Progress in Nutrition 2020; Vol. 22, Supplement 1: 44-49 DOI: 10.23751/pn.v22i1-S.9781

Original article

Acute effects of carbohydrate gel and isotonic usage on power, heart rate and glucose levels in elite cyclists

Gürhan Suna[1], *İbrahim Kubilay Türkay*[2]

[1] Department of Coaching Training, Faculty of Sport Sciences, Süleyman Demirel University, Isparta, Turkey - E-mail: gurhan_suna@windowslive.com; [2] Department of Sports Management, Faculty of Sport Sciences, Süleyman Demirel University, Isparta, Turkey

Abstract. *Study Objective:* This study aimed to compare the acute effects of carbohydrate gel and isotonic usage on power, heart rate (HR), and glucose levels of elite cyclists. *Method:* Twenty licensed cyclists participated in the study voluntarily. Cyclists are randomly divided into two groups (The first group: carbohydrate gel receiving group; second group: isotonic drink receiving group). Cyclists performed about one hour of velodrome training. The first group continued to operate using one energy carbohydrate gel in the fifth minute of the training. The second group used a 2 scale (27 g) electrolyte and carbohydrate mixture in 500 ml water and added powder product during the training. Athletes' mean HR values were recorded with the Garmin brand watch. The mean power (watt) values of the athletes were also obtained with the Garmin Power meter. Heart rate and power values were compared as the mean values after the training that the athletes applied after carbohydrate gel and isotonic drink intake. OKmeter Optima OK-10H (Taiwan) sugar meter was used in the measurement of blood glucose values of cyclists. Glucose measurement was taken pre- and post-test. The analysis of data was made in the statistical package program by using "Descriptive statistics", "Independent samples-t Test" and "Repeated Measures Analysis of Variance (ANOVA)" for comparison. *Results:* There were no significant differences in the mean HR, mean power, and glucose pre-and post-test values of the cyclists who took carbohydrate gel and isotonic drink before and after the training ($p > 0.05$). *Conclusion: As a* result, carbohydrate gel or isotonic usage during cyclists' sports activity didn't effect on performance and physiological properties.

Key words: Cyclist, Carbohydrate Gel, Isotonic Drink

Introduction

Cycling has become a branch of sport that is growing in popularity in the world and subject to scientific studies. Cycling is now within the scope of the Olympic sports and is considered as one of the most difficult sports branches of it. Races organized at the national and international levels are held in different disciplines (1).

Training intensely to maximize and maintain their performances in the cycling branch which requires endurance, elite cycling athletes prefer to use supplementary nutrients (gel and isotonic) they require for their body during training. Carbohydrates should be taken as a supplement during exercise to renew limited glycogen stores, discharge as late as possible, and maintain muscle strength by maintaining blood glucose concentration. It is recommended to use sports drinks and gels designed especially for athletes during exercise. The use of sports drinks helps the recovery of both carbohydrate needs and fluid and electrolytes lost through exercise (2).

Carbohydrates, which can also be used as a nutritional supplement, are the most important component of energy metabolism in exercise and play an important role in exercise performance (3). Additional

carbohydrate intake is important as the fuel cost of metabolism exceeds endogenous carbohydrate stores during sub-maximal and high-intensity intermittent exercises and races (4). Carbohydrate (CHO) intake during exercise has been reported to increase exercise performance, especially in long-term exercises where endogenous carbohydrates are limited (5). Athletes frequently consume carbohydrate-electrolyte solutions during exercises to increase blood glucose concentration (6).

Sports drinks are products designed to balance blood glucose concentration before, during, and after exercise, and while carbohydrates in them contribute to energy balance, electrolytes affect the performance positively by reducing the risk of dehydration and hypothermia (7).

In this context, the information obtained from the literature, this study aimed to compare the acute effects of carbohydrate gel and isotonic usage on power, heart rate (HR), and glucose levels of elite cyclists.

Material and Method

Twenty licensed cyclists voluntarily participated in the study. The "Informed Volunteer Consent Forms" were obtained from the cyclists to make them about the importance of the study, and to increase their desires and motivation levels to participate in the study. Cyclists were randomly divided into two equal groups. The first group is the carbohydrate gel receiving group (n: 10) and the second group is isotonic drink receiving group (n: 10). Cyclists practiced in the velodrome, which lasted about an hour (nearly its sizes is 400 m). Cyclists applied the velodrome training at 110-120 cadence, 35-40 km/h. The first group continued the activity using one energy gel in the fifth minute of the training. The second group used 2 scale (27 g) electrolyte and carbohydrate mixture powder product in 500 ml of water and used it throughout the training. We applied the principles outlined in the Declaration of Helsinki.

Heart Rate and Power Measurements

Using a "Garmin" brand watch, the mean Heart Rate values of the athletes were recorded. Mean power values of the athletes were taken with the Garmin Power meter measurement device. Heart rate and power values were compared as the mean values after the training that the athletes applied after carbohydrate gel and isotonic drink intake.

Glucose Measurement

OKmeter Optima brand, OK-10H model (Taiwan) glucose meter was used to measure cyclists' blood glucose values. Blood Glucose measurements were taken from the fingertip using the OK meter Optima Brand (OK-10H-Taiwan) and dropped on the "Glucose Test Strip". Blood glucose values were measured as "pre-test" before carbohydrate gel and isotonic drink intake while cyclists were at rest, and as "post-test" immediately after the end training that the athletes applied after carbohydrate gel and isotonic drink intake.

Statistical Analysis

In this study, SPSS 24.0 was used to obtain statistical results. The demographic data of the cyclists were evaluated by summarizing and using the Descriptive Statistics $\bar{x}$ (Arithmetic Mean) and Sd (Standard Deviation) values. "Shapiro-Wilk" test was used to determine whether data have normal distribution or not ($p>0.05$). Comparisons among the groups were performed using the Independent Sample t test for HR and power variables. Differences in glucose levels were analyzed using a 2X2 (treatment X time) repeated measures ANOVA. The results were evaluated according to "0.05" significance level.

Results

When Table 1 is examined, carbohydrate gel receiving groups' mean age was 24.3 ± .9 year, mean length was 175.8 ± 4.8 cm, mean weight was 70.7 ± 7.5 kg, mean sport age was 8.3 ± 1.1 years; of the isotonic drink receiving groups' mean age was 25.4 ± 3.3 year, mean length was 176.6 ± 3.8 cm, mean weight was 65.1 ± 3.7 kg, mean sport age was 7.2 ± 1.4 year.

Table 2 shows the mean HR and mean power values. There were no statistically significant differences for mean HR and mean power values ($p>0.05$).

Table 1. Demographic Features of Cyclists

	Groups	N	Minimum	Maximum	$\bar{x} \pm Sd$
Age (year)	Carbohydrate gel receiving group	10	23	26	24.3 ± .9
	Isotonic drink receiving group	10	20	29	25.4 ± 3.3
Length (cm)	Carbohydrate gel receiving group	10	168	182	175.8 ± 4.8
	Isotonic drink receiving group	10	172	182	176.6 ± 3.8
Body Weight (kg)	Carbohydrate gel receiving group	10	61	82	70.7 ± 7.5
	Isotonic drink receiving group	10	60	71	65.1 ± 3.7
Sport Age (year)	Carbohydrate gel receiving group	10	6	10	8.3 ± 1.1
	Isotonic drink receiving group	10	5	9	7.2 ± 1.4

Table 2. Comparing Mean HR and Mean Power Values of Cyclists Using Carbohydrate Gel and Isotonic Drink

Parameters	Groups	$\bar{x} \pm Sd$	t	p
Mean HR (beats/min)	Carbohydrate gel receiving group	148.3 ± 7.3	–1.191	.249
	Isotonic drink receiving group	152.9 ± 9.7		
Mean Power (watt)	Carbohydrate gel receiving group	170.1 ± 17.8	–.167	.869
	Isotonic drink receiving group	168.9 ± 13.9		

Table 3. Comparing the pre- and post-test Glucose Levels of Cyclists

Parameters	Groups	Pre-test	Post-test	Total	F	P
		$\bar{x} \pm Sd$	$\bar{x} \pm Sd$	$\bar{x} \pm Sd$		
Glucose (mg/dl)	Carbohydrate gel receiving group	96.3 ± 3.5	98.6 ± 11.7	97.4 ± 1.1	**.079**	**.782**
	Isotonic drink receiving group	99 ± 2.1	98 ± 2.6	98.5 ± 1.1		
	Total	97.6 ± 3.1	98.3 ± 8.2	Trial x Time		
			F = .401; p = .534	**F = .509; p = .485**		

According to Table 3, there were no statistically significant differences in the means by time, means of groups, and interaction between measurement times of glucose values pre- and post-test of cyclists receiving carbohydrate gel and isotonic drink (p>0.05).

Discussion

In the study, it was found that there was no significant difference in the comparison of the values of mean heart rate and the mean power of cyclists (p>0.05), We think that the reason for the difference in these values is not because of the similarly applied load intensity in the training. However, we can say that the group that received the gel had better performance values.

In scientific studies conducted in the literature, it was stated in this discipline that athletes spent a mean of 140–150 beats/min during the race and 80% of their M_{ax}HR was exerted (8).

In the study where Patlar (1999) examined the effect of the game form on durability and breathing parameters with continuous running in players, the pulse post-test measurement values were 145.6 ± 12.26 beats/min in group 1 and 141.14 ± 9.72 beats/min in group 2 / It has been determined as min (9). Suna and Alp (2019) defined the mean HR values in pre- and post-test competition as 157 ± 12.06 beats/min

146.88 ± 11.99 beats/min (10). In Pündük and Öztürk (2019) study, the $M_{ax}HR$ of the cyclists decreased even if the end of season value was not significant, and they found that there was a significant improvement in mean watt (11). In their study, Müniroğlu et al. (2000) obtained a statistically significant difference at the 0.05 level in aerobic power means ($p<0.05$) (12). When we look at similar studies in the literature, it is seen that the power and mean muscle values in our study are in line with other studies. Alp and Görür (2020) found differences between branches in mean power values in their study (13). The researchers have suggested that the reasons for the difference depending on the training differences and physical needs according to the branches. We believe that the reason for this study's incompatibility with our study is due to the application of different training intensities arising from the characteristics of the branches.

Considering the Repeated Measures ANOVA Test's results of glucose values before and after the training of cyclists who took carbohydrate gel and isotonic drinks, there was no significant difference in the means by time, means of groups and interaction between measurement times ($p>0.05$). However, while glucose levels increased in the group taking the carbohydrate gel, a decrease occurred in the group taking the isotonic drinks. According to these results, we can comment that carbohydrate gel intake has more effect in terms of performance and providing energy during sports activities.

Current research findings indicate that carbohydrate intake is important in maintaining the blood glycogen concentration before and during long-term exercises in cyclists and this is one of the most important factors affecting performance (14). When the data obtained are evaluated on the increase of blood glycogen concentration, it shows that it shares similarities with the previous research data, but the increase rates are negotiable. In the study of Khoo et al. (2010) examining the effects of exercise application on glucose, insulin, and glucagon in healthy individuals, they reported that insulin levels decreased after cycling exercise (15). Aydın et al. (2000) conducted the study of insulin and blood glucose levels after aerobic and anaerobic exercise on 9 male football players and reported that the mean insulin values decreased after aerobic exercise (16). In the studies of Moghadasi et al. (2013), in which they examined the effect of intense aerobic exercise applied to athletes on insulin levels, they reported that insulin levels decreased after aerobic exercise athletes (17). Our study is similar to other study findings on the subject. In their study, Brooks et al. (2002) reported a high increase in blood glucose levels in the experimental group athletes who received carbohydrate gel compared to the control group who only drank water and did not take carbohydrates (18). Campbell et al. (2008) stated in their research, where they examined different carbohydrate supplements, that athletes using supplements had significantly different blood glucose concentrations for all products compared to those who did not use them (19).

It is said that footballers' consumption of isotonic drinks containing 4–8% carbohydrates can help maintain exercise performance by delaying fatigue which may occur. According to the suggestion of NATA, 200–250 ml of water or sports drink should be consumed every 10–15 minutes during exercise to ensure hydration (20). In the study conducted by Harper et al. (2016) on football players, the effects of the use of carbohydrate gels on psychological status and performance in prolonged football competitions were examined and it was observed that the physical performances and hydration status of football players who consumed carbohydrate-electrolyte-containing gel (0.7 g/kg body weight) were preserved in extra time (21). Demiriz et al. (2015). In the study in which they examined the effects of anaerobic interval training on different resting intervals on aerobic capacity, anaerobic threshold and blood parameters, as a result of the training performed by the intensive interval training group, an increase in the level of blood glucose ($z=-2.19$) before and after the training was found at $p<0.05$ level (22). In another study, Phillips et al. (2012) reported that the time spent in the game for athletes using carbohydrate gel was 21% longer than the placebo group in their study they performed on adolescent young athletes (23).

Beyleroğlu (2019), found that cyclists' use of carbohydrate gels was higher after the aerobic exercise and that the mountain cyclist exhaustion times were higher than those who did not use carbohydrate gel. Studies examining CHO gel intake show that

exhaustion times of athletes, when they consume CHO gel may be higher than when they do not consume carbohydrate gel (24). Patterson and Gray (2007) reported in their study, they examined the effects of the addition of carbohydrate gel on the intermittent high-density shuttle run, and they found that using carbohydrate gel, the group's exhaustion time was 45% higher than the placebo group (25). When the literature is examined, it is observed that the performance of athletes increased after the use of carbohydrate gel. However, there is insufficient information about the effects of the use of isotonic drinks on athletes. In this context, we think that the information we obtained after isotonic consumption will contribute to future studies.

Conclusion

In conclusion, in the study we performed, the values of performance and physiological properties of the group receiving carbohydrate gel were higher than the isotonic drinking group. According to this result, it can be said that the carbohydrate gel used before and during the exercises positively affects athletic performance by increasing the blood glucose level and fatigue time and reducing the use of carbohydrates. Furthermore, we think that our research is very important in terms of making a detailed analysis of the characteristics and field performance of elite cyclists in our country. It is thought that increasing the number of samples in the future will be important in terms of determining the differences between them and that this is important in terms of the maturity of our research and its contribution to sports science.

Conflict of interest

The authors declare that there is no conflict of interest in this manuscript.

References

1. Özen G. Elit bisikletçilerin fiziksel, fizyolojik özelliklerinin ve izokinetik kuvvet düzeylerinin performans parametrelerine etkisinin incelenmesi. Ankara Üniversitesi, Sağlık Bilimleri Enstitüsü, Doktora Tezi, Ankara. 2018. (in Turkish)
2. Meyer NL, Manore MM, Beming J. Food and fluid recommendations for before, during and after exercise. American College of Sports Medicine 2012;16(3):7–12.
3. Gollnick PD. Energy metabolism and prolonged exercise. InLamb, D.R. &Murray, R. (Eds) Perspectives in Exercise Science and Sports Medicine. Prolonged Exercise. Indianapolis: Benchmark Press. 2001;1–37.
4. Hargreaves M. Metabolic responses to carbohydrate ingestion: Effects on exercise performance. In D. R. Lamb & R. Murray (Eds.), Perspectives in exercise science and sports medicine. Carmel, IN: Cooper 1999;93–124.
5. Luden ND, Saunders MJ, D'Lugos AC, et al. Carbohydrate mouth rinsing enhances high intensity time trial performance following prolonged cycling. Nutrients 2016;8(9):576.
6. Jeukendrup AE. Carbohydrate and exercise performance: the role of multiple transportable carbohydrates. Current Opinion in Clinical Nutrition & Metabolic Care 2010; 13(4):452–457.
7. Katch VL, McArdle WD, Katch FI. Factors affecting physiologic function. E. Lupash (Ed.), Essentials of exercise physiology. China: Lippincott Williams and Wilkins. 2011;4:502–505.
8. Wirnitzer KC, Kornexl E. Exercise intensity during an 8-day mountain bike marathon race. Eur J Appl Physiol 2008;104: 999–1005.
9. Patlar S. Effect of game form on endurance and respiration parameters with continuous running in football players (Doctoral Thesis). Selcuk University Institute of Health Sciences. 1999. (in Turkish)
10. Suna G, Alp M. Comparison of strength, heart rate, oxygen saturation and technical test values of 12–14 year male tennis players in competition period. Journal of Education and Learning 2019;8(6):187–194.
11. Pündük Z, Öztürk S. Evaluation of overloading with physical performance parameters in elite cyclists and triathletes during the training season. Journal of Sports and Performance Research 2019;10 (2):104–113
12. Müniroğlu S, Koz M, Atıl M, et al. Examination of the physical and physiological characteristics of a football team fighting in Turkish 1st professional league. Gazi Physical Education and Sports Sciences Congress Proceedings 2000:109–115. (in Turkish)
13. Alp M, Görür B. Comparison of explosive strength and anaerobic power performance of taekwondo and karate athletes. Journal of Education and Learning, 2020;9(1): 149–155.
14. Earnest CP, Lancaster SL, Rasmussen CJ, et al. Low vs. high glycemic index carbohydrate gel ingestion during simulated 64-km cycling time trial performance. The Journal of Strength & Conditioning Research 2004;18(3):466–472.
15. Khoo EYH, Wallis J, Tsintzas K, et al. Effect of exenatide on circulating glucose, insülin, glikagon, cortisol and catecholamines in healthy volunteers. Diabetologia 2010;53:139–43.

16. Aydın C, Gökdemir K, Cicioğlu G. Aerobik egzersiz sonrasında insülin ve kan glikoz değerlerinin incelenmesi. Spor Bilimleri Dergisi, Hacettepe J. of Sport Sciences 2000; 11 (1-2-3-4), 47–55. (in Turkish)
17. Moghadasi M, Nuri R, Ahmadi N. Effects of 8 weeks high intensity aerobic exercise on serum retinol binding protein 4, cortizol and insulin levels in female athletes. Brazilian Journal of Biomotricity 2013;7(1):37–42.
18. Brooks D, Bradley JL, Lane P, et al. Assessment of the effects of an isotonic carbohydrate gel on exercise performance. Medicine & Science in Sports & Exercise 2002;34(5):139.
19. Campbell C, Prince D, Braun M, et al. Carbohydrate-supplement form and exercise performance. International journal of sport nutrition and exercise metabolism 2008;18(2): 179–190.
20. Casa DJ, Armstrong LE, Hillman SK, et al. National Athletic Trainers' Association position statement: fluid replacement for athletes. Journal of athletic training, 2000;35(2):212.
21. Harper LD, Briggs MA, McNamee G, et al. Physiological and performance effects of carbohydrate gels consumed prior to the extra-time period of prolonged simulated soccer match-play. J Sci Med Sport. 2016; 19(6):509–514.
22. Demiriz M, Erdemir İ, Kayhan RF. Farklı dinlenme aralıklarında yapılan anaerobik interval antrenmanın, aerobik kapasite, anaerobik eşik ve kan parametreleri üzerine etkileri. Uluslararası Spor Egzersiz ve Antrenman Bilimi Dergisi 2015;1(1):1–8. (in Turkish)
23. Phillips SM, Turner AP, Sanderson MF, et al. Carbohydrate gel ingestion significantly improves the intermittent endurance capacity, but not sprint performance, of adolescent team games players during a simulated team games protocol. Eur J Appl Physiol. 2012; 112(3):1133–1141.
24. Beyleroğlu M. The effect of carbohydrate gel consumption on elite mountain bikers' time to exhaustion and blood glucose metabolism. Progress in Nutrition 2019;21(1): 19–24.
25. Patterson SD, Gray SC. Carbohydrate-gel supplementation and endurance performance during intermittent high intensity shuttle running. Int J Sport Nutr Exerc Metab. 2007; 17(5):445–455.

Correspondence:
Gürhan Suna
Department of Coaching Training, Faculty of Sport Sciences, Süleyman Demirel University, Isparta, Turkey
E-mail: gurhan_suna@windowslive.com;