The Effect of Caffeine on Maximal Oxygen Consumption (VO_2 max) and Lactate Threshold in Cross-Country Runners

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Abstract

THE EFFECT OF CAFFEINE ON MAXIMAL OXYGEN CONSUMPTION AND LACTATE THRESHOLD IN CROSS-COUNTRY RUNNERS
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Caffeine benefits endurance performance but evidence of its effects on maximal oxygen consumption (VO_2 max) and lactate threshold (LT) is limited. VO_2 max and lactate threshold are reliable gauges of training adaptation and highly correlate with endurance performance. Individuals can exercise longer and at a higher intensity with improvement in these parameters. **PURPOSE:** The purpose of this study was to examine the effects of a low caffeine dose (3 mg/kg) on VO_2 max and LT on an acute basis. A low dose of caffeine was used to minimize the risk of side effects. **METHODS:** Nine male collegiate cross-country runners (21 ± 2 yrs, 176 ± 7 cm, 70 ± 6 kg) were recruited to participate in the study based on their endurance ability and previous racing performances. The study was randomized and double blind with each subject tested on two separate occasions: once with caffeine (3mg/kg) and once with a placebo. The treatment was anhydrous caffeine mixed in 8 ounces of an artificially sweetened grape beverage (caffeine) or 8 ounces of the grape beverage (placebo). VO_2 max was determined using a treadmill, metabolic system, and an individualized protocol. Subjects dismounted the treadmill for 10-12 seconds every two minutes so blood lactate levels could be measured simultaneously with the VO_2 max test. Subjects provided urine samples before and after each test to assess hydration status. Each of the subjects gave informed, written consent. The research was formally approved by the Institutional Review Board of Saint John's University and the College of Saint Benedict. Each of the subjects gave informed, written consent. **RESULTS:** Caffeine resulted in mean increases of 3.26% for VO_2 max ($p < 0.003$), and 4.79% for LT ($p < 0.190$) compared to placebo. There were strong trends in the caffeine group for increases in maximum heart rates and power output although the results were not statistically significant ($0.05 < p < 0.10$). **CONCLUSION:** A low dose of caffeine [3 mg/kg] significantly increased subjects' aerobic capacity and anaerobic threshold which could allow a runner to maintain a faster pace for a longer period of time. These improvements can translate into enhanced performances in a race such as a marathon or 8K. The effects were accomplished without any reported side effects.

Introduction

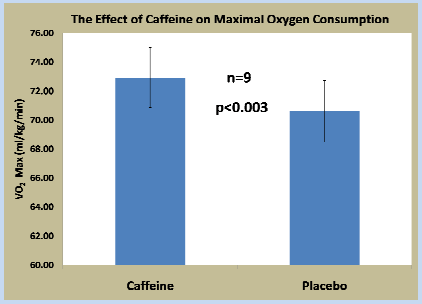
- Caffeine is a competitive inhibitor of adenosine receptors
- ↓ activity of adenosine receptors in ↑ systemic levels of dopamine and glutamate
- ↑ Psychostimulation and ↓ pain perception and fatigue
  - Caffeine increases catecholamine release during exercise
    -Potentiates cardiovascular effects of catecholamines
  - Caffeine increases β endorphin release during exercise
    -Decreases pain perception
    -Elevates feelings of comfort and well-being, especially during exercise

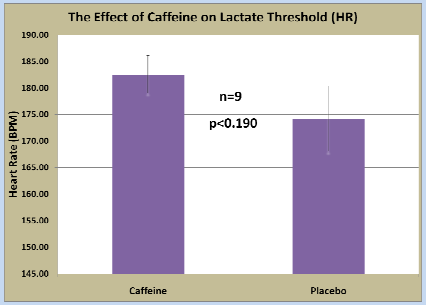
Procedure

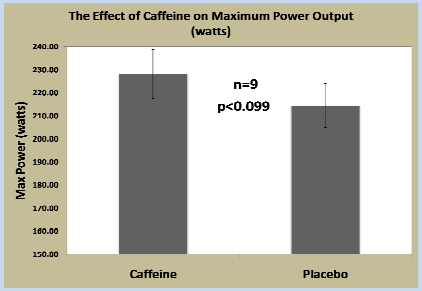
Subjects: Nine male collegiate cross-country runners (21 ± 2 yrs, 176 ± 7 cm, 70 ± 6 kg) Subjects recruited based on endurance ability

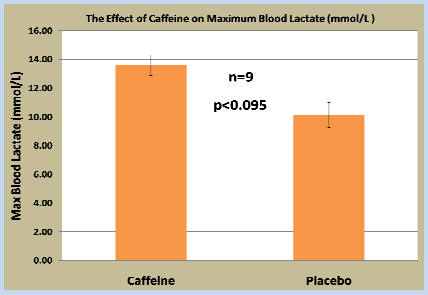
- Treatment [3 mg/kg] anhydrous caffeine w/ 8 ounces of artificially sweetened grape beverage
- Assigned randomly and coded to be *double-blind*
  –Beverage consumed 60 minutes before test
- Subjects provided pre and post-exercise urine sample to test for urine osmolalities

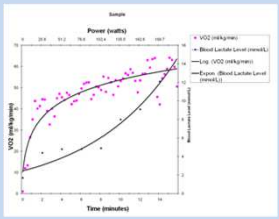
Results











Peak VO2 Max, Lactate Threshold Heart Rate, Blood Lactate, and Power Output with the 2 Beverage Treatments, Mean ± SD

	VO_2 Max (ml/kg/min)	Lactate Threshold (HR)	Max Blood Lactate (mmol/L)	Max Power (Watts)
Caffeine	72.91 ± 6.18	182.8 ± 10.5	13.60 ± 2.12	228.11 ± 31.6
Placebo	70.60 ± 6.35	174.22 ± 6.15	10.12 ± 2.64	214.49 ± 28.5
Difference	**2.31**	**8.58**	**3.48**	**13.62**

Discussion

- 3 mg/kg of caffeine significantly increased VO_2 max w/ no reported side effects
- VO_2 max ↑ by 3.26%
- Hydration status not a confounding variable
- Trends towards ↑ lactate threshold HR, power outputs and blood lactate values with caffeine
- Significant improvements may be due to adenosine antagonism and ↑ levels of catecholamines and β endorphins

Conclusion

- Caffeine can be an effective ergogenic aid in high intensity exercise
- A low dose of caffeine significantly ↑ VO_2 max without side effects
- 3.26% ↑ VO_2 max could
  ↓ 5K by 26 seconds
  ↓ 10K by 38 seconds
  ↓ Marathon time by 3.5 minutes

Future Research

- Assess caffeine's effects on performance in a field setting or a race
- Test women as well as men
- Determine plasma and urine concentrations of caffeine associated with 3mg/kg dose

Acknowledgements

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