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Effect of Carbohydrate Ingestion on Sprint Performance Following Continuous Exercise

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Abstract: The purpose of this study was to determine the effect of 5% carbohydrate ingestion on the sprint performance immediately following 90 min of running at 70-80% of maximal heart rate reserve. Thirty young active men were selected as subjects and allocated randomly to two carbohydrate (CHO, N = 15) and placebo (PL, N = 15) groups. Pre-test 200 m dash, 90 min running and post-test 200 m dash took place, respectively. Exercise heart rate monitored during 90 min running by a cardio frequency meter. Significant differences were found between the CHO and PL post-test 200 m dash records ($p<0.05$). Blood glucose was found to be significantly higher at the end of the 90 min running for the CHO group than for the PL group ($p<0.01$). The results suggest that carbohydrate ingestion during endurance exercise inhibits failing of Sprint performance of young active men.

Key words: Carbohydrate ingestion, sprint performance

INTRODUCTION

Although carbohydrate ingestion during prolonged exercise has been widely studied (Backhouse *et al*., 2007; Francescato and Puntel, 2006; Bosch *et al*., 2005) because of improving endurance performance by preventing hypoglycemia (Stannard *et al*., 2007; Kavouras *et al*., 2004) and by other factors that are still unclear (Below *et al*., 1995; Jeukendrup *et al*., 1997), the potential benefits of carbohydrate ingestion on anaerobic performance has not been systematically investigated. While most of the available evidence indicates exogenous carbohydrate ingestion to be beneficial during moderate intensity aerobic exercise, recent evidence has suggested the use of an exogenous carbohydrate source to also be of benefit during high intensity exercise performance (Ball *et al*., 1995; Below *et al*., 1995; Wilber and Moffatt, 1992). By mediating favorable alterations in blood glucose concentration, muscle glycogen depletion during exercise of shorter duration (i.e., <60 min) and higher (i.e., >80% $VO_{2\ max}$) intensity is reduced. As a result of this glycogen sparing, sprint performance at the end of an exercise activity is enhanced (Ali *et al*., 2007).

Guerra *et al*. (2004) have shown that when subjects (20 soccer players) ingested a 6% carbohydrate-electrolyte solution at regular 15 min intervals, during 75 min on field soccer game, significant changes occurred in the number of sprints performed. This study results indicates that supplementation with a carbohydrate-electrolyte drink during a soccer match is beneficial in helping to prevent deterioration in performance.

Febbraio *et al*. (2000) exercised seven trained men, who cycled 120 min at ~63% of peak power output, followed by a 7 kJ kg^{-1} b.wt. time trail. They concluded that ingestion of CHO during 120 min of cycling improve subsequent time trial performance.

Fritzsche *et al*. (2000) have shown that water and carbohydrate ingestion during prolonged exercise increases maximal neuromuscular power (P_{max}). They also observed that ingestion of water plus carbohydrate attenuates the decline in maximal power more than dose water alone and ingestion of carbohydrate alone dose not attenuate the decline in maximal neuromuscular power compared with placebo.

The results of Sugiura and Kobayashi (1998) study have shown that consuming 20% glucose polymer [the subjects cycled at moderate (65% $VO_{2\ max}$) and high (100% $VO_{2\ max}$) intensity for 90 min with a 15 min half-time break], results in maintained plasma glucose levels and carbohydrate oxidation rate in both trails. These results clearly showed that ingestion of glucose during half-time of 90 min exercise could maintain carbohydrate utilization and improve sprint performance in both continuous and intermittent trails.

Below *et al*. (1995) studied 8 endurance-trained (mean $VO_{2\ max}$, 4.44±0.08 L min^{-1}) males. These subjects cycled for 50 min at 80% $VO_{2\ max}$. During the trials in which they received a carbohydrate supplement, they received 79±4 g of a carbohydrate-electrolyte beverage. A cycling performance test followed in which the subjects were required to complete predetermined amounts of work in the shortest amount of time possible. Fluid and

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carbohydrate ingestion were both found to improve cycling performance, with the effects being additive. These researchers found carbohydrate ingestion to improve sprint performance following high intensity exercise.

Ball *et al.* (1995) also examined the effects of carbohydrate feeding on the cycle ergometer sprint performance of 8 trained male cyclists. Intensity of exercise prior to measured sprint performance was also set at 80% $VO_{2\ max}$ for 50 min of cycle ergometry. Sprint performance was improved with the intermittent ingestion of a carbohydrate supplement providing approximately 53 g CHO/h. Whereas, Jarvis *et al.* (1999) study results have shown that high intensity exercise performance of female cyclists is not improved with the consumption of a CHO beverage during exercise despite a reduced perception of effort.

According to this literature, the present study examined the effect of CHO supplementation and the impact of 5% carbohydrate ingestion on the sprint performance immediately following 90 min of running at 70-80% of maximal heart rate reserve.

MATERIALS AND METHODS

Subjects: In 2006, thirty young active men who volunteered to participate in the study read and signed an informed consent document prepared and approved by the Board for Protection of Human Rights affiliated to the Mohaghegh Ardabili University. All the subjects were screened and homogenized for absence of cardiovascular disease, substance use, surgery histories and then allocated randomly into two groups of carbohydrate (CHO, N = 15) and Placebo (PL, N = 15), before completing a physical activity readiness questionnaire.

Testing apparatus: Body height (cm) and weight (kg) and body composition variables of subjects were determined using an electronic SECA scale and Lange skinfold caliper, respectively. Subject heart rate was measured with a Polar Vantage XL Heart Rate Monitor (Stamford, CT Model 45900). A digital photo finish was used to determine 200 m dashes records. The plasma concentrations of blood glucose were measured using a Reflotron (Boehringer Mannheim Corp., Indianapolis, IN).

Procedures: Diet (three days) and training logs were requested from each subject prior to each experimental trial. The diet logs were analyzed using the Nutritionist III Version 7.0 (N-squared computing, Salem, OR). This was done in order to determine the calorie intake and the percentages of carbohydrate, fat and protein which were ingested prior to the treatment trials. During the treatment trials the subjects were given, in a counterbalanced and double blind fashion, either a 5% solution of sucrose polymer solution or a placebo solution (PL). All subjects consumed the given treatment in a volume that was set at 3 mL kg^{-1} body weight. The CHO or PL solutions were given at 10 min intervals throughout the 90 min of exercise. This equated to the consumption of 1900 to 2100 mL during exercise. All fluids were kept refrigerated until the time of consumption.

Blood glucose collected at baseline and immediately after post-test 200 m dash via capillary puncture (Yoshida and Imafuku, 2007).

Following pre-test 200 m dash, both 90 min of running exercise at 70-80% of maximal heart rate reserve and the post-test 200 m dash was administered, respectively.

Statistical analysis: The data were analyzed using Independent and Paired-Samples t-tests when appropriate. All statistics were run using the $SPSS_{13}$ statistical package. Treatment effects are considered significant at a value of $p \leq 0.05$.

RESULTS

There was no significantly differences in physical and body compositional characteristics between two groups (Table 1).

The results of the paired samples t-tests yielded no significant ($p>0.05$) differences between the two treatment conditions for total calories; grams of carbohydrate, fats and proteins and percentage of calories from carbohydrates, fats and proteins.

Blood glucose: No significant ($p>0.05$) difference was found between the carbohydrate beverage (CHO) and the placebo (PL) at baseline. However, mean blood glucose was found to be significantly ($p<0.01$) higher for CHO than PL at the end of the 90 min running (Table 2).

Table 1: Physical and body compositional characteristics of the two groups subjects

Variables	CHO group	PL group
Age (years)	21.46±1.24	21.10±1.62
Height (cm)	176.13±6.83	174.73±5.27
Weight (kg)	69.20±7.04	69.21±7.51
Body fat (%)	11.96±3.15	10.93±2.75
Mean body mass (kg m^{-2})	61.60±6.24	62.37±8.53

All values are mean±standard deviation

Table 2: Blood glucose levels for the carbohydrate and placebo groups

Blood glucose levels (mg dL^{-1})	Groups CHO	PL	P
Pre-test	80±8.80	83±6.41	0.650
Post-test*	99±14.55	77±8.32	0.001

All values are mean±standard deviation, Statistical analysis with independent t-test, *: Different is significant at the 0.01 level (2-tailed)

Table 3: 200 m dashes records for the carbohydrate and placebo groups

200 m dashes records (sec)	Groups		
	CHO	PL	P
Pre-test	27.85±1.57	28.21±1.94	0.730
Post-test*	28.94±2.64	30.67±1.95	0.025

All values are mean±standard deviation, Statistical analysis with independent t-test, *: Different is significant at the 0.05 level (2-tailed)

Sprint performance: No significant ($p>0.05$) difference was found between the carbohydrate beverage (CHO) and the placebo (PL) at baseline. However, mean 200 m dash records were found to be significantly ($p\leq 0.05$) lower for CHO than PL at the end of the 90 min running (Table 3).

DISCUSSION

There would be a tendency for plasma glucose levels to be reduced if an exogenous source of glucose is not ingested during prolonged exercise. In this study, as expected, blood glucose levels were higher in the CHO group than in the PL group as well as those of Khanna and Manna (2005), Mark *et al.* (2000) and Tsintzas *et al.* (1996).

Higher blood glucose levels and therefore, maintained sprint performance during the later stages of prolonged strenuous exercise in the CHO group compared to the PL group have been reported by Guerra *et al.* (2004), Febbraio *et al.* (2000), Fritzsche *et al.* (2000), Sugiura and Kobayashi (1998), Ball *et al.* (1995), Below *et al.* (1995) and Wilber and Moffatt (1992), whereas Jarvis *et al.* (1999) study results have shown that high intensity exercise performance of female cyclists is not improved with the consumption of a CHO beverage during exercise despite a reduced perception of effort. It is possible that the female subjects may have received the carbohydrate supplement at a rate that was below the minimum threshold needed to have an ergogenic effect (Coggan and Swanson, 1992). Therefore, the results of the present study indicating a higher blood glucose levels and therefore, maintained sprint performance during the post-test 200 m dash records in the CHO group compared to the PL group that is in line with most studies reported.

It is important to note that in this study, subjects were given 3 mL kg^{-1} of the identical carbohydrate beverage. This was equivalent to the consumption of carbohydrate at the rate of approximately 67 g h^{-1}. Therefore, it is possible that the subjects may have received the carbohydrate supplement at a rate that was needed to have an ergogenic effect (Wallis *et al.*, 2005). The administration of an exogenous carbohydrate source allows for the oxidation of carbohydrate from sources other than muscle glycogen during the later stages of prolonged strenuous exercise (Stellingwerff *et al.*, 2007). Indeed CHO feeding during exercise has been shown to increase muscle glucose uptake compared with the ingestion of a placebo (McConnell *et al.*, 1996). Such an increase in blood glucose availability could, theoretically, more than compensate for any hyperinsulinemia-induced reduction in lipolysis while also reducing the reliance on intramuscular glycogen stores. Such a metabolic process is likely to lead to an enhanced exercise performance.

CONCLUSION

In conclusion, the feeding of a 5% CHO solution during endurance exercise inhibits failing of Sprint performance of young active men. This may be caused by exogenous carbohydrate source that allows for the oxidation of carbohydrate from sources other than muscle glycogen during the later stages of prolonged strenuous exercise.

- Blood glucose was found to be significantly higher for CHO than PL at the end of the 90 min running.
- Carbohydrate ingestion during endurance exercise inhibits failing of Sprint performance of young active men during the later stages of prolonged strenuous exercise.

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