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OPINION PAPER

Pekar et al: AI-powered CT body composition analysis

Beyond BMI: An opinion on the clinical value of AI-powered CT body composition analysis

Matej Pekar[1,2*], Marek Kantor[1], Jakub Balusik[1], Jan Hecko[1,3], and Piotr Branny[1,4]

[1]Complex Cardiovascular Center, Hospital AGEL Trinec-Podlesi, Trinec, Czech Republic;

[2]Physiology, Faculty of Medicine, Masaryk University, Brno, Czech Republic;

[3]Faculty of Electrical Engineering and Computer Science, VSB-Technical University of Ostrava, Ostrava, Czech Republic;

[4]Cardiac Surgery, Faculty of Medicine, Palacky University, Olomouc, Czech Republic.

***Correspondence to** Matej Pekar: matej.pekar@npo.agel.cz

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ABSTRACT

Body Mass Index (BMI) has long been used as a standard measure for assessing population-level health risks, but its clinical adequacy has increasingly been called into question. This opinion paper challenges the clinical adequacy of BMI and presents AI-enhanced CT body composition analysis as a superior alternative for individualized risk assessment. While BMI serves population-level screening, its inability to differentiate between tissue types leads to critical misclassifications, particularly for sarcopenic obesity. AI-powered analysis of CT imaging at the L3 vertebra level provides precise quantification of skeletal muscle index, visceral, and subcutaneous adipose tissues -metrics that consistently outperform BMI in predicting outcomes across oncology, cardiology, and critical care. Recent technological advances have transformed this approach: the "opportunistic" use of existing clinical CT scans eliminates radiation concerns, while AI automation has reduced analysis time from 15-20 minutes to mere seconds. These innovations effectively address previous implementation barriers and enable practical clinical application with minimal resource demands, creating opportunities for targeted interventions and personalized care pathways.

Keywords: Body composition; artificial intelligence; AI; computed tomography; CT; sarcopenia; visceral adipose tissue

INTRODUCTION

For decades, Body Mass Index (BMI) has served as the cornerstone of obesity assessment in clinical practice. However, as our understanding of body composition and its relationship to health outcomes has evolved, the limitations of this simple metric have become increasingly apparent [1,2]. While BMI remains valuable for population-level screening, it fails to distinguish between fat and muscle mass, leading to significant misclassification of individual risk profiles [3].

The growing prevalence of phenotypes such as sarcopenic obesity - where reduced muscle mass coexists with increased adiposity - challenges our traditional approaches to body composition assessment. In our view, this situation demands a paradigm shift in how we evaluate, categorize, and treat patients with varying body composition profiles.

Our analysis reveals compelling evidence that more sophisticated approaches to body composition assessment are not merely technical advancements but significant fundamental improvements in patient care.

METHODS

This opinion article is based on our clinical expertise in implementing AI-powered CT body composition analysis, supported by a comprehensive but non-systematic examination of the relevant literature. We searched PubMed, Scopus, and Google Scholar databases from inception through January 2025 using key terms including "body composition," "computed tomography," "artificial intelligence," "sarcopenia," "visceral adipose tissue," "BMI limitations," and combinations thereof.

We prioritized peer-reviewed articles published between 2020-2025 that demonstrated clinical applications of CT-derived body composition analysis across medical specialties, validation studies of AI segmentation tools, comparative effectiveness studies between BMI and CT metrics, and consensus statements from relevant professional societies. Seminal older studies establishing foundational concepts were also included regardless of publication date. We excluded studies focusing solely on animal models, pediatric populations (due to different reference standards), purely methodological papers without clinical applications, and studies where full text was not available in English.

Articles were selected based on their relevance to our clinical perspective and direct experience with AI-powered body composition assessment in cardiovascular patients. As an opinion article, our methodology combines expert clinical perspective with supporting literature examination rather than following formal systematic review protocols. This approach allows us to present our informed clinical opinion while providing appropriate scientific context through contemporary evidence.

The Growing Challenge of Body Composition Assessment

The landscape of obesity has changed dramatically in recent decades. We now recognize that body composition, rather than simple weight metrics, plays a crucial role in determining health outcomes [2]. Traditional anthropometric measurements, including BMI, waist circumference, and waist-to-hip ratio, while accessible and widely used, provide an oversimplified view of an individual's metabolic health and risk profile.

This aligns with the European Society for Clinical Nutrition and Metabolism (ESPEN) and European Association for the Study of Obesity (EASO) consensus statement, which emphasizes the importance of identifying sarcopenic obesity as a distinct clinical condition with bidirectional pathogenic interactions between adiposity and muscle loss [4].

Multiple recent reviews underscore that CT-derived body composition measures often outperform BMI in predicting patient outcomes. A systematic review found that CT analysis detected sarcopenia 27–67% more frequently than BMI-based screening [5]. In oncology, CT-based metrics have shown stronger prognostic value than BMI: Caan et al. reported that low muscle mass and high adiposity on CT were associated with worse survival in breast cancer patients, whereas BMI alone did not capture this risk [6].

In clinical practice, we frequently encounter patients who defy conventional categorization. Consider the paradox of metabolically healthy obesity or the hidden risks of normal-weight central adiposity. These phenotypes highlight a crucial reality: our traditional tools for assessing body composition often miss critical information that could inform better clinical decision-making. The rising prevalence of sarcopenic obesity, particularly in aging populations, further complicates this picture, as it represents a unique risk profile that traditional metrics fail to capture [7].

Advanced Imaging and Tissue Quantification

Recent technological advances have opened new possibilities for detailed body composition assessment. Computed tomography (CT) imaging, particularly at the third lumbar vertebra (L3) level, has emerged as a powerful tool for precise tissue quantification [8]. This approach enables accurate measurement of skeletal muscle index (SMI), with established cutoff values for sarcopenia being <38.9 cm²/m² for women and <55.4 cm²/m² for men [9-

11], visceral adipose tissue (VAT), and subcutaneous adipose tissue (SAT), providing unprecedented insight into body composition profiles.

It is important to define these key metrics clearly. Skeletal Muscle Index (SMI) is the cross-sectional area of skeletal muscle at L3 normalized to height squared (cm^2/m^2). Low SMI is linked to frailty, chemotherapy toxicity, surgical complications, and higher mortality. Visceral Adipose Tissue (VAT) refers to fat within the abdominal cavity surrounding organs. While both VAT cross-sectional area (cm^2) and tissue density (Hounsfield Units) are routinely measured, VAT density serves as the primary parameter for metabolic risk assessment and clinical interpretation in our analysis. Higher VAT density values indicate increased tissue fibrosis and inflammation, reflecting more pronounced metabolic dysfunction. Based on our previous research using maximization of log-rank statistics, we established gender-specific cut-off values for high-risk classification: VAT density >-93.27 HU for men and >-95.02 HU for women [2]. While VAT area measurements provide additional context, with values >100 cm^2 associated with metabolic syndrome and ≥ 160 cm^2 considered "very high" risk, the density parameter demonstrates superior prognostic value for survival prediction in TAVI patients [12]. Both VAT cross-sectional area (cm^2) and tissue density (Hounsfield Units) are measured, with density values used for metabolic risk assessment in this analysis.Subcutaneous Adipose Tissue (SAT) is fat located beneath the skin. While generally less metabolically active than VAT, extreme amounts still indicate obesity with mechanical and endocrine effects.

The power of this approach is best illustrated through real-world examples. In our clinical experience, we have encountered numerous patients that demonstrate the limitations of BMI-based assessment (Fig. 1). The first patient, with a BMI of 18.8 kg/m^2, would traditionally be classified as underweight. However, CT analysis revealed an SMI of 32.31 cm2/m2, indicating significant sarcopenia, alongside concerning patterns of fat distribution. The second patient, despite a BMI of 26.1 kg/m^2 placing them in the overweight category, demonstrated preserved muscle mass with an SMI of 61.28 cm2/m2, representing a significantly healthier body composition profile.

The Role of Artificial Intelligence

The implementation of advanced body composition analysis has historically faced significant barriers including technical complexity, specialized expertise requirements, and substantial time investments. Recent advances in artificial intelligence and deep learning have revolutionized this field, making complex tissue analysis increasingly accessible for clinical implementation.

Fully automated algorithms can now identify the relevant CT slice and segment tissues in seconds, with accuracy equivalent to expert manual analysis [13]. This dramaticallysignificantly reduces analysis time to seconds while eliminating observer variability. Manual segmentation of a single abdominal CT slice historically took 15–20 minutes of a technician's time, making large-scale use costly and time-intensive. In our experience, AI automation has substantially improved efficiency, allowing all abdomen CTs to be processed with body composition metrics automatically reported. AutoMATiCA, the validated AI segmentation framework we reference, employs a U-Net neural network architecture and was rigorously validated on 893 patients (80% training, 10% validation, 10% testing). In the testing cohort, Dice Similarity Coefficient (DSC) scores demonstrated excellent agreement between human and network-predicted segmentations, with processing speeds of approximately 350 ms per scan on modern computing hardware [8].

It's important to note that these analyses typically utilize existing CT scans obtained for other clinical indications, rather than requiring dedicated scans solely for body composition assessment. This "opportunistic" approach minimizes additional radiation exposure and costs while maximizing the clinical value of imaging studies already being performed [5,14]. The growing prevalence of CT imaging in routine clinical care—for oncologic staging, surveillance, cardiac evaluation, and other indications—provides a wealth of imaging data that can be leveraged for body composition assessment without additional patient risk or healthcare expenditure.

Clinical Applications Across Specialties

Evidence demonstrates that detailed CT-based tissue analysis proves especially valuable in several clinical contexts by improving risk stratification and guiding treatment where BMI falls short. Table 1 provides a comprehensive comparison of BMI limitations versus CT-derived metrics advantages across clinical specialties.

In oncology, patients with low skeletal muscle area on CT have significantly shorter survival and higher chemotherapy toxicity independent of BMI. Bernardi et al. found that CT-based body composition profiling improved outcomes prediction after oncologic liver surgery [15]. A meta-analysis by van Helsdingen et al. of over 16,500 cancer surgery patients showed that high visceral fat on CT more than doubled the odds of postoperative complications [16].

In cardiology, CT-derived metrics have refined risk assessment in ways BMI cannot. In our own research, Pekař et al. demonstrated in transcatheter aortic valve implantation (TAVI) patients that CT-derived metrics predicted higher all-cause mortality, even though the average BMI was in the "overweight" range [2]. BMI alone was misleading due to an obesity paradox in this elderly cohort, but CT measures identified frail patients at high risk who would otherwise appear "healthy" by BMI.

In surgery and critical care, we advocate for CT body composition analysis to provide granularity for risk stratification. CT-measured visceral fat correlates with hospitalization risk in COVID-19 patients, while BMI shows no such clear relationship [17]. CT analysis reveals that muscle adiposity and visceral fat distribution provide crucial prognostic information independent of BMI. In critical illness, decreased muscle mass on imaging is associated with poorer outcomes, potentially identifying patients who might benefit from earlier physiotherapy or nutrition support.

A recent study by Chen et al. further demonstrated the clinical utility of CT-derived body composition metrics in acute pancreatitis patients, where skeletal muscle index changes and pre-treatment skeletal muscle radiodensity were used to develop a metabolic score that accurately predicted disease severity with AUCs of 0.764 and 0.741 in different patient populations [18]. This study exemplifies how CT body composition analysis can provide superior prognostic information compared to traditional clinical indicators across diverse acute care settings.

In clinical nutrition and frailty management, CT analysis helps target therapy to those who truly need it. Martin et al. implemented CT skeletal muscle assessments in clinical practice, finding that 63–71% of normal-BMI hospitalized patients actually had muscle depletion detected on CT, leading to adjusted protein/calorie provision [13]. Through early identification of sarcopenic obesity, clinicians can now intervene before significant functional decline occurs, potentially altering disease trajectories. This enhanced diagnostic capability enables more precise risk stratification across various health outcomes, significantly changing how we approach patient care. The technology's ability to precisely measure body composition changes also transforms how we design and monitor interventions, allowing for more targeted nutritional and exercise programs.

Comparison with Alternative Methods

It is important to acknowledge the spectrum of body composition assessment methods available, each with their own advantages and limitations. Anthropometry (BMI, circumferences, skinfolds) is simple, inexpensive, and widely available, but lacks precision for individual assessment and cannot distinguish fat from lean mass or assess fat distribution [3]. Bioelectrical Impedance Analysis (BIA) is portable, non-invasive, and provides quick results, but can be significantly affected by hydration status and electrolyte balance, making it unreliable in patients with fluid imbalances [19]. According to Ackermans et al. (2022), bioelectrical impedance analysis (BIA), while relatively cheap and widely available, shows reduced accuracy in obese and cachectic patients due to the disproportion of body mass and conductivity. This limitation is particularly relevant for patients with sarcopenic obesity, where CT-based measurements provide superior assessment of both muscle quantity and quality [20]. Dual-Energy X-ray Absorptiometry (DEXA) is considered a reference technique for body composition assessment, but has limitations. Palmas et al. noted that while DEXA provides accurate tissue mass measurements, it doesn't distinguish between visceral and subcutaneous fat distribution. Their study validated that CT imaging, when analyzed with appropriate software and algorithms that consider both tissue area and density (Hounsfield Units), can provide comparable accuracy to DEXA for body composition assessment in patients with obesity [19]. CT and MRI provide the most detailed "inside look" at tissue distribution but at higher cost and complexity. They remain the gold standard for precise tissue quantification when such detail is clinically warranted [14]. CT uses ionizing radiation, raising concerns about repeated scans. However, in the context of opportunistic analysis, we believe the radiation concern is minimized since the CT is performed for a valid medical reason. Modern CT technology has also markedly reduced radiation doses through low-dose techniques and iterative reconstruction algorithms. No additional radiation exposure occurs beyond that of the clinically indicated scan, and if a CT were ever done primarily for body composition analysis, it could be performed at a low dose focused on the L3 region.

This context helps explain why BMI remains in use (largely due to simplicity and established reference ranges) while highlighting where advanced imaging offers substantial clinical advantages. Bazzocchi et al. emphasized that while CT/MRI are highly accurate, their use has been limited by cost and availability, but automation and increased imaging frequency are overcoming those barriers [14].

Implementation Considerations

Challenges and Solutions

The implementation of CT-derived body composition analysis faces several interconnected challenges that require practical solutions. Radiation exposure concerns naturally arise when discussing CT-based assessments. However, in the context of opportunistic analysis, this concern is substantially minimized since the CT is performed for a valid medical reason, with modern technology significantly reducing radiation doses through low-dose techniques and iterative reconstruction algorithms [5]. While radiation exposure is often cited as a limitation of CT-based assessment, Ackermans et al. (2022) highlight that 'opportunistic' use of existing CT scans is a practical approach to mitigate this concern, allowing muscle analysis without additional radiation exposure to the patient [20]. No additional radiation exposure occurs beyond that of the clinically indicated scan.

Cost and accessibility represent another significant challenge. While CT scanners are expensive to operate, we have found that AI-powered analysis dramatically improves accessibility by automating measurements that previously required dedicated specialists [14]. The incremental cost to derive body composition from an existing CT is minimal with automation, especially when compared to the potential clinical value of identifying high-risk individuals. This transforms the cost-benefit equation by adding significant diagnostic value to imaging studies already being performed.

Implementation into existing workflows presents practical obstacles that cannot be overlooked. Martin et al. [13] found that when introducing CT muscle measurement in clinical nutrition practice, the main barriers were cumbersome processes for image acquisition and integrating analysis software into existing systems. However, once established, clinicians reported that the measurements positively contributed to their nutrition care practice.

In our opinion, the most pressing need is establishing robust reference values across diverse populations and standardizing these new systems into existing clinical workflows. As artificial intelligence platforms evolve, we anticipate increasingly sophisticated risk assessments, improved accessibility through cloud-based processing, and greater integration with other imaging modalities, creating a more comprehensive approach to body composition assessment.

Acknowledge Methodological Limitations

While we advocate for the clinical adoption of CT-based body composition analysis, it is important to acknowledge several methodological considerations. Current research, though promising, remains heterogeneous in analytical approaches, making direct comparison between studies challenging. The field still lacks standardized cutoff values across diverse populations, particularly for ethnic minorities, pediatric patients, and those with specific disease states. Technical variability between different CT scanner protocols, contrast phases, and reconstruction algorithms may influence tissue attenuation values and segmentation accuracy. Implementation studies have predominantly occurred in academic medical centers with specialized expertise, potentially limiting generalizability to community settings. Additionally, while AI automation has dramatically improved efficiency, the "black box" nature of some algorithms raises questions about interpretability and regulatory oversight. Longitudinal validation studies examining how these metrics change over time and with interventions remain limited. Transparent acknowledgment of these limitations, rather than diminishing the approach's value, highlights opportunities for methodological refinement and demonstrates the need for continued research to establish this promising technology as a clinical standard.

Practical Implementation Strategy

For institutions seeking to implement AI-powered CT body composition analysis, our recent experience with a web-based interface for TAVI patient assessment offers valuable insights. We developed a user-friendly system that integrates AutoMATiCA's validated AI segmentation capabilities [8] with an intuitive clinical interface, reducing analysis time to approximately 21 seconds from image upload to results display.

The ESPEN-EASO diagnostic algorithm recommends a two-stage approach: first screening high-risk individuals using BMI or waist circumference plus clinical risk factors, followed by comprehensive assessment of muscle function and body composition, which aligns with our proposed AI-powered workflow [4].

The implementation operates on standard hospital infrastructure, requiring minimal technical expertise from clinicians while providing comprehensive visualization of body composition metrics including SMI, VAT, and SAT. User experience validation with clinicians from multiple specialties confirmed that the most valued features were clear visual representation of obesity and sarcopenia metrics and immediate access to clinical implications.

Our case studies demonstrated the system's ability to identify critical conditions such as sarcopenic obesity that would be missed by BMI assessment alone, providing compelling evidence for clinical adoption (Fig. 1). The key to successful implementation lies not in technical sophistication but in seamless workflow integration that transforms complex analytical capabilities into actionable insights without disrupting established clinical processes.

We recommend a staged implementation approach for institutions interested in adopting this technology. Institutions should begin with opportunistic analysis of existing CT scans for highest-risk patient groups where the clinical impact would be most immediate. Next, they should establish local reference values based on their specific patient populations to ensure appropriate contextual interpretation. Integration of reporting into standard radiology workflows is essential for sustainability, followed by development of clinical decision pathways that incorporate body composition metrics. Finally, providing targeted education to clinicians on interpretation and clinical applications will ensure optimal utilization of these new metrics in daily practice.

Future Directions

We anticipate several promising developments in CT-based body composition analysis that will further enhance its clinical utility. Incorporation of artificial intelligence beyond simple segmentation toward predictive modeling represents a significant frontier. By integrating body composition metrics with other clinical variables (laboratory values, functional assessments, comorbidities), machine learning algorithms could generate personalized risk profiles and treatment recommendations. We expect continued refinement of population-specific reference values across ethnic groups, age ranges, and disease states, addressing a critical gap in current implementation. Multi-center validation studies and consensus initiatives led by professional societies will likely establish standardized reporting frameworks and integration pathways. Additionally, the development of cloud-based processing platforms could democratize access to these advanced analytics, making them available even in resource-limited settings. Future research should focus on demonstrating how these imaging biomarkers can guide personalized interventions that meaningfully improve clinical outcomes, moving beyond risk stratification to directly inform therapeutic decisions across medical specialties.

CONCLUSION

While BMI remains valuable for population-level screening, evidence increasingly suggests that optimal individual patient care demands more sophisticated analysis than BMI alone can provide. The evidence reviewed in this paper demonstrates that CT-based metrics often outperform BMI in predicting important clinical outcomes across multiple specialties, from oncology to cardiology and critical care.

The opportunistic approach of extracting body composition data from clinically indicated CT scans addresses both radiation exposure and cost concerns. By leveraging AI automation, what was once a labor-intensive process requiring specialized expertise has become increasingly accessible for routine clinical implementation.

In our opinion, the future of body composition assessment lies in embracing these more sophisticated approaches that recognize the limitations of traditional anthropometrics. As we work to standardize these techniques and integrate them into clinical workflows, we move closer to our goal of providing truly personalized patient care based on objective, detailed understanding of individual body composition. This shift represents not merely a technical advancement but a significant improvement in how we assess, stratify, and treat patients across the spectrum of medical specialties.

Declaration of generative AI in scientific writing

During the preparation of this work the authors used Claude 3.7 Sonnet in order to assist with the writing process. After using this tool, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Conflicts of interest: Authors declare no conflicts of interest.

Ethical Statement: This opinion paper includes de-identified patient CT images and body composition data (Figure 1) from cases that received ethical approval from the Ethics Committee of Hospital AGEL Trinec-Podlesi (approval number: EK 301/22). No patient-identifiable data is included in the presented examples.

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REFERENCES

1. Pekař M, Pekařová A, Bužga M, Holéczy P, Soltes M. The risk of sarcopenia 24 months after bariatric surgery - assessment by dual energy X-ray absorptiometry (DEXA): a prospective study. Wideochir Inne Tech Maloinwazyjne. 2020 Dec;15(4):583-587. doi: 10.5114/wiitm.2020.93463.
2. Pekař M, Jiravský O, Novák J, Branny P, Balušík J, Daniš D, et al. Sarcopenia and adipose tissue evaluation by artificial intelligence predicts the overall survival after TAVI. Sci Rep. 2024 Apr 17;14(1):8842. doi: 10.1038/s41598-024-59134-z. Erratum in: Sci Rep. 2024 May 10;14(1):10749. doi: 10.1038/s41598-024-61601-6.
3. Khanna D, Peltzer C, Kahar P, Parmar MS. Body Mass Index (BMI): A Screening Tool Analysis. Cureus. 2022;14(2):e22119. doi: 10.7759/cureus.22119
4. Donini LM, Busetto L, Bischoff SC, Cederholm T, Ballesteros-Pomar MD, Batsis JA, et al. Definition and diagnostic criteria for sarcopenic obesity: ESPEN and EASO consensus statement. Clin Nutr. 2022 Apr;41(4):990-1000. doi: 10.1016/j.clnu.2021.11.014
5. Elhakim T, Trinh K, Mansur A, Bridge C, Daye D. Role of Machine Learning-Based CT Body Composition in Risk Prediction and Prognostication: Current State and Future Directions. Diagnostics (Basel). 2023 Mar 3;13(5):968. doi: 10.3390/diagnostics13050968
6. Caan BJ, Cespedes Feliciano EM, Prado CM, Alexeeff S, Kroenke CH, Bradshaw P, et al. Association of muscle and adiposity measured by computed tomography with survival in patients with non-metastatic breast cancer. JAMA Oncol. 2018;4(6):798–804. doi: 10.1001/jamaoncol.2018.0137
7. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ. 2005 Aug 30;173(5):489-95. doi: 10.1503/cmaj.050051.
8. Paris MT, Tandon P, Heyland DK, Furberg H, Premji T, Low G et al. Automated body composition analysis of clinically acquired computed tomography scans using neural networks. Clin Nutr. 2020 Oct;39(10):3049-3055. doi: 10.1016/j.clnu.2020.01.008.
9. Tokuda T, Yamamoto M, Kagase A, Koyama Y, Otsuka T, Tada N, et al. Importance of combined assessment of skeletal muscle mass and density by computed tomography in predicting clinical outcomes after transcatheter aortic valve replacement. Int J Cardiovasc Imaging. 2020 May;36(5):929-938. doi: 10.1007/s10554-020-01776-x. Epub 2020 Feb 10. PMID: 32040683.
10. Mok M, Allende R, Leipsic J, Altisent OA, Del Trigo M, Campelo-Parada F, et al. Prognostic Value of Fat Mass and Skeletal Muscle Mass Determined by Computed

Tomography in Patients Who Underwent Transcatheter Aortic Valve Implantation. Am J Cardiol. 2016 Mar 1;117(5):828-33. doi: 10.1016/j.amjcard.2015.12.015.
11. Heidari B, Al-Hijji MA, Moynagh MR, Takahashi N, Welle G, Eleid M, et al. Transcatheter aortic valve replacement outcomes in patients with sarcopaenia. EuroIntervention. 2019 Oct 20;15(8):671-677. doi: 10.4244/EIJ-D-19-00110.
12. Saad RK, Ghezzawi M, Horanieh R, Khamis AM, Saunders KH, Batsis JA, et al. Abdominal Visceral Adipose Tissue and All-Cause Mortality: A Systematic Review. Front Endocrinol (Lausanne). 2022 Aug 22;13:922931. doi: 10.3389/fendo.2022.922931.
13. Martin L, Tom M, Basualdo-Hammond C, Baracos VE, Gramlich L. Explanatory sequential mixed-methods approach to understand how registered dietitians implemented computed tomography skeletal muscle assessments in clinical practice. Nutr Clin Pract. 2024;39(2):409–425. doi: 10.1002/ncp.11093
14. Bazzocchi A, Gazzotti S, Santarpia L, Madeddu C, Petroni ML, Aparisi Gómez MP. Editorial: Importance of body composition analysis in clinical nutrition. Front Nutr. 2023;9:1080636. doi: 10.3389/fnut.2022.1080636
15. Bernardi L, Roesel R, Vagelli F, Majno-Hurst P, Cristaudi A. Imaging-based body composition profiling and outcomes after oncologic liver surgery: A systematic review. Front Oncol. 2022;12:1007771. doi: 10.3389/fonc.2022.1007771
16. van Helsdingen CPM, van Wijlick JGA, de Vries R, Bouvy ND, Leeflang MMG, Hemke R, et al. Association of computed tomography–derived body composition and complications after colorectal cancer surgery: A systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2024;15(6):2234–2269. doi: 10.1002/jcsm.13580
17. Chandarana H, Pisuchpen N, Krieger R, Dane B, Mikheev A, Feng Y, et al. Association of body composition parameters measured on CT with risk of hospitalization in patients with COVID-19. Eur J Radiol. 2021;145:110031. doi: 10.1016/j.ejrad.2021.110031
18. Chen SJ, Wang SL, Chen CS, Xie Y, Lin YY, Chen CR, Hu JX. Metabolic score tool for personalized acute pancreatitis prognosis: A multicenter analysis. Biomol Biomed. 2024 Mar 19;24(4):1004-1015. doi: 10.17305/bb.2024.10222.
19. Saunders MJ, Blevins JE, Broeder CE. Effects of hydration changes on bioelectrical impedance in endurance trained individuals. Med Sci Sports Exerc. 1998 Jun;30(6):885-92. doi: 10.1097/00005768-199806000-00017.
20. Ackermans LLGC, Rabou J, Basrai M, Schweinlin A, Bischoff SC, Cussenot O, et al. Screening, diagnosis and monitoring of sarcopenia: When to use which tool? Clin Nutr ESPEN. 2022 Apr;48:36-44. doi: 10.1016/j.clnesp.2022.01.027

TABLES AND FIGURES WITH LEGENDS

Table 1. Comparison of BMI and CT-Derived Body Composition Metrics Across Clinical Specialties

Clinical Domain	BMI Assessment Limitations	CT-Derived Metrics Advantages	Key Study Findings	Clinical Implications
General Assessment	• Cannot distinguish between fat and muscle mass • No indication of fat distribution • Misclassifies muscular individuals as overweight	• Precise tissue quantification (SMI, VAT, SAT) • Distinction between different tissue types • Detailed fat distribution assessment	• Systematic review found CT analysis detected sarcopenia 27-67% more frequently than BMI-based screening (Elhakim et al., 2023 [5])	• Improved phenotyping • Better risk stratification • More targeted interventions
Oncology	• Poor predictor of treatment toxicity • Limited prognostic value • Cannot identify sarcopenic obesity	• Identifies low muscle mass despite normal BMI • Quantifies metabolically active visceral fat • Predicts chemotherapy toxicity and surgical complications	• CT-derived metrics showed stronger prognostic value than BMI in breast cancer patients (Caan et al., 2018 [6]) • CT-based profiling improved outcomes prediction after oncologic liver surgery (Bernardi et al., 2022 [15])	• Better patient selection for therapy • Optimized chemotherapy dosing • Enhanced surgical risk assessment
Cardiology	• "Obesity paradox" confounds risk assessment • Unable to identify frail patients with normal BMI	• Identifies high-risk patients with sarcopenia • Detects visceral adiposity associated with cardiovascular risk	• CT-derived metrics predicted higher all-cause mortality in TAVI patients even when BMI was in "overweight" range (Pekař et al., 2024 [2])	• Refined risk stratification • Better patient selection for procedures • Improved post-procedural care planning
Surgery & Critical Care	• Poor predictor of post-surgical complications • Limited value in critical illness	• Predicts functional recovery • Identifies patients at risk for prolonged ventilation • Determines nutritional needs	• High visceral fat on CT more than doubled odds of postoperative complications in cancer surgery patients (van Helsdingen et al., 2024 [16]) • CT-measured visceral fat correlated with hospitalization risk in COVID-19 patients (Chandarana et al., 2021 [17])	• Tailored perioperative care • Targeted nutritional support • Enhanced rehabilitation planning
Clinical Nutrition & Frailty	• Cannot detect sarcopenic obesity • Misses muscle depletion in normal-weight patients	• Detects sarcopenia regardless of weight • Quantifies muscle quality (density) • Measures specific tissue compartments	• 63-71% of normal-BMI hospitalized patients had muscle depletion detected on CT (Martin et al., 2024 [13])	• Personalized nutrition plans • Early intervention for sarcopenia • Targeted protein supplementation

Abbreviations: SMI = Skeletal Muscle Index; VAT = Visceral Adipose Tissue; SAT = Subcutaneous

Adipose Tissue; TAVI = Transcatheter Aortic Valve Implantation

Table 1 Footnotes: Statistical measures from cited studies:

[5] Elhakim et al. (2023): Review found CT body composition detects sarcopenia at a rate 27.3–66.7% higher compared to BMI-based detection methods across multiple clinical populations.

[6] Caan et al. (2018): In 3,241 nonmetastatic breast cancer patients, sarcopenia was associated with 41% increased mortality risk (HR = 1.41; 95% CI: 1.18-1.69), while high total adiposity increased mortality risk by 35% (HR = 1.35; 95% CI: 1.08-1.69). BMI alone was not significantly related to overall mortality.

[15] Bernardi et al. (2022): Comprehensive review of 33 studies (16,537 patients) confirmed CT body composition profiling as an established prognostic factor in hepatocellular carcinoma, with sarcopenia consistently associated with worse short- and long-term outcomes after liver surgery across multiple tumor types.

[2] Pekař et al. (2024): In 866 TAVI patients, AI-assisted CT analysis showed skeletal muscle index (SMI HR = 0.986; 95% CI: 0.975-0.996), visceral adipose tissue density (VAT density HR = 1.015; 95% CI: 1.002-1.028) and subcutaneous adipose tissue density SAT 1.014 (1.004–1.023), all $p < 0.05$ significantly predicted all-cause mortality.

[16] van Helsdingen et al. (2024): Meta-analysis of colorectal cancer surgery patients revealed high visceral fat significantly increased risk of overall postoperative complications (OR = 2.52; 95% CI: 1.58-4.00, P < 0.0001) and anastomotic leakage (OR = 1.76; 95% CI: 1.17-2.65, P = 0.006).

[17] Chandarana et al. (2021): In COVID-19 patients, CT body composition analysis improved hospitalization risk prediction: clinical model alone (AUC = 0.70), clinical + visceral adiposity (AUC = 0.73), and optimal model including muscle adiposity measures (AUC = 0.83).

[13] Martin et al. (2024): Clinical implementation study showed registered dietitians using CT skeletal muscle assessments identified muscle depletion in 63% of men (45/72) and 71% of women (17/24), with 94% of assessments completed in <15 minutes.

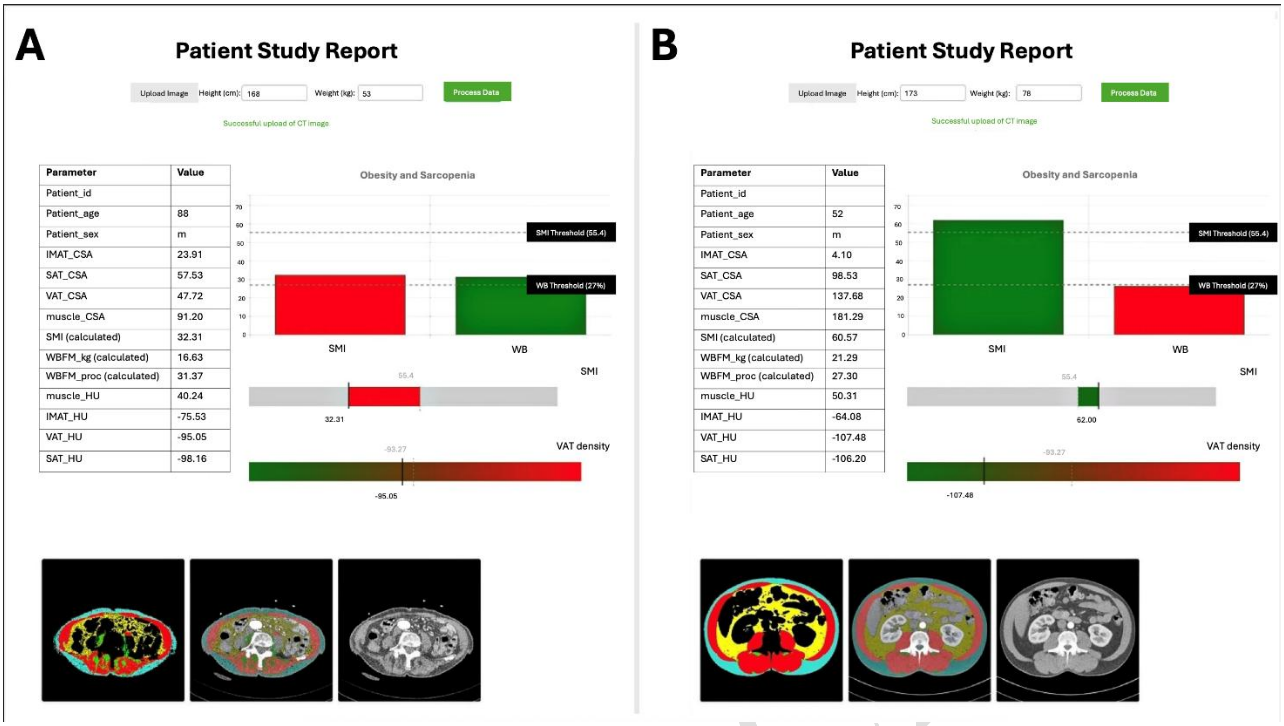

Figure 1. Contrasting Body Composition Phenotypes Revealed Through CT Analysis.
Panel A shows CT-derived body composition analysis of a patient with low BMI (18.8 kg/m²) but significant sarcopenia. The analysis reveals reduced skeletal muscle index (SMI 32.31), low muscle cross-sectional area (muscle_CSA 91.20), and elevated VAT density (-95.05). Color-coded CT segmentation displays muscle (red), visceral adipose tissue (yellow), and subcutaneous adipose tissue (blue) distribution, demonstrating the limitations of BMI-based assessment. Despite appearing "underweight" by BMI standards, this patient's low muscle mass and unfavorable fat distribution indicate significant metabolic risk.

Panel B demonstrates CT analysis of a patient with higher BMI (26.1 kg/m²) but preserved muscle mass. The analysis shows healthy skeletal muscle index (SMI 61.28), adequate muscle cross-sectional area (muscle_CSA 181.29), and lower VAT density (-107.48). The color-coded segmentation illustrates a more favorable distribution of muscle and adipose tissue compartments. This example highlights how patients classified as "overweight" by BMI may actually possess more favorable body composition profiles with lower metabolic risk.

These cases were selected from our clinical database as representative examples illustrating contrasting body composition phenotypes that demonstrate the limitations of BMI-based assessment. Both patients underwent clinically indicated CT imaging as part of their routine care.