Relationship Between Raw Bioimpedance Values and Muscle Mass, Size, and Quality in Eumenorrheic Women.

CL. Unrein[1], K.T. Ramey, S.J. Rhoades[1], H.E. Karns[1], K.T. Persaud[1], E.T. Babcock[1], K.R. Hirsch[1]

[1]Department of Exercise Science, Arnold School of Public Health, University of South Carolina.

UNIVERSITY OF South Carolina

SUSTAIN LAB
exercise . nutrition . metabolism . body composition

Introduction

- Assessing muscle mass, size, and quality is important for tracking performance and recovery in women.
- While ultrasound (US) is commonly used to assess muscle characteristics, bioelectrical impedance spectroscopy (BIS) may offer an accessible alternative.
- Prior research in men has shown that BIS-derived phase angle is negatively correlated with echo intensity (lower echo, higher muscle quality), suggesting an association between bioelectrical properties and muscle characteristics.
- However, the direct relationship between raw BIS values (impedance [Z], resistance [R], reactance [Xc], and phase angle [PhA]) and muscle characteristics (mass, size, and quality) remains largely unexplored in women.

PURPOSE

To evaluate the relationship between raw BIS values and muscle characteristics—mass (fat-free mass index [FFMI]), size (cross-sectional area [mCSA]), and quality (echo intensity [EI])—in the leg and thigh segments of eumenorrheic women.

Experimental Design

Participants

15 eumenorrheic women completed a single visit during the low hormone phase (1–7 days from the start of menses).

Participant Demographics	
N	15
Age (yrs)	21.2 ± 1.0
BMI (kg/m²)	23.9 ± 0.6
%BF (%)	26.4 ± 1.2
FFMI (kg/m²)	9.4 ± 0.9
mCSA (cm²)	874.1 ± 151.4
EI (AU)	86.7 ± 51.6

Methods

- Raw BIS values (Z, R, Xc, PhA) were obtained for both the full leg and thigh (vastus lateralis [VL]) segments.
- Leg FFMI (kg/m²), was calculated based on leg fat-free mass (FFM; via a separate multifrequency bioimpedance analysis device) and leg length [FFMI=Leg FFM/Leg Length].
- Size (mCSA) and quality (EI) of the VL were assessed via US scan.
- Two BIS and US measurements were taken and averaged for analysis.
- All BIS data were analyzed at 50 kHz using time-delay corrected values.

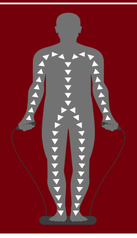
Statistical Analysis

Pearson's correlation coefficients were used to assess associations between BIS and muscle characteristic outcomes.

Results

- Higher leg Z and R were associated with lower FFMI (Z bivariate: r= -0.526, p=0.044; R bivariate: r=-0.527, p=0.043).
- No other leg bioimpedance reached significance for FFMI:
  - Xc (r=-0.286, p=0.301)
  - PhA (r=0.151, p=0.592)
- There were no significant associations between leg Z, R, Xc, or PhA and:
  - mCSA (bivariate: r=-0.277 to -0.169, p=0.318–0.548)
  - EI (bivariate: r=-0.035 to 0.173, p=0.381–0.902)
- Similarly, no significant associations were observed between thigh bioimpedance and:
  - FFMI (bivariate: r=-0.073 to -0.052, p=0.797–0.852)
  - mCSA (bivariate: r=0.024 to 0.329, p=0.231–0.931)
  - EI (bivariate: r=-0.223 to 0.138, p=0.425–0.631)

	Leg (MD±SD)	Thigh (MD±SD)
Z	268.4±29.2	132.0±21.8
R	265.3±29.0	131.2±21.8
Xc	40.5±5.3	14.3±3.5
PhA	8.7±0.9	6.3±1.6



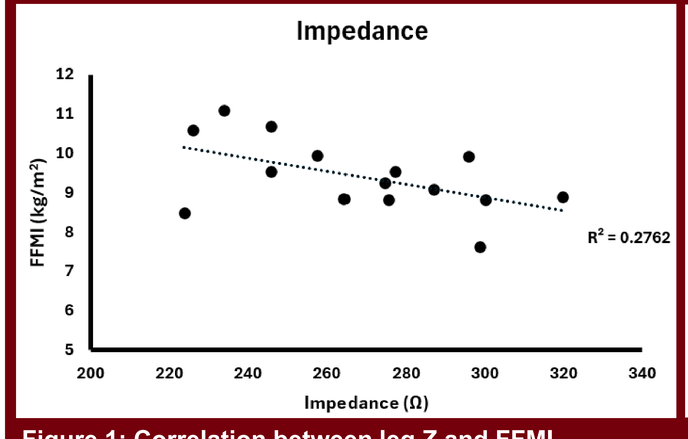


Figure 1: Correlation between leg Z and FFMI.

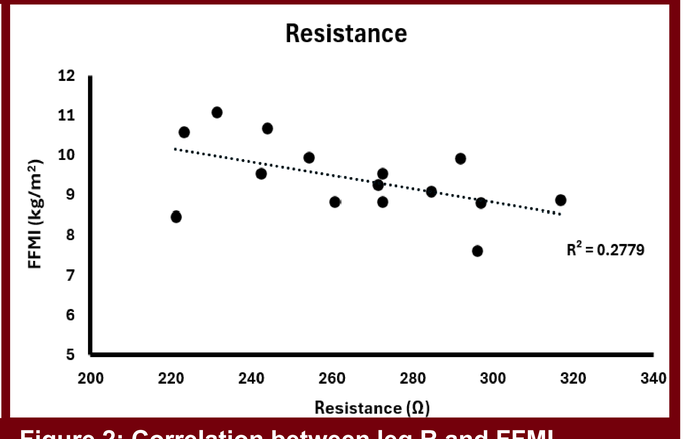


Figure 2: Correlation between leg R and FFMI.

Conclusion

- These findings suggest that leg BIS-derived Z and R are inversely associated with leg FFMI but are not significantly related to muscle size (mCSA) or quality (EI).
- The inverse relationship between Z and R with FFMI is consistent with the physiological expectation that lower FFM corresponds to higher R due to FFM and muscle's positive association with intracellular water.
- In contrast, thigh BIS-derived bioimpedance showed no significant associations with muscle mass (FFMI), size (mCSA), or quality (EI).

Practical Application

- **BIS may serve as a quick, non-invasive tool for athletes and clinicians to monitor leg muscle mass trends of FFMI in eumenorrheic women.**
- **However, the weak correlations between BIS values of the leg and thigh with US-derived muscle characteristics, suggest that its utility as an independent method for assessing muscle size and quality require further investigation.**