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Utilizing Heart Rate to predict Excess Post-exercise Oxygen Consumption: A Mathematical Model

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Introduction

- In the transition from rest to exercise the body's energy and oxygen requirements increase dramatically[1]
- Oxygen deficit describes the lag in oxygen uptake when the body goes from a resting state to exercise[1]
- Excess Post-Exercise Oxygen Consumption (EPOC) describes the elevated oxygen consumption that occurs for a period following exercise. EPOC occurs in two phases, a rapid component during the first few minutes after exercise, and a slow component that is a gradual decrease to baseline[6]. An estimated 20% of EPOC is used for gluconeogenesis[1,3,6]
- There is a potential relationship between heart rate (HR) and EPOC during recovery of exercise[7]

Purpose

- The purpose of this study was to determine the relationship between excess post exercise oxygen consumption (EPOC) and heart rate (HR) during recovery from exercise and determine if HR may be used to predict EPOC in a fit college-aged population.

Methods

- 14 active and healthy college students performed two exercise sessions

Table 1. Descriptive statistics of participants by sex.

	Males (n=11)	Females (n=3)
Average weight (kg)	83.0	57.8
Average height (cm)	178.8	165.2
Average VO2peak (ml/kg/min)	47.8	41.3

- The first session was a VO2peak test during which HR, VO2, and blood lactate values were recorded
- The second session was a 20-minute run at 70% of the subject's VO2peak as determined from the first session. HR and VO2 was recorded throughout this session. After exercise, participants took a seated position until a) heart rate and VO2 levels returned to baseline or b) 15 minutes had passed. Blood lactate values were recorded at baseline and immediately post exercise, then every 5 minutes during recovery
- Data from the second exercise session was analyzed. The 0-minute to 2-minute exercise data was chosen to represent oxygen deficit. 3.5 minutes post exercise was chosen to represent the fast component of EPOC. Median values of HR and VO2 were determined for oxygen deficit and EPOC periods to create a mathematical model
- Data from the second exercise session was analyzed for 12 of the 14 subjects

Results

- Least squares lines were used to predict oxygen median, oxygen deficit, and EPOC values from the heart rate data. The model equations displayed low correlation indicating low predictive value of HR for EPOC.

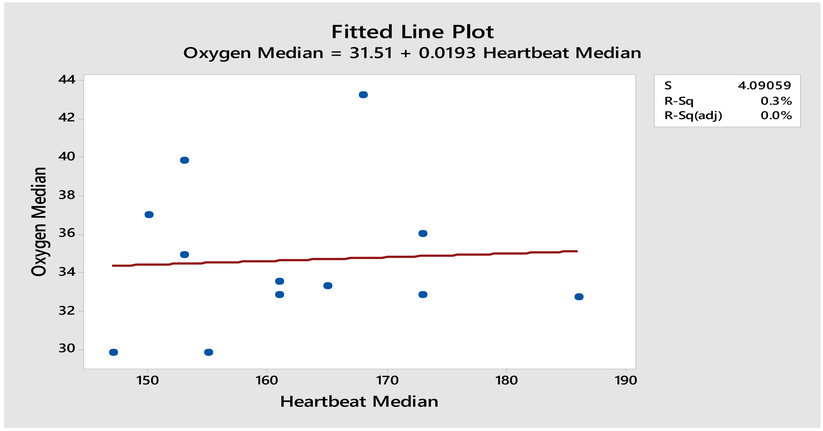

Figure 1: Model equation created from heart rate median and oxygen median.

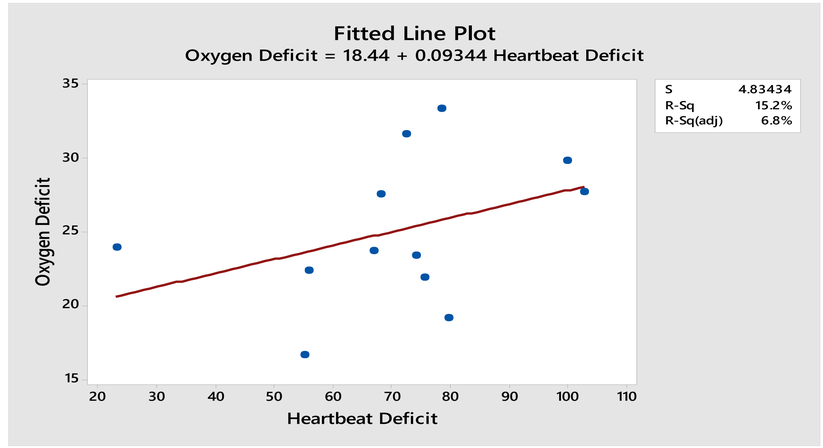

Figure 2: Model equation created from heart rate deficit and oxygen deficit.

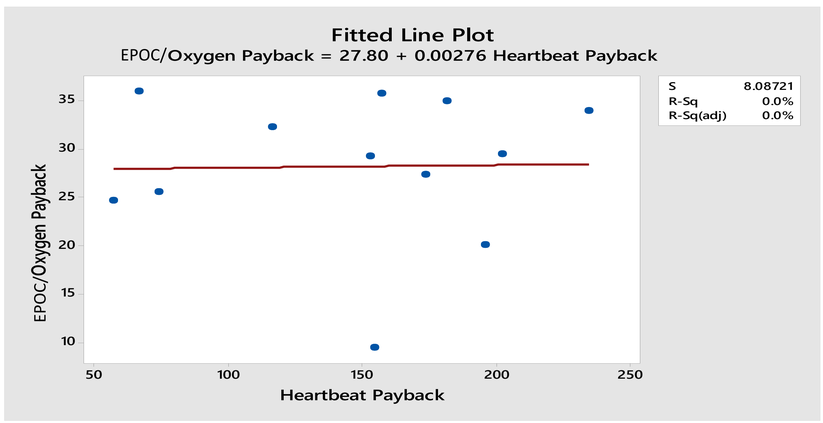

Figure 3: Model equation created from heart rate payback and oxygen payback.

Discussion

- For the 12 data sets analyzed, heart rate was not a good predictor of EPOC
  - Data for 12 subjects was used to create the model initially, with hopes that the data from the final two subjects could be used to further validate the model. Unfortunately, the model proved low correlation, so data from the final two subjects was not analyzed
- Heart Rate is one component of the Fick equation. The Fick equation explains the determinants of oxygen consumption[6,10]
- Heart rate is a commonly measured non-invasive post exercise recovery component. Because this is such an easy measurement and non-invasive, the benefits of heart rate being a predicting EPOC would be advantageous for athletes attempting to estimate EPOC easily
- The results contradict those of previous researchers who have found a close relationship between heart rate and EPOC[1,2,4,7]
- There are several limiting factors that might explain why the model was unsuccessful. This was a relatively small sample size, and a larger sample size may have yielded better results. Further, complications during the exercise protocol led to some inconsistencies in the test protocol
- Recommendations for future research include taking VO_2 and HR measurements continuously, considering blood lactate, and measuring different durations and intensities[2,5,8]

Conclusions

- This study suggests that heart rate may not be a good proxy for estimating EPOC in active, healthy college students.

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