

Liquid Carbohydrate Feeding Improves Self-Selected Exercise Performance During A 24km Hike

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General Summary

Field research with Hotshot crews had previously found that blood glucose was reduced late in the afternoon when supplemental carbohydrates were not eaten. During those studies, the work that the crewmembers were required to accomplish was not controlled and so some questions remained concerning the data collection techniques even though the trials had been a randomized, blinded cross-over design across two crews.

The current research was an effort to evaluate blood glucose levels and self selected work rates during extended low intensity work in a more controlled setting. 12 students hiked 24 km twice; once with supplemental carbohydrates every 4 km (about 160 calories/hour) and once with a placebo.

During the final 12 km of the hike blood glucose was statistically lower and hiking rates were reduced 10% in the placebo trial compared to the carbohydrate trial. There were no differences in perceived exertion between trials suggesting that subjects did not yet perceive that there was a problem with blood glucose.

These data duplicated what we found with firefighters during extended workdays when they did not eat supplemental carbohydrates. In both studies, self-selected work rates were reduced under the placebo intervention.

The practical implications for these findings are that wildland firefighters need to eat small amounts frequently between meals. The food should be high in carbohydrates (sugars, pasta, grains, potatoes) and be the equivalent of about 150 calories an hour. This is especially important during the afternoon.



A summary of the scientific report follows on the next page.

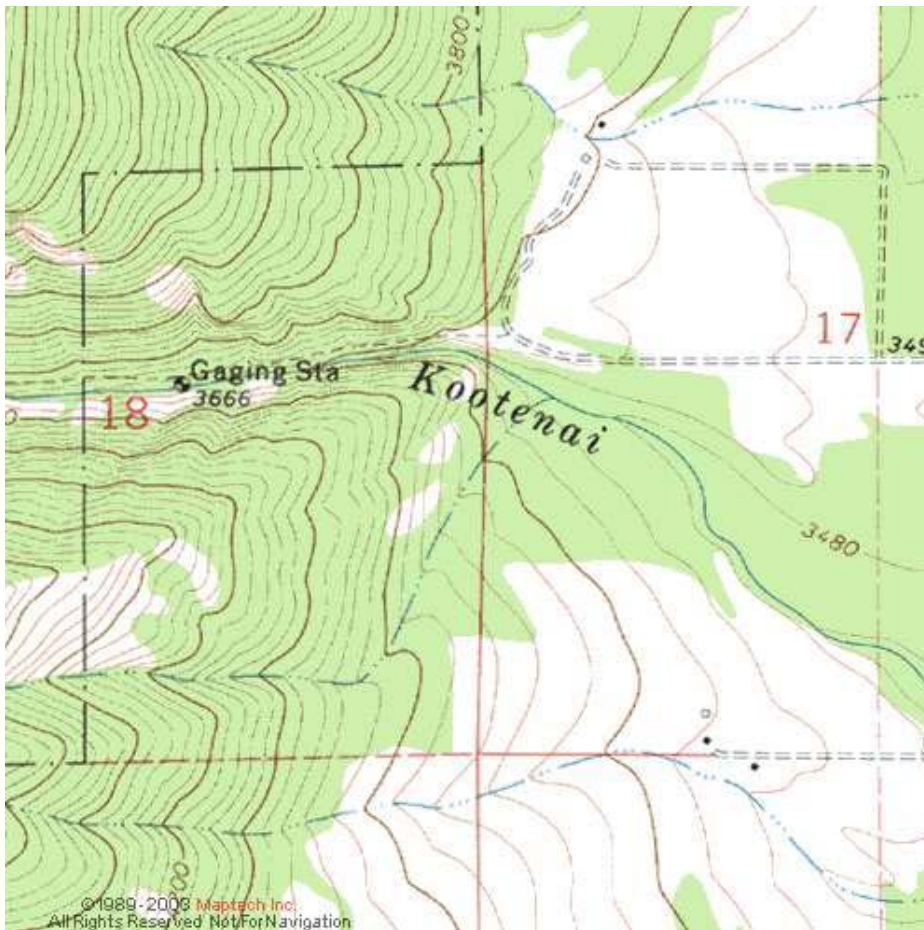
Liquid Carbohydrate Feeding Improves Self-Selected Exercise Performance During A 24km Hike

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Abstract

During prolonged exercise, when muscle glycogen stores are depleted, blood glucose can assume 100% of the total carbohydrate (CHO) oxidation. The effectiveness of exogenous CHO during endurance exercise has been widely documented. However, CHO ingestion during extended exercise at lower intensities has received little attention. PURPOSE: To determine the effects of carbohydrate feeding on blood glucose and self-selected hiking speed during a prolonged submaximal exercise bout. METHODS: Subjects (n=12) completed two extended hikes (24K) in a single-blind double-crossover design 7 days apart. Blood glucose concentration was measured pre, post, and hourly during the hike using an automated glucometer.

Concurrently, subjects consumed 200mL of a CHO (40g·hour⁻¹, 20% maltodextrin) or placebo (PLA) drink hourly. Rating of perceived exertion (RPE) was also recorded hourly using the Borg 6-20 scale. Data were analyzed using a priori planned comparisons across trials. RESULTS: Blood glucose was similar prior to exercise and for the first 8K of the hike. Thereafter blood glucose remained significantly higher ($p<0.05$) during the CHO trial (12K: CHO=6.1±0.9, PLA=5.2±0.6; 16K: CHO=6.3±1.0, PLA=5.4±1.1; 20K: CHO=7.8±1.0, PLA=5.8±1.2; 24K: CHO=7.4±0.9, PLA=5.7±1.0 mM). Subjects self-selected a faster hiking speed during the CHO trial as demonstrated by the significant difference in return time (124±15 and 136±12 minutes for the CHO and PLA trials, respectively, $p<0.05$) despite no differences in RPE values (11.92±3.00 vs. 11.75±2.30, $p<0.05$). CONCLUSION: These data demonstrate that supplemental CHO feedings can improve self-selected exercise performance during low to moderate extended hiking regardless of the subject's rating of perceived exertion.



Introduction

During long duration exercise muscle glycogen may become depleted and blood glucose can assume 100% of the total CHO oxidation often resulting in low blood glucose, reduced cognitive function and reduced work output. Welsh, R.S. et al. had subjects consume either a placebo (PLA) or a carbohydrate (CHO) drink before and at half-time of four 15-minute exercise trials which mimicked intermittent high-intensity exercise similar to competitive soccer or basketball and found that CHO improved performance. Angus D.J. et al. instructed eight endurance trained men to complete a cycle trial as quickly as possible when consuming either a CHO or PLA beverage, again with improved performance with CHO supplementation. Both studies show that CHO improved performance, as compared to the PLA drink, during short term laboratory studies. Few studies have been completed on CHO feedings during extended sub-maximal exercise.



Purpose

This study was designed to determine the effects of CHO feeding on blood glucose and self-selected hiking speed during a prolonged 6 hour sub-maximal exercise bout.

Methods

- Twelve recreationally trained males (n=6) and females (n=6) completed this study.
- VO_2 peak was measured prior to the hikes via a graded exercise test using a walking protocol with increasing grade (4 mph, 1% grade increase each minute to volitional exhaustion).
- Body composition was measured prior to the hikes via hydrostatic weighing.
- Subjects fasted for 12 hours prior to pre-hike data collection in the laboratory.
- Subjects consumed a standardized breakfast (granola bar, banana, six-ounce juice) the morning of each hike.
- Subjects completed two extended hikes (24K) in a single-blind, double-crossover design seven days apart.
 - BG was measured prior to breakfast, upon arrival at the trailhead and approximately every 4K for the duration of the hike using an automated glucometer (One Touch Ultra).
 - Rating of perceived exertion (RPE) was recorded using a Borg 6-20 scale every 4K.
 - CHO beverage was consumed at a rate of 200 mL every 4K (40g $hour^{-1}$, 20% maltodextrin) or PLA drink (similar flavoring w/o CHO).
 - For the final 12K, subjects self selected their pace and were encouraged to return to the trailhead as fast as they could.
- Data were analyzed using a priori planned comparisons across trials.

Results:

Descriptive variables for the 12 subjects (6 males and 6 females) are shown in the table below.

Variable	Mean±SD
Height (cm)	168.20 ± 9.31
Weight (kg)	65.43 ± 16.47
VO ₂ peak (ml/kg/min)	47.95 ± 6.41
VO ₂ peak (l/min)	3.13 ± 0.83



Figure 1 shows the changes in blood glucose during the course of the hike. Each sample was taken at approximately 4km intervals. From 16km on, blood glucose was significantly higher in during the carbohydrate trial than with placebo. While blood glucose was never clinically low, the differences did have an effect on performance.

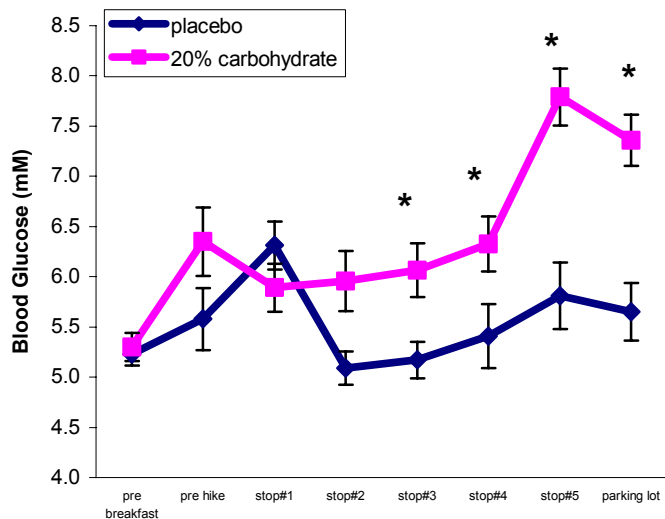


Figure 1. Changes in blood glucose across the two exercise trials. * p<0.05 vs. placebo.

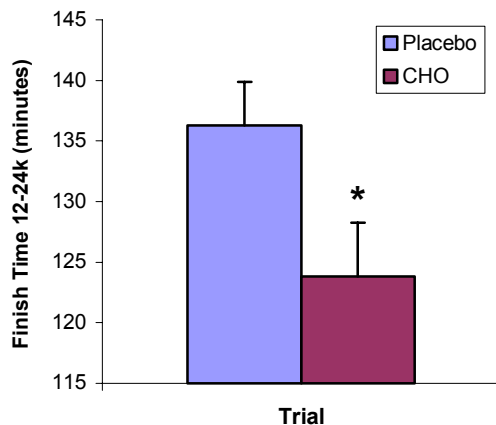


Figure 2. Return time (minutes) from the 12k turnaround to the finish at 24k * p<0.05 vs. placebo.

Figure 2 shows that the subjects selected a higher hiking speed during the final half of the hike when receiving the carbohydrate supplement as opposed to placebo. This difference represented about a significant difference of about 10%.

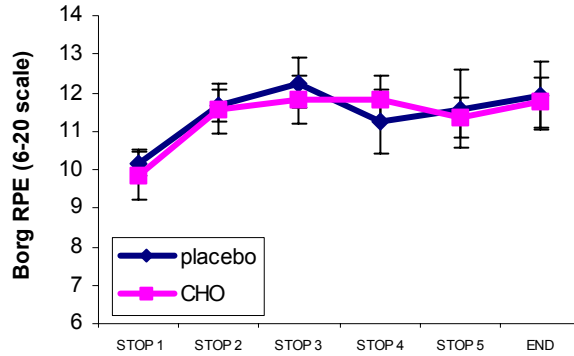


Figure 3. Changes in RPE during the two extended hike trials.

Figure 3 shows that there were no difference in rating of perceived exertion (RPE) during the two hikes either with carbohydrate supplementation or placebo.

Discussion and Conclusions

In prior research with cyclists during relatively short duration, high intensity exercise, el-Sayed, et al. found that a significantly greater workload was accomplished in the CHO trial as compared to the PLA trial. This is consistent with our findings during long duration, low intensity, that CHO ingestion improves maximal exercise performance.

Wright, et al. demonstrated that performance was improved by ingesting CHO before and/or during exercise, and even better in combination, which is probably due to enhanced CHO oxidation during later stages of exercise. This supports our results, which show an improvement in performance during the CHO trial, during the final 12K of the hike. Finally, Ball, et al. showed that CHO consumption, during exercise, improves performance, particularly following an overnight fast.

This study was unlike previous studies in that the intensity of exercise was kept low (hiking). Our findings show that exercise performance during CHO was improved during the last 12K of the 24 km hike even though blood glucose values in the placebo group were not clinically low and there was no feeling of distress (RPE not different between trials). These data demonstrate that supplemental CHO feedings can improve self-selected exercise performance during low to moderate extended hiking, regardless of the subject's RPE.



References

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