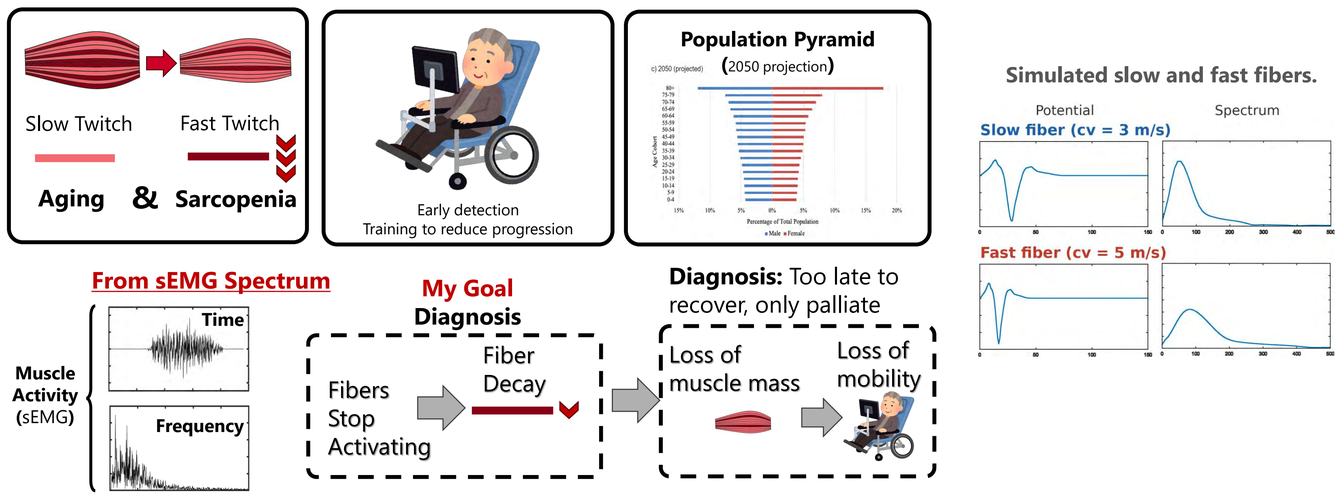
Listening to fast and slow muscle fibers: sEMG spectral monitoring toward early detection of sarcopenia

Alvaro Costa-Garcia, Eduardo Ianez, Moeka Yokoyama, Sayako Ueda, Shotaro Okajima, Shingo Shimoda

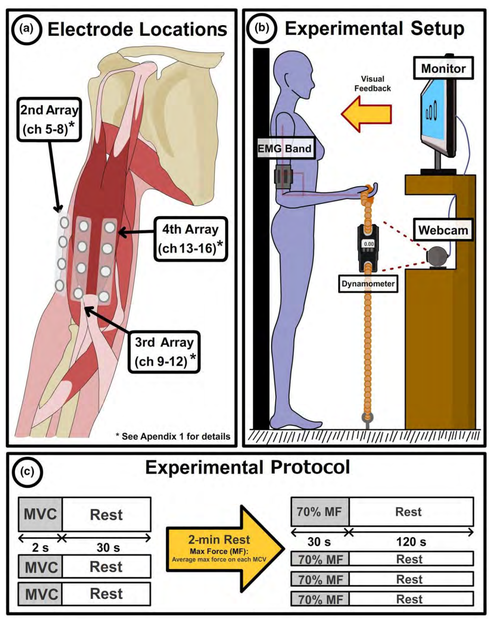
- Sarcopenia is diagnosed when muscle is already lost: too late to recover
- Fast fibers fail first: following them could give an early warning
- sEMG spectrum splits into high- and low-frequency components we can track

Why sarcopenia?

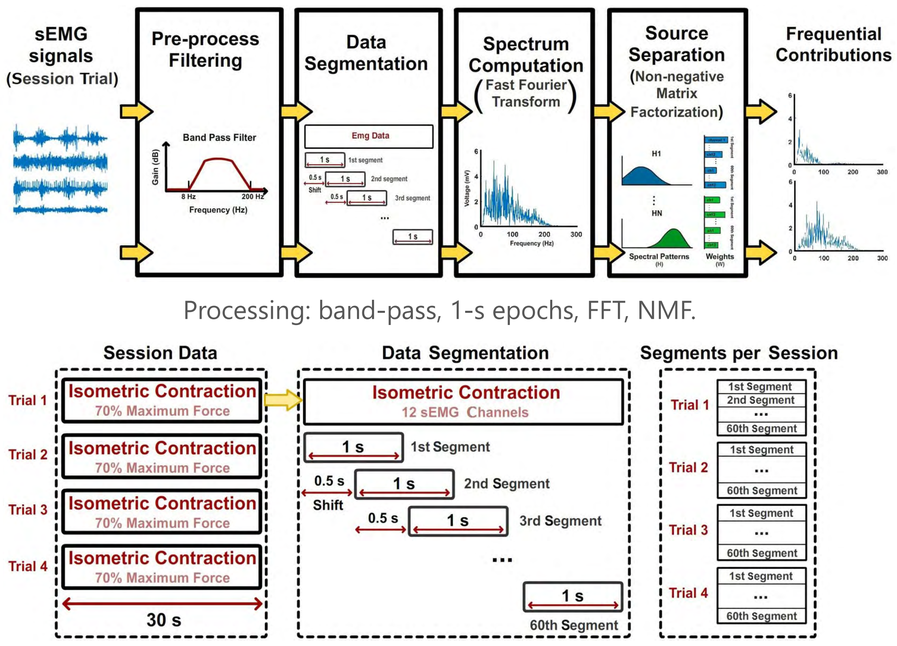
- **Sarcopenia:** age-related loss of muscle mass and function, leading to loss of mobility and dependence in ageing societies.
- Fast and slow fibers leave different footprints in the sEMG spectrum.
- **This study:** fatigue tires fast fibers first, a controlled model to test whether the two spectral components can be separated and tracked over time.



Methods



Electrodes, setup and protocol.



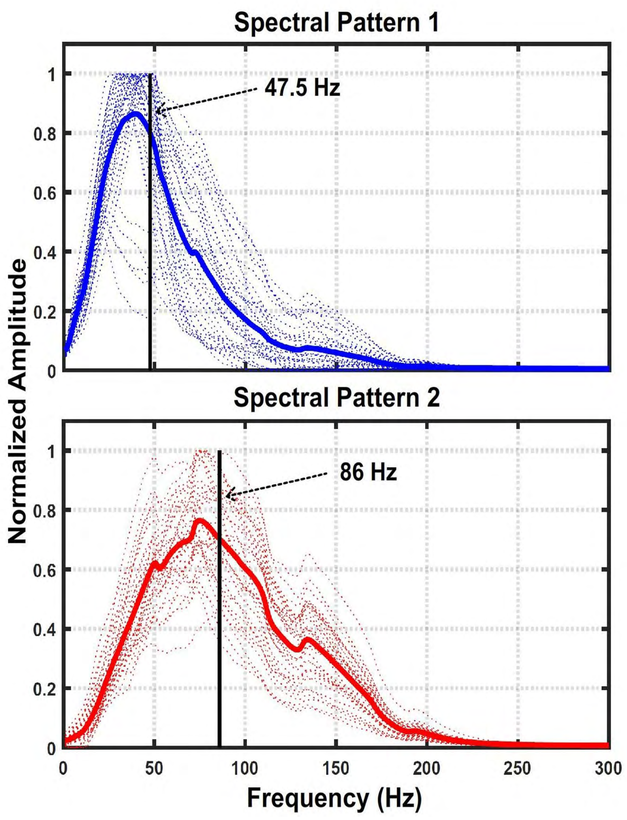
Processing: band-pass, 1-s epochs, FFT, NMF.

Each trial: 60 epochs × 12 channels = 720 spectra.

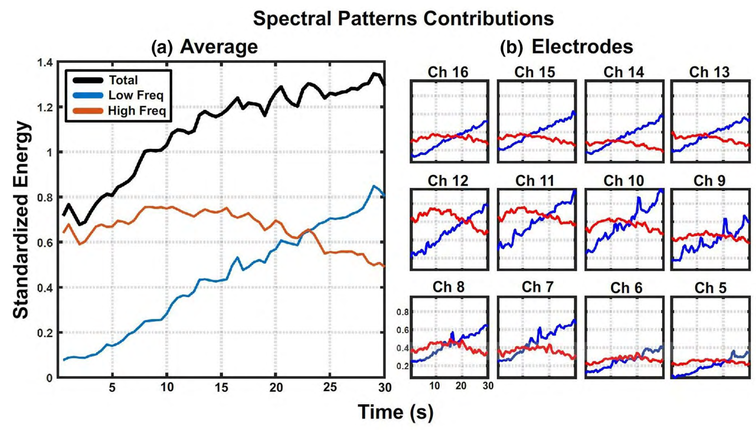
- 9 participants, 27–45 years.
- 4 × 30 s at 70% of maximal force.
- Fatigue rated 0–10 before each trial.
- **NMF** on the 720 spectra of a trial; fewest components with VAF > 80%.
- **Separability:** Bhattacharyya distance; Wilcoxon tests (Holm–Bonferroni).

Results

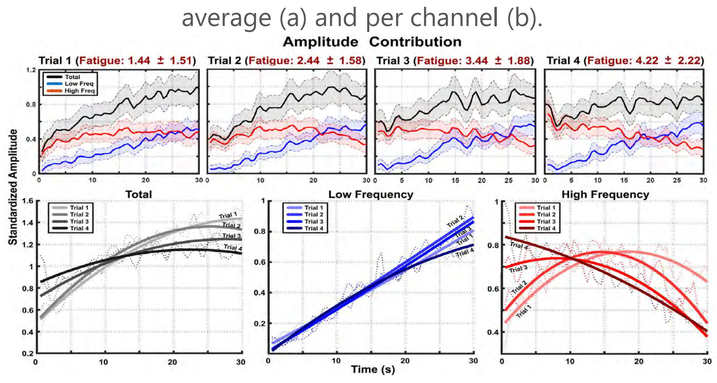
- Two separable components (VAF ≈ 84%), with low inter-subject variability.
- Consistent behavior across spatially distributed electrode.
- Low-frequency energy overtakes high-frequency energy after 20–25 s.
- More initial fatigue: high-frequency energy starts higher and decays faster.
- Foundations for active fiber estimation from sEMG spectrum



Shape of the two components



Energy of each component during the 30-s contraction: average (a) and per channel (b).



Energy and median frequencies by trial, as initial fatigue increases (1.4 to 4.2 out of 10).

Costa-García Á. et al., Physiological Reports 2022; 10: e15296, https://doi.org/10.14814/phy2.15296.

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