INTERNATIONAL JOURNAL of IJSETS SPORT, EXERCISE & TRAINING SCIENCES

e-ISSN 2149-8229 **Vol** 8, **Issue** 3, 1–11, (2022) ***Original Article***

http://dergipark.gov.tr/useeabd

Karbonhidrat ve Sodyum Kloridi Ağızda Çalkalamanın Tekrarlı Sprint Performansına Etkisi*

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Özet

Amaç: Bu çalışmanın amacı, antrenmanlı sporcularda oral CHO ve NaCl ile durulamanın tekrarlanan sprint performansı üzerindeki etkilerini araştırmaktır.

Materyal ve Metot: On beş antrenmanlı sporcu (5 kadın; 10 erkek) gönüllü olarak tekrarlanan, tek kör, plasebo kontrollü ve çapraz tasarım çalışmasına katılmışlardır. Sporcular laboratuvara en az 48 saat arayla dört kez gece açlığı ile gelmişler ve 30 dakikalık dayanıklılık egzersizi (%70 maxVO2) sonrasında tekrarlı sprint testine (10 sn x 6, 40 sn aralıklarla) katılmışlardır. Dayanıklılık egzersizinin 0, 10, 20 ve 30. dakikalarında CHO (%6.4 maltodekstrin), sodyum klorür (%6.4) solüsyonu ve su (plasebo) veya durulamasız (kontrol) ile MR istenmiştir.

Bulgular: 3×4 ANOVA ile yapılan analizler sonucunda, tekrarlı sprint performansı ile elde edilen güç çıkış değişkenleri [tepe güç, ortalama güç, minimum güç (W, W/kg) ve yorulma indeksi (%)] ve yorulma değişkenleri (kalp) oranı, kan laktat düzeyi ve algılanan efor oranı) seanslar arasında istatiksel olarak anlamlı farklılıklar bulunmamıştır.

Sonuç: Elde edilen sonuçlardan, bu çalışmada kullanılan yöntem ve uyaranların fiziksel performansın sonuç değişkenlerini etkilemek için düşük düzeyde etki gösterdiği sonucuna varılabilir.

Anahtar Kelimeler

Ergojenik yardım,
Yorgunluk indeksi,
Kalp atımı,
Laktat seviyesi.

Yayın Bilgisi

Gönderi Tarihi: 06.06.2022
Kabul Tarihi: 10.08.2022
Online Yayın Tarihi: 15.09.2022

DOI: 10.18826/useeabd.1126881

Effects of Carbohydrate and Sodium Chloride Mouth Rinses on Repeated Sprint Performance

Abstract

Aim: The purpose of this research is to examine the effects of oral rinsing of CHO and NaCl on repeated sprint performance in trained athletes.

Methods: Fifteen trained athletes (5 women; 10 men) voluntarily participated in the repeated, single-blind, placebo-controlled and crossover design study. Athletes came to the laboratory with a night fasting four times with an interval of at least 48 hours and participated in the repeated sprint test (10 sec × 6, 40 sec intervals) after 30 minutes of endurance exercise (70% maxVO_2). At the 0th, 10th, 20th and 30th minutes of the endurance exercise, it was requested to MR with CHO (6.4% maltodextrin), sodium chloride (6.4%) solution and water (placebo) or no rinsing (control).

Results: As a result of the analyzes performed with 3 × 4 ANOVA, the power output variables obtained by repeated sprint performance [peak power, average power, minimum power (W, W/kg) and fatigue index (%)] and fatigue variables (heart rate, blood lactate level and rate of perceived exertion) between sessions were not found to be significantly different.

Conclusion From the obtained results, it may be concluded that the method and stimuli used in this study seem insufficient to affect the outcome variables of physical performance.

Keywords

Ergogenic effect,
Fatigue index,
Heart rate,
Lactate level.

Article Info

Received: 06.06.2022
Accepted: 10.08.2022
Online Published: 15.09.2022

DOI:10.18826/useeabd.1126881

INTRODUCTION

Carbohydrate mouth rinsing (CHO-MR) method can increase performances especially in aerobic exercises ranging from 30 minutes to 120 minutes (Chambers, Bridge, and Jones, 2009; Pottier, Bouckaert, Gilis, Roels, and Derave, 2010) without increasing the blood glucose concentration in post-exercise recovery (Rollo, Cole, Miller, and Williams, 2010). This effect was found to be associated with brain activity alterations in special regions of the brain related to motor control, reward, and motivation via oral receptors (Chambers, Bridge, and Jones, 2009; Jeukendrup, Rollo, and Carter, 2013; Turner, Byblow, Stinear, and Gant, 2014).

On the other hand, the effects of CHO-MR method on short-term and high-intensity exercises with anaerobic properties were examined in a limited number of studies and found contradictory results. Besides those who report that the method affects the early stages of sprint performances (Chong, Guelfi,

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and Fournier, 2014; Gant, Stinear, and Byblow, 2010; Phillips, Findlay, Kavaliauskas, and Grant, 2014), there are those who claim that it has no favorable impact on sprint performance (Chong Guelfi, and Fournier, 2011). The possible reasons for these conflicting results were reported that may be the training levels of the participants, the hunger conditions during the test, the content of the solution to be rinsed, the time of rinsing the solution in the mouth and/or the differences in the performance tasks performed (Přibyslavská et al., 2016; Rollo et al., 2010).

Its potential to activate the motor and insular cortex is not limited to the CHO taste receptors. This is because sodium chloride (NaCl) can elicit functional magnetic resonance imaging responses during exercise in the right part of the insular cortex, which is connected to other parts of the brain, including cardiovascular regulation (Waldrop, Eldridge, Iwamoto, and Mitchell, 1996) (Prinster et al. 2017). In addition, electromyographic recordings showed that NaCl elicited a higher contraction and activation rate of the swallowing muscles (Ding, Logemann, Larson, and Rademaker, 2003). The results suggest that excitation of the oral NaCl receptors may increase muscle activity and thus the potential enhancement of force production. In the first and only study to examine the effect of NaCl oral rinses (Khong, Selvanayagam, and Yusof, 2021), it was found that maximal voluntary contraction performance due to fatigue in the strength test decreased slightly after 30 minutes of endurance training. This effect was similar to CHO-MR but better than water-MR. Although the exact mechanism is not yet clear, under the influence of NaCl, it is thought that the stimulation of 'salty' tasting receptors located in the oral cavity may effect the insular cortex and/or opioid receptor actions, which may stimulate the parasympathetic nervous system organizing the cardiac automatic actiions (Khong, et al., 2021). The purpose of this research is to examine the influence of mouth rinsing of solutions containing CHO and NaCl on repetitive sprint performance after 30 minutes of endurance exercise.

MATERIAL AND METHOD

Participants

Fifteen healthy athletes (10 men and 5 women) who have been in involving in different sports branches were voluntarily participated in the research. All of the participants had at least 5 years regular training experience, between the ages of 18-25 years old, regular training composing 4 days a week at least 60 minutes per session, participaton in national or international competitions, no a serious injury within 6 months, and using no alcohol or drugs regularly. Moreover, subjects of the study had no prior experience of any type of MR intervention.

At the beginning of the study, all participants' health control were made with the athlete's health examination form evaluated by a sports physician. In addition, a questionnaire prepared by the researchers was filled face-to-face, in order to get information regarding their training levels, injury history, and competition levels of the participants. All of the athletes who met the criteria of the research were invited to take part in the study.

Subjects were given information about the nature of the research and asked to sign an informed consent form which was in accordance with the principles of the Declaration of Helsinki. Furthermore, the permission was gathered from the Ege University Ethical Committee (number: 20-10T/39).

Experimental Design

The research is a repetitive, double-blind, and crossover design laboratory study. Subjects participated in five sessions in the testing laboratory over a period of 35-40 days. Participants were invited to the laboratory with overnight fasting for each session, to avoid vigorous activity in the 24 hours prior to the test, and to record their diet for the day before the first session and were asked to have the same diet prior to the subsequent sessions. In addition, it was emphasized that alcohol and caffeine should not be consumed before the test, but they were told to consume 500 ml of water in the morning prior to testing. All of the sessions were carried out at the same time of the day, between 09:00 and 10:00 in the morning in order to minimize potential circadian rhythm effects, when the ambient temperature was 22-24°C and a relative humidity of ~70%, in a noise-free and light-filled test environment.

Familiarization session

The familiarization session aimed to familiarize the subjects with the test instrument, test environment, test protocol and researchers. By adjusting the bicycle ergometer according to the participant, slow and fast pedaling administrations were carried out. In addition, participants rinsed their mouth with 25 ml of water, and were requested to spit the water out into a bowl at the same amount without swallowing it. Height, body mass, and body fat were measured, respectively, and the VO_2max test (with VO_2peak and verification tests) was performed.

Height and body mass measurement

The height measurement of the participants was measured with a height meter (Seca, Germany) with an accuracy of 0.1 cm, and the measurement of body mass with a portable scale with an accuracy of 0.1 kg (Seca, Germany), without shoes and with minimal clothing.

Body fat ratio measurement

Bioelectric impedance analysis (BIA, Tanita BC 300 MA, Tanita Corp., Tokyo, Japan) method was used to measure and evaluate the body fat ratio of the athletes. This measurement was made in the morning on an empty stomach and after urination.

Determination of VO_2max level (with VO_2 peak test and Verification test)

The VO_2peak test was carried out with the principle of gradually increasing load, after a standard warm-up of 5 minutes. Then the test started with a 2-minute warm-up at 50 W load on a mechanical resistance bicycle ergometer (Monark Ergomedic 894E, Monark, Sweden) and was repeated every 30 seconds until the 10 W increments were exhausted. Analysis of inhaled gases (VO_2) was done with an automatic metabolic system (Cosmed Fitmate Pro, Cosmed, Italy) associated with a face-worn mask. Heart rate (HR) was measured continuously with the telemetric system. The VO_2peak test was completed according to established confirmation criteria (Lee, 2011).

To prove the accuracy (verification) of the VO_2peak test 3-4 hours after this test, the subjects were requested to pedal again until they are exhausted with the final speed, they reached in the VO2peak test. VO_2max value was determined as the highest oxygen consumption value reached in one minute calculated on the gas analyzer.

Testing sessions (CHO/ NaCl / placebo (water)-MR/ without rinsing (control))

After the dietary recommendations to affect the performance were questioned verbally one by one, participants were asked to rest in the laboratory for at least 15 minutes, then resting HR and blood lactate levels (La) were measured.

Following the warm-up consisting of 10 minutes of running and dynamic stretching for the whole body, the participants were taken to the 30-minute endurance exercise and then the repeated sprint test. After the tests, HR, La and rate of perceived exertion level (RPE) measured repeatedly.

Participants came to the laboratory four times in a month, a different administration was performed in each measurement session, and MR was repeated at the 0^{th}, 10^{th}, 20^{th} and 30^{th} minutes of the endurance exercise in the sessions, except for the control session.

Heart Rate

HR was measured by telemetric method (Polar RS 800 CX Electro Oy, Kempele, Finland). Measurement; three times in each session: at rest (HR1), after the endurance test (HR2) and after the repeated sprint test (HR3).

Blood lactate level

Blood La was measured by using a lactate analyzer (Lactate Scout (+) LSP, SensLab GmbH, Germany). For blood La determination, the fingertip of the individual was first wiped with alcohol cotton by the investigator, then the fingertip was pierced with a lancet and gently squeezed. The blood sample taken from the fingertip was taken to the tip of the strip (Lactate Scout Test Strips-2014) and the value was recorded by the device was measured after 10 seconds. Measurements were performed three times in each session as rest (La1), after endurance test (La2) and after repeated sprint test (La3).

Rate of perceived exertion level

RPE was determined by the BORG scale (Borg, Hassmén, Lagerström, 1987) in which perceived effort is graded on a scale of 6-20. Measurements were repeated twice in each session, following the endurance test (RPE2) and after the repeated sprint test (RPE3).

Endurance exercise

Endurance exercise load was 70% (±2) of the value determined by the VO_2max test at 30 minutes of constant load and free cadence with a bicycle ergometer. The monitor of the gas analyzer was constantly monitored, and when the VO_2 value decreased to 67% or increased to 73%, the participant's speed was increased or decreased to stabilize the load. During the 30-minute endurance performance, the participants rinsed the mouth with one of three different solutions every 10 minutes.

Repeated sprint test

At the end of the endurance exercise, the participants were asked to pedal the fastest (sprint) for 6 × 10 seconds at a load corresponding to 0.075 kg per body mass on the bicycle ergometer. There was a 40 second rest between sprints, which was spent cycling at low speed. Verbal motivation was provided during the sprints. With this test, peak power (PP- W, W/kg), average power (AP- W, W/kg), minimum power (MG- W, W/kg), and fatigue index (FI, %) were determined.

Mouth rinsing administration

Mouth rinsing was performed by rinsing randomly one of 3 different solutions of 25 ml in the mouth for 5 seconds in different sessions: CHO (6.4% maltodextrin) solution, NaCl (6.4% sodium chloride) solution and placebo (water).

The application was prepared for each participant with 25 ml × 6.4% = 1.6 g powdered maltodextrin and 25 ml × 6.4% = 1.6 g powdered NaCl placed in graduated tubes (Falcon Isolap Sterile Tube). The solution, which was rinsed in the mouth, was asked to be spit out again into the graduated tube, thus it was checked if the solution was swallowed or not.

Statistical analyzes

The necessary sample size was assessed by using G∗Power software (version 3.1.9.2, Franz Faul, Universitat Kiel, Dusseldorf, Germany) for repeated measures ANOVA for determining a small effect size (f=0.3) with $\alpha = 0.05$, and a $1 - \beta$ error probability of 0.75, which indicated a sample size of 15 subjects were necessary.

The data were given as mean ± SD and analyzed by using SPSS Statistics for Windows version 25 (IBM, Armonk, NY; 2015). Moreover, The Shapiro-Wilk test was conducted to measure the normality of data, and skewness and kurtosis values were observed between ±1.0. Therefore normal distrubiton of data was assumed (Tabahcnick and Fidell 2013). Levene test was conducted for testing homogenty of variance. Levene test was calculated as $p>.05$ and homogeneity was assumed. After normality and homogeneity assumptions were met, two-way (3 × 4) ANOVA test was used in repeated measurements (repetition × time interaction) to determine whether time-dependent changes in the variables (HR, La, RPE) examined on different administration days showed a similar pattern. Inter-intervention comparison of related variables (PP, MP, AP, FI) was carried out by using repeated measures ANOVA, with Bonferroni post hoc tests to conduct pairwise comparisons. Effect size of the differences (Cohen's d) according to Cohen's classification (<0.2 weak; $0.2 \leq d < 0.5$ small; $0.5 \leq d < 0.8$ medium; $d \geq 0.8$ strong effect size) and reported according to partial eta squared (ηp^2) values. Statistical significance level was set as $p \leq 0.05$ in all tests.

RESULTS

Table 1. Participant characteristics (n=15)

	Min value	Max value	Mean value	Standard deviation
Age (year)	18.05	24.87	20.70	2.54
Height (cm)	159.0	184.0	173.0	0.09
Body mass (kg)	50.60	99.70	68.76	13.2
BMI (kg/m^2)	18.81	30.77	22.82	3.07
BFR (%)	6.60	23.71	15.10	6.51
VO_2max (ml.kg.dk^{-1})	30.90	59.90	42.50	9.21

BMI: Body mass index, BFR: body fat ratio, VO_2max: maximal oxygen consumption

Comparison of different mouth rinse intervention effects on dependent variables. In the measurement session in which control and placebo (water)-, NACl-, CHO-MR were applied, the HR (beats/min), La level (mmol) and RPE (6-20) were measured before and after the 30-minute endurance exercise and foollowing the repeated sprint test, and the data obtained in the repeated sprint test are presented in Table 2.

Table 2. Power outputs and fatigue parameters of the control, Plecebo (water MR), NaCl-MR, CHO-MR session

		Control session				Placebo (water-MR) session				NaCl-MR session				CHO-MR session			
		Min	**Max**	**Mean**	**±SD**	**Min**	**Max**	**Mean**	**±SD**	**Min**	**Max**	**Mean**	**± SD**	**Min**	**Max**	**Mean**	**±SD**
Before endurance exercise (1)	**HR**	61.0	67.0	63.6	3.0	57.0	68.0	63.3	2.55	60.0	67.0	63.7	1.92	61.0	68.0	63.5	1.64
	La	0.50	0.90	0.70	0.12	0.60	0.90	0.71	0.08	0.50	0.90	0.73	0.12	0.60	0.90	0.71	0.09
After endurance exercise (2)	**HR**	151	178	164	8.15	145	183	164	10.5	145	185	165	10.6	159	181	167	6.32
	La	9.70	16.0	13.3	1.56	9.70	14.6	11.9	1.5	7.8	13.7	11.5	1.53	9.00	13.0	11.4	1.28
	RPE	15.0	17.0	15.9	0.80	14.0	18.0	15.9	1.2	14.0	18.0	16.1	2.00	16.0	18.0	16.4	0.63
After repeated sprint test (3)	**HR**	160	181	174	6.05	148	189	168	11	152	191	169	10.5	159	180	171	6.01
	La	14.5	21.4	17.6	2.33	14.4	20.2	17.5	1.8	13.5	19.4	17.5	1.76	12.4	19.9	17.1	2.17
	RPE	15.0	18.0	16.9	0.80	14.0	18.0	16.4	1.1	15	19.0	16.5	1.13	15.0	18.0	16.7	0.70
Peak power (watt)		745	1755	1209	309	721	1573	1252	247	784	1644	1232	278	632	1814	1259	317
Mean power (watt)		285	621	449	110	249	544	436	76	291	533	418	77.1	274	882	456	145
Minimum power (watt)		31.8	190	94.2	41.7	8.88	149	92.3	34.1	60.5	153	101	25.2	11.6	186	102	47.5
Fatigue index (%)		88.0	96.0	92.2	2.5	90.0	99.0	92.7	2.2	90.0	94.0	91.7	1.4	88.0	98.0	92.3	2.7
Peak power (watt/kg)		12.9	24.5	17.7	3.8	12.5	27.3	18.5	3.8	14.0	25.0	18	3.05	11	25.7	18.3	3.4
Mean power (watt/kg)		4.95	9.33	6.53	1.1	4.2	7.83	6.45	1.1	5	7.24	6.1	0.59	4.8	12.5	6.65	1.8
Minimum power (watt/kg)		0.6	2.23	1.34	0.5	0.2	1.9	1.34	0.5	1.0	2.0	1.5	0.3	0.2	2.2	1.44	0.5

HR: heart rate (beat/min), La: blood lactate level (mmol), RPE: rate of perceived exertion (6-20)

The comparison of the participants' data on the repeated sprint test measured in four separate sessions is shown in Table 3. Accordingly, there is no significant difference between all the data obtained with the repeated sprint test between sessions.

Table 3. Comparison of the participants' average data of the repeated sprint test measured in four separate sessions

	F value	*p* value	ηp^2
Peak power (watt)	F (3,42) = 0.735	p = 0.537	0.050
Peak power (watt/kg)	F (3,42) = 0.956	p = 0.422	0.064
Mean power (watt)	F (3,42) = 0.927	p = 0.436	0.062
Mean power (watt/kg)	F (3,42) = 0.858	p = 0.471	0.058
Minimum power (watt)	F (3,42) = 0.701	p = 0.557	0.048
Minimum power (watt/kg)	F (3,42) = 0.638	p = 0.595	0.044
Fatigue index (%)	F (3,42) = 0.806	p = 0.498	0.054

The in-group comparison of the peak power/body weight (kg) data for each repetition of the repeated sprint test is in Table 4. Accordingly, the peak power/body weight (kg) output produced in 6 sprint repetitions performed in each session significantly different between repetitions.

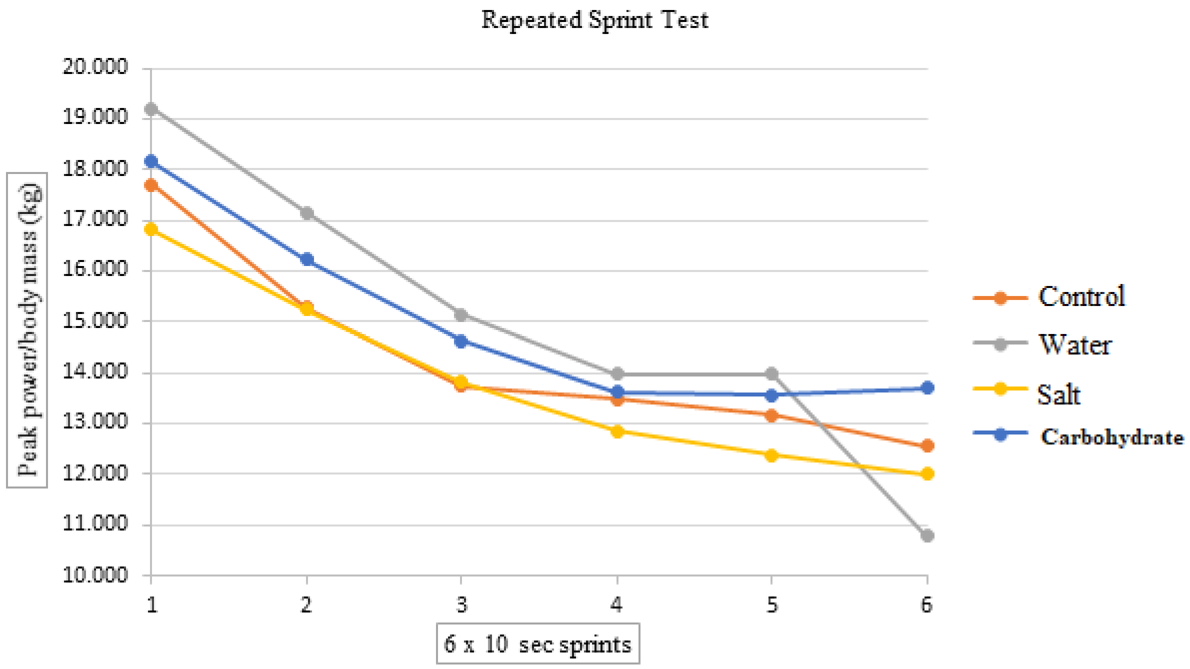
Table 4. Comparison of the participants' peak strength/body weight (kg) data for each repetition of the measured repeated sprint test

Peak power (watt/kg)	F value	p value	ηp²	Post hoc*
Control session	F (1.703,22.137) = 17.861	0.001	0.579	1-2, 1-3, 1-4, 1-5, 1-6, 2-3
Placebo session	F (2.120,19.083) = 16.688	0.000	0.650	1-2, 1-3, 1-4, 1-5, 1-6, 2-3, 2-6
NaCl-MR session	F (2.225,22.247) = 17.416	0.000	0.635	1-3, 1-4, 1-5, 1-6, 2-4, 2-5, 3-4
CHO-MR session	F (1.400,11.203) = 7.188	0.015	0.473	1-2, 1-3, 1-4, 1-6, 2-3, 2-4, 2-6, 3-4

*Post hoc test shows significant pairwise comparisons between sprint repetitions.

The peak power/body weight (kg) data obtained in each repetition of the repeated sprint test performed by the participants in each session is shown in Figure 1.

Figure 1. Peak power/body weight data in the repeated sprint test for each session



The comparison of peak power/body weight (kg) data for each repetition of the repeated sprint test between sessions is shown in Table 5. Accordingly, it was observed that the peak power/body weight (kg) output produced in 6 sprint repetitions performed in each session did not differ between repetitions.

Table 5. Inter-session comparison of participants' peak strength/body weight (kg) data for each repetition of the measured repeated sprint test

Peak power (watt/kg)	F value	p value	ηp²
1st sprint	F (3,39) = 0.806	0.498	0.058
2nd sprint	F (3,9) = 0.459	0.718	0.133
3rd sprint	F (3,9) = 0.441	0.730	0.128
4th sprint	F (3,9) = 0.376	0,.773	0.111
5th sprint	F (3,12) = 1.260	0.332	0.240
6th sprint	F (3,9) = 0.498	0.693	0.142

According to the evaluation of the fatigue parameters (La, HR, RPE) of the participants, whose measurements were repeated three times in four separate sessions, with two-way (3 × 4) ANOVA in repeated measurements, there was no significant difference between the sessions. (Table 6).

Table 6. Comparison of the fatigue parameters measured three times in each session

	F value	p value	η_p^2
HR (beat/min)	F (6.110) = 1.610	0.165	0.081
La (mmol)	F (6.112) = 1.997	0.072	0.097
RPE (6-20)	F (6.112) = 1.145	0.341	0.058

HR: heart rate, La: blood lactate level, RPE: rate of perceived exertion

Discussion

This research was aimed to determine the effect of mouth rinsing of solutions containing CHO and NaCl on power output in repeated sprint performance by comparing it with control and placebo (water) MR sessions. The key findings of this study indicate that there is no different effect on power outputs and fatigue parameters produced in repeated sprint performances after 30 minutes of endurance exercise in administrations with CHO-, NaCl-, water- MR, and without rinsing.

Khong, Selvanayagam and Yusof (2021), in the first and only study on this topic, investigated the effects of MR solutions on maximal voluntary contraction after 30 minutes of cycling at 70% of VO2max, glucose and NaCl. Their hypothesis based on that the salty (NaCl) mouth rinse solution, which is frequently used in dentistry to desensitize the oral cavity to pain, may influence the insular cortex and/or opioid receptor activities by activating the 'salty' taste receptors in the oral cavity, which in turn affects the parasympathetic nervous system, which regulates cardiac automatic activity that it can potentially cause changes in the brain and protect the maximum voluntary contraction performance. In addition, it was suggested that since CHO-MR had no effect on metabolic processes in the study (Carter et al., 2004), alterations in central drive (executive) or motivation level may contribute to reported enhancements in performance. For this reason, it has been claimed that it is appropriate to examine the effect of mouth rinsing on exercises involving high central drive, such as maximum voluntary contraction. Consequently, it was ascertained that after 30 minutes of endurance training at 70% VO_2max, mouth rinsing of liquid containing 6% glucose and 6% NaCl can produce significantly more maximal voluntary contractions compared to water-MR. These findings have been interpreted as the biochemical traits of glucose and NaCl may stimulate the nervous system and sections of the brain to sustain the neural impulse of power production (Khong, et al., 2021).

The fact that NaCl mouth rinsing did not have an effect on repetitive sprint performance in our study suggests that the stimulus produced by NaCl rinsing in the mouth may not be strong enough to affect this type of maximal dynamic exercise.

Many studies have shown that CHO-MR has positive effects on endurance performances lasting about an hour (Chambers, et al., 2009; Pottier, et al., 2010; Rollo, Williams, and Nevill, 2011), as well as the effects of CHO-MR solutions on anaerobic performance, suggesting that changes in strength are mediated by a "central drive" and that a CHO stimulus can reveal positive afferent signals that can enhance motor performance (Jeukendrup and Chambers, 2010). However, contradictory results have been obtained in this limited number of studies.

In a study investigating the effect of CHO-MR on repeated sprints, compared to control, CHO and placebo had significant increases in PP and MP data, but no difference was found between CHO and placebo. HR was significantly higher in control session compared to CHO and placebo despite the higher PP and MP outputs. In addition, CHO-MR had no influence on RPE and La variables throughout the sprint test and recovery phases (Karabıyık et al., 2017). The method differences such as using a protocol consisting of 12 × 4 second interval sprints, rinsing the solution containing 6.4% CHO before each sprint, selecting 10 seconds for rinsing time, and using running performance may have been effective in the discrepancies in our results.

When other investiagations exemaning the effect of CHO-MR on sprint performance indicated that, Phillips et al. (2014) studied the effect of 8 × 5 seconds rinsing of a solution containing 6% maltodextrin in 25 ml on 30 seconds sprint performance in recreationally active participants. It was reported that mouth rinsing significantly increased the PP achieved in the first 5 seconds, compared with placebo administration. Also, no significant differences between sessions were reported for FI, RPE, or blood La levels. Beaven et al. (2013) reported that PP improved only in the first 5-second sprint during 5 × 6-second sprint test applied on a bicycle ergometer as a result of having CHO-MR before each sprint in a 24-second active recovery. They attributed their results to the existence of a central mechanism in the ability of MR practice to rapidly improve maximum exercise performance.

Unlike these studies, in the research in which combined and repeated nutrition administrations were carried out, the highest PP output from 45-second sprint performance was achieved with 10% glucose-MR compared to 0.05% aspartame-MR, 9% maltodextrin-MR and water-MR (Chong et al., 2014). In another research in which combined exercise performance designed to similar a cyclocross or mountain bike competition, they found that rinsing a 6.4% KH solution in the mouth for 10 seconds had a positive effect on MP produced only in the 6th set of high-intensity multi-sprint performance. They expressed this finding as a small but practical ergogenic advantage (Simpson, et al., 2018).

These positive results are generally accredited to the alterations in power generation through a "central governor" and a mechanism that can enhance positive afferent signals that may improve motor output owing to ascending cortical excitability with mouth rinsing (Beaven et al., 2013; Gant, et al., 2010). Přibyslavská et al. (2016), on the other hand, interpreted the performance-improving influence of CHO-MR as likely to occur merely in the intial phases of short-term tasks, and this effect was negligible.

In contrast to studies reporting these positive results, the effects of rinsing the mouth with 7.1% glucose solution and 6.4% maltodextrin solution on 30-second maximal sprint performance were investigated by comparing them with rinsing and no rinsing sessions, and on all indicators of sprint performance (PP and MP), no differences were found between sessions in nausea or RPE. The findings were interpreted as rinsing an isoenergetic amount of maltodextrin or glucose in the mouth for 5 seconds is not beneficial for maximum speed performance (Chong et al., 2011). In studies conducted with futsal (De Oliveira et al., 2020) and football (De Oliveira et al., 2019) players, it was found that post-activation potentiation application positively affected repetitive sprint running performance, on the other hand, combination of the application and CHO-MR has been shown to have no additive effect. Similarly, in a study testing performance of 6 × 40 m sprints (round trip = 20 m + 20 m) divided by 20 s of passive recovery, it was found that CHO-MR had no significant effect on repeated sprint performance compared to placebo and control sessions (Bortolotti et al., 2013). Cherif et al. (2018) revealed that 5 × 5s × 2sets (3 min rest between sets, 25 s rest between sprints) performed in the fasting state, CHO-MR (10% maltodextrin) performed before each sprint in the maximal sprint protocol does not have a significant influence on sprint performance. Pibyslavska et al. (2016) reported that CHO-MR during morning training had no effect on the 18 m sprint performance of female soccer players. Krings et al. (2017) compared the effect of CHO consumption or MR (50 ml, 10%) before each sprint on the performance of a 5 × 15s maximum repetition sprint on a bicycle ergometer. They have reported that only CHO consumption is more likely to give a beneficial performance effect.

Bortolotti et al. (2013) and Clarke, Kornilios, and Richardson (2015) stated that the stimulus produced by CHO-MR may not be strong enough to affect short-term and high-intensity training. Although it is known that CHO-MR has the ability to mechanically stimulate the motivation centers (orbitofrontal cortex) in the brain (De Pauw et al., 2015), with the method constructed from the results obtained in this study, it seems that the stimuli used are insufficient to affect the outcome variables of physical performance.

It is thought that the probable reasons for these negative findings may be the training status of the participants, the satiety status of the participants, the selected content of the MR solution, the duration of rinsing, and/or performance tasks (Beaven et al., 2013; Clarke et al., 2015; Přibyslavská et al., 2016; Rollo et al., 2010; Washif and Beaven, 2018). These negative results indicate that the possible influence of these variables (if any) may not be reflected in the findings, this is because they are hidden by the probable effects of other variables (Karuk, Nalcakan and Pekünlü, 2021). This query in the literature may be a study topic for future research.

Conclusion

This research investigated the effects of MR solutions containing 6.4% maltodextrin, 6.4% NaCl, and water (placebo) on repeated sprint performance (6 × 10 sec, 40 sec interval) after 30 minutes of endurance exercise at 70% VO_2max. It was found that there was no significant difference in any power and fatigue parameters obtained with repetitive sprint performance between sessions.

Recommendations

It suggests that the possible effects of variables such as participants' training status, satiety status, content of solution rinse in the mouth, duration of agitating and/or performance tasks (if any) may not have been reflected in the findings because they were obscured by the probable effects of other variables. This gap in the associated literature may become a subject of research for future investigations.

Acknowledgements

I would like to thank to the Assoc. Prof. Dr. Gülbin Rudarlı Nalçakan and Assoc. Prof. Dr. Gülşah Şahin for their valuable support throughout the study.

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