Opposition of Carbohydrate in a Mouth-Rinse Solution to the Detrimental Effect of Mouth Rinsing During Cycling Time Trials

Sharon Gam, Kym J. Guelfi, and Paul A. Fournier

Studies have reported that rinsing the mouth with a carbohydrate (CHO) solution improves cycling time-trial performance compared with rinsing with a placebo solution. However, no studies have compared the effect of mouth rinsing with a no-mouth-rinse control condition. The aim of this study was to compare the effects of a CHO mouth rinse with those of a placebo rinse and a no-rinse condition. Ten male cyclists completed three 1,000-kJ cycling time trials in a randomized, counterbalanced order. At every 12.5% of the time trial completed, participants were required to rinse their mouths for 5 s with either a 6.4% maltodextrin solution (CHO), water (WA), or no solution (CON). Heart rate and ratings of perceived exertion (RPE) were recorded every 25% of the time trial completed. Time to completion was faster in both CHO (65.7 ± 11.07 min) and CON (67.6 ± 12.68 min) than in WA (69.4 ± 13.81 min; \( p = .013 \) and \( p = .042 \), respectively). The difference between CHO and CON approached significance (\( p = .086 \)). There were no differences in heart rate or RPE between any conditions. In summary, repeated mouth rinsing with water results in decreased performance relative to not rinsing at all. Adding CHO to the rinse solution appears to oppose this fall in performance, possibly providing additional benefits to performance compared with not rinsing the mouth at all. This brings into question the magnitude of the effect of CHO mouth rinsing reported in previous studies that did not include a no-rinse condition.

**Keywords**: maltodextrin, ratings of perceived exertion, ergogenic aid, control condition

Several studies have reported that repeated mouth rinsing with a carbohydrate (CHO) solution can significantly improve performance in relatively short-duration (<1 hr), high-intensity exercise. The first of these studies was conducted by Carter, Jeukendrup, and Jones (2004), who examined the effect of rinsing the mouth with a CHO solution without ingesting it to prevent exogenous CHO oxidation from affecting performance. Participants completed 1-hr cycling time trials during which they rinsed their mouths with either a 6.4% maltodextrin solution or a plain-water placebo for 5 s at every 12.5% of the time trial completed. A small significant improvement in performance was observed with the CHO rinse compared with the placebo. Since then, several other studies have been performed using a similar design to investigate the effects of CHO mouth rinsing on performance, and some (Chambers, Bridge, & Jones, 2009; Pottier, Bouckaert, Gilis, Roels, & Derave, 2010; Rollo, Cole, Miller, & Williams, 2010; Rollo, Williams, Gant, & Nute, 2008) but not all (Beelen et al., 2009; Whitham & McKinney, 2007) have corroborated the findings of Carter et al. For comprehensive reviews of these studies investigating the effect of mouth rinsing CHO solutions on endurance performance, see Rollo and Williams (2011), as well as de Salles Painelli, Nicastro, and Lancha (2010).

To explain the ergogenic effect of a CHO mouth rinse on exercise performance, Carter et al. (2004) postulated that there might be receptors in the oral cavity that detect the presence of CHO and send signals to the brain, possibly activating reward or pleasure centers, which in turn may enhance exercise performance. In support of this view, rinsing the mouth with either glucose or maltodextrin, but not an artificially sweetened placebo containing no CHO, was found to activate brain regions that are believed to mediate the behavioral and autonomic responses to rewarding stimuli (e.g., the anterior cingulate cortex and the right caudate that forms part of the striatum; Chambers et al., 2009).

Unfortunately, one major limitation shared by all of the endurance-based CHO-mouth-rinse studies conducted to date is that none have compared the effect of a CHO mouth rinse with a no-mouth-rinse control condition (Beelen et al., 2009; Carter et al., 2004; Chambers et al., 2009; Pottier et al., 2010; Rollo et al., 2010; Rollo et al., 2008; Whitham & McKinney, 2007). Although two recent studies included no-rinse control conditions, they...
investigated the effect of a CHO mouth rinse on maximal strength (Painelli et al., 2011) and maximal sprint performance (Chong, Guelfi, & Fournier, 2011), and both administered mouth rinses before the start of exercise, rather than during exercise as in the endurance-based studies. This leaves untested the possibility that the act of repeatedly rinsing the mouth during exercise may in itself have a detrimental effect on performance, possibly by interrupting the athlete’s concentration and focus or by interrupting the breathing cycle, since participants must either hold their breath or breathe through the nose (either of which would change the natural breathing cycle) while the solution is rinsed in the mouth. This latter possibility is supported by studies that have found that breathing entrainment (the synchronization of the rhythm of breathing with the rhythm of exercise) can improve efficiency by decreasing VO2 for a given workload (Bonsignore, Morici, Abate, Romano, & Bonsignore, 1998; Garlando, Kohl, Koller, & Pietsch, 1985). The benefit of adding CHO to the mouth-rinse solution may be that it opposes the negative effect associated with repeated mouth rinsing per se, with no improvement in performance compared with a no-mouth-rinse control condition. For this reason, the aim of this study was to compare the effect of a CHO mouth rinse with a plain-water mouth rinse, as well as the no-mouth-rinse control condition. For this reason, we hypothesized that the CHO mouth rinse would improve cycling time-trial performance compared with a plain-water mouth rinse, but not compared with a no-rinse condition.

Methods

Participants

Ten healthy, moderately trained male cyclists provided written consent to participate in this study, with this number of participants based on sample-size calculations using the findings of Carter et al. (2004). Their mean age, body mass, sum of skinfolds, percentage body fat (using the equation from Jackson & Pollock, 1978), VO2peak, Wmax, and anaerobic threshold were 29.6 ± 6.6 years, 79.04 ± 10.80 kg, 78.3 ± 17.6 mm, 11.36% ± 2.67%, 53.85 ± 5.40 ml · kg⁻¹ · min⁻¹, 378 ± 58 W, and 293 ± 55 W, respectively (M ± SD). All participants were competitive or recreational cyclists who, at the time of the design of this study with the original mouth-rinsing study (Carter et al., 2004), each participant was exposed to only one familiarization session, an assessment of maximal aerobic capacity (VO2peak test), and three 1,000-kJ cycling time trials conducted following a randomized, counterbalanced design. The time trials consisted of a CHO-rinse trial (CHO), a plain-water-rinse trial (WA), and a no-rinse control trial (CON). Sessions were conducted at the same time of day for each participant after a 4-hr postprandial period during which no food was consumed, in accordance with previous studies including that of Carter et al. (2004). Participants were instructed to abstain from alcohol, caffeine, tobacco, and exercise during the 24-hr period before each visit. Since the ergogenic benefit of a CHO mouth rinse may depend on nutritional status (Beelen et al., 2009), participants were also asked to record all food and drink intake including the type of food, the amount consumed, and the timing of consumption in a diary for 24 hr before each time trial, including the meal ingested 4 hr before the time trial. To ensure that preexercise food intake was standardized, a copy of the food record from the first trial was provided to each participant before each subsequent trial and they were instructed to replicate this energy intake as closely as possible before each trial (Jeacocke & Burke, 2010). Compliance was confirmed on arrival at the laboratory for each experimental trial after inspection of food diaries from the prior 24 hr by the investigator.

Experimental Design

Participants attended the laboratory on five occasions, each separated by 7 days. These sessions included a familiarization session, an assessment of maximal aerobic capacity (VO2peak test), and three 1,000-kJ cycling time trials conducted following a randomized, counterbalanced design. The time trials consisted of a CHO-rinse trial (CHO), a plain-water-rinse trial (WA), and a no-rinse control trial (CON). Sessions were conducted at the same time of day for each participant after a 4-hr postprandial period during which no food was consumed, in accordance with previous studies including that of Carter et al. (2004). Participants were instructed to abstain from alcohol, caffeine, tobacco, and exercise during the 24-hr period before each visit. Since the ergogenic benefit of a CHO mouth rinse may depend on nutritional status (Beelen et al., 2009), participants were also asked to record all food and drink intake including the type of food, the amount consumed, and the timing of consumption in a diary for 24 hr before each time trial, including the meal ingested 4 hr before the time trial. To ensure that preexercise food intake was standardized, a copy of the food record from the first trial was provided to each participant before each subsequent trial and they were instructed to replicate this energy intake as closely as possible before each trial (Jeacocke & Burke, 2010). Compliance was confirmed on arrival at the laboratory for each experimental trial after inspection of food diaries from the prior 24 hr by the investigator.

Familiarization Session

For the first session, participants had their skinfold measurements taken at seven sites (triceps, pectoral, midaxillary, subscapular, iliac crest, midabdominal, and thigh). Then, they completed a 1,000-kJ familiarization cycling time trial during which a plain-water mouth rinse was administered, to become accustomed to the equipment, practice their pacing strategy, and become accustomed to the use of a mouth rinse during exercise. To match the design of this study with the original mouth-rinsing study (Carter et al., 2004), each participant was exposed to only one familiarization session. All testing was completed on an air-braked cycle ergometer (Evolution Pty. Ltd., Adelaide), with resistance being related to pedaling rate. The ergometer was connected to a computer running a customized program (Cyclemax, School of Sports Science Exercise and Health, University of Western Australia, WA, Australia) that allowed for the measurement of work and power output every 0.2 s.

Determination of VO2peak

In a separate visit, participants completed an incremental exercise test to determine their VO2peak. The test consisted of 3-min stages with 1 min rest between stages, with participants cycling at a set power output that increased by 50 W in each stage. The 1-min rest periods served
to allow for the collection of capillary blood samples that were analyzed for blood lactate concentration to determine the anaerobic threshold for each participant. The test continued until volitional exhaustion or until the participant was unable to maintain the prescribed power output. During this test, participants breathed through a mouthpiece connected to a Hans Rudolph valve and tubing into a computerized gas-analysis system (Meta 2000, School of Sports Science Exercise and Health, University of Western Australia). This system consisted of a ventilometer (Morgan, Kent, United Kingdom) to measure the volume of inspired air and Ametek Applied Electrochemistry S-3A/I oxygen and CD-3A carbon dioxide analyzers (AEI Technologies, Pittsburgh, PA) to measure the fraction of O2 and CO2 in expired air. The ventilometer was calibrated before the test using a 1-L syringe, while the O2 and CO2 analyzers were calibrated against a beta gas containing a known physiological concentration of O2 and CO2 (BOC Gases Australia Ltd.). The criterion for reaching VO2peak was the attainment of two of the following three conditions: a plateau of age-predicted maximum.

**Experimental Trials**

For the following three experimental sessions, participants completed a 1,000-kJ time trial with either a CHO mouth rinse (CHO), a plain-water mouth rinse (WA), or a no-rinse control (CON) administered in a randomized counterbalanced order. A 1,000-kJ time trial was chosen to reflect a 40-km cycling time trial (Ihsan, Landers, Brearley, & Peeling, 2010). On arriving at the laboratory, participants had their body mass measured and were fitted with a heart-rate monitor (Garmin Ltd., Olathe, KS). They then completed a 5-min warm-up at a standardized power output (100–200 W) based on their familiarization-trial performance. Seat and handlebar heights were the same during each time trial for each participant. After the warm-up, a blood sample was collected from the fingertip in a 35-μl heparinized capillary tube (Clinitubes, Radiometer, Copenhagen, Denmark), which was analyzed immediately using a blood-gas analyzer (ABL 725, Radiometer) to determine blood glucose and blood lactate concentrations.

Participants were asked to complete the time trial in the fastest time possible. During the time trial, the computer display was covered so participants could only see the number of kilojoules remaining. For the mouth-rinse trials, participants were given either 25 ml of a 6.4% maltodextrin solution (CHO; Polycose, Ross Nutrition, Columbus, OH) or 25 ml of plain water (WA) in a plastic cup to rinse in the mouth every 12.5% of the time trial completed or they were given no rinse at all (CON). Maltodextrin was chosen because it has a nonsweet taste and it has been reported to have an ergogenic effect on cycling performance (Carter et al., 2004). Each participant was instructed to rinse his mouth with the solution for 5 s, then spit the solution back into the plastic cup. The expelled fluid was measured to determine if any was ingested.

Every 25% of the time trial completed, the participants’ heart rates were recorded and they were asked to rate their perceived exertion using the 6- to 20-point Borg scale (Borg, 1982). During the trials, interaction between the participant and investigator was kept to a minimum, with the investigator only approaching the participant to administer mouth rinses and record heart rates and RPE. After the time trial was completed, another 35-μl blood sample was taken from the fingertip, blood glucose and lactate concentrations were recorded, and body mass was again measured to evaluate water loss.

**Data Analysis**

The main dependent variable (time to completion) was compared between the three experimental trials using one-way repeated-measures analysis of variance (ANOVA). Other variables that were compared between the experimental trials included performance time for each 12.5% segment of the time trials, blood glucose, blood lactate, body-mass loss, expelled solution, heart rate, and ratings of perceived exertion. These were analyzed using two-way repeated-measures ANOVA. Fisher’s least significant difference was used as appropriate for post hoc comparisons. In addition, average power output was recorded for 10 s during each mouth-rinse period (to capture the time of the 5-s mouth rinse) and compared with the power output for 10 s midway between consecutive mouth rinses (i.e., when no rinse was being performed) using Student’s *t* tests. Statistical significance was accepted at *p* < .05 (SPSS 17.0 for Windows computer software). As described by Hopkins (2007), the *p* value was converted into 90% confidence intervals (CI) for, and inferences about, the true value of the effect statistic. All results were expressed as *M* ± *SD*.

**Results**

**Total Time to Completion**

There was a significant main effect of treatment on total time to completion for the time trials (*p* = .020). Post hoc analysis revealed that time to completion in the WA condition (69.4 ± 13.81 min) was significantly slower than both the CHO (65.7 ± 11.07 min; *p* = .013; ES = 0.30; mean % change ± 90% CI = 5.4% ± 3.9%) and CON conditions (67.6 ± 12.68 min; *p* = .042; ES = 0.14; mean % change ± 90% CI = 2.7% ± 2.5%). There was no significant difference in time to completion between CHO and CON (*p* = .086; Figure 1) despite increased performance in the CHO condition, with a mean percentage change similar to that between the WA and CON trials (mean percentage change ± 90% CI = 2.8% ± 4.0%). Figure 2 shows the individual change in time to completion for WA and CHO compared with CON. Eight of the 10 participants completed the time trial faster in CHO than in CON, while 8 out of 10 participants completed the WA condition slower than in CON. Of note, there was
Figure 1 — Time to completion for a 1,000-kJ cycling time trial performed with no rinse at all (CON) or regular rinsing of the mouth with either a water solution (WA) or a carbohydrate solution (CHO), $M \pm SD$ ($N = 10$). *Significant difference from WA ($p < .05$).

Figure 2 — Time to completion for each individual participant during a 1,000-kJ cycling time trial performed with regular rinsing of the mouth with either a water solution (WA) or a carbohydrate solution (CHO) compared with a no-rinse condition (CON).
no effect of the order of trial administration on total time to completion \( (p = .137) \), suggesting that the familiarization trial was sufficient to negate any learning effects. In addition, the coefficient of variation between the familiarization trial (which included a water rinse) and the placebo water-rinse trial was 1.74\%, suggesting limited variability with the type of athlete and performance test used in this study.

**Time to Complete Each 12.5\% Segment**

There was a significant main effect of treatment on segment time to completion \( (p = .020) \), with post hoc analysis revealing that six of the eight segments of the CHO trial were significantly faster than in WA. CON was also significantly faster than WA at 75\% of the time trial completed. There were no significant differences between CON and CHO at any period during the time trials (Figure 3).

**Power Output**

Average power output recorded for 10 s during the mouth-rinse period was not significantly different from that recorded during the 10-s segment midway between consecutive mouth rinses. However, there was a tendency for lower power outputs around the time of rinsing for both WA and CHO trials compared with average power output during the 10-s segment midway between consecutive mouth rinses, as indicated by effect sizes of 0.49 and 0.53, respectively (Table 1).

**Heart Rate, RPE, Blood Glucose and Lactate Levels, Body-Mass Loss, Expelled Solution, and Environmental Conditions**

Heart rate and RPE did not differ between the three experimental treatments. However, within each trial, both heart

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**Table 1** Power Output Recorded for 10 s During the Mouth-Rinse Period Compared With Power Output Recorded During the 10-s Segment Midway Between Consecutive Mouth Rinses During a 1,000-kJ Cycling Time Trial, \( M \pm SD (N = 10) \)

<table>
<thead>
<tr>
<th>Power output</th>
<th>CHO</th>
<th>WA</th>
<th>CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rinse (W)</td>
<td>250 ± 9.50</td>
<td>254 ± 11.19</td>
<td>258 ± 9.69</td>
</tr>
<tr>
<td>Midway (W)</td>
<td>259 ± 9.66</td>
<td>260 ± 11.21</td>
<td>255 ± 10.81</td>
</tr>
<tr>
<td>( p )</td>
<td>.075</td>
<td>.091</td>
<td>.155</td>
</tr>
<tr>
<td>Effect size</td>
<td>0.53</td>
<td>0.49</td>
<td>−0.36</td>
</tr>
</tbody>
</table>

*Note.* Time trial performed with regular rinsing of the mouth with a carbohydrate solution (CHO), plain water (WA), or no rinse at all (CON).
rate and RPE increased steadily, reaching maximal values at 100% of the trial completed ($p < .001$; Figures 4 and 5). Likewise, there were no significant differences between trials for blood glucose and blood lactate levels, although both rose significantly within each trial (Table 2; $p = .007$ and $p < .001$, respectively). The loss of body mass and mean amount of solution expelled after each mouth rinse were similar between trials (Table 2; $p > .05$), as were the laboratory temperature and relative humidity (Table 2; $p > .05$).

Figure 4 — Heart-rate responses to a 1,000-kJ cycling time trial performed with no rinse at all (CON) or with regular rinsing of the mouth with either a water solution (WA) or a carbohydrate solution (CHO), $M \pm SD$ ($N = 10$). *Significant difference from baseline ($p > .05$).

Figure 5 — Rating-of-perceived-exertion (RPE) response to a 1,000-kJ cycling time trial performed with no rinse at all (CON) or with regular rinsing of the mouth with a water solution (WA) or a carbohydrate solution (CHO), $M \pm SD$ ($N = 10$). *Significant difference from the 25%-completed trial score ($p > .05$).
to note that the participants in the previous study were dehydrated, which may have made them more sensitive to the presence of plain water in the oral cavity. In addition, a time-to-exhaustion protocol is not as sensitive as a time-trial protocol (Jeukendrup, Saris, Brouns, & Kester, 1996), therefore making any direct comparison with the current study limited. Since it is highly unlikely that the increase in time to completion in the current study is associated with the presence of water in the mouth per se, we suggest that the act of repeatedly rinsing the mouth was responsible for the poorer performance. Indeed, there was a tendency (supported by moderate effect sizes) for average power output recorded for 10 s around the time of mouth rinsing to be lower in both CHO and WA than the average power output during the 10-s segment midway between consecutive mouth rinses. It is possible that the act of repeatedly rinsing the mouth during the time trials caused a loss of attention and focus on the task (i.e., to complete the time trial as fast as possible), which resulted in these transient declines in power output. These declines in power output, while small and short-lived, may have added up to cause an overall decrease in performance.

Alternatively, rinsing the mouth may have affected performance by impairing breathing entrainment, which is defined as the synchronization of the rhythm of breathing with the rhythm of exercise. It has been observed that breathing entrainment can increase efficiency by decreasing VO₂ for a given workload (Bonsignore et al., 1998; Garlando et al., 1985). This increase in efficiency has been attributed to the relaxing effect of breathing entrainment, which is thought to reduce the tone of the sympathoadrenal system, resulting in a reduction in VO₂ for a given workload (Garlando et al., 1985). It has also been suggested that synchronization between the ventilatory and postural functions of the respiratory muscles may allow cyclists to reduce the energy costs of exercise (Bonsignore et al., 1998). Based on these observations, it is possible that interrupting the natural breathing cycle if participants either hold their breath or breathe through their nose while the solution is rinsed in the mouth may decrease efficiency, resulting in an increase in time to

Table 2  Blood Glucose, Blood Lactate, Body-Mass Loss, Expelled Solution, and Environmental Conditions in the Laboratory During a 1,000-kJ Cycling Time Trial, M ± SD (N = 10)

<table>
<thead>
<tr>
<th>Portion of time trial completed</th>
<th>CHO</th>
<th>WA</th>
<th>CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose (mM)</td>
<td>0%</td>
<td>5.3 ± 0.4</td>
<td>5.1 ± 0.4</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>5.8 ± 1.0*</td>
<td>5.6 ± 0.8*</td>
</tr>
<tr>
<td>Blood lactate (mM)</td>
<td>0%</td>
<td>1.6 ± 0.8</td>
<td>1.5 ± 0.6</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>7.8 ± 2.1*</td>
<td>9.2 ± 3.9*</td>
</tr>
<tr>
<td>Body-mass loss (kg)</td>
<td></td>
<td>1.2 ± 0.3</td>
<td>1.3 ± 0.3</td>
</tr>
<tr>
<td>Expelled solution per rinse (ml)</td>
<td>24.3 ± 0.3</td>
<td>23.8 ± 0.2</td>
<td>N/A</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td>21.69 ± 1.37</td>
<td>21.69 ± 2.21</td>
</tr>
<tr>
<td>Relative humidity (%)</td>
<td></td>
<td>46.34 ± 6.34</td>
<td>42.46 ± 10.09</td>
</tr>
</tbody>
</table>

Note. Time trial performed with regular rinsing of the mouth with a carbohydrate solution (CHO), plain water (WA), or no rinse at all (CON).

*Significant difference from 0% of time trial completed, p < .05.
completion. Unfortunately, it was not possible to test this hypothesis in the current study, since the measurement of respiratory gases during exercise would have required the use of a mask or mouthpiece, which would not have allowed the administration of the mouth-rinse solution. Irrespective of the mechanisms underlying the detrimental effect of mouth rinsing on time-trial performance relative to no mouth rinsing, it is possible that this effect would have been less pronounced had a greater number of familiarization sessions been adopted in this and all previous studies on mouth rinsing. However, it is unclear whether this would have resulted in an even lower or comparable ergogenic effect of CHO mouth rinsing relative to placebo mouth rinsing.

Although our results show that the use of a water mouth rinse impairs cycling time-trial performance, the administration of a CHO mouth rinse did not negatively affect performance compared with the no-rinse condition. It therefore appears that adding CHO to the rinse solution may oppose the detrimental effect of the action of mouth rinsing itself, though it is not clear how the presence of CHO in the solution achieved this effect. Given the view of previous researchers who proposed that a CHO mouth rinse may improve performance by lowering the perception of effort of the exercise (Carter et al., 2004), it is possible that the presence of CHO in the rinse solution may have counteracted the negative effect of mouth rinsing by lowering perception of effort, thus allowing for an increase in exercise intensity for the same level of subjective fatigue. This is supported in the current study by the finding of similar RPE values across the three conditions despite differences in actual work rate.

Our finding that a CHO mouth rinse improved performance compared with a plain-water mouth rinse corroborates those of others who have reported an ergogenic effect of CHO mouth rinsing on exercise performance when compared with placebo rinses (Carter et al., 2004; Chambers et al., 2009; Pottier et al., 2010; Rollo et al., 2010; Rollo et al., 2008), with significantly better performance in the CHO trial than with WA. Because the aerobic fitness level of our participants was lower than that of the participants involved in previous CHO-mouth-rinse studies, we were expecting greater day-to-day variations in performance and a less significant difference between treatments. However, as indicated by the small coefficient of variation between the familiarization trial (which included a water rinse) and the placebo water-rinse trial, this was not the case. In fact, a highly significant ergogenic effect of CHO mouth rinsing was observed. This ergogenic effect appears to have been overestimated in previous research as a result of the negative effect of the rinse itself and the absence of a no-rinse control condition. In the current study, the use of a CHO rinse improved performance by 5.4% compared with the water rinse, but when compared with a no-rinse condition only a 2.8% improvement was found. It therefore appears that a proportion of the ergogenic effect of a CHO mouth rinse serves to oppose the detrimental effect of the act of mouth rinsing itself. This suggests that, while there does appear to be an ergogenic effect of rinsing the mouth with a CHO solution compared with a no-mouth-rinse control condition, this effect may be much smaller than that determined in previous studies in which a CHO rinse was compared with a placebo rinse.

It is important to note that in comparing a CHO mouth rinse with a no-rinse condition, a placebo effect cannot be excluded despite efforts to prevent it. To minimize the possibility of a placebo effect between mouth-rinse trials and the no-rinse condition, participants in the current study were blinded to the composition of the mouth-rinse solutions they were receiving and were also deceived as to the true objective of the experiment. Taking these precautions is important, since it has been demonstrated that placebo effects may have a significant impact on physical performance (Clark, Hopkins, Hawley, & Burke, 2000). It is this possibility of a placebo effect that presumably explains why previous researchers compared mouth rinsing with a CHO solution with rinsing with a placebo solution rather than with a no-rinse control. However, in attempting to exclude any placebo effect, previous research on CHO mouth rinsing overlooked the effect of the mouth rinse itself and overestimated the ergogenic effect of a CHO mouth rinse on exercise performance relative to a no-rinse condition.

The published evidence that nutritional status might affect the efficacy of mouth rinsing on exercise performance raises the question of the practical applications of CHO mouth rinsing. Indeed, there is evidence that the efficacy of a CHO mouth rinse depends on the nutritional status of the individual. Beelen et al. (2009) reported no ergogenic effect of a CHO mouth rinse in fed participants. In contrast, Fares and Kayser (2011) reported an ergogenic effect of a CHO mouth rinse in both fasted and fed states, although it should be noted that their participants were nonathletes. Given the findings of Beelen et al., it appears that a CHO mouth rinse may not be useful in improving competitive exercise performance since athletes will generally consume a CHO-rich meal before competition and ingest CHO during their events. It is important to note, however, that the primary purpose of most of the research on CHO mouth rinsing is not to provide another means to improve exercise performance but to identify some of the mechanisms underlying the ergogenic effect of CHO ingestion. Nevertheless, a CHO mouth rinse may be practical for weight loss by prompting individuals to exercise at a higher intensity without ingesting additional energy or increasing perceived exertion (Rollo & Williams, 2011). In addition, further research into the mechanisms responsible for the effect of a CHO mouth rinse may yield new insights into the effect of brain function on exercise performance and could lead to the development of new ergogenic aids for athletic competition.

In conclusion, the findings of this study indicate that the act of repeatedly rinsing the mouth during a cycling time trial has a detrimental effect on performance, with the addition of CHO to the rinse solution opposing the decrease in performance associated with repeated mouth rinsing. While a CHO mouth rinse does appear to have an ergogenic effect, the magnitude of this effect seems to
have been overestimated in previous research. Given the ever-increasing body of research into the effects of CHO mouth rinse, future studies should take this into consideration and include a no-rinse condition in their study design to ensure that the true effect of a CHO mouth rinse can be evaluated. This is particularly important for studies concerned with elucidating the mechanisms responsible for the ergogenic effect of CHO mouth rinsing.

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References


