

1 **THE INFLUENCE OF CARBOHYDRATE MOUTH RINSE ON SELF-SELECTED**
2 **INTERMITTENT RUNNING PERFORMANCE**

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19 ***Running Title:* CARBOHYDRATE MOUTH RINSE AND VARIABLE INTENSITY**
20 **RUNNING**

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1 **ABSTRACT**

2 The present study investigated the influence of mouth rinsing a carbohydrate solution on self-
3 selected intermittent variable speed running performance. Eleven male soccer players
4 completed a modified version of the Loughborough Intermittent Shuttle Test (LIST) on two
5 occasions separated by 1 week. The modified LIST allowed the self-selection of running
6 speeds during block 6 of the protocol (75-90 min). Players rinsed and expectorated 25 ml of
7 non-caloric placebo (PLA) or 10% maltodextrin solution (CHO) for 10 s, routinely during
8 block 6 of the LIST. Self-selected speeds during the walk and cruise phases of the LIST were
9 similar between trials. Jogging speed was significantly faster during the CHO (11.3 ± 0.7
10 $\text{km}\cdot\text{h}^{-1}$) than during the PLA trial ($10.5 \pm 1.3 \text{ km} \cdot \text{h}^{-1}$) ($P=0.010$). 15 m sprint speeds were
11 not different between trials (PLA: $2.69 \text{ s} \pm 0.18 \text{ s}$; CHO: $2.65 \text{ s} \pm 0.13 \text{ s}$) ($F(2, 10)$, $P =$
12 0.157) but significant benefits were observed for sprint distance covered ($P = 0.024$). The
13 threshold for the smallest worthwhile change in sprint performance was set at 0.2 s.
14 Inferential statistical analysis showed the chance that CHO mouth rinse was beneficial,
15 negligible or detrimental to repeated sprint performance was 86%, 10% and 4% respectively.
16 In conclusion, mouth rinsing and expectorating a 10% maltodextrin solution was associated
17 with a significant increase in self-selected jogging speed. Repeated 15 m sprint performance
18 was also 86% likely to benefit from routinely mouth rinsing a carbohydrate solution in
19 comparison to a taste matched placebo.

20 **Word count: 246**

21 **Key Words**

22 *Soccer, Sprint, maltodextrin*

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1 INTRODUCTION

2 The ingestion of well formulated carbohydrate-electrolyte (CHO-E) solutions have been
3 reported to improve both continuous and intermittent running performance (Nicholas et al.,
4 1995; Tsintzas & Williams 1998). During prolonged exercise, carbohydrate (CHO) ingestion
5 exerts its effect by maintaining blood glucose concentrations, maintaining CHO oxidation,
6 and, under certain circumstances, delaying the depletion of liver and muscle glycogen.
7 However, some athletes are intolerant to ingesting CHO-E solutions and gels during exercise
8 because of gastrointestinal distress (Brouns 1991). Furthermore, during prolonged variable
9 high speed running the rate of gastric emptying is slowed, though it appears to adapt as
10 exercise continues (Leiper et al., 2005).

11 Several recent studies have shown that simply mouth rinsing a CHO solution improves self-
12 selected 1 h cycling time-trial and treadmill running performances (Carter et al., 2004;
13 Chambers et al., 2009; Rollo et al., 2010; Lane et al., 2013). However, not all studies have
14 found improvements in performance which may be due to several factors such as whether
15 participants are fed or fasted, the duration and the concentration of the CHO rinse and the
16 method of assessing exercise performance (Whitham & McKinney 2007; Beelen et al., 2009;
17 Sinclair et al., 2014). Nevertheless, when athletes are able to self-select their exercise
18 intensities then the consensus view is that under some but not all exercise conditions mouth
19 rinsing improves performance (Jeukendrup & Chambers 2010; Rollo & Williams 2011)
20 (Burke & Maughan 2014; de Ataide e Silva et al., 2014). One simple speculation about the
21 positive influence of mouth rinsing is that CHO in the oral cavity is detected by the brain as
22 an incoming supply of its essential fuel supply i.e. glucose. In the presence of this perceived
23 impending increase in its fuel supply, the balance of excitation and inhibition of the brains
24 motor cortex may be altered in favour of excitation, allowing athletes to increase their
25 running speeds.

1 In a recent study, mouth rinsing a 6.4% maltodextrin solution was reported to have no benefit
2 on sprint running or repeated sprint performance of soccer players completing 4 blocks of the
3 Loughborough Intermittent Shuttle Running Test (LIST) (Dorling & Earnest 2013).
4 However, performing this standard version of the LIST does not allow participants to self-
5 select running speeds, other than during the sprints. Recently, a modified form of the LIST
6 was introduced that includes a block of self-selected running speed that allows participants to
7 reduce their speed as they fatigue, as is the case during real-world competitions (Ali et al.,
8 2014). This more ecologically valid protocol has been used to tease out the performance
9 benefits of ingesting a CHO solution during prolonged intermittent high intensity running
10 (Highton et al., 2013).

11 Therefore, the aim of the present study was to investigate the influence of mouth rinsing a
12 CHO solution on “self-selected” variable speed running and repeated sprint performance.

13

14 **METHOD**

15 *Participants*

16 Eleven male soccer players gave their written consent before participating in this study
17 approved by the Loughborough University Ethical Advisory Committee. The players’
18 physiological characteristics are reported in Table 1. All players regularly ingested
19 carbohydrate-electrolyte solutions during training and when playing matches.

20 *Preliminary Measures*

21 All tests were completed in an indoor sports hall with a marked 20 m running track. Ambient
22 conditions were maintained at $22.0 \pm 1.0^\circ\text{C}$; relative humidity $32 \pm 2\%$. During visit 1 each
23 participant’s $\dot{V}O_{2\text{max}}$ and velocity at $\dot{V}O_{2\text{max}}$ was measured using a progressive multistage

1 shuttle run test (Ramsbottom et al., 1988). This information was used to determine five
2 discrete pacing intervals to dictate the jogging (55% $\dot{V}O_2\text{max}$) and cruising (95% $\dot{V}O_2\text{max}$)
3 speeds required for the experimental trials. Participants then completed a single 15-min block
4 of the Loughborough Intermittent Shuttle Test (LIST) (Figure 1) to familiarise themselves
5 with the exercise protocol (Nicholas et al., 2000). The participants also practiced mouth
6 rinsing with water during the final 3 cycles of activities.

7 Three psychological scales; Perceived Activation Scale (FAS) (Svebak & Murgatroyd 1985),
8 Feeling Scale (FS) (Hardy & Rejeski 1989) and Rating of Perceived Exertion Scale (RPE)
9 (Borg, 1982), were administered at rest and throughout exercise. Heart rate was recorded
10 every 5 s during the familiarisation and all experimental trials using short-range telemetry
11 (Polar Electro, UK).

12 *Experimental Procedures*

13 *Study Design*

14 The study employed a double blinded counter-balanced, cross-over design. Trials were
15 performed at the same time of day, separated by 1 week. The experimental solutions were
16 prepared and labelled by a non-affiliated research assistant. In the 24 h preceding each
17 experimental trial participants were asked to abstain from strenuous exercise, caffeine and
18 alcohol. On the morning of each trial participants were asked to consume a breakfast which
19 represented their usual match day meal 3 h before exercise.

20 Prior to both trials participants' body mass was recorded and their water bottles weighed.
21 Water intake was *ad-libitum* during the first 5 blocks of the LIST in the first experimental
22 trial. The volume ingested was then prescribed as the water intake during the second trial. All
23 but one participant completed the two experimental trials in pairs. The participants were

1 matched based on their predicted $\dot{V}O_{2\max}$ scores from the progressive multistage shuttle run
2 test.

3 The LIST protocol is displayed (Figure 1). The run timing throughout the first five blocks of
4 the LIST was dictated by audio cues (Nicholas et al., 2000). The sixth and final stage of the
5 LIST was a self-selected stage without audio cues (Ali et al., 2014). Participants were
6 instructed to replicate the running routine of the five previous up to the completion of 90 min.
7 Investigators gave no other verbal instruction during the self-paced section, apart from when
8 to cease exercise. During the self-paced section of the LIST participants were video recorded.
9 Analysis of the video provided an accurate record of the time spent (s) completing each
10 activity, the number of LIST cycles completed and the stage of the LIST cycle that had been
11 completed following the completion of 15 min. The self-selected speed for each LIST activity
12 was then calculated using the equation; distance/time. Sprint time was recorded over a
13 distance of 15 m using infrared timing gates (Brower Timing Systems, USA).

14 *Carbohydrate Solutions and Procedure*

15 The carbohydrate (CHO) solution was a 10% maltodextrin solution (MuscleTalk,
16 Northamptonshire, UK). The placebo (PLA) solution was water. In an attempt to disguise the
17 solutions both the CHO and PLA solutions were flavoured by an artificial non-caloric
18 sweetener (FlavDrops, MyProtein UK). Each participant mouth rinsed the prescribed solution
19 while performing the second of the three 20 m walks during the activity cycles in block 6 of
20 the LIST (Figure 1). The mouth rinse procedure involved participants rinsing 25 ml of
21 experimental solution for 10 s before expectorating the solution into a pre-weighed container.
22 This protocol resulted in the prescribed solutions being rinsed a total of 11 times during the
23 final stage of the LIST. On completion of the trial, cups and containers were re-weighed to
24 determine if any of the solution has been ingested.

1 *Statistical Analysis*

2 Statistical analyses were performed using SPSS software package (version 18; SPSS inc.,
3 Chicago IL. USA). The Shapiro-Wilk test assessed the distribution of all data sets. In cases of
4 non-normal distribution, the equivalent nonparametric statistical test was used. The mean
5 differences in performance (walking, sprint, jogging, cruising speed, sprint number) were
6 detected using a paired samples t-test. Changes in sprint times during block 6 of LIST were
7 assessed using two-way (sprint number x condition) repeated measures ANOVA. The
8 quantitative approach to likelihoods of benefit, triviality, and detrimental to running
9 performance was further enriched by dividing the range of substantial values into more finely
10 graded magnitudes. Using the spreadsheet by Hopkins (2007), the *P* value was converted into
11 90% confidence intervals (CI) for, and inferences about, the true value of the effect statistic
12 (Hopkins 2007). The smallest worthwhile change in sprint time was set at 0.8% of the mean
13 sprint time in both trials (Paton et al., 2001; Hopkins 2004). All results are reported as mean
14 \pm standard deviation (SD) or 90% confidence intervals when appropriate. Statistical
15 significance was set as $P < 0.10$.

16

17 **RESULTS**

18 *Running performance*

19 The self-selected distance covered and speed for each running occasion during the self-
20 selected block 6 (75-90 min) of the LIST is shown in Table 2. There was no trial order effect
21 for all performance measures between trials ($P > 0.10$, Table 2).

22 There were no differences in the sprint times between CHO and PLA trials $F(2, 10)$, $P =$
23 0.157 (Figure 2). There was a small but significant increase in the number of 15 m sprints
24 completed, Figure 3). In addition, participants maintained a significantly faster jogging speed

1 in the final 15 min LIST block: $10.5 \pm 1.3 \text{ km}\cdot\text{h}^{-1}$ (PLA) vs. $11.3 \pm 0.7 \text{ km}\cdot\text{h}^{-1}$ (CHO). The
2 threshold value for the smallest worthwhile change in sprint time was set at 0.2 s (0.8% of
3 mean sprint time). Thus the chance that the value effect was beneficial, negligible or
4 detrimental to repeated sprint performance was 86%, 10% and 4% respectively.

5 *Physiological Measures and Psychological Scales*

6 Heart rate and psychological scores for the Feeling Scale, Felt Arousal Scale and Ratings of
7 Perceived Exertion during exercise are shown in Table 3. The mean volume of fluid
8 consumed during the first 5 blocks of the LIST was $1087 \pm 207 \text{ ml}$ (834 ml-1403 ml). There
9 was no difference in the percentage of body mass lost over the duration of 90 min between
10 trials $1.3 \pm 0.5\%$ (0.6-2.3%). The mean volume of expectorate for the PLA and CHO trials
11 was $23 \pm 2 \text{ ml}$ and $24 \pm 1 \text{ ml}$, respectively. Thus the difference between the volume rinsed
12 and expectorated was $2 \pm 2 \text{ ml}$ in the PLA trial and $1 \pm 1 \text{ ml}$ in the CHO trial.

13 **Detection of Rinse solution**

14 Following the completion of the second experimental trial participants were asked two
15 questions. First, if they could distinguish between experimental solutions and second in
16 which of the two trials they believed they were mouth rinsing CHO. Out of the 11 players
17 none were able to distinguish between the two test solutions. However, when asked which
18 trial they believed they were mouth rinsing CHO, 6 players correctly identified the CHO
19 mouth rinse trial (i.e. more than would be predicted by chance). Of these six, only 2 had
20 better jogging and sprint performance in the CHO trial.

21 **DISCUSSION**

22 The main finding of this study was that mouth rinsing and expectorating a 10% maltodextrin
23 solution significantly increased self-selected jogging speed during 75-90 min of variable

1 intensity running. Furthermore, mouth rinsing with CHO was associated with an 86 %
2 likelihood of being beneficial to repeated 15 m sprint speed, with small but **significant effect**
3 on **sprint distance covered**. To our knowledge this was the first study to investigate the
4 influence of CHO mouth rinse on self-selected variable intensity running performance.

5 The results of the present study are consistent with previous running studies which have
6 reported the routine mouth rinse of a CHO solution increases self-selected submaximal
7 running speeds (Rollo et al., 2008; Rollo et al., 2010). However, these previous studies
8 involved continuous treadmill running for 30 min and 1 h and are therefore not specific to
9 demands of intermittent variable speed running and maximal sprints. To date, there have
10 been few studies conducted on the influence of CHO mouth rinsing on performance during
11 intermittent exercise, of variable intensity, or sprinting.

12 Dorling and Earnest (2013) reported that sprint and repeated sprint ability was not improved
13 when games players mouth rinsed a 6.4% maltodextrin or flavour matched placebo during the
14 LIST. In this study, male games players completed four blocks of the LIST, identical to that
15 of the present study, up to the completion of 60 min. The authors reported no difference in 20
16 m sprint performance throughout exercise or repeated sprint ability (4 x 20 m sprint; 20 s
17 recovery) performed at 0, 30 and 60 min. To our knowledge this the only study to have
18 investigated CHO mouth rinse and repeated sprint running performance. That Dorling and
19 Earnest (2013) observed no differences in performance may possibly be a consequence of
20 several key aspects of their protocol which differed from the present study. The exercise
21 duration was 90 min in the present study compared to 60 min in the Dorling and Earnest
22 (2013). It is not unreasonable to suggest that the reduction in muscle glycogen concentration
23 was probably greater in the present study (Nicholas et al., 1999). The participants also
24 reported increased perception of effort and detriment in 'feeling scale' following block five
25 of the LIST (Table 3). Perceptions of greater effort during the latter stages of prolonged

1 exercise are commonly associated with a decrease in CHO availability (Jeukendrup et al.,
2 2006). As such, it may be speculated that mouth rinsing a CHO solution during the last 15
3 min of a 90 min LIST may have had a greater impact than if administered earlier in exercise,
4 i.e. when participants are likely to have a greater endogenous store of CHO.

5 The limitation of the traditional LIST protocol is that, other than the 20 m sprints, running
6 speeds are dictated by audio cues. Previous studies have shown that protocols which do not
7 allow “self-selected” exercise may not be sufficiently sensitive to detecting subtle alterations
8 in running speed in response to a CHO mouth rinse intervention (Rollo & Williams 2009;
9 Rollo et al., 2010). The modified LIST protocol allowed participants to self-select their speed
10 during the last 15 min of exercise (Ali et al., 2014). As a result, small but significant
11 performance benefits were observed in response to mouth rinsing CHO (Table 2).

12 The mechanism(s) by which mouth rinsing with a CHO solution increased jogging speed and
13 sprint performance during variable intensity running are unknown. A consequence of the
14 mouth rinse and expectorate procedure is the absence of substrate delivery to the systemic
15 circulation. Therefore, it is reasonable to speculate that the exposure of CHO to the oral
16 cavity had a “central” effect. In support of this hypothesis, it is known that humans have the
17 ability to “taste” glucose polymers (maltodextrin) (Lapis et al., 2014). In addition, studies
18 have reported that mouth rinsing CHO is associated with the activation of reward centres in
19 the brain (Chambers et al., 2009) and improved sensory perception (Turner et al., 2014). We
20 have previous speculated that potential corresponding feelings of pleasure or perceived
21 activation may manifest as altered exercise behaviour (increased running speed) (Rollo et al.,
22 2008). However, the present study found no differences in perceived exertion or any
23 psychological measures during exercise between trials (Table 3). Thus, an alternate
24 explanation may be that towards the end of prolonged intermittent running the CHO rinse
25 may alter the excitation and inhibition balance of centrally mediated motor output, which

1 resulted in improved running performance (Gant et al., 2010). However, many of the studies
2 designed to provide explanations for the favourable influence of CHO mouth rinse on
3 exercise performance have either been conducted at rest or in single limb exercise. Further
4 research is needed to ascertain if results from these studies also translate to whole body
5 exercise.

6 These speculations are largely based on the hypothesis that mouth rinsing a CHO solution
7 offers the “promise” of incoming energy to the brain when liver and muscle glycogen stores
8 are reduced by exercise. However, this theory does not explain improvements in peak power,
9 during sprint cycling, following pre-exercise mouth rinsing a carbohydrate solution reported
10 by some (Beaven et al., 2013; Chong et al., 2014; Phillips et al., 2014) but not others (Chong
11 et al., 2011) or reducing the fall in muscle torque during several isometric leg extensions
12 contractions (Jensen et al., 2014). It is relevant to note that CHO mouth rinse has been
13 reported to increase the activation of cortico-motor pathways and voluntary force production
14 in both “fresh” and fatigued muscle (Gant et al., 2010). Therefore the mouth rinse
15 phenomenon may not simply be a consequence of promising the brain incoming energy
16 during exercise that involves a significant demand on endogenous CHO stores.

17 A limitation of the present study is that it is unknown whether a full familiarisation would
18 have impacted on subsequent pacing strategy employed by the participants during the main
19 trials. The present study replicated the protocol of Ali *et al.*, (2014). In this study the
20 investigators did not include a full familiarisation in the preliminary measurements. Instead
21 participants completed two blocks of the list, one prescribed and one self-paced. The present
22 study used a single block of the LIST in the familiarisation, to introduce the players to the
23 pattern of running and rinse procedure. As recommended by Ali et al. (2014) the present
24 study utilised randomised counterbalanced design, which was sufficient to prevent a trial
25 order effect (Table 2). Finally, as the experimental trials were ran in pairs it is unknown how

1 the pacing of one player may have influenced the performance of the other. Future studies
2 may consider placing a partition between runners, staggered starts or individual performance
3 trials.

4 *Practical Implications*

5 The ability to measure self-selected running at a range of intensities under laboratory
6 conditions is of relevance to team “stop-and-go” sports. Although, players are unlikely to
7 repeatedly rinse CHO during a match, the findings of the present study suggest that when
8 CHO solutions are ingested late in exercise, performance benefits may be gained before the
9 substrate reaches the systemic circulation. Several studies report that both elite and sub-elite
10 football players’ ability to perform high-intensity exercise is reduced in the final 15 min of a
11 90 min game (Bangsbo 2014). Exposing the mouth to CHO mouth rinse may offer an acute
12 performance benefit, both in terms of faster ‘recovery’ speeds but also in small improvements
13 in sprinting in this critical period of a game (Mohr et al., 2003; Mohr et al., 2005).

14 In conclusion, mouth rinsing a 10% maltodextrin solution was associated with increased self-
15 selected jogging speed between 75 and 90 min of variable intensity running. Repeated 15 m
16 sprint performance was also 86% likely to benefit from routinely mouth rinsing a
17 carbohydrate solution in comparison to a taste matched placebo. These findings add to the
18 evidence that mechanisms independent of CHO delivery to the circulation may influence
19 exercise performance.

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1 **Disclaimer**

2 Ian Rollo & James Carter are employees of the Gatorade Sports Science Institute, a division
3 of PepsiCo, Inc. The views expressed in this manuscript are those of the authors and do not
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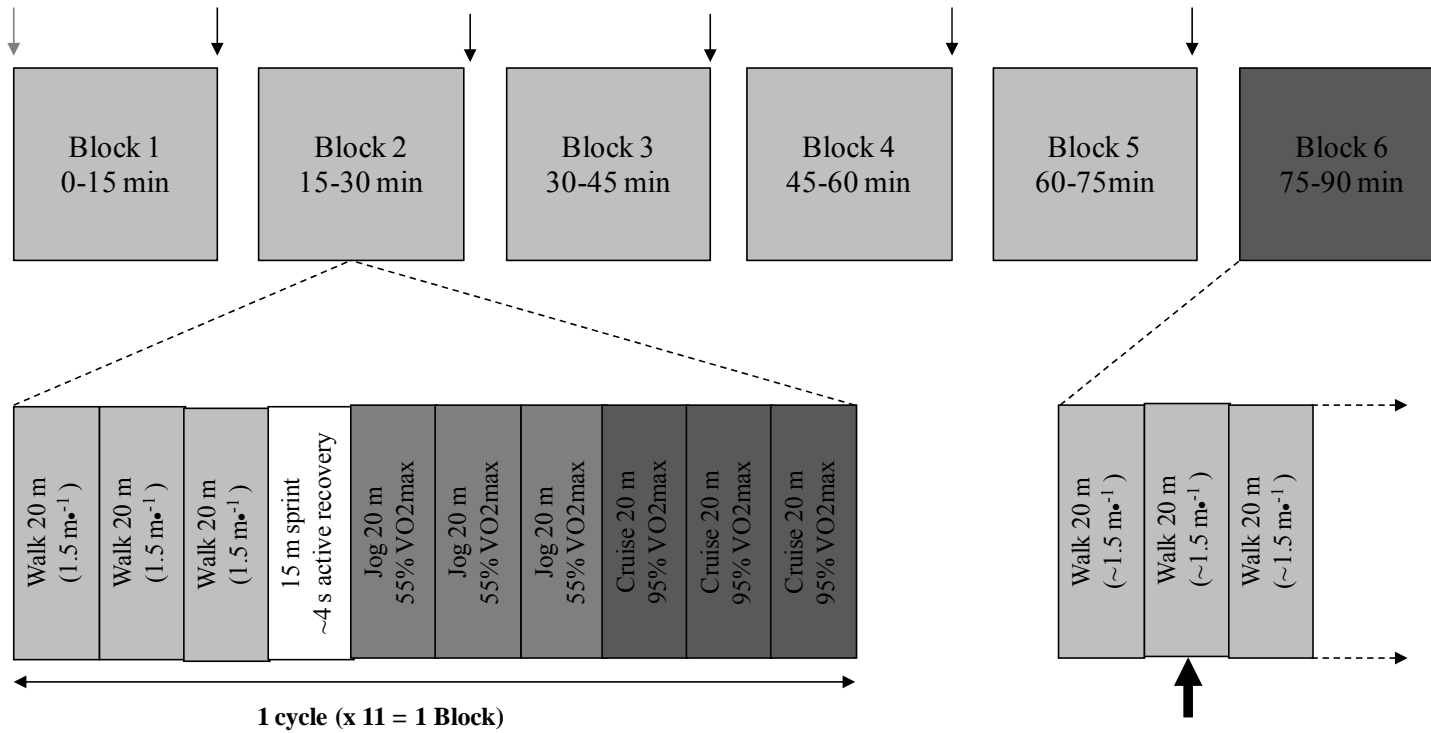
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1 **Table 1.** Physiological Characteristics of the soccer players (n=11, mean \pm SD).

Characteristic	Measure
Age (years)	22 \pm 3
Height (m)	1.78 \pm 0.10
Weight (kg)	75.0 \pm 7.6
Estimated $\dot{V}O_2$ max (ml \cdot kg ⁻¹ \cdot min ⁻¹)	54.0 \pm 3.0
Soccer Experience (years)	13 \pm 5
Training and/or matches per week	1-4

- 1 **Figure 1.** Schematic of study experimental protocol. Light shaded blocks represent audio dictated running speeds. Dark shaded block 6 represents self-selected speeds
- 2



Key

- ↓ FS, FAS
- ↓ FS, FAS, RPE
- ↑ Mouth Rinse

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1 **Table 2.** Self-selected running performance during block 6 (75-90 min) of the LIST, * indicates significant difference between trials.

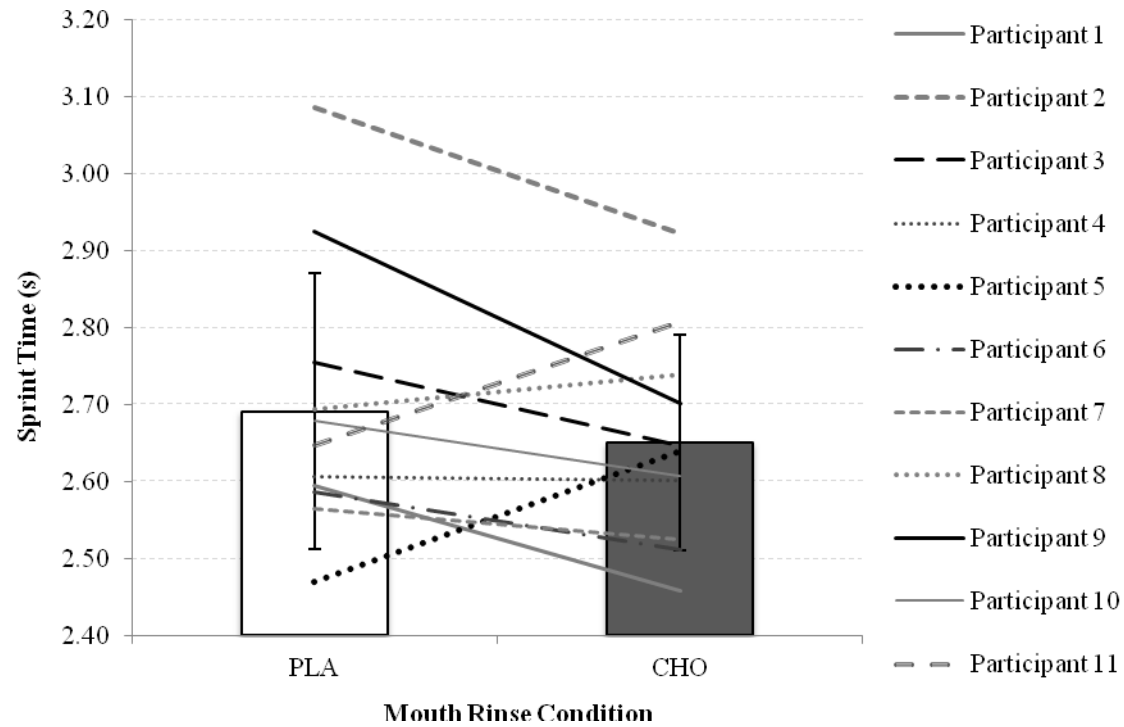
Variable	PLA	CHO	90% CI		P	Trial Order P
			Lower	Upper		
Distance covered (km)	2.0 ± 0.1	2.0 ± 0.0	-0.8	0.3	0.494	0.601
Mean speed (km•h ⁻¹)	8.7 ± 0.5	8.8 ± 0.1	-0.3	0.1	0.513	0.563
Walking						
Distance covered (km)	0.65 ± 0.4	0.65 ± 0.2	-0.2	0.1	0.831	0.518
Mean speed (km•h ⁻¹)	5.5 ± 0.2	5.5 ± 0.3	-0.1	0.3	0.419	0.930
15 m Sprint						
15 m sprint time (s)	2.69 ± 0.18	2.65 ± 0.13	-0.2	0.10	0.298	0.839
Distance covered (km)	0.15 ± 0.12	0.16 ± 0.10	-0.0	-0.00	0.024*	0.676
Mean speed (km•h ⁻¹)	20.1 ± 1.2	20.4 ± 1.0	-0.8	0.2	0.316	0.855
Jogging						
Distance covered (km)	0.60 ± 0.0	0.61 ± 0.0	-0.0	-0.0	0.450	0.653
Mean speed (km•h ⁻¹)	10.5 ± 1.3	11.3 ± 0.7	-1.3	-0.3	0.010*	0.549
Cruising						
Distance covered (km)	0.6 ± 0.4	0.6 ± 0.0	-0.0	0.0	0.676	0.676
Mean speed (km•h ⁻¹)	12.7 ± 1.0	12.8 ± 0.9	-0.4	0.3	0.896	0.828
Recovery Time						
Total (s)	78 ± 22	76 ± 13	-4.0	7.0	0.625	0.894
Mean time (s)	7.8 ± 2.6	7.2 ± 1.6	-0.1	1.2	0.171	1.000

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1 **Figure 2.** Mean and individual sprint times (s) during block 6 of LIST for PLA and CHO mouth rinse trials.



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- 1 **Table 3.** Heart rate and psychological scale scores for Rating of Perceived Exertion (RPE), Felt Arousal Scale and Feeling Scale during each
 2 block of the LIST. # Denotes a significant difference over time i.e. between blocks.

Measure	Rest	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Heat rate (beat•min⁻¹)							
PLA	100 ± 10	165 ± 14 #	170 ± 12	170 ± 11	169 ± 11	167 ± 13	163 ± 13
CHO	101 ± 10	167 ± 15 #	168 ± 12	167 ± 12	167 ± 15	168 ± 12	165 ± 12
RPE							
PLA	n/a	12.4 ± 1.1	13.6 ± 1.2 #	14.4 ± 1.8 #	15.2 ± 1.6 #	16.2 ± 1.7 #	16.4 ± 1.8
CHO	n/a	12.0 ± 1.4	13.5 ± 1.6 #	14.4 ± 1.5 #	15.4 ± 1.9 #	16.4 ± 2.0 #	16.3 ± 2.2
Felt Arousal Scale							
PLA	2.2 ± 0.9	2.9 ± 1.0	3.1 ± 1.0	3.0 ± 0.9	2.8 ± 1.3	2.9 ± 1.4	3.0 ± 1.4
CHO	2.9 ± 0.9	3.4 ± 1.0	3.3 ± 1.4	2.8 ± 1.5	2.8 ± 1.4	2.4 ± 1.7	2.7 ± 1.4
Feeling scale							
PLA	2.5 ± 1.7	1.0 ± 0.8 #	0.7 ± 1.2	0.9 ± 1.6	-1.0 ± 1.7 #	-1.5 ± 2.2	-1.2 ± 2.0
CHO	2.6 ± 0.9	1.8 ± 0.8 #	0.5 ± 1.7	0.2 ± 2.1	-1.0 ± 2.0 #	-1.5 ± 2.6	-1.2 ± 3.2

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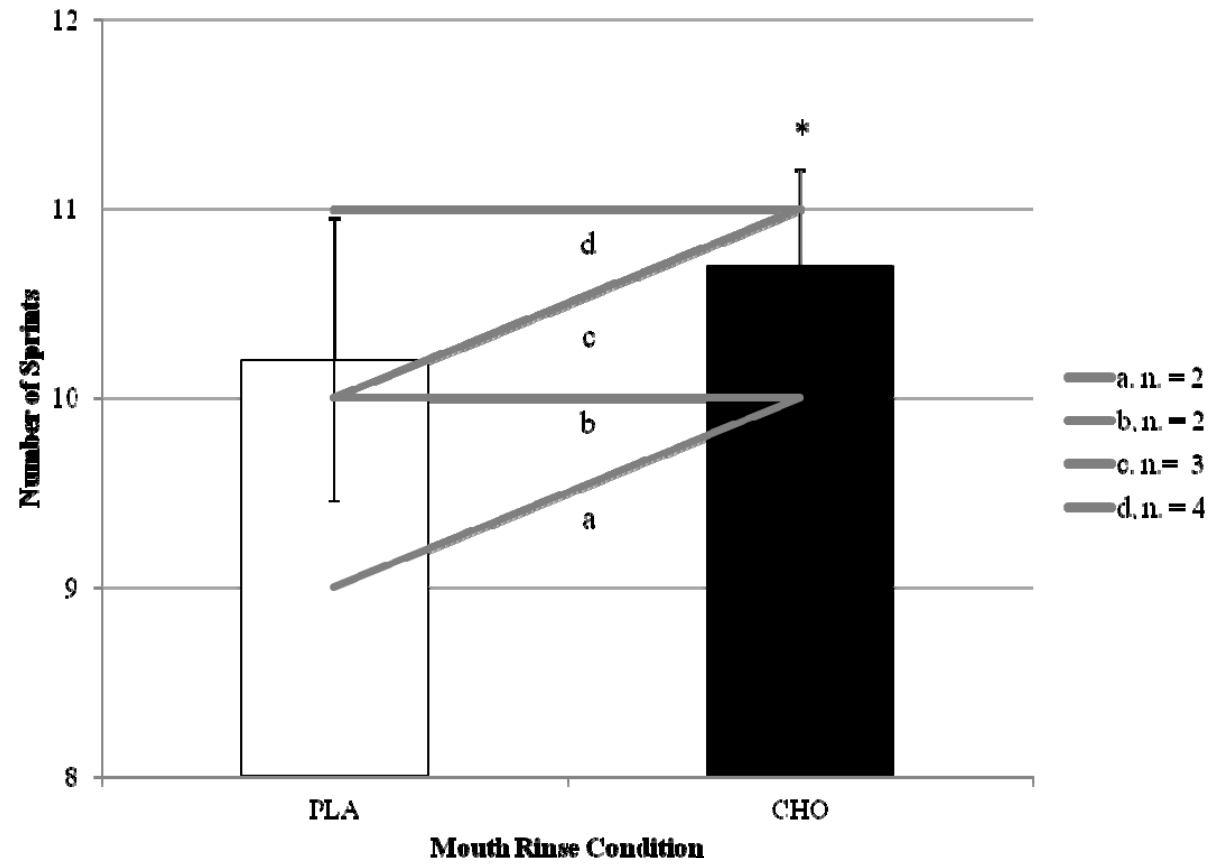
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1 **Figure 3.** Mean number of sprints completed during block 6 of LIST for PLA and CHO mouth rinse trials. The lines “a” to “d” present the
2 number of players who either maintained or increased the number of sprints completed ($P = 0.016$).

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