracy; no radiation and detailed tissue characterization	High cost; limited availability and time-consuming	Research settings and less common in routine oncology
DEXA	Measures total and regional muscle and fat; relatively low radiation and established cutoffs	Requires specialized equipment and cannot assess muscle quality	Clinical and research use and also common in geriatrics and metabolic studies
Ultrasound	Portable; inexpensive; no radiation and bedside use	Operator-dependent; no standardized cutoffs and limited validation in cancer	Increasingly used in research and some clinical practice
Anthropometry (MAMC, skinfolds and handgrip)	Simple; inexpensive; bedside applicability and included in the GLIM criteria	Low precision; assessor-dependent and insensitive to small changes	Screening and nutritional assessment
BIA	Non-invasive; portable; inexpensive; provides fat-free mass, muscle mass, hydration and tracks changes over time	Accuracy affected by hydration, equations, device variability and may overestimate muscle mass in cancer	Supportive care; prognosis and nutritional monitoring

BIA = bioelectrical impedance analysis; CT = computed tomography; DEXA = dual-energy X-ray absorptiometry; GLIM = Global Leadership Initiative on Malnutrition; MAMC = mid-arm muscle circumference; MRI = magnetic resonance imaging.

or clinically indicated.³¹ The key advantages of BIA include its clinical value in preoperative risk assessment, reduction in postoperative complications and its role as a prognostic indicator in patients with cancer.

However, the accuracy of BIA is limited by factors such as a variation in intracellular fluid volume, age, ethnicity, hydration status, medical condition, comorbidities, recent food intake and exercise.³² Notably, BIA may overestimate muscle mass and underestimate fat mass.

Choosing the right method

The selection of appropriate tests and tools for assessing muscle mass should depend on various factors, such as patient's health status, mobility, availability of suitable equipment and the specific purpose of the assessment, whether for screening or follow-up evaluation.¹⁹ While radiological methods remain the preferred choice for assessing muscle mass due to their accuracy, BIA offers a cost-effective and practical alternative, particularly in settings where advanced imaging is not feasible.¹⁸

Muscle mass and treatment outcomes in lung cancer

A higher risk of chemotherapy-related toxicities, such as low blood cell counts and other dose-limiting toxicities, is linked to sarcopenia, a condition marked by a loss of muscle mass and strength. Sarcopenia can worsen treatment side effects and make it harder for patients with lung cancer receiving chemotherapy to tolerate their treatment.³³ This occurs because patients with sarcopenia often have reduced physiological reserve, making it harder for their bodies to metabolize chemotherapy drugs effectively.³⁴

Chemotherapy can worsen by accelerating muscle breakdown, slowing muscle repair, disrupting cellular energy production and directly damaging muscle tissue.³⁵ These effects lead to further muscle loss and weakness, weakening the patient's overall health and ability to cope with treatment. The combination of inflammation from cancer and chemotherapy also contributes to muscle wasting, creating a cycle where sarcopenia worsens during treatment and increasing the severity of side effects.³⁶ Table 2 summarizes key studies that have

evaluated the impact of sarcopenia and related functional measures on survival in patients with lung cancer.^{37–43}

Low muscle mass is strongly associated with a higher risk of severe blood-related toxicities and dose-limiting side effects in patients with non-small cell lung cancer (NSCLC) treated with platinum-based chemotherapy.³⁴ This suggests that patients with cachexia or sarcopenia may experience more severe side effects, leading to dose reductions or treatment delays, ultimately affecting their chances of successful treatment and overall survival (OS).

Sarcopenia is a significant concern for patients with lung cancer undergoing treatment, as it is highly associated with poor outcomes and increased treatment toxicity. Numerous studies have explored this association, highlighting the importance of monitoring and addressing muscle mass during cancer therapy.^{37–39}

In 2023, a meta-analysis of data from 867 participants showed that during an average of 5 months of chemotherapy, patients with lung cancer experienced a loss of SMM, with a standardized mean difference of 0.25. The prevalence of sarcopenia before treatment ranged from 35 to 74%, and it increased during chemotherapy, indicating the need for interventions to prevent muscle loss.³⁷

Another study recruited 200 patients with lung cancer for a series of tests before and after chemotherapy.³⁸ After chemotherapy, patients showed signs of sarcopenia, with reduced muscle mass and increased fat tissue. These changes were not fully reflected by traditional measures like BMI or weight loss but were more accurately detected through imaging techniques. Notably, patients with more severe sarcopenia tended to receive fewer chemotherapy cycles and had worse survival outcomes. Since muscle loss, weight loss and low BMI are all linked to poorer survival, early detection through imaging and proactive measures like physical exercise and improved nutrition could help prevent sarcopenia, potentially improving treatment outcomes and reducing chemotherapy-related side effects.

In 2019, a study found that during chemoradiation treatment for NSCLC, many patients experienced significant muscle loss early on, with some already showing signs of sarcopenia before starting therapy.³⁹

Table 2: Studies evaluating the impact of sarcopenia and related functional measures on survival in lung cancer^{37–43}

Author (year)	Study design/population	Method to assess sarcopenia	Key findings	Impact on survival
Jensen et al. (2023) ³⁷	Meta-analysis, 867 patients with lung cancer on chemotherapy	CT and BIA	Sarcopenia prevalence before chemo: 35–74%; increased during treatment	Sarcopenia linked with progressive muscle loss and worse survival
Nattenmüller et al. (2017) ³⁸	Prospective cohort, 200 patients with lung cancer	CT	CT detected sarcopenia more accurately than BMI	Sarcopenic patients received fewer chemo cycles and had poorer OS
Kiss et al. (2019) ³⁹	Observational study, patients with NSCLC on chemoradiation	CT	Early muscle loss during treatment	Early sarcopenia predicted poorer prognosis
Katsui et al. (2021) ⁴⁰	Retrospective, stage III NSCLC, chemoradiotherapy	CT (SMI at L3)	Low SMI correlated with poor OS	Sarcopenia independently predicted worse survival
Sánchez-Lara et al. (2012) ⁴¹	Prospective, advanced NSCLC	BIA+ nutritional parameters	Malnutrition and sarcopenia associated with poor QoL and survival	Independent prognostic factor for survival
Prete et al. (2024) ⁴²	Systematic review, 11 studies of patients with lung cancer	BIA (phase angle)	Low phase angle consistently linked with malnutrition, sarcopenia and poor performance	Lower phase angle predicted shorter survival
Bettariga et al. (2025) ⁴³	Meta-analysis, >46,000 patients with cancer (including lung)	Muscle strength and cardiorespiratory fitness	Higher strength and fitness linked with reduced mortality	Particularly strong survival benefit in lung cancer

Sarcopenia was assessed using CT, BIA, or functional parameters, with most studies demonstrating an association between reduced muscle mass or function and poorer overall survival.

BIA = bioelectrical impedance analysis; CT = computed tomography; NSCLC = non-small cell lung cancer; OS = overall survival; QoL = quality of life; SMI = skeletal muscle index.

Interestingly, while sarcopenia did not significantly correlate with survival outcomes in this group, the early drop in muscle mass highlights the importance of monitoring these changes. This suggests that interventions to manage muscle health during treatment may be necessary.

Another example is a 2021 study that showed sarcopenia negatively impacts outcomes for patients with stage III NSCLC receiving chemoradiotherapy.⁴⁰ Specifically, those with a lower SMI tended to have worse OS rates.

Sarcopenia significantly affects lung cancer treatment, influencing both patient survival and their ability to manage treatments.⁴⁰ While BIA is a helpful tool for measuring muscle mass, it has limitations when used alone. Combining it with CT scans provides a more comprehensive picture of a patient's health. Improving nutrition and exercise can boost treatment outcomes and help patients manage side effects more effectively.⁴⁰

Lung cancer survivors report significantly lower health-related quality of life (HR-QoL) than the general population due to several factors, including patient, tumour and treatment factors.⁴⁴ Weight management is a modifiable risk factor among patient factors. In cancer survivors, a low BMI has been associated with reduced survival. While this relationship may partly reflect sarcopenia and poor performance status, it is also influenced by disease progression and the increased metabolic activity of tumours. Distinguishing between treatment-induced sarcopenia and disease-related sarcopenia is important, as these mechanisms may carry different prognostic implications. Nevertheless, BMI alone does not account for muscle mass loss, making body composition – rather than just weight – an important consideration. Maintaining an optimal muscle and fat mass balance may be more relevant than BMI alone in improving outcomes.^{45,46} In a prospective study by Sanchez-Lara et al., pretreatment nutritional parameters in patients with advanced NSCLC were shown to correlate with lower HR-QoL and serve as an independent prognostic

factor.⁴¹ This highlights the importance of nutritional assessment, as it can be intervened upon to ultimately improve quality of life and survival.

There are multiple benefits of muscle mass gain in lung cancer treatment, especially when considering nutritional strategies to mitigate muscle loss and improve treatment outcomes. As seen in studies, preserving muscle mass is crucial for patients with cancer as low muscle mass is associated with increased toxicity, reduced survival and lower quality of life.^{47–49}

Personalized approaches that consider metabolic and behavioural changes during cancer treatment are essential. By understanding the unique nutritional needs of patients with cancer, more effective plans help them maintain muscle mass and recover better, improving treatment tolerance and survival chances. However, more in-depth, cancer-focused studies are needed to refine these strategies and demonstrate their effectiveness in real-world clinical settings.⁵⁰

Nutrient needs in cancer

Boosting muscle mass in patients with cancer is not just about eating more; it involves addressing the unique challenges they face with metabolism and the limitations of tools like BIA. The primary goal is to combat muscle wasting and promote muscle growth, which is challenging due to anabolic resistance, where the body struggles to build muscle even with proper nutrition.

Protein and amino acid supplementation

Protein is essential. The recommended daily intake for patients with cancer is typically 1.0–1.5 g of protein per kilogram of body weight. High-quality proteins rich in essential amino acids, particularly leucine, are crucial. Leucine activates pathways that promote muscle building, and supplementing with 2–4 g/day can make a significant difference.⁴⁷

Energy intake

Caloric intake is also important. Patients with cancer often have higher energy needs, so ensuring they consume enough calories (typically 25–30 kcal per kg of body weight) is vital. This prevents energy deficits, which can exacerbate muscle loss. Adequate caloric intake allows the body to use protein and amino acids more effectively, supporting muscle growth.^{47,48,51}

Specific nutrients and supplements

Other supplements may also help. For example, β -Hydroxy β -Methylbutyrate (HMB; about 3 g/day) supports protein synthesis, helping the body retain muscle. Omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have anti-inflammatory effects and may help preserve muscle, especially when cancer treatments tend to break it down.⁴⁷

Multimodal approaches

Combining strategies often yields the best results. Alongside nutrition, adding exercise (such as resistance training) can make a difference – even if muscle gains are modest. The focus is on building strength and improving function, which are essential for maintaining quality of life. In some situations, pharmacological treatments — such as appetite stimulants like megestrol acetate or anabolic agents like oxandrolone — may be used to help reverse the weight loss and muscle atrophy brought on by cancer.^{52–55} In patients with cancer presenting with anorexia–cachexia syndrome, megestrol acetate has been demonstrated to increase appetite and encourage weight gain; in patients receiving chemotherapy for solid tumours, oxandrolone has shown promise in boosting lean body mass and decreasing fatigue. The goal is to use a combination of approaches to help patients not only survive but also feel stronger and healthier overall.^{52–55}

Another tool is using BIA to monitor interventions in patients with cancer. Although BIA has limitations, it can motivate patients to track muscle mass as they see their progress throughout BIA measurements.³⁴

It is important to remember that patients with cancer must be viewed holistically. Nutritional strategies should be individualized based on patient's needs, including the type and stage of cancer, diet, physical activity preferences, treatment plan and overall health status.

Challenges and limitations in bioelectrical impedance analysis in clinical practice

BIA is a popular tool for assessing muscle mass because it is non-invasive, easy to use and relatively affordable. However, it has limitations, particularly regarding accuracy and reliability in real-world settings.⁵⁶

One major challenge is the inconsistency in prediction equations used to estimate muscle mass. These equations are often designed for specific populations or devices, meaning different devices or methods can give different results.⁵⁶ For example, the same person might get a different muscle mass reading when measured with different BIA machines or equations. This lack of standardization can affect study results, leading to discrepancies in sarcopenia's prevalence even within the same population. Thus, while BIA is convenient, it is not always precise, especially when comparing data from different devices or populations.⁵⁶ Standardized prediction equations, serial

measurements with the same device and BIA validation against reference techniques like CT or DEXA in the relevant population can all help to reduce this variability. To increase reliability in clinical practice, results should be interpreted in conjunction with clinical and nutritional evaluations.

Recent studies have added essential insights into the role of BIA in lung cancer prognosis. Its usefulness as a practical prognostic marker was highlighted by Prete et al., who discovered that a lower PhA was associated with worse nutritional status, a higher risk of sarcopenia and a shorter survival time.⁴² Another important factor that has been found to affect BIA results is the state of hydration. Nwosu et al. demonstrated that using BIA to monitor hydration in a palliative care setting is both practical and clinically relevant, highlighting the importance of taking fluid balance into consideration when interpreting results in patients with advanced lung cancer.⁵⁷

Additionally, functional outcomes are becoming increasingly acknowledged as prognostically significant, in addition to static body composition measurements. A large meta-analysis by Bettariga et al. demonstrated that higher muscle strength and cardiorespiratory fitness were associated with reduced all-cause and cancer-specific mortality, with powerful effects in lung cancer.⁴³ These results are consistent with BIA-derived metrics and imply that integrating functional evaluations with body composition could improve prognostic assessment and facilitate the incorporation of BIA into multidisciplinary cancer care.

While functional measures strengthen the prognostic value of BIA, its application is still constrained by several practical and methodological limitations. BIA struggles to accurately assess muscle mass in certain groups, especially critically ill patients or those with significant changes in fluid balance or body shape. For example, in severely ill patients, the assumption that fat-free mass remains consistently hydrated does not hold, leading to inaccurate readings.^{58,59} This is further complicated by the lack of widely accepted reference values for interpreting BIA results in critical care settings.⁵⁹

In patients with cancer, BIA often overestimates muscle mass due to factors like malnutrition and changes in body composition. This can lead to missed signs of malnutrition or muscle loss, as clinicians may believe that muscle mass is higher than it actually is.^{60,61} While BIA is useful, it is far from perfect, especially in patients with complex medical conditions.

Conclusion

Sarcopenia, a common side effect of chemotherapy and cancer itself in patients with lung cancer, can be managed with several strategies, including nutrition, physical exercise, vitamin supplements and tracking muscle mass with BIA. These approaches not only improve quality of life but may also boost survival rates and reduce treatment toxicity.

Despite its practical advantages, there is still limited evidence supporting the use of BIA in cancer care, and concerns remain about its accuracy and reliability, especially across different types of cancer. Although there is increasing interest in using BIA to help customize recovery and treatment plans, more robust clinical data are required before it can be incorporated into standard care.

Therefore, more research is necessary. To learn more about how BIA functions over time and whether it reflects significant changes in patient outcomes, we need carefully planned, prospective studies, ideally conducted across several centres. Standardizing the use of BIA, confirming its accuracy across cancer types and connecting

muscle alterations to the most important factors – treatment success, postoperative recovery and overall survival – should be the goals of these studies. With more proof, BIA may prove to be a valuable tool for helping patients with cancer and enhancing sarcopenia care. $\square$

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