

ANALYSIS OF ULTRASOUND SIGNAL BANDS AND THE EFFECT OF SEX

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PURPOSE

Background:

- Ultrasound echo intensity (EI) is a method of quantifying muscle quality using non-invasive imaging (Pillen 2009)
- EI is often assessed as the mean pixel brightness within an area of interest (Pillen 2009)
- EI may provide insight to muscle function (Mota & Stock 2017) by potentially distinguishing between contractile and non-contractile tissues within skeletal muscle.
- Recently, there has been interest in assessing individual sections of the EI signal (i.e., bands of signal) (Pinto & Pinto 2021, Logeson et al., 2022)
- Analyzing bands of signal may increase the sensitivity of EI and provide more meaningful insight into whole muscle outcomes. (Pinto & Pinto 2021, Logeson et al., 2022)
- The effect of sex on EI band analysis has not been explored
- **The purpose** of this study was to compare the effect of sex on the relationships between mean echo intensity and bands of echo intensity signal of the vastus lateralis with metrics of whole muscle performance in adults.

PRACTICAL APPLICATIONS

- In males unique EI bands may predict isokinetic fatigue
- Echo Intensity was unrelated to isokinetic fatigue in females

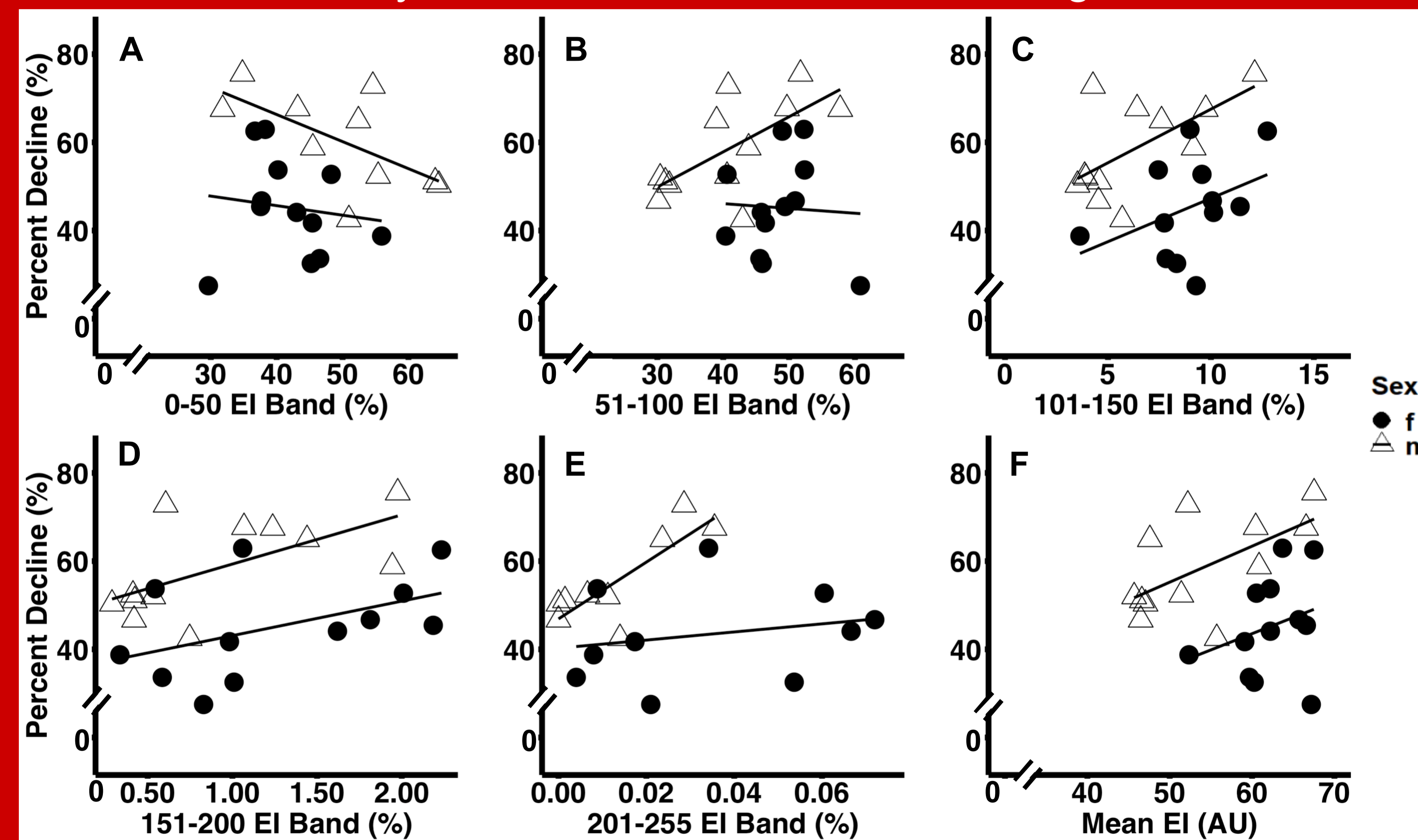


Figure 4. (A) a correlation between the 0-50 EI band percentage and percent decline. (B) a correlation between the 51-100 EI band percentage and percent decline. (C) a correlation between the 101-150 EI band percentage and percent decline. (D) a correlation between the 151-200 EI band percentage and percent decline. (E) a correlation between the 201-255 EI band percentage and percent decline. (F) a correlation between mean EI and percent decline.

METHODS

Participants and Study Design:

- Males: n = 12; age, 23.4 ± 5.1 yrs
- Females: n = 12; age, 20.6 ± 1.6 yrs
- Completed two visits to the laboratory

Ultrasound

- B-mode ultrasound was used to image the vastus lateralis (VL) at 50% muscle length
- Images were analyzed using open-source software (ImageJ) to perform gray-scale analysis
- Each pixel is assigned a gray-scale value from 0 (black) to 255 (white)

- Echo intensity bands were calculated in pixel value intervals of 0-50, 51-100, 101-150, 151-200, 201-255.
- Percentage of pixels per EI band:

$$EI \text{ Band (\%)} = \frac{n \text{ pixels per band}}{n \text{ pixels within selection}}$$

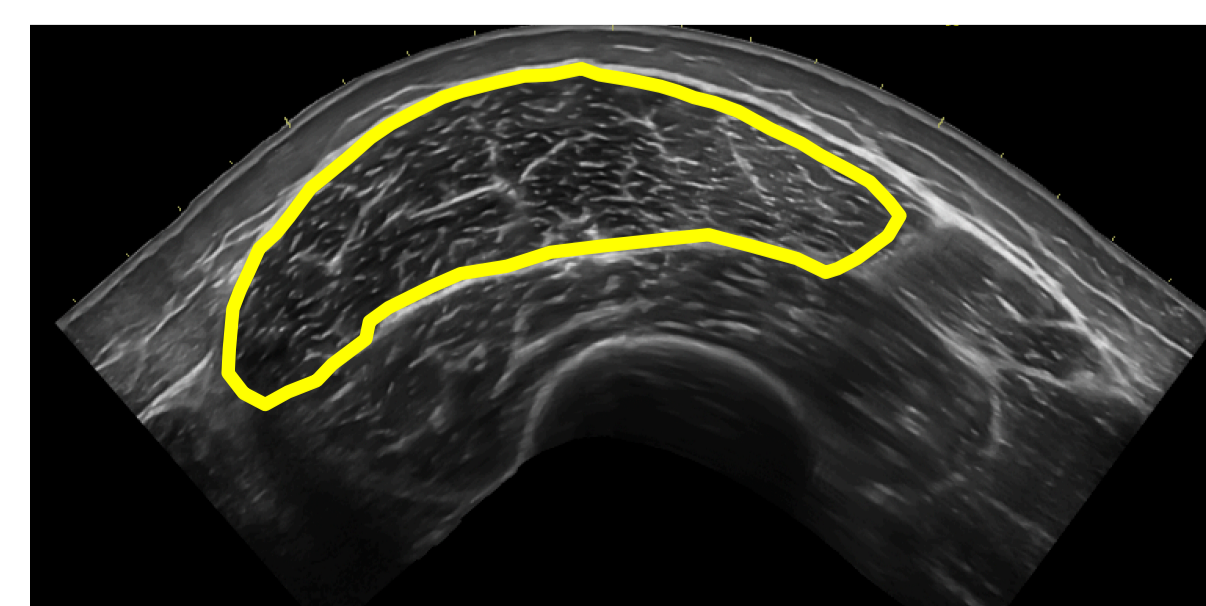


Figure 1. Example ultrasound image of the VL

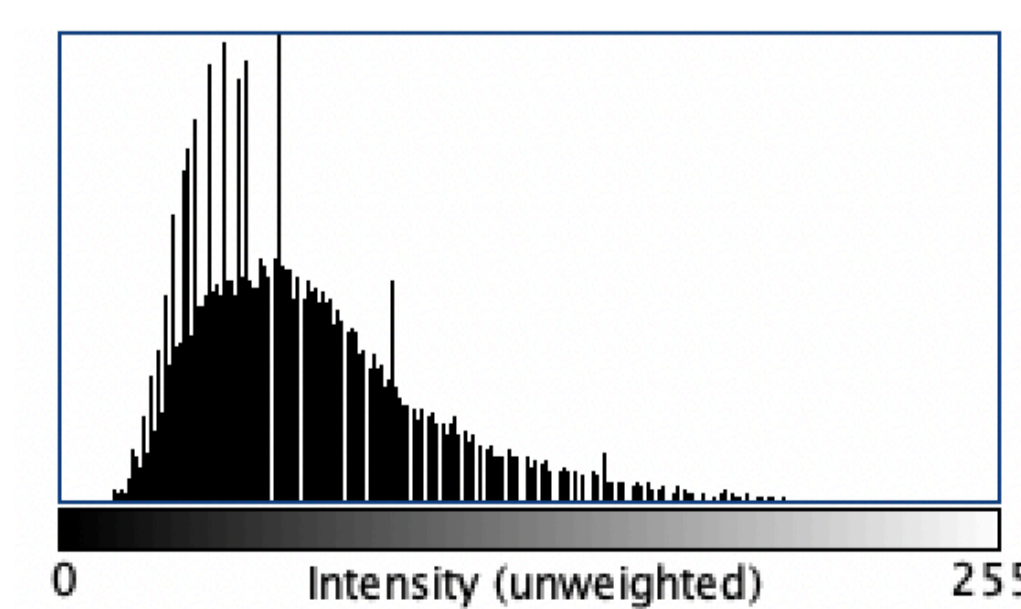


Figure 2. The histogram represents the frequency of each pixel value from 0-255

Fatigue Assessment

- 100 repeated, maximal, isokinetic (120° /sec) muscle actions
- Initial and final peak torque were calculated by averaging the highest and lowest 3 of the first and last 5 repetitions respectively

$$\%Decline = \frac{(PT_{Initial} - PT_{Final})}{PT_{Initial}}$$



Figure 3. Isokinetic dynamometer

Statistical Analysis

- Pearson's correlation coefficient (r) was used to assess the relationship between each EI band (e.g., 0-50, 51-100, etc...) and mean EI with %Dec, respectively.
- The Stieger's Z procedure was used to compare correlation coefficients between EI bands, mean EI, and sex

RESULTS

Females EI Bands and Percent Decline

	0-50	51-100	101-150	151-200	201-255	mean EI
r	-0.131	-0.054	0.396	0.466	0.352	0.2814
p	0.686	0.8681	0.203	0.127	0.261	0.3756

Table 1. Correlation between each EI band and percent decline for females.

Males EI Bands and Percent Decline

	0-50	51-100	101-150	151-200	201-255	mean EI
r	-0.687	0.662	0.624	0.619	0.673	0.605
p	0.014	0.019	0.030	0.032	0.016	0.037

Table 2. Correlation between each EI band and percent decline for males.

Males Mean EI and EI Bands

	0-50	51-100	101-150	151-200	201-255
Z	3.27	0.2	0.07	0.05	0.25
p	<0.001	0.84	0.95	0.96	0.81

Table 3. Correlation between mean EI and each EI band for males

Effect of Sex

	0-50	51-100	101-150	151-200	201-255	mean EI
Z	2.3	2.76	1.01	0.71	1.45	1.33
p	0.02	0.01	0.31	0.48	0.15	0.18

Table 4. Correlations between sex

CONCLUSION

- This study investigated the effect of sex on the relationship between EI and whole muscle performance. Most uniquely, this study employed an EI band-specific analysis technique
- Our results indicate that individual EI signal bands may contribute unique insights on whole muscle function
- However, it seems that this effect is mitigated in females
- Future investigations are needed to determine the sensitivity of EI band signal analysis on other measures of muscle function.