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Original article

The effect of carbohydrate gel consumption on elite mountain bikers time to exhaustion and blood glucose metabolism

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Summary. *Study Objectives:* In athletes, additional carbohydrate (CHO) uptake is important during sub-maximal and high-intensity exercise and competitions where the cost of metabolism exceeds endogenous carbohydrate depots. The aim of this study was to investigate the effects of carbohydrate gel consumption on glucose concentration and exercise time to exhaustion of elite mountain bikers. *Methods:* 20 mountain bikers (22,5 ± 2,64 years; 67,4 ± 5,44 kg; 174,7 ± 4,59 cm) performed bicycle ergometer with increasing overload test at 48 hours intervals. The experimental group was given 42 g of carbohydrate gel 20 minutes before test and control group was not consumed carbohydrate gel. In addition, the glucose levels of the athletes were followed with blood samples taken before and after the tests. *Results:* The averages of glucose levels and exhaustion times were higher according to the carbohydrate gel consumption ($p<0.001$). The consumption of carbohydrate gel decreases the glucose levels by 4.48% and does not the consumption of carbohydrate gel decrease by 8.90%. The glucose levels of mountain bikers in the trials decrease by 4.48% and 8.90% according to carbohydrate gel consumption and not, respectively. The exhaustion times of carbohydrate gel consumed mountain bikers were higher (9.35%; 00:31 sec.). *Conclusion:* Mountain bikers consuming carbohydrate gels were found longer exercise times and higher blood glucose levels than those who did not consume carbohydrate gels.

Key words: carbohydrate gel consumption, exhaustion time, glucose, mountain biker

Introduction

In recent years, the ergogenic aids are commonly used to increase performance and achieve success by the athletes (1). Sportive performance improves with a balanced diet; unbalanced diet may affect negatively the performance (2). For this reason, supplement products have been one of the important issues that should be emphasized (3). Supplement products, having a wide range of products, are general vitamins, minerals, amino acid, essential fatty acid, various vegetables and their extracts (4). Carbohydrates used as nutrition support are the most significant component of energy metabolism during exercises (5). Additional carbohydrate intake is significant since sub-maximal and intermittent high intense exercises and metabolism energy consumption exceed the endogenous carbohydrate storage during competitions (6). It has been reported that carbohydrate (CHO) intake during exercises increases the performance of long exercises with limited endogenous carbohydrate (7). Recreational athletes and team sports players frequently consume carbohydrate-electrolyte solutions in order to raise blood glucose concentration.

Former studies showed that multiple transportable carbohydrates products caused low fatigue level and a positive increase in athletic performance (8-10). Recent studies have reported that carbohydrate gel consumption has become popular among athletes to eliminate loss of carbohydrate and dehydration during exercises (11-13). It was commonly shown in the literature that carbohydrate (CHO) based supplement

increases the endurance performance (14-17). Earnest et al. (12) examined the carbohydrate gel ingestion during simulated endurance (64 km) cycling time trial performance and their results showed a trend in time and wattage over the last 16 km of 64 km simulated time trial. In addition, Kingsley, Penas-Ruiz, Terry Russell, (18) stated in their study, conducted on recreational footballers, that carbohydrate-electrolyte gel increased sprint performance during intermittent high-intense exercises. It was also stated in another study that carbohydrate gel ingestion significantly raised intermittent endurance capacity of adolescent team players (19). Moreover, Campbell, Braun, Applegate, and Casazza, (20) examined the effectiveness of carbohydrate supplements (drink, gel and jellybeans) over water only on cyclists 80 min followed 10 km time trial performance. They reported that carbohydrate supplements in the form of a drink, gel, or sports beans during of approximately 2 hr with sufficient glycogen and in normal environmental conditions were effective in maintaining blood glucose levels and improving performance over water only.

The effects of carbohydrate gel consumption on blood levels and performance of different athletes in different branches have been researched in many studies. These studies have generally been conducted on recreational athletes (21) or young athletes training at early ages (19,13). Also, there are limited numbers of studies studying blood levels and performance components on the elite athletes. Although carbohydrate-based supplements are commonly used by cyclists, there is no study investigating the effects of carbohydrate-based supplementation on elite mountain bikers. In this context, the purpose of this study is to examine the effect of carbohydrate gel consumption on elite mountain biker's time to exhaustion and blood glucose concentration.

Method

Participants

20 elite (Turkish national team) mountain bikers ($\overline{X}_{age}$: 22,5±2,64 years; $\overline{X}_{height}$: 174,7±4,59 cm; $\overline{X}_{weight}$: 67,4±5,44 kg; $\overline{X}_{experience}$: 7,7±2,4 years) participated voluntarily in this research. Participants were informed about the purpose of the research, details of the tests, and the risks they may encounter. The participants were informed about the purpose of the study, details of the application and the risks that may cause due to the application and voluntary consent forms were signed by the athletes. Ethical approval was obtained from the Faculty of Medicine of Sakarya University with protocol number 16214662/050.01.04/71.

Data Collections Tools

Participants' heights were measured with Seca 213 (Germany) brand portable stadiometer with 1 mm sensitivity, and participants' weights were measured with Seca 808 (Germany) brand digital scale. Monark 839 E modal (Vansbro, Sweden) bicycle ergometer and computer software connected to the bicycle were used to measure endurance performance of participants. Polar M400 (Kempele, Finland) was used to follow the heart beats during tests. Participants' blood glucose levels were measured with Okmeter Optime OK-10H (Taiwan).

Observation of Participants' Diet and Activity

Participants were not performed physical activity 48 hours before and between the two test trials. The same diet programs (different food for every day) were applied to all athletes who perform a pre-competition preparation camp.

Collecting Data and Exhaustion Test Protocol

The cross-sectional study design was used to collect data from control and experimental group. Participants were randomly separated into two groups, 10 athletes in the control group and 10 athletes in the experimental group. Twenty minutes before the first trial, the experimental group was given carbohydrate gel (Multipower Multicarbo® 1 packet gel 40 g; 104 kcal, 26 g carbohydrate, 10 g sugar 350 mg salt) by a nutrition expert who was not involved in the research. Carbohydrate gel was not given to the control group. The resting heart rates of all athletes were determined before warm up and then all participants performed a standardized 15-min warm-up session. A graded exercises test with bicycle ergometer applied to determine bikers' time to exhaustion. The ergometer bike load was increased by 50 watts in every 2 minutes for the

Table 1. Comparison of glucose levels according to two-way repeated measures ANOVA of carbohydrate gel consumption

Variables	Glucose Levels (mg/dL)			Δ %	F	p
	Pre-test	Post-test	Total			
	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD			
CHO +	98.00±2.62	93.80±3.16	95.90±2.89	4.48	12.911	0.001**
CHO –	96.70±2.68	88.80±3.22	92.75±2,95	8.90		
Total	97.35±2.69	91.30±4.04		Trial x Time F=37.972; p=0.001**		
	F=406.101; p=0.001**					

duration of the test. The test ended at athletes' exhaustion time and exhaustion time was recorded. At the end of every two minutes, heart rates (HR) of athletes were obtained via a HR monitor (Polar M400) during test protocol. Additionally, athletes' blood glucose levels were measured immediately after exercise. After 48 hours all athletes participated in the second trial and did the same study protocol as the first trial.

Statistical Analysis

SPSS 18 was used for data analysis. The descriptive statistics for heart rate during the tests were given as the mean and standard deviation. Differences in time to exhaustion between treatments were assessed using a paired t-test. Differences in glucose levels were analyzed using a 2X2 (treatment X time) repeated measures analysis of variance (ANOVA). The effects of carbohydrate gel consumption on exhaustion times and changes in Glucose levels were assessed by examining the carbohydrate gel consumption X trial interaction effect in 2-way repeated-measures ANOVA. Differences in percentages of glucose levels were calculated using the formula Δ% = ((Pretest - Posttest) / Pretest) × 100 (22). Significance was set at 0.05.

Findings

It was observed that the averages of glucose levels were statistically different according to measurement times (F=406.101; p=0.001). Accordingly, it was found that the total glucose levels decreased by a mean of 6.63% between the pre and post measurements. Moreover, it was also detected that the averages of glucose levels were statistically different according to the carbohydrate gel consumption (F=12.911; p<0.001). In addition, the interaction between the glucose levels of the carbohydrate gel consumption and measurement times was statistically significant (F=37.972; p=0.001). Accordingly, it was found that in exhaustion exercise, the consumption of carbohydrate gel decreases the glucose levels by 4.48% and does not the consumption of carbohydrate gel decrease by 8.90% (Table 1).

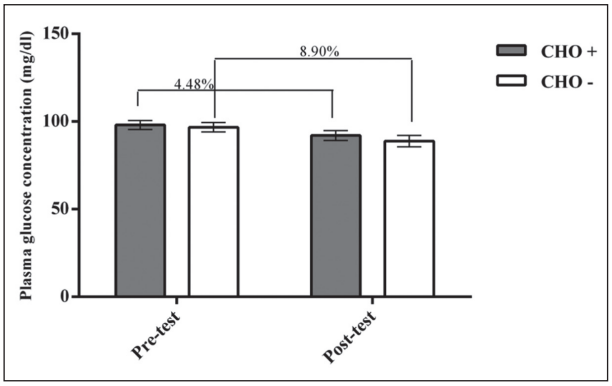

Figure 1. Comparison of glucose levels of mountain bikers according to carbohydrate gel consumption

It was observed that in the exhaustion times of mountain bikers were statistically different according to carbohydrate gel consumption (p<0,05; Table 2).

The heart rate of mountain bikers was increased linearly during the test period. According to these results, the average heart rate of mountain bikers who consumed carbohydrate gel was determined as 196.65±1.31 (bpm) at the end of the test.

Table 2. Comparison of time to exhaustion according to carbohydrate gel consumption

Variables	$\bar{X}$ ± SD (min)	t	p
CHO +	15:13±00:43	2,199	**0,040***
CHO -	14:42±00:38		

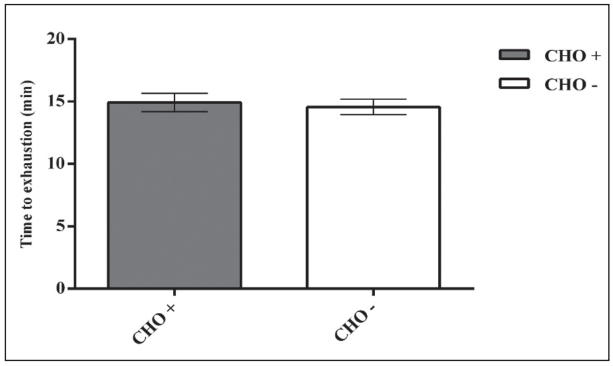

Figure 2. Comparison of the exhaustion times of mountain bikers according to carbohydrate gel consumption

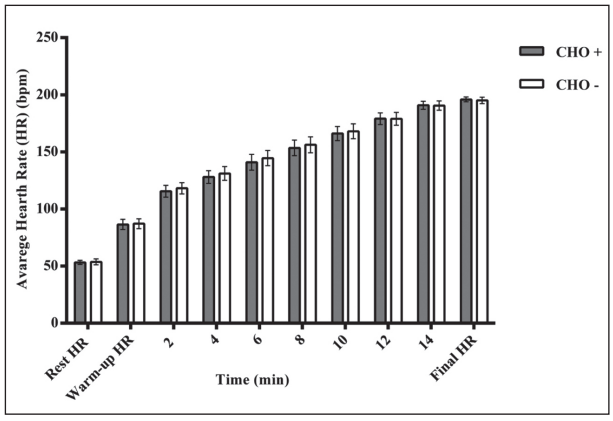

Figure 3. Comparison of average heart rate according to carbohydrate gel consumption in the exhaustion exercise

Discussion

The primary finding of this study was that the carbohydrate gel consumption increased the elite mountain bikers' blood glucose levels and exhaustion times during graded tests. When blood glucose concentration data was examined, it was determined that there were differences in total glucose levels of mountain bikers according to carbohydrate gel consumption. Additionally, the interaction between carbohydrate gel consumption and measuring time was significant. Athletes' blood glucose level decreased by 8.90% without CHO gel consumption; whereas, the blood glucose levels of the athletes who ingested CHO gel decreased by 4.48%.

Recent studies show that carbohydrate intake before and during exercises is important for maintaining blood glucose concentration and this situation is one of the important factors affecting performance (12). When the results of previous studies were examined, it was seen that carbohydrate gel causes an increase in blood glucose levels of athletes. However, the rate of increase in blood glucose levels greater than our study. For instance; Brooks, Bradley, Lane, and Hodgson, (23) reported that carbohydrate gel consumption produced a significantly greater increase in blood glucose levels against control treatment (1.6 mmol/l compared to 0.6 mmol/L). Similarly, Campbell et al. (20), examining different carbohydrate supplement products (jellybeans, sport drink and gel) in several studies, stated that blood glucose concentration of athletes, consuming supplement products were significantly higher from the athletes' glucose level who consume only water (5.7 ± 0.2 mmol/L for sports beans, 5.6 ± 0.2 mmol/L for sports drink, 5.7 ± 0.3 mmol/L for gel, and 4.6 ± 0.3 mmol/L for water). Nicholas et al. (24) reported that carbohydrate-electrolyte consumption (5 mL x kg^{-1}) and after every 15 min of exercise thereafter (2 mL x kg^{-1}) decreased muscle glycogen utilization levels during 90 min of intermittent high-intensity running by 22% (192.5 ± 26.3 mmol compare to control group 245.3 ± 22.9 mmol). These samples support the results of current research about blood glucose levels, but the level of increase in blood glucose or rates glucose utilization seems to be greater than the results of this study.

According to the second findings of the study, it was determined that exhaustion time of mountain bikers, consuming carbohydrate gel, was higher than those of bikers not using carbohydrate gel. Studies examining CHO gel ingestion show that exhaustion time of the athletes consume carbohydrate gel can be higher than the athletes do not consume CHO gel. Patterson and Gray (25) reported in their study, they examined effects of carbohydrate gel supplementation on intermittent high-intensity shuttle running, exhaustion time of the group, using carbohydrate gel, was 45% higher than the placebo group. Similarly, Phillips, Turner, Sanderson, and Sproule (19) stated in their study, applied to adolescent young athletes, exhaustion time of athletes using carbohydrate gel was 21% higher than the placebo group. In our study, there was a rate of 9.35% (00:31 seconds) difference between exhaustion times according to the carbohydrate gel

consumption. Moreover, any statistical difference was not found between athletes' heart rates using carbohydrate gel and not using. However, it was determined that mountain bikers using carbohydrate gel continued their exercises with higher heart rates towards the end of the exercise. Patterson and Gray (25) reported that carbohydrate gel consumption didn't change athletes' heart rates.

According to previous researches' results, it was determined that the effect of carbohydrate consumption on time to exhaustion and blood glucose concentration were higher than our results. Sample group in our study consists of athletes who race in international competitions, have similar training history, and condition levels. Sample group consists of recreational athletes in other studies. Low positive effects of carbohydrate consumption may result from the sample group. Hopkins has reported that the differences between the performances of the athletes competing at the international level may be very low (26).

Conclusion

In conclusion, it was determined that the exhaustion time of mountain bikers consuming carbohydrate gel was longer and the blood glucose level of the bikers was higher than bikers who didn't consume carbohydrate gel. According to this result, it can be said that carbohydrate gel used before exercises affects positively athletic performances by increasing blood glucose level, exhaustion time and by decreasing carbohydrate utilization.

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