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Sympathovagal Imbalance Assessed by Heart Rate Variability Correlates With Percent Body Fat and Skeletal Muscle, Independent of Body Mass Index

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Introduction: Heart rate variability (HRV) has been used to assess sympathovagal balance and it has been described as correlating with obesity. Body mass index (BMI) is one of the most accurate ways to determine when overweight translates into health risks. We propose that bioelectric impedance may be used as an alternative measure to correlate with sympathovagal balance using body fat percentage (%BF), skeletal muscle percentage (%SM), and %BF/%SM ratio.

Methods: Two hundred twenty-eight healthy volunteers, 110 males (20.7 ± 2.0 years) and 118 females (20.2 ± 1.6 years), participated in the study. Five-minute recordings of HRV time-and frequency-domain indices were analyzed and correlated with bioelectric impedance variables **(Table)**: The root mean of the squared successive interbeat intervals differences (RMSSD) was taken as the time domain measure of HRV. High-frequency (HF: 0.15–0.4 Hz), low-frequency (LF: 0.04–0.15 Hz), very-low-frequency (VLF: < 0.04 Hz) band power, and HF power or LF/HF ratio were calculated on the electrocardiogram (ECG) recordings obtained. All time- and frequency-domain indices were automatically calculated by the commercially available Norav ECG Management System (Wiesbaden, Germany). Standard measures for BMI and bioelectric impedance for %BF, %SM, and %BF/%SM ratio were measured with the commercially available Omron BF500 Body Composition Monitor (Kyoto, Japan).

Results: Bioimpedance variables: For all volunteers mean BMI was 23.9 ± 4.2, %BF 29.6 ± 9.4, %SM 31.6 ± 7.0, and %BF/%SM 1.0 ± 0.5.

HRV variables: For all volunteers mean average RR 883.9 ± 144.7, RMSSD 57.5 ± 30.7, LF 157.0 ± 79.3, HF 240.3 ± 96.7, LF/HF 0.88 ± 0.79.

No correlation was observed between BMI and any of the HRV analyzed.

BMI had a direct correlation with %BF/%SM ratio (.464, $P <$ .001). %BF had an inverse correlation with LF (−.222, $P = .001$), a positive correlation with HF (.336, $P < .01$), and an inverse correlation with VLF (−.224, $P = .001$). %SM had a direct correlation with LF (.221, $P = .001$), an inverse correlation with HF (−.396, $P < .01$), and a direct correlation with VLF (.254, $P =$ .001). %BF/%SM ratio had an inverse correlation with LF (−.228, $P = .001$), a positive correlation with HF (.359, $P < .001$), and an inverse correlation with VLF (−.240, $P = .001$) and with LF/HF ratio (−.228, $P = .001$).

Conclusion: Sympathovagal balance is affected by weight gain and its measurement correlates with %BF, %SM, and %BF/%SM ratio, and not BMI. Sympathetic tone (LF) and VLF (related to thermogenesis) have a direct correlation with greater %SM and less %BF. Vagal tone (HF) has a direct correlation with greater %BF and less %SM. Studies to measure sympathovagal balance assessed by HRV may help to distinguish bioelectric impedance measurements as additional cardiovascular risk factors independent of BMI, and may help address focused training and followup programs in overweight patients.

TABLE
HEART RATE VARIABILITY AND BIOIMPEDANCE VARIABLES

		Heart rate variability (frequency-domain)			
		HF	LF	VLF	LF/HF
Bioimpedance	BMI	.034 (P = ns)	−.097 (P = ns)	−.029 (P = ns)	−.032 (P = ns)
	%Fat	.336 ($P < .001$)	−.222 ($P = .001$)	−.224 ($P = .001$)	−.217 ($P = .001$)
	%Skeletal muscle	−.396 ($P < .001$)	.221 ($P = .001$)	.254 ($P < .001$)	.252 ($P < .001$)
	%Fat/%SM	.359 ($P < .001$)	−.228 ($P = .001$)	−.240 ($P < .001$)	−.228 ($P = .001$)

HF = high frequency; LF = low frequency; VLF = very low frequency