Carbohydrates and Exercise

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Introduction

- Carbohydrates are made up of carbon, oxygen, and hydrogen with this proportion: CH_2O
- Major source of energy fuel in the body → glucose
- RDA : 130 g/d for adults
- Three major types:
  - Monosaccharides (simple sugars→cane sugar)
  - Disaccharides (simple sugars→lactose)
  - Polysaccharides (complex →starches)

Introduction

- Metabolic pathways of carbohydrates :
  - **Glycolysis:** glucose → pyruvate
  - **Tricarboxylic acid cycle (TCA):** pyruvate→Acetyl-CoA→TCA
  - **Glycogenesis:** glucose →glycogen
  - **Glycogenolysis:** glycogen →glucose
  - **Gluconeogenesis:** non-carbohydrate sources →glucose

The Talk about Carbohydrates and Exercise

- Carbohydrates have been studied in the aerobic exercise realm for many years
- Carbohydrates are considered the main fuel for aerobic exercise capacity
- Carbohydrates are suggested to improve aerobic exercise by decreasing muscle glycogen use, therefore increasing performance
- Carbohydrates are suggested to replenish muscle glycogen after exercise causing a shorter recovery period

No Effect of Carbohydrate Feeding on 16 km Cycling Time Trial Performance

Jeukendrup, A. E., Hopkins, S., Arago´n-Vargas, L. F., & Hulston, C. (2008). No effect of carbohydrate feeding on 16 km cycling time trial performance. *European Journal of Applied Physiology*, *104*, 831–837.

Purpose

- To investigate the effect of carbohydrates ingestion during high intensity exercise performance lasting approximately 25 minutes

Methods

- Subjects: twelve endurance trained male cyclists aged 19–41
- Inclusion criteria:
  - Had experience in 16 km time trial (had at least done 5 times in the last 3 years)
  - were training at least three times a week
  - had been involved in competition for at least 2 years

Methods

- Each subject completed 3 simulated 16 km trials.
- Subjects consumed one time carbohydrate drink and a water placebo drink twice.
- Time of consumption was 5 minutes before the start and at 25, 50, and 75% of completion of the time trial.
- Double blind crossover design

Results

- No significant differences were observed in:
  - The time to complete the time trials with either treatment
  - Power output during the time trials
  - Heart rate average

Discussion & Conclusion

- Different mechanisms:
  - In prolonged exercise the role of carbohydrates is to maintain blood glucose level and high rates of carbohydrate oxidation
  - During a short and high intensity exercise the blood glucose concentrations do not decrease, but it may increase because the hepatic glucose is increased

Discussion & Conclusion

- Ingestion of carbohydrate-electrolyte solution did not improve performance during a simulated 16 km cycling time trial compared with a placebo drink.

Article's Short Message

Carbohydrates do not improve performance in short duration and high intensity exercise.

Implication

- It is important to know that CHO feeding during short duration and high intensity exercise become impractical for athletes.

Evaluation

- (+)
  - Choosing subjects
    - Healthy
    - VO2max test
    - Diet record
    - Activity pattern
    - Well trained
  - Accurate time of trials
  - 23 references (1986-2004)
  - Easy to follow
- (-)
  - Cannot be generalized
    - Male subjects
  - Small sample size

Resistance Exercise & Carbohydrates Past &Recent Hype

TRADITIONAL -PAST

- RT is primarily anaerobic using adenosine triphosphate (ATP), creatine phosphate ADP→ATP
- Muscle glycogenolysis and glycolysis play a minor role is RT

PRESENT

- Carbohydrate use may increase performance and exercise capacity during RT
- Carbohydrate use may maintain or save muscle glycogen stores during RT
- Carbohydrate use after exercise may help replenish muscle glycogen loss

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise

Brown, V.A., Dumke, C.L., Kang, J., McAnulty, L.S., Mcnulty, S.L., Nieman, D.C., Utter, A.C. (2005). Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise. *Journal of Strength and Conditioning Research*, 19(4), 939-943.

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise

- ***Purpose***: The study looked at the relationship between carbohydrate consumption and perceived exertion during a RT workout.
- ***Question***: Does carbohydrate supplementation increase performance and effort during RT?

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise (cont.)

- ***Methods***:
  - 30 male subjects (19-27 yrs.)
  - Double blind design (CHO group/placebo group)
  - Pre-exercise assessment: 1RM and unweighted 10 exercises (4sets/10 reps)
  - Borg Scale: 6-20

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise (cont.)

- ***Methods (cont.):***
  - CHO (liquid) or placebo consumption 10am, 3pm, 15-30 mins before exercise, and during exercise
  - Recording of RPE of overall body exertion and muscle specific exertion after exercises in both groups

- ***Inclusion Criteria*:**
  - minimum of 6 months total body training experience
  - were able to back squat 1.25 their body mass

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise (cont.)

- ***Results***:
  - Carbohydrate supplementation did not effect the RPE between the two groups.

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise (cont.)

- ***Discussion & Conclusion***:
  - Carbohydrate supplementation during RT did not effect RPE.
  - Carbohydrate supplementation during RT bout does not provide any psychological benefit on RPE results.
  - Other benefits of carbohydrate supplementation should be taken into account, such as an increase in work output and recovery time.

Carbohydrate Supplementation and Perceived Exertion During Resistance Exercise (cont.)

Evaluation

- (-)
  - small sample size
  - male only
  - carbohydrate quality and form
  - overall dietary intake not mentioned
  - psychological effect
  - timing of supplementation
- (+)
  - strong background information
  - opportunity for more in-depth research

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy

Cribb, P.J., Hayes, A. (2006). Effects of Supplement Timing and Resistance Exercise on skeletal Muscle Hypertrophy. *Medicine & Science in Sports & Exercise*, 38(11), 1918-1925.

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy

- ***Purpose***:
  - Examine the effect of supplementation timing on RT muscle hypertrophy, strength, and body composition before and after a workout or at other hours not close to the workout during a 10 week RE program.

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy (cont.)

- ***Methods***:
  - 17 males
  - single-blind, randomized protocol
  - Two groups: PRE/POST and MOR-EVE
  - Assessments completed 1st and 10th week of study: 1RM (3exercises), body composition, and vastus lateralis muscle biopsies for glycogen, creatine, and contractile protein.
  - Supplementation: protein/creatine/glucose

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy (cont.)

- ***Inclusion Criteria:***
  - no history of anabolic steroid use
  - 6 months on a training program
  - no use of ergogenic supplementation in the past 12wks.
  - agree not to take any supplementation or nonprescription drugs during the study

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy (cont.)

- ***Results***:
  - PRE/POST group showed increased lean body mass and 1RM strength. The change in body composition was supported by an increase in the size of type II fibers and contractile protein. There was also an increase in glycogen after the training program.

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy (cont.)

- ***Discussion & Conclusion:***
  - Although the supplementation was a mixture of protein and CHO, the study suggests that CHO may have helped to spare muscle glycogen thus, enabling greater work capacity during RT or subsequent RT sessions.

Effects of Supplement Timing and Resistance Exercise on Skeletal Muscle Hypertrophy (cont.)

Evaluation

- (+)
  - easy to understand
  - clear explanations and background information
- (-)
  - males only
  - small sample size
  - no independent CHO supplementation

Take Home Message for Resistance Training

Carbohydrates may be used to help spare muscle glycogen allowing increased work capacity/force during workouts and in subsequent workout sessions.

Effect of CHO Loading Patterns on Running Performace

Chen, Y., Wong, H. S., XU, X., Hao, X., Wong, C. K., & Lam, C. W. (2008). Effect of CHO Loading Patterns on Running Performance. *International Journal Sport Nutrition*, 29:598-606.

Some abbreviation and terminology

- Isoenergetic: showing equal force or activity
- Carbohydrates: CHO
- Glycemic Index: GI
  - Definition: is a ranking of foods based on their actual postprandial blood glucose response as compared to a reference food
- Glycemic load: GL
  - Definition: measures both quantity and quality of the dietary CHO consumed

Purpose

- To examine the impact of 3-day CHO loading with different GI and GL meals on running performance and subsequent metabolic responses

Introduction

- Fatigue could be a result of prolonged exercise and the depletion of the body's stored muscle glycogen
- CHO loading:
  - To increase the stored muscle glycogen
  - Has a positive impact on performance during exercise event that lasts over 90 min

Methods

- Subjects:
  - 9 healthy male runners
    - (they performed a 1 hr run at 70% VO2 max followed a 10 km performance run after 3-day diet adaptation)
  - Medical history questionnaires and running ability were obtained
  - No history of diabetes
- Experiential design:
  - 3 different standardized pre-load treadmill performance runs were completed
  - 3-day CHO loading with different GI and GL meals after a 1-h exhaustive run followed by a standardized preloaded exercise protocol

Methods

- Performed a glycogen-depletion exercise
- Randomly assigned to 3 trials

HH	LL	HL
High GI	Low GI	High GI
High GL	Low GL	Low GL

Methods

- Completed 3-d food diary record before the 3 d before introducing GI/GL different diets
- Avoid alcohol & caffeine; performing strenuous exercise a day before the main trial

1st day	2nd day	3rd day	4th day
•1-h exhaustive exercise •3o min run at 80% VO2 max •Then, another 30 min at 70% VO2 max •Why: to reduce the muscle glycogen	•Light exercise training: 20 min run at 70% VO2 max on the treadmill	•Light exercise training: 20 min run at 70% VO2 max on the treadmill	•Standardized exercise protocol

Methods

- Afterward, subjects were seated in a quiet area in the lab
  - Blood concentration and perceived rating gut fullness were assessed 2-h postprandial

Results

- The performance in the LL trial was improved comparing to HL trail
- High BS conc. were observed in high CHO trial (HH, LL) during exercise and the recovering period comparing the low CHO trial (HL)
- No difference in the plasma insulin values were observed in the 3 trails during exercise and recovering period

Discussion & Conclusion

- Improved endurance performance and improved recovery from prolonged exercise were observed when low GI meals were consumed comparing to high GI meal
- Studies showed that pre-exercise ingestion of HGI CHO produces immediate hyperglycemic responses causing rapid drop in the plasma glucose conc.

Discussion & Conclusion

- Low GI and low GL is more effective in improving endurance performance compared to low CHO diet with High GI and low GL
- In conclusion, the main factor that has an impact on metabolism and endurance run performance appears to related to the amount rather than the nature of CHO consumed.

Implication

- It is important for endurance runner athletes to consume adequate CHO intake to be able to perform better

Evaluation

- (+)
  - 3 day dietary record was obtained and Registered Dietitian was involved in the process
  - 32 references
- (-)
  - Small no. of subjects.
  - Conclusions are limited to male, could not be generalized to other population

Effects of Carbohydrate Ingestion 15 min before Exercise on Endurance Running Capacity

Tokmakidis, S. P., & Karamanolis, I. (2008). Effects of Carbohydrate Ingestion 15 min Before Exercise on Endurance running capacity. *Apply Physiology Nutrition Metabolism*, 33: 441-449.

Purpose

- To test the effect of pre-exercise glucose ingestion on exercise metabolism and endurance running capacity during prolonged treadmill exercise

Introduction

- Many research studies showed that CHO ingestion before exercise has been shown to affect metabolic response, substrate utilization during performance, and exercise time to exhaustion
- There is a relationship between the Consumption of glucose and hyperinsulinaemia 30-60 min before strenuous exercise

Methods

- Subjects:
  - 11 recreational runners
    - 10 males and 1 female
  - Insulin sensitivity and insulin secretion were assessed using the oral glucose tolerance test.
    - All subjects had normal response
  - Maximal oxygen consumption (VO2 max) was measured
- Experiential design:
  - Each subject was involved in 2 running trials on treadmill to exhaustion
  - Glucose (G) and Placebo (CON) solutions were ingest 15 min before the onset of exercise

Results

- Endurance time, oxygen consumption:
  - Subjects who were in the G group ran longer than the CON group
  - Date showed oxygen consumption during exercise was not different between the two trials

Results

- Serum glucose and plasma insulin:
  - After 15 min ingestion, serum glucose levels were significantly higher in the G group vs the CON
- Serum glycerol and serum FFAs:
  - Serum FFAs was lowered in the G group vs the CON
- CHO and fat oxidation:
  - Throughout the exercise, there was no difference in CHO oxidation in both trials, but fat oxidation was lowered in the G trial compared to the CON trial

Discussion & Conclusion

- This study agreed with other research that there is a positive relation between CHO ingestion and exercise performance
- Other studies showed that glucose ingestion before exercise caused hypoglycaemia during the first min of exercise
  - Causes could be possibly due to:
    - The time of glucose supplementation
    - The amount of glucose ingested before the exercise

Discussion & Conclusion

- During this study, none of the subjects were hypoglycemic
  - Researcher suggesting that fatigue was delayed and performance time improved because:
    - Availability of circulating serum glucose which provided extra source of energy
    - Reserved muscle glycogen stores

Implication

- CHO ingestion before exercise is essential
  - To maintain good glycemic control
  - To provide extra energy
  - To help runners to perform better

Evaluation

- (+)
  - Easier to read, follow and understand
  - Included male and female subjects
- (-)
  - Not enough subjects to relate to other populations
  - 15 references only

Conclusion

- Benefits of carbohydrates in exercise depend on :
  - Amount and time of consumption
  - Type of carbohydrates
  - Duration and intensity of exercise
- As RDs educating athletes on the essential of carbohydrate intake
- Higher needs of CHO which help athletes with their physical endurance and metabolism

References

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Any Questions???