Reliability of Impedance Cardiography in the Measurement of Cardiovascular Hemodynamics during Exercise.

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Impedance cardiography (IC) is a non-invasive method for measuring cardiovascular hemodynamics during exercise. However, the consistency of measurements obtained via IC across different exercise modes has not been investigated.

PURPOSE: To investigate whether hemodynamic measures assessed via IC are consistent between treadmill (TM) and cycle (CYC) exercise at two, submaximal absolute intensities.

METHODS: 21 men (age = 21.4 $\pm$ 0.5 y; BMI = 24.4 $\pm$ 0.5) completed four exercise tests, two TM and two CYC. Within each test, two, five-minute, steady-state stages were completed with a targeted intensity of 5 and 7 METs (Stage 1 and Stage 2). Oxygen consumption (VO_2) was measured by indirect calorimetry. Hemodynamic measures were obtained via IC (PhysioFlow, PF07 Enduro) and included cardiac output (CO), cardiac index (CI), heart rate (HR), stroke volume (SV), stroke volume index (SVi), end diastolic volume (EDV), ejection fraction (EF), systemic vascular resistance (SVR), systemic vascular resistance index (SVRi), contractility index (CTi), ventricular ejection time (VET), early diastolic filling ratio (EDFR), and left cardiac work index (LCWi).

RESULTS: There were no significant differences in VO_2 and CO across all TM and CYC tests for a given intensity ($p > 0.05$). There was no mean statistical difference in hemodynamic variables between TM1 and TM2, as well as CYC1 and CYC2 trials. There were no significant differences between TM1 vs CYC1 in all hemodynamic variables, except for EDFR and VET differed between trials in Stage 2. Significant intraclass correlation coefficients (ICCs, $r = 0.70 – 0.90$, $p < 0.05$) were observed between TM trials for all variables except VET and Stage 1 EDFR. Within CYC trials, significant ICCs were observed for CO, CI, HR, SV, EDV, EF, VET and LCWi in Stage 1, and HR for Stage 2. Across modes ICCs were significant for HR, EDV, and EF, but not for CO, CI, SV, SVi, SVR, SVRi, CTi, VET, EDFR, and LCWi in Stage 1, and ICCs for Stage 2 were significant in HR, EF, CTi, and EDFR but not for CO, CI, SV, SVi, EDV, SVR, SVRi, VET, and LCWi. Bland-Altman analysis indicated good agreement between TM1 and CYC1 for all hemodynamic variables except for EDFR in Stage 1 and SVi, HR, VET, and EDFR in Stage 2 ($p<0.05$).

CONCLUSION: The majority of hemodynamic measurements obtained via IC during moderate and vigorous exercise showed moderate-strong consistency within TM trials, at moderate intensity for CYC trials. Across modes, lack of agreement in most variables may be due to discrepancies in $\%VO_2$ max. Future research utilizing IC during exercise should be conducted

across a greater range of exercise modes with the incorporation of invasive methods for validation of the hemodynamic variables' similarities and differences.