Effects of Intermittent Caffeine Ingestion on Aerobic Power During a 16.1K Cycling Time Trial

Brett M. Warner, Lauren Clune, Jessica Weimert, Reuben Pine, Noah Smith, Brienne Wickenheiser, H. Scott Kieffer, FACSM, Presented at the American College of Sports Medicine Annual Meeting in San Diego, California, May, 2016.

PURPOSE: This study compared the efficacy of two different modes of caffeine administration on cycling performance during a 16.1K time trial (TT). **METHODS**: A randomized, placebo-controlled (PL) double-blind study was used to compare a caffeine bolus administered in a single dose via capsule to an intermittent bolus administered via caffeinated gum. Eight trained cyclists, 6 male, 2 female (Mean±SD: 27.8±11.8 years, 76.7±13.9 kg, 176.1±8.2 cm, VO_{2peak} = 47.9±6.4 ml·kg^{-1}·min^{-1}) completed one familiarization and three experimental trials. During the first session, the cyclists completed a graded cycling protocol to determine VO_{2peak} and an orientation to the Velotron cycle ergometer. During the experimental trials, the subjects received a dual $pill_p$-gum_g bolus containing either a placebo (PL) or caffeine (CAF) dose equal to 5 mg·kg^{-1} of body mass. The pill-gum combination included PL_p-PL_g, PL_p-CAF_g and CAF_p-PL_g. The pill was given 60 minutes prior to the TT and the gum was given in equal doses at 5 minutes prior to the TT and at 8K. Subjects performed the 16.1K TT on a 2% ramped incline with VO_2, RER, HR, Watts, and RPM measured continuously. Data was analyzed using a two-way ANOVA (condition x time). **RESULTS**: There was no statistical difference in finish time for any condition, PL_p-PL_g = 2387.4±237.0, PL_p-CAF_g = 2393.5±194.5 and CAF_p-PL_g = 2410.8±228.7 s. There were no statistical differences for the main effects of condition for any variable, PL_p-PL_g, PL_p-CAF_g and CAF_p-PL_g for VO_2 (Mean±SD: 36.6±8.0; 36.5±7.0; 36.6±8.6 ml·kg^{-1}·min^{-1}, respectively), Watts (204.9±33.1; 202.34±32.9; 200.2±33.4 W, respectively), or HR (163.4±20.8; 168.4±21.7; 163.1±24.0 bpm, respectively). In addition, there were no significant differences for VO2, Watts, or HR across the TT; however, significant decreases were found in RER and decreases in RPM (Mean RER = -7.1% (P = 0.001); Mean RPM = -4.4% (P = 0.34)). No interaction effects were found. **CONCLUSION**: The present findings indicate 5 mg·kg^{-1} of caffeine does not improve overall 16.1K TT performance, metabolic response, or cycling efficiency with no statistical difference between a single bolus dose in capsular form or intermittent doses in gum form. RER decreases over distance as the body may increase fat utilization, and RPM decreases over distance as subjects succumb to fatigue.

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Abstract

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Introduction

Research supports the notion that caffeine may have ergogenic effects during endurance-based exercise (Conway et al., 2002; Graham et al., 1991; McNaughton, et al., 2008). Specifically, studies show that ingestion of caffeine prior to endurance cycling increases exercise time to exhaustion (Graham et al.; Simmonds et al., 2010) and distance traveled within a specific time frame of prolonged activity (McNaughton, et al.). However, the timing of caffeine ingestion is an important factor that has not been fully studied. Many studies have been conducted in which participants received the full caffeine dosage sixty to ninety minutes prior to activity (Graham et al.; McNaughton, et al.; Simmonds et al.) but few studies used intermittent ingestion during exercise. The emerging research suggest that intermittent caffeine improves performance but not prior-ingestion groups (Conway et al.) yet others suggest that caffeine has no effect on performance (Hunter et al., 2002). Therefore, the effect of caffeine varies based on ingestion time.

Human buccal mucosa has been studied as an alternative for drug ingestion (Campisi et al., 2010). The extensive permeability of buccal cells offers many advantages including increased bioavailability, an increased absorption rate, and a more predictable effect (Campisi et al.). An increased absorption rate increases the speed of delivery, of which the onset of drug action is often dependent upon (Kamimori et al., 2002). Gum has been shown to be a quick and effective transbuccal administrator of caffeine (Kamimori et al.; Campisi et al.; Syed et al., 2005; McLellan et al., 2004; Bellar et al., 2011). Previous studies have shown that caffeine elicits a quicker dynamic response when administered in gum form as opposed to capsular form (Kamimori et al.). The bioavailability of caffeine absorption was comparable to that of the capsule, and the absorption rate was much faster (Kamimori et al.). Within 5-10 min of administration, onset of action from the drug delivery occurred (Kamimori et al.).

Purpose

Therefore, the purpose of this study was to compare the efficacy of two different modes of caffeine administration on cycling performance during a 16.1K time trial. It was hypothesized in the null form that there will be no difference between average heart rate, RER, VO_2, power, and performance following a 16.1K TT between trials with caffeine ingested via gum (5mg•kg^{-1} body weight) dosed intermittently (2equal doses), a onetime dose (5mg•kg^{-1} body weight) one hour prior to performance, or a placebo dose.

Methods

Eight trained cyclists, 6 male, 2 female (Mean±SD: 27.8±11.8 years, 76.7±13.9 kg, 176.1±8.2 cm, VO_{2peak} = 47.9±6.4 ml·kg^{-1}·min^{-1}) participated in the study. Upon the initial visit to the lab, each subject submitted a health history questionnaire and informed consent. Demographic data such as age, height, and weight was recorded for data entry in the computer software. Each subject completed a portion of the course (approx. 10 minutes) with the heart rate monitor and the headgear of the Moxus II specifically fitted to their head and adjusted for comfort. Each subject additionally completed a graded maximal oxygen consumption protocol on the Velotron cycle ergometer.

Subjects completed 3 16.1K TT with a minimum of one week of rest between trials. The virtual 10 mile course contained a constant 2% incline and was projected on a television screen connected to the Velotron cycling software (Figure 1). Subjects reported to the Human Performance Lab approximately one hour prior to each test protocol. They then ingested a pill consisting of either placebo or caffeine in the amount of 5 mg·kg^{-1} body weight. Five minutes prior to the start of the protocol the subjects were given a bolus of placebo or caffeinated gum equal to 1/2 the weight of the measured dose. At the halfway point, the subject will be given an additional 1/2 of the required total gum weight for the entire protocol. VO_2 and RER were measured continuously while heart rate, power in watts, and RPM were measured each minute. Final completion time was recorded.

Figure 1. Screenshot of the Velotron Cycling Protocol

Results

There were no statistical differences for the main effects of condition for mean finish time (Figure 2), VO_2 (Figure 3), mean power (Figure 4), or mean heart rate (Figure 5). In addition, there were no significant differences for, VO_2 power, or heart rate across the time trial.

Significant decreases were found in RER (-7.1%, p = 0.001) across the time trial (Figure 6). Decreases were found in RPM (-4.4%, p = 0.3), though not significant. No interaction effects were found for RER or RPM.

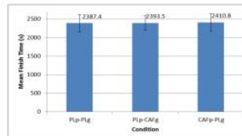

Figure 2. Mean finish time across conditions

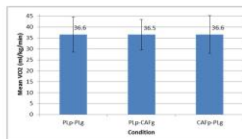

Figure 3. Mean VO_2 across conditions.

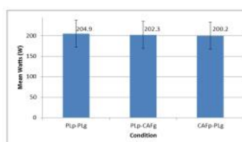

Figure 4. Mean watts across conditions

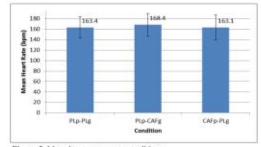

Figure 5. Mean heart rate across conditions.

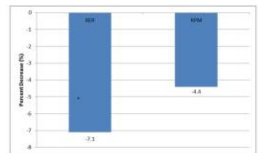

Figure 6. RER and RPM across the time trial. * p = 0.001

Conclusions

- **5mg•kg^{-1} of caffeine does not improve overall 16.1K TT performance, metabolic response, or cycling efficiency.**
- **There was no statistical difference between a single bolus dose of caffeine in capsular form or intermittent doses in gum form.**
- **RER decreases over distance as the body may increase fat utilization**
- **RPM decreases over distance as subjects succumb to fatigue**

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