Estimating oxygen consumption from heart rate and heart rate variability without individual calibration

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Summary
Heart rate (HR) as an estimator of oxygen consumption (VO₂) usually requires HR to be individually calibrated in a separate test. This study examined the validity of a new HR – and HR variability-based method (Firstbeat PRO heartbeat analysis software) in the estimation of VO₂ in real-life tasks. The method takes into account the respiration rate determined from HR variability and the differences in the on/off dynamics of HR and VO₂, and no calibration tests are needed. Ten men and nine women performed 25 tasks representing different types of daily activities. Portable devices were used to measure R-to-R intervals (ECG), VO₂ and respiration rate. In pooled regression analysis, the estimated VO₂ accounted for 87% of the variability in the actual VO₂, SEE 3·5 ml min⁻¹ kg⁻¹ (1 MET). At group level, the method underestimated slightly the measured VO₂ (mean difference – 1·5 ml min⁻¹ kg⁻¹ or –0·4 METs). Some of the values at low exercise intensities were markedly underestimated, but the agreement was better during light and heavy activities. The limits of agreement for the data were from –8·4 to 5·4 ml min⁻¹ kg⁻¹ or from –2·4 to 1·5 METs. At individual level, the average deviations of the predicted VO₂ ranged from –1·0 to 0·6 METs and $R^2$ from 0·77 to 0·94, respectively. The present data indicate that the prediction method may be considered sufficiently accurate to determine the average VO₂ in field use, but it does not allow precise estimation of VO₂.

Keywords: heart rate; heart rate variability; oxygen uptake; prediction; respiration rate.