

Physiological Markers of Phase Change in Heart Rate Response to Work

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ABSTRACT

Heart rate response to increasing workload is accompanied by a series of physiologically marked stages, which can be identified through a linear and logarithmic regression line cross-over. These stages represent the withdrawal and activation of neural, hormonal and reflex mechanisms. However identification of physiological mechanisms associated with rate change is lacking in the literature. **PURPOSE:** The purpose of this study is to establish mathematical regression trend-lines for segmental changes in heart rate response to increased work, and identify the physiological mechanisms associated with said change. **METHODS:** Ten (n=10) male cyclists acted as subjects. Each signed a university approved informed consent prior to testing. Pre-test measures included the following: medical and fitness questionnaires; height (cm), weight (kg), age (y), body fat (%) and seated resting heart rate ($b \cdot \text{min}^{-1}$). Subjects were then fitted to the Velotron™ bicycle ergometer. The ergometer protocol began at 150 watts (w) of work at a pedal rate between 80 and 90 (RPM). The work increased at 25 (w) per minute until volitional fatigue. The following measures were taken during the cycle ergometer test: beat-by-beat heart rate ($b \cdot \text{min}^{-1}$), expired ventilation ($V_E, l \cdot \text{min}^{-1}$), minute volume of oxygen consumption ($VO_2, l \cdot \text{min}^{-1}, \text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) and minute volume of carbon dioxide production ($VCO_2, l \cdot \text{min}^{-1}$). Statistical analyses included logarithmic and linear regression lines of group mean heart rates to establish segments of heart rate change during the test. Trend-lines of best fit were then utilized for established phases of heart rate change. Mean (SD) values were established across subjects for measured variables. **RESULTS:** Demographic means (SD) were the following: height, 178.3 (5.1); weight, 81.4 (6.8); body fat, 10.5 (3.8); age, 29.6 (8.1); $VO_{2\text{Max}}$, 70.3 (6.03). Three phases (I, II, III) were established from the logarithmic/linear cross-over. Each phase had a distinct trend-line established as the line of best fit. These trend-lines were the following: Phase I, logarithmic; Phase II, linear; Phase III, 4th degree polynomial. **CONCLUSION:** This research demonstrates the three distinct segments of heart rate response due to incremental increases in workload and can be identified through the application of a linear-logarithmic regression analysis. Associated physiological mechanisms include the following: parasympathetic deactivation, sympathetic activation, baroreceptor reflex, catecholamines, peripheral afferent signal from specific metabolites.