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White Paper: Detecting Ventilatory Threshold with BioHarness™

Introduction

This report concerns an evaluation of the physiological monitoring performance of Zephyr Technology's BioHarness™ product, available from BIOPAC Systems, Inc. The evaluation aimed to assess the ability of the BioHarness system to detect the second Ventilatory Threshold (VT).

The BioHarness is a bio-monitoring system used to measure physiological conditions including heart rate, respiration rate, temperature, activity and posture.

The system comprises an electronics module and a Smart Fabric garment that is worn on the torso. Data may be transmitted to a PC and viewed in real-time or logged on the device and later uploaded for review and analysis.

Methods

Four male participants (aged 21 to 52) with moderate to excellent fitness levels completed a modified Conconi test protocol of running on a treadmill. Speed and gradient were incrementally increased every alternative minute to exhaustion. During the exercises, the participants wore a BioHarness and a Cortex BioPhysik MetaMax CPX system with 3-lead ECG. Physiological data from each person was then sampled and compared to determine correlation coefficient, standard error of the mean for each participant.

Ventilatory Threshold Detection

The assumption was made that VT can be detected by a rapid increase in breathing rate, as measured by BioHarness. The point in time of this inflection point was compared to that indicated by the Cortex BioPhysik MetaMax system using three commonly cited methods of identifying VT; The V-Slope method (V-Slope), the Respiratory exchange ratio (RER=0.95) and the Ventilatory Equivalent (VE Method).

Results

The results showed correlation coefficients between the BioHarnessTM breathing rate inflection point, and Ventilatory Equivalent (VE) (r=0.91), V-slope and RER methods of 0.91, 0.95 and 0.71 respectively.

Standard errors were 50.4, 19 and 18.13 seconds respectively.

Table 1
Summary of BioHarness Ventilatory Threshold Detection Method Compared to standard methods

Method	r	SE
V slope	0.95	50.37
V E	0.91	19.00
RER	0.72	18.13

r = correlation; SE = Standard Error in seconds

Table 2
Time of Ventilatory Threshold detection by BioHarness and other commonly used methods.

Subject	BioH BR	VSlope	MM RER	VE Method
1	439	392	247	462
2	548	573	575	486
3	348	320	320	320
4	439	390	438	457

Time is measured in seconds.

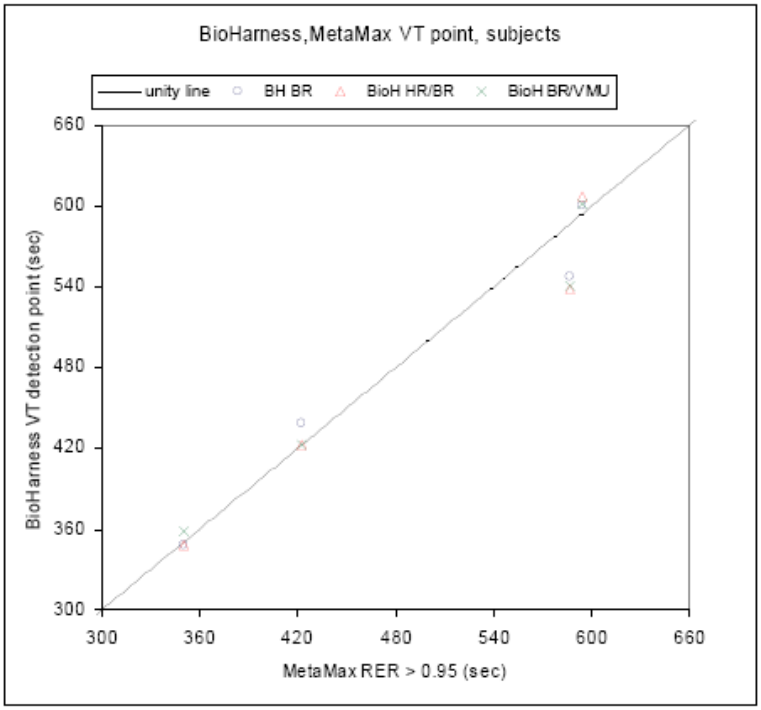

Fig 3.1 Comparison of Ventilatory Threshold (VT) during incremental exercise determined by RER from Cortex BioPhysik MetaMax CPX System vs Zephyr's Bioharness™.

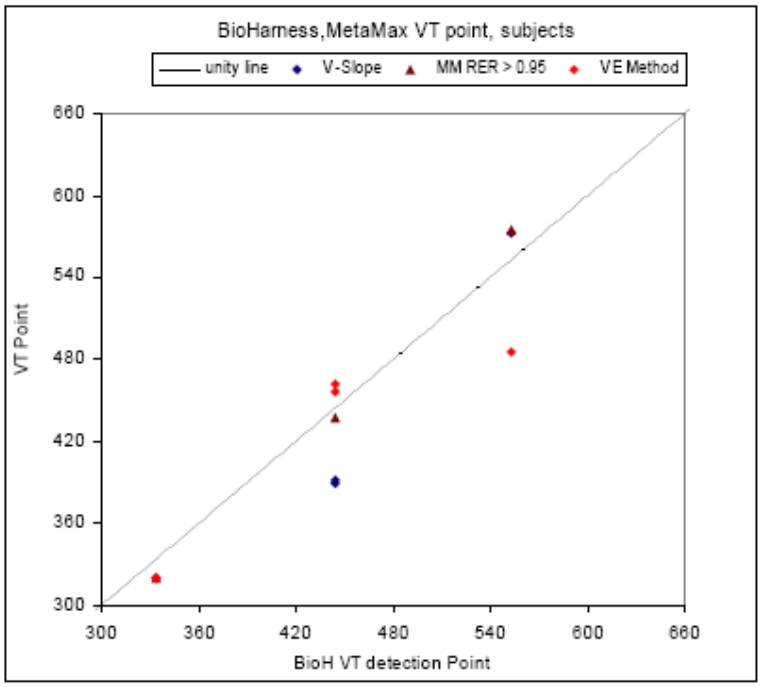

Fig 3.2 Comparison of BioHarness' ™ ability to detect VT point compared with 3 other common methods; V-Slope Method, VE Method and Respiratory Exchange Ratio (RER). Axes = time (s)

Conclusions

From the results from this small data set it appears that the BioHarness System has the ability to determine the Ventilatory Threshold through respiratory rate. Ongoing testing and a larger dataset will increase confidence in the ability of the BioHarness™ to detect the second Ventilatory Threshold using a Respiratory Rate detection method.

Reference

1. Respiratory rate is a valid and reliable marker for the anaerobic threshold: implications for measuring change in fitness. Daniel G. Carey, Leslie A. Schwarz, German J. Pliego and Robert L. Raymond, *Journal of Sports Science and Medicine* (2005) 4, 482-488.