The effects of caffeine on swimming performance in correlation with respiratory function

Caitlin Rejman, Biology Department., Hartwick Drive, Oneonta, NY 13820, USA

Abstract

Caffeine is often used by athletes to enhance performance, however the magnitude of its effects varies (Rauh, Burkert, Siepmann, & Mueck-Weymann 2006). The effects of caffeine on heart rates, blood flow, blood vessels and skeletal muscles have all been evaluated. However, little has been done to correlate the effects of caffeine on respiratory function with its effects on performance (Chapman & Mickleborough 2009). In competitive swimming , respiratory parameters play a major role. Thus the effects of caffeine on swimmers' respiratory functions may play an important part in performance enhancement. I hypothesized that caffeine improves swimming performance and that its effects can be explained by the effects of caffeine on both metabolism and ventilation. To evaluate this hypothesis within the methodological constraints imposed by swimming, I measured metabolism and ventilation during exercise recovery using Excess Post-Exercise Oxygen Consumption (EPOC) as an index of metabolism and using tidal volume and respiratory rate to calculate ventilation. With IRB approval, trained competitive swimmers completed a standard pool workout following treatment with caffeinated or decaffeinated coffee prior to exercise. Heart rate, O_2, CO_2, ventilation and EPOC were measured before and directly after swimming using iWorks Lab scribe software, an SP-304 spirometer, and a GA-300 gas analyzer. The data was compared using paired T test with Dunn's correction for multiple comparisons. We observed significant difference in performance times, as well as consistently higher mean metabolic and respiratory parameters with the caffeine, as well as lower mean time to recovery, but none that were statistically different. This was all likely due to low n.

Introduction

In 2004, the World Anti-Doping Agency (WADA) removed caffeine from the list of restricted substances. Since, many studies have been done to test its effects on athletes (Debrow & Leveritt 2007). The effects on other endurance sports such as cycling and running have been evaluated, but few studies on competitive swimmers have been done. The effects on ventilation and respiratory function have often also been over looked (Chapman & Mickleborough 2009). In competitive swimming, breathing is a critical aspect in performance. When sprinting, swimmers breath minimal amounts, and during long distance events, carbon dioxide really starts to build up. This study evaluates the effect of caffeine on improvement in performance time when swimming and relates it to how respiratory and metabolic parameters react and if there is any correlation between the change in respiratory or metabolic function, and performance. If the results are conclusive, they will be reported to the Hartwick swimming coach for use in training practices.

Methods

• Members of the Hartwick College swimming and diving team were asked to participate in this experiment due to their level of training. All procedures were approved by the college's IRB.

•Each participant came in one week apart for two separate trials. Trials were identical in nature with caffeine being randomly distributed to participants. For both trials participants drank a standard sized cup of coffee made from a Keurig, but they did not know which trial involved caffeinated or decaffeinated blends.

•Participants breathed into a GA-300 respirometer connected to a Labscribe program for a baseline of CO_2 and O_2 measurements, and took resting heart rate.

•Each participant completed a half hour swim practice written by the Hartwick Swimming coach, ending with a 100 yard free style sprint for time.

•Immediately upon completion of the swim, the participants breathed into the respirometer until CO_2 and O_2 levels reached the previously established baseline taking their heart rate immediately and again at the end of recovery. Delay time between sprint completion, and breathing into the respirometer were accounted for.

•Measurements taken include; heart rate, tidal volume, relative VO_2, EPOC, respiratory rate, time to recovery, oxygen consumption, and carbon dioxide production.

•The data was analyzed using a paired T test with Dunn's correction for multiple comparisons, and EPOC (ml O_2/g) was calculated by multiplying the RelVO_2 (ml O_2/min/g) during recovery by the time to recover (min).

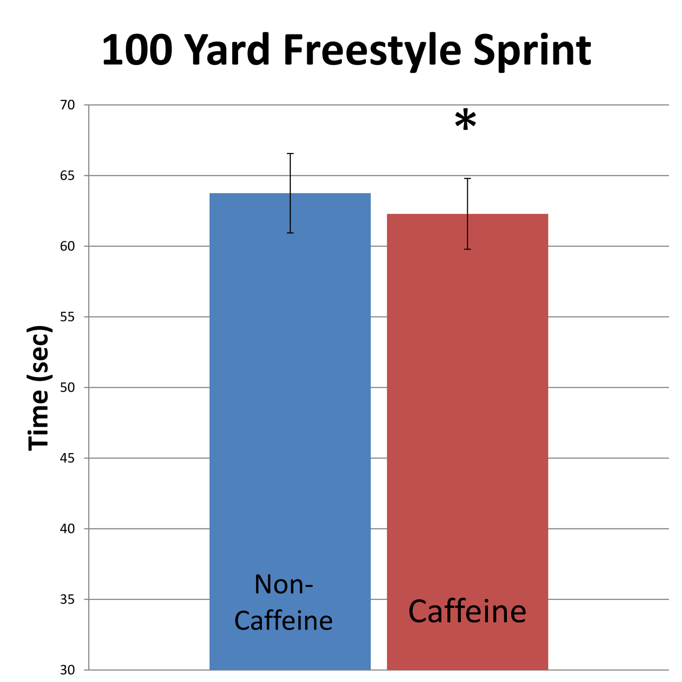

Figure 1. Average times for the 100 yard freestyle sprint. Values are mean +/- S.E., compared using paired t test; (* designates p≤0.05). On average, swimmers swam faster after drinking caffeine.

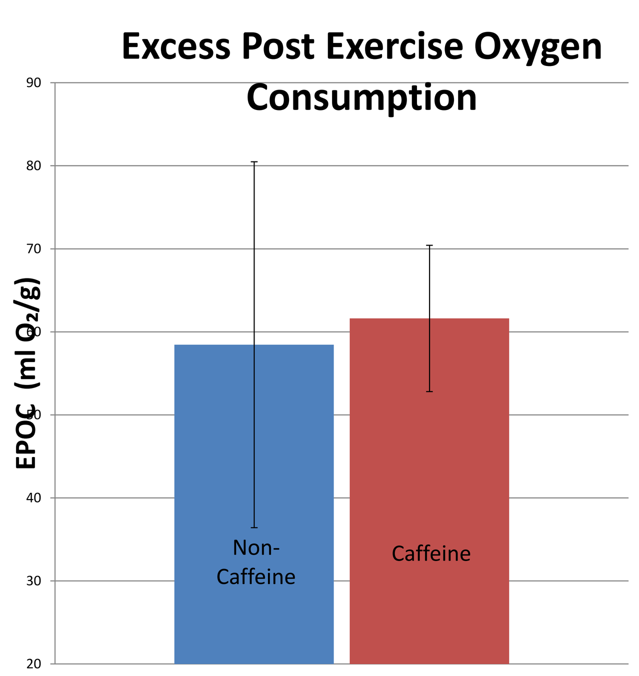

Figure 2. Excess post exercise oxygen consumption. This depicts the recovery phase post exercise. Values are mean +/- S.E., compared using paired t test

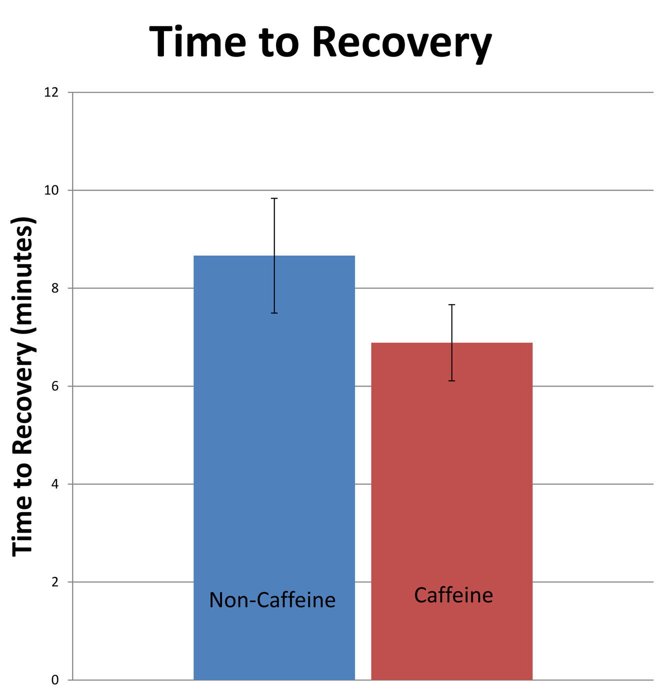

Figure 3. Time to recovery is the time from the end of the sprint, to the time oxygen and carbon dioxide levels reach baseline. Values are mean +/- S.E., compared using paired t test.

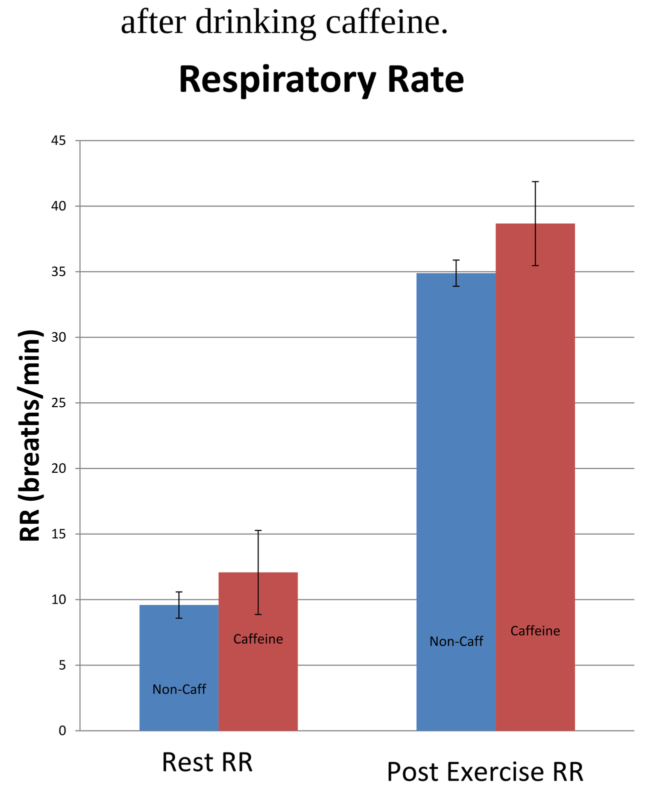

Figure 4. Respiratory Rate was measured and compared at rest and post exercise. Values are mean +/- S.E., compared using paired t test;.

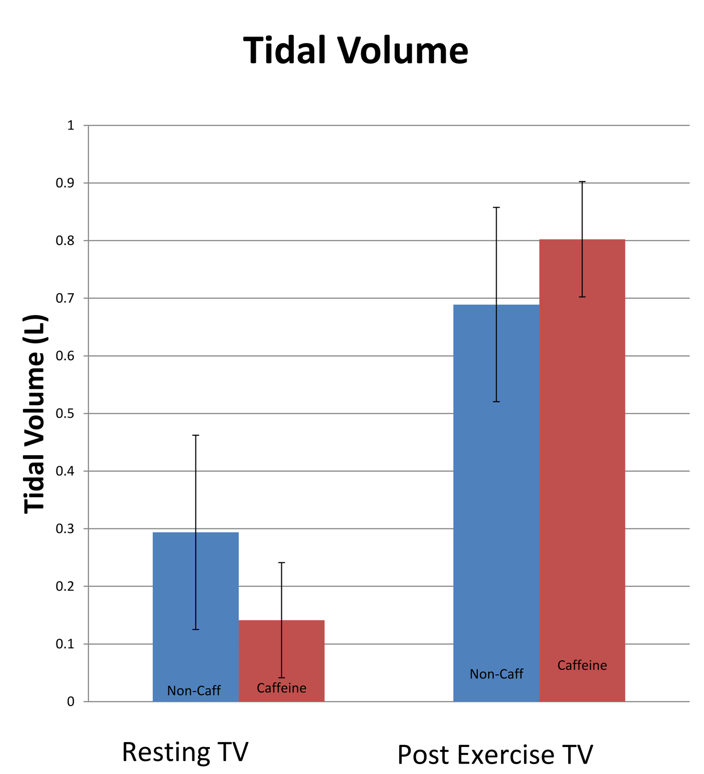

Figure 5. Tidal Volume resting prior to exercise, and post exercise, immediately following the sprint. Values are mean +/- S.E., compared using paired t test.

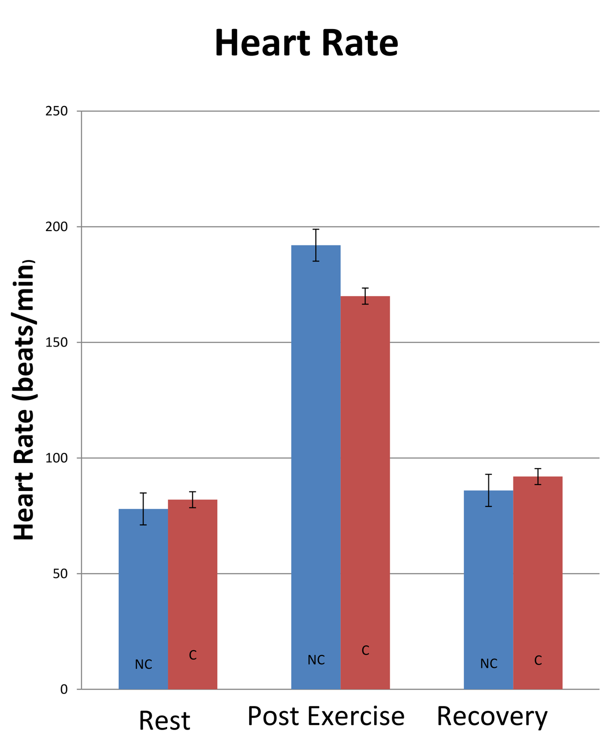

Figure 6. Heart rate was measured at three different points. Rest, post exercise, and after recovery. Values are mean +/- S.E., compared using paired t test with Dunn's correction for multiple comparisons.

Figure 7. Face mask, head strap and valve for Iworx GA-300 gas analyzer.

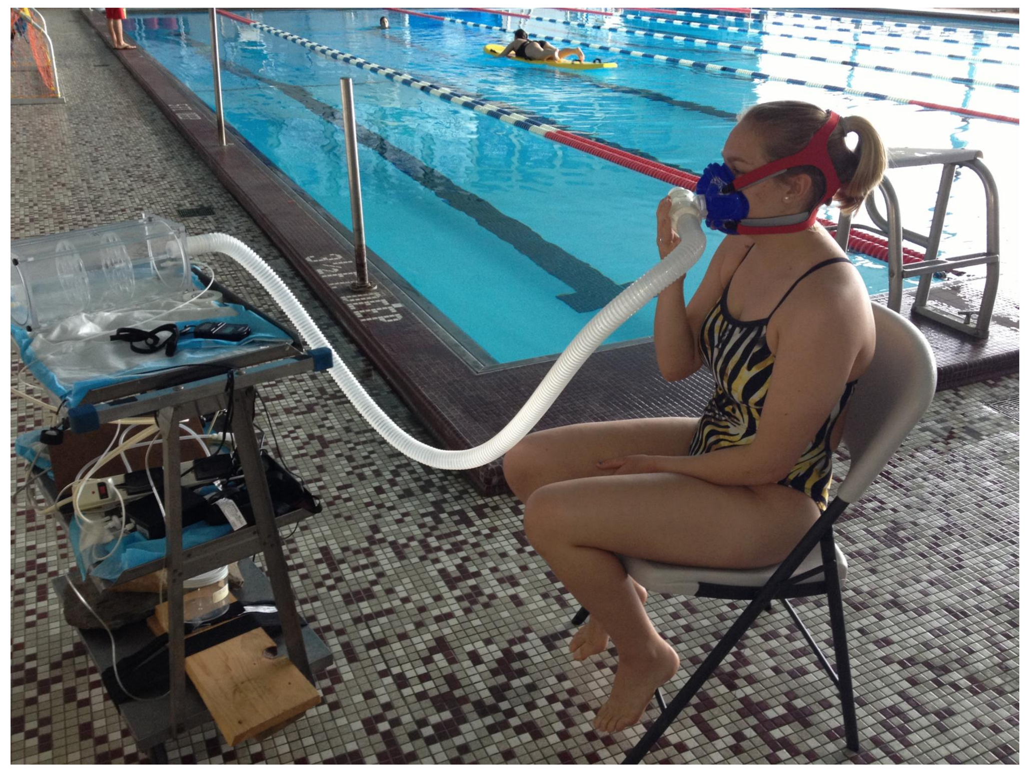

Figure 8. Swimmer connected to breathing apparatus

Discussion

When swimmers drank caffeinated coffee, their times decreased thus improving performance. Mean metabolic and respiratory parameters were consistently higher with caffeine, however none were at a statistically significant level. The mean recovery time was also lower. Due to problems encountered with the equipment during the beginning of my testing, only three subjects were able to contribute data to the results show. More data is continuing to be collected to gain a better understanding of how caffeine effects the competitive swimmer .

References

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