

AI in cancer imaging: Body composition as a predictor of clinical outcome

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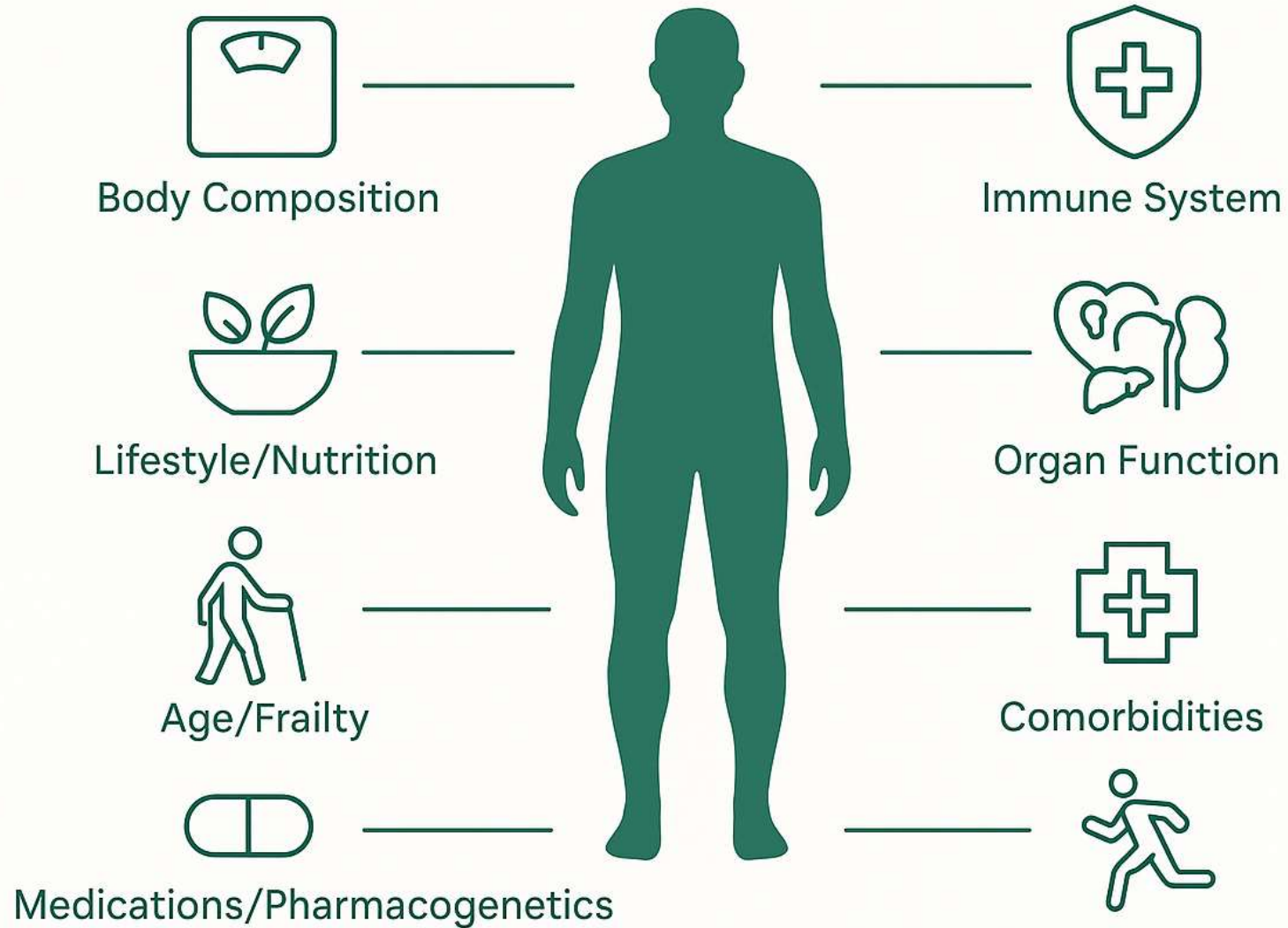


SHIP





Patient Factors

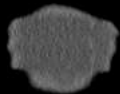








Quantitative Imaging

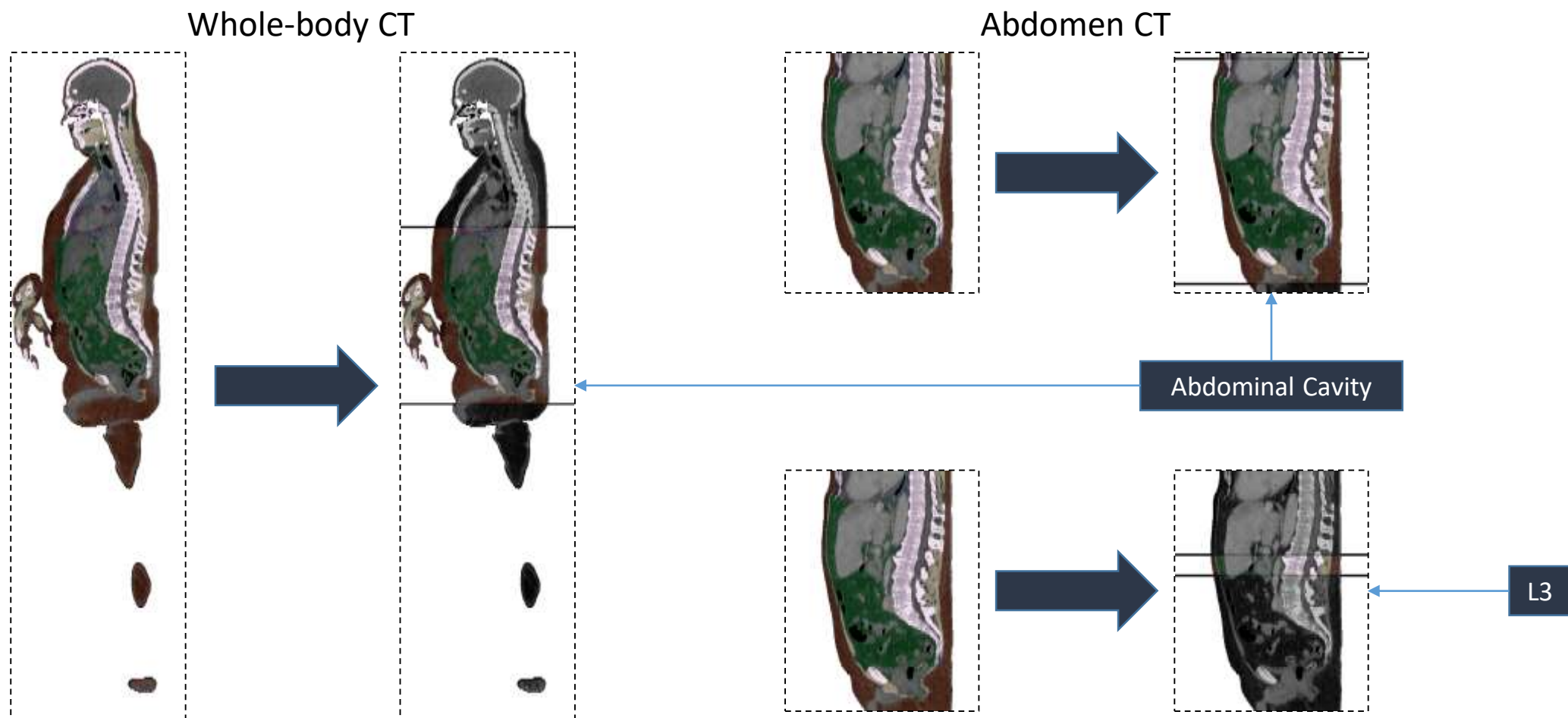


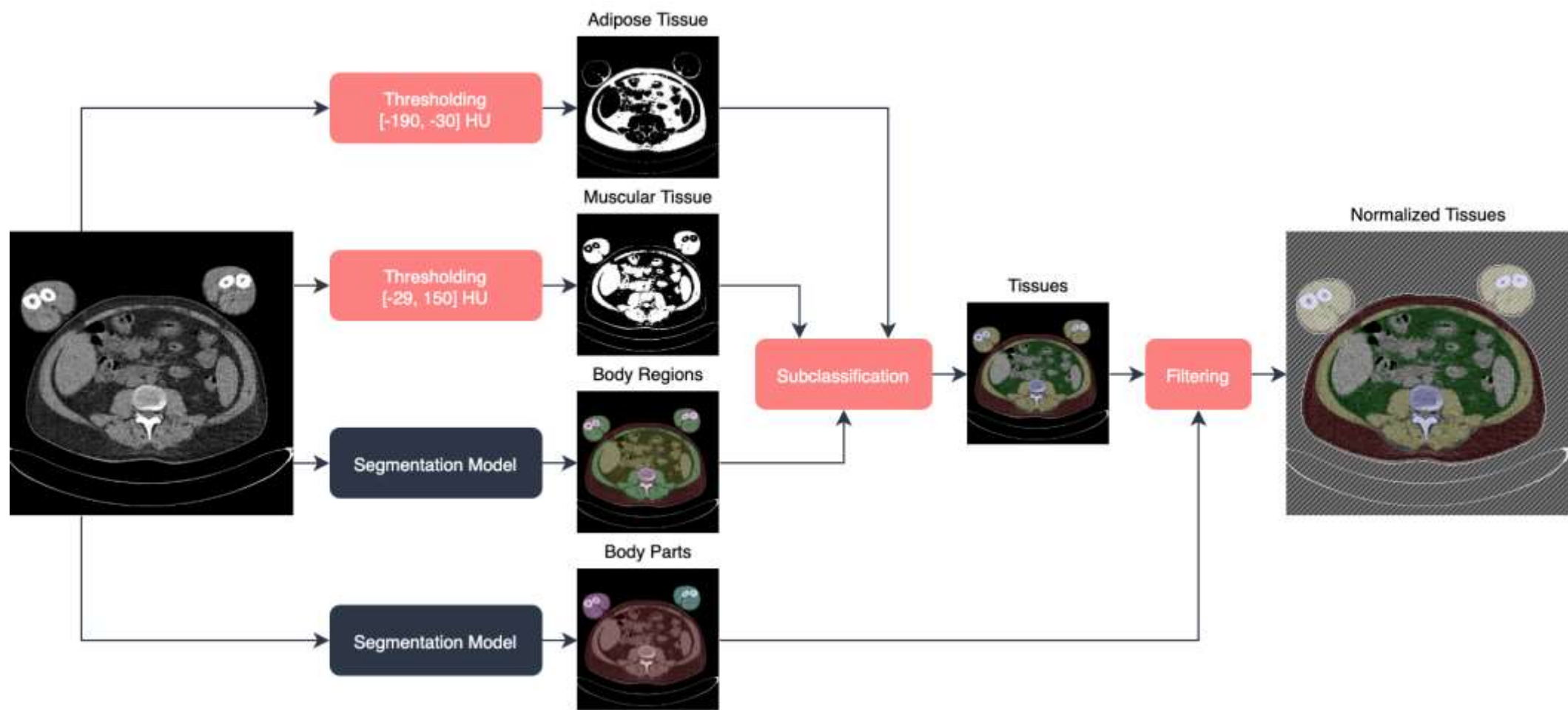


Body and Organ Analysis - BOA



<https://github.com/UMEssen/Body-and-Organ-Analysis>



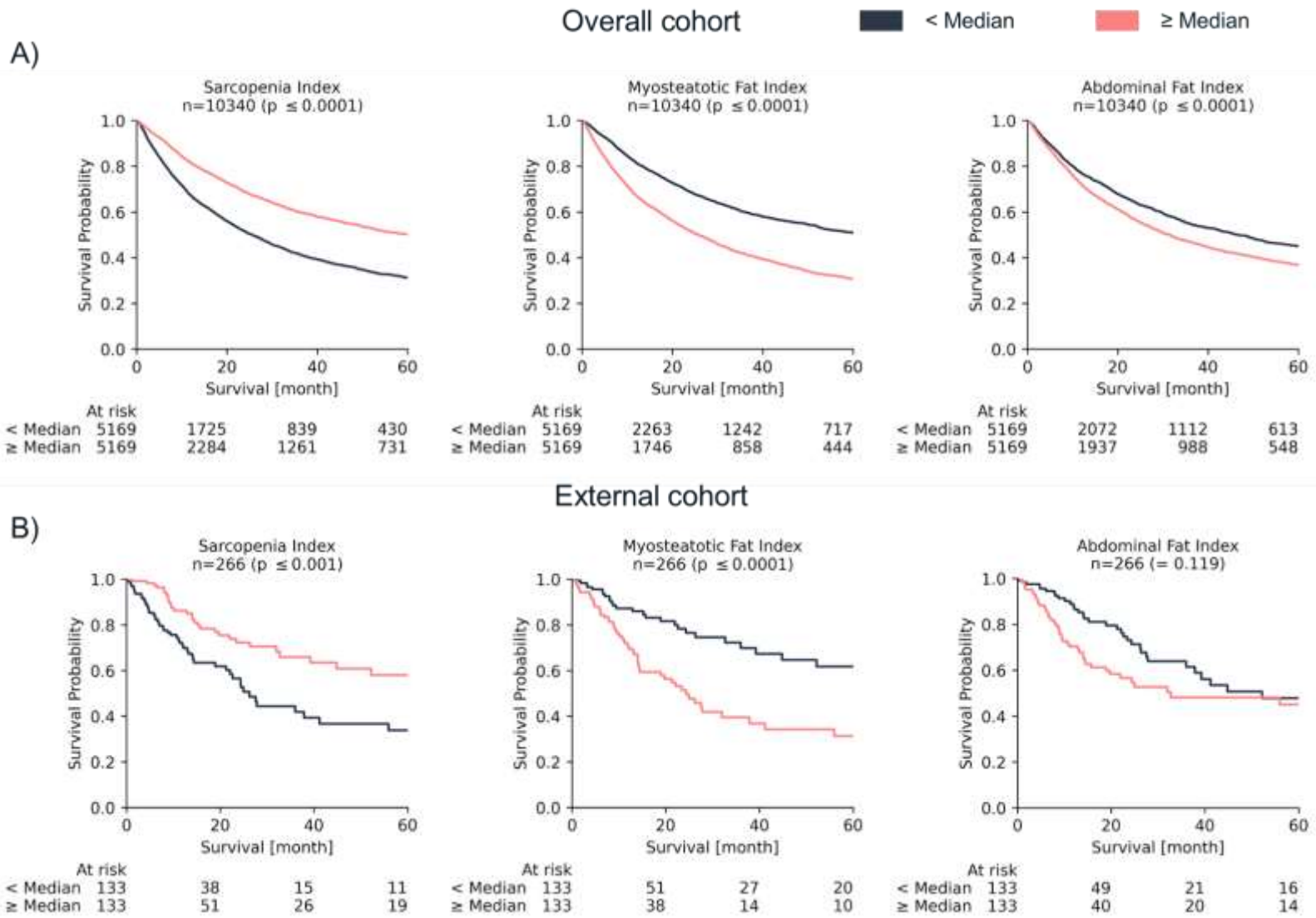




Survival



Pan-Cancer BCA Biomarker

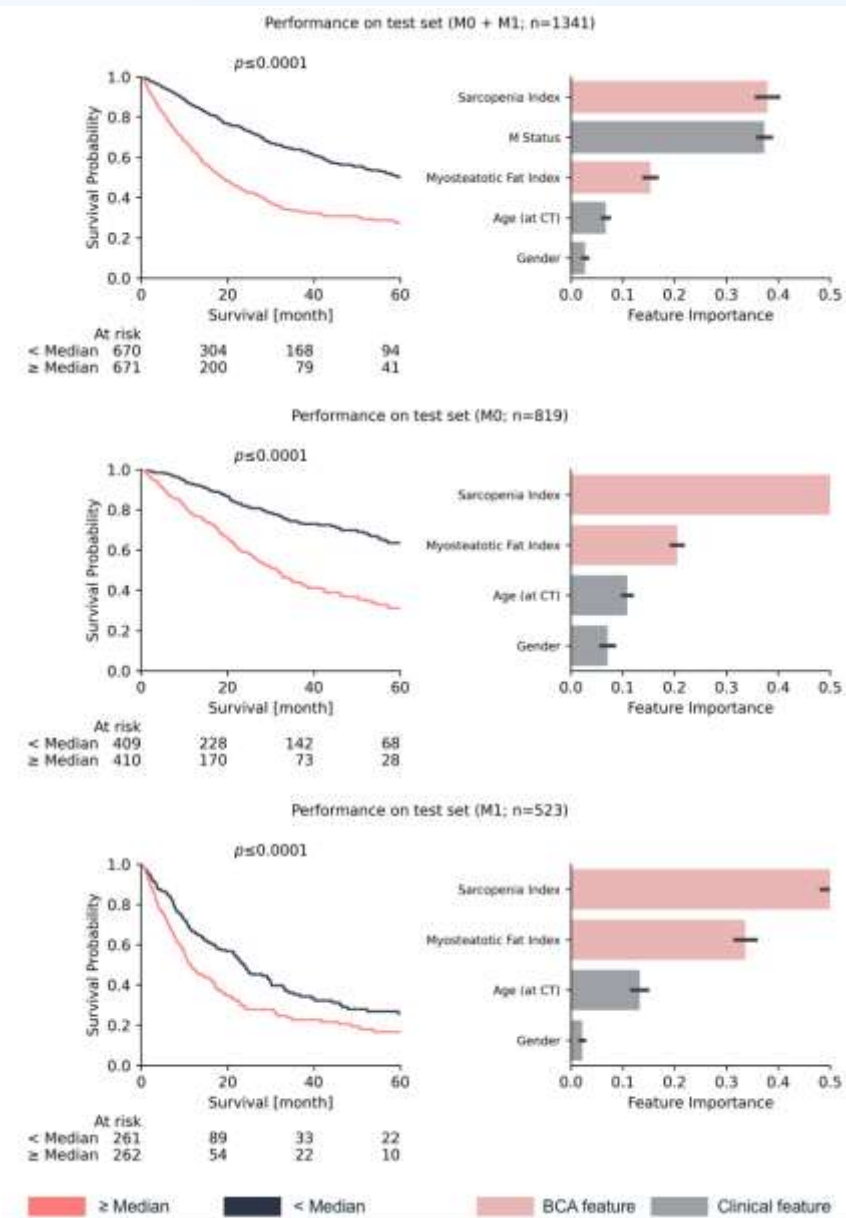


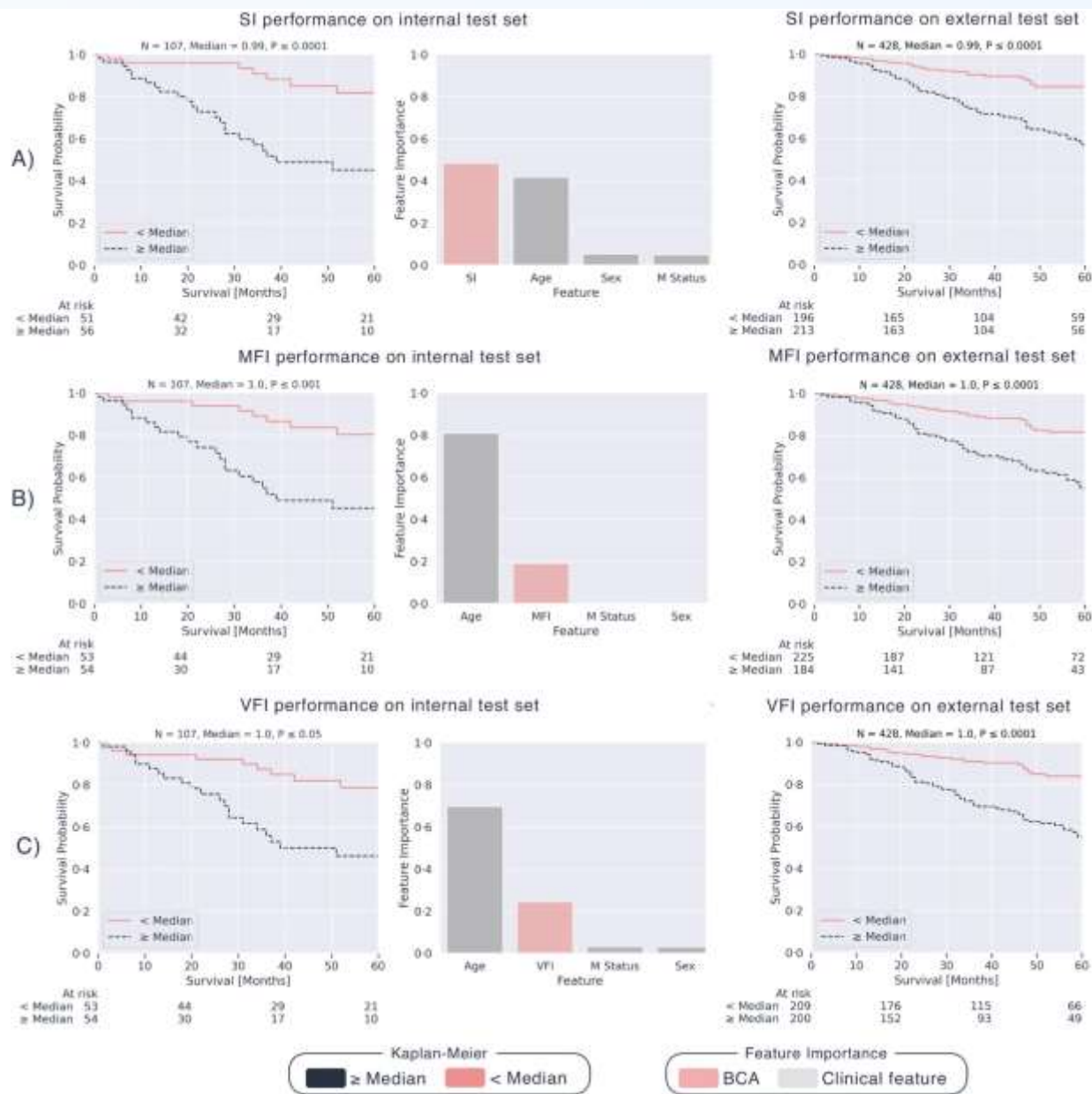
10340 patients with
the initial diagnosis
of a solid
malignancy



Pan-Cancer BCA Biomarker

Sarcopenia is more important than M Status (M0 vs. M1)





Multivariate machine learning results for internal and external abdomen CTs: Kaplan-Meier curves on the internal (left and middle column) and external (right column) abdomen CTs for the SI (A), MFI (B), and VFI (C) using the predicted risk scores of the multivariable abdomen-based BCA models trained and tested on patients with known M status (M0 + M1). Also, the averaged feature importance is shown for each model.

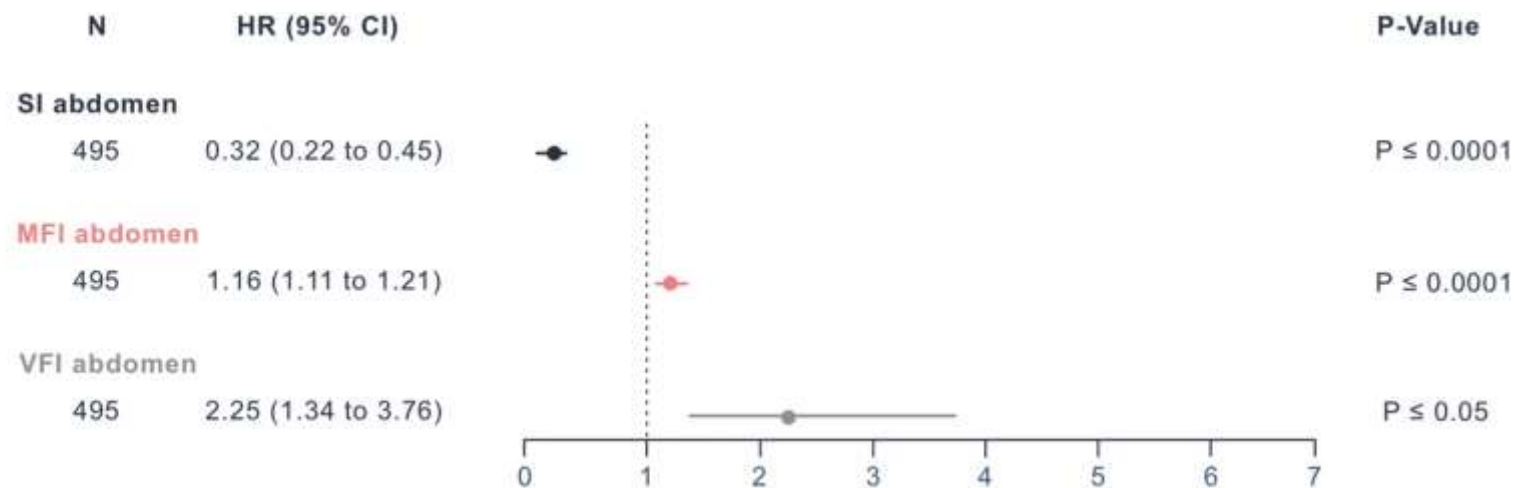
SI Sarcopenia Index
MFI Myosteatosis Fat Index
VFI Visceral Fat Index

Fully volumetric body composition analysis for prognostic overall survival stratification in melanoma patients.

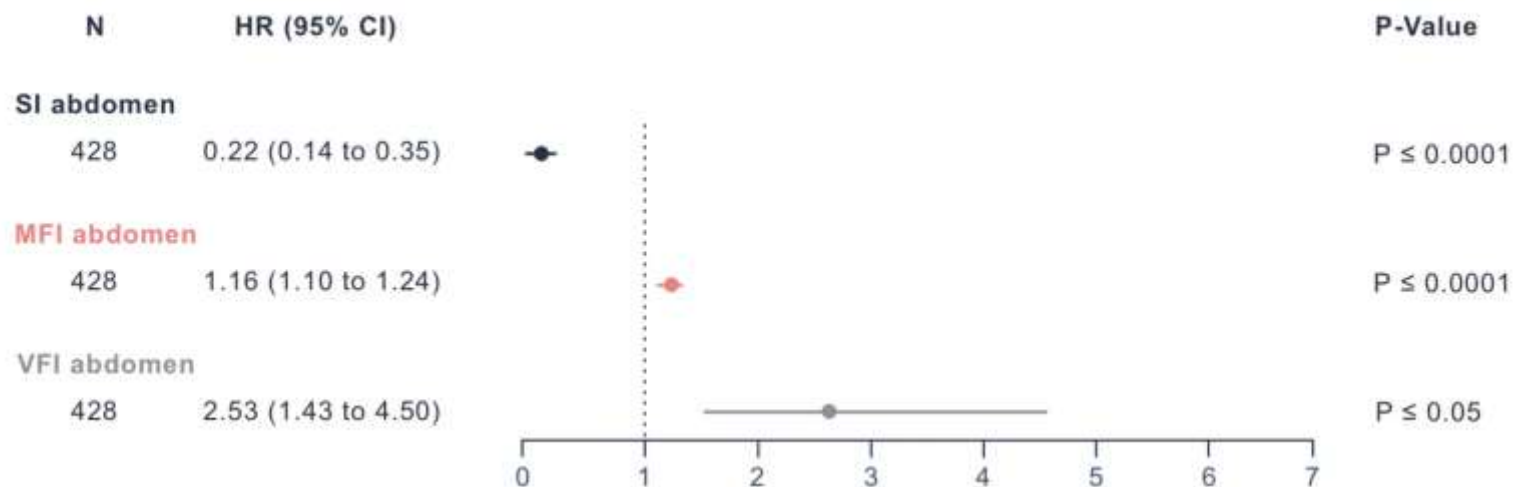
Borys K, Lodde G, Livingstone E, Weishaupt C, Römer C, Künnemann MD, Helfen A, Zimmer L, Galetzka W, Haubold J, Friedrich CM, Umutlu L, Heindel W, Schadendorf D, Hosch R, Nensa F. J Transl Med. 2025 May 12;23(1):532. doi: 10.1186/s12967-025-06507-1.



A)



B)



Multivariate Cox regression for internal and external abdomen CT scans: Multivariate Cox regression results obtained from the internal (A) and external (B) cohort's abdominal CT scans showing P-Values, HRs, and 95% CIs for the SI, MFI, and VFI. *HR* Hazard Ratio, *CI* Confidence Interval, *SI* Sarcopenia Index, *MFI* Myosteatos Fat Index, *VFI* Visceral Fat Index

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Toxicity



Body Composition & Chemotherapy Toxicity

- Across 48 studies (n=4,803), low skeletal muscle mass (LSMM) doubled the odds of severe treatment-related toxicity overall: OR 2.19 (95% CI 1.78–2.68). Strongest for tyrosine kinase inhibitors (OR 3.08), also seen in curative (OR 2.48) and palliative (OR 2.06) settings; weaker for checkpoint inhibitors (OR 1.30, NS). [1]
- Metastatic breast cancer on first-line taxanes: sarcopenia → Grade 3–4 toxicity 57% vs 18% and more hospitalizations 39% vs 0%. [2]
- Capecitabine-treated metastatic breast cancer: sarcopenia → toxicity after cycle 1 in 50% vs 20% and shorter time-to-progression (101 vs 173 days). [3]
- Systematic review/meta-analysis confirms predictive value of LSMM for anti-cancer drug toxicity across tumor types. [4]

[1] Surov A. et al. Clin Nutr. 2021;40(10):5298–5310.

[2] Shachar SS. et al. Clin Cancer Res. 2017;23(3):658–665.

[3] Prado CM. et al. Clin Cancer Res. 2009;15(8):2920–2926.

[4] Huiskamp LFJ. et al. J Clin Med. 2020;9(11):3780.



Therapy response



- Meta-analysis (35 studies; n=3,858): LSMM predicted lower objective response rate (ORR) overall (OR 0.70; 95% CI 0.54–0.91) and lower disease control rate (DCR) (OR 0.69; 95% CI 0.50–0.95). In curative (adjuvant/neoadjuvant) chemotherapy: ORR OR 0.24; in palliative chemo/TKIs: no association; in immunotherapy: LSMM predicted lower DCR (OR 0.53). [5]
- Nonmetastatic breast cancer: CT-derived sarcopenia and higher adiposity independently associated with higher mortality; BMI alone failed to identify risk. [6]
- Large cohort (n=1,395) on anthracycline/taxane: greater visceral/intramuscular adiposity → higher odds of relative dose intensity (RDI) <0.85; RDI<0.85 linked to higher mortality (HR 1.30). Greater muscle mass → fewer hematologic toxic effects. [7]

[5] Surov A. et al. Eur Radiol. 2023;33(9):6426–6437.

[6] Caan BJ. et al. JAMA Oncol. 2018;4(6):798–804.

[7] Cespedes Feliciano EM. et al. JAMA Oncol. 2020;6(2):264–270.



Prehabilitation



- Esophagogastric cancer: Multimodal, personalized prehabilitation associated with higher completion of neoadjuvant chemotherapy vs control (retrospective cohort; n=92; p=0.029). [8]
- Breast cancer RCT (LEANer): Diet+exercise improved pathological complete response in the neoadjuvant subgroup (53% vs 28%; p=0.037). [9]
- Esophageal cancer (prospective non-randomized): Exercise prehabilitation during neoadjuvant chemotherapy increased tumor regression (Mandard TRG 1–3: 75% vs 36.8%; adjusted OR 6.57, 95% CI 1.52–28.30). [10]

Selected references:

[8] Christodoulidis G et al. Personalized Prehabilitation Improves Tolerance to Chemotherapy in Oesophageal Cancer. *Curr Oncol*. 2023;30(2):1538–1545. PMID: PMC9955115.

[9] Sanft T et al. Randomized Trial of Exercise and Nutrition on Chemotherapy Completion and pCR (LEANer). *J Clin Oncol*. 2023;41(34):5285–5295. PMID: PMC10691793.

[10] Zylstra J et al. Exercise prehabilitation during neoadjuvant chemotherapy may enhance tumour regression in oesophageal cancer. *Br J Sports Med*. 2022;56(7):402–409.



Limitations

- There are no standard cut-off values for the definition auf LSMM.
- There are no standard ways to measure the body composition (L3 vs. volumetric)
- Myosteatorsis can be quantified as intramuscular adipose tissue and as muscle density.



Conclusions

- Body composition influences survival, toxicity and therapy response in various solid malignancies.
- There is a growing evidence that prehabilitation may (partially) obviate those factors.
 - A trial may fail due to unevenly distributed body composition parameters.

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