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DETERMINANTS OF VE/VCO2 SLOPE IN NORMAL INDIVIDUALS - VENTILATORY EFFICIENCY IS MODIFIABLE WITH ENDURANCE TRAINING

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Background: Ventilatory efficiency, as indicated by the increment in minute ventilation (VE) relative to CO2 production (VCO2), reflects right ventricular-pulmonary vascular (RV-PV) function during exercise. In patients with heart failure (HF), a VE/VCO2 slope greater than 34 purports a poor prognosis. Less is known about determinants of VE/VCO2 slope in normal individuals and whether or not VE/VCO2 is modifiable with exercise training.

Methods and Results: We examined determinants of VE/VCO2 in 40 individuals with normal exercise capacity (age 53±2.3 years, weight 84±3 kg, baseline peak VO2=2.1±0.1 L/min, 100±2 % predicted VO2 max, mean±SEM) who underwent cardiopulmonary exercise testing (CPET) with invasive hemodynamic monitoring. VE/VCO2 was related to indices of pulmonary vascular function (rest and exercise pulmonary artery pressure (PAP) and pulmonary vascular resistance) and indicators of ventilatory drive (PaCO2, all $P<0.05$). Multivariate analysis adjusting for age, sex, and BMI identified PaCO2 at anaerobic threshold (AT) as the leading predictor of VE/VCO2 slope. To assess the modifiability of VE/VCO2, we performed serial CPETs on ten student athletes participating in the Harvard University Rowing Program (age 19±0.6 years, weight 91±2 kg, baseline peak VO2=4.7±0.2 L/min) before and after a standardized 90-day exercise program, consisting mainly of endurance training (11.9±1.1 hours/week). Training was associated with a 24±5% increase in peak VO2 and a reduction in VE/VCO2 slope pre-ventilatory anaerobic threshold (VAT) from 21.3±0.3 to 20.0±0.5, $P=0.02$. Post-VAT VE/VCO2 slope was steeper than pre-VAT slope, and also tended to decrease after training (45±3 to 38±4, $P=0.08$). Pre-AT VE/VCO2 slope was closely related to peak VO2 as measured before and after training.

Conclusions: Our data demonstrate that VE/VCO2 slope is related to RV-PV function, ventilatory drive, and fitness levels in normal individuals and is modifiable with endurance training in athletes. Training-induced adaptations may protect against development of inefficient ventilation and provide a useful surrogate for peak exercise capacity that can be serially measured during submaximum testing.