

Carbohydrates & Exercise

FCS 608

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History

- India, circa 300 A.D.
 - Sanskrit
 - “su” = sweet
 - “gar” = sand
- Egypt, circa 640 A.D.
 - “Glucose”
- Int’l Union of Chemistry, 1938
 - “Carbohydrates”



Title IMG source: <http://www.consumeraffairs.com/images02/wheat.png>
Source: <http://acnefriend.com/images/glycolic-acid-acne-sugarcane.jpg>

Biochemistry

- CHO = primary source of energy
 - During exercise and physical activity
- Stored CHO in form of **Glycogen**
 - Liver
 - Muscle tissue
- Digestion
 - Enzymatic breakdown in small intestine
 - Complex carbohydrates are found as long chains of glucose.

Biochemistry

- Complex CHO
 - long chains of glucose
 - aka polysaccharides (amylose & amylopectin)
- Simple CHO
 - Mono- or disaccharides
 - One or two sugar molecules

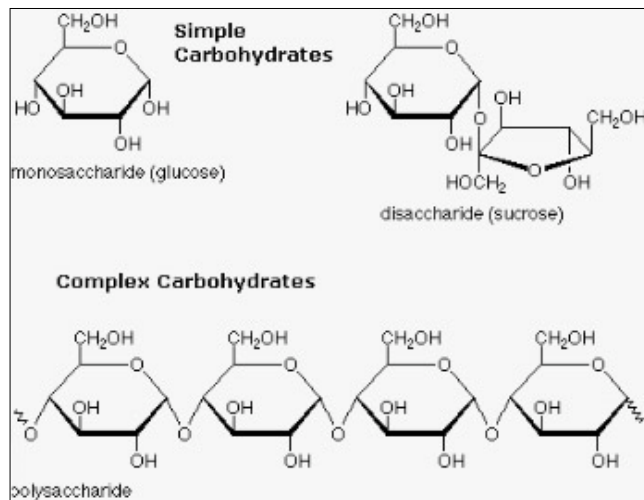


Figure 1. Simple and Complex Carbohydrates

Source: <http://jennifer.nutritiontransition.co.uk/images/carbohydrate-diagram.jpg>

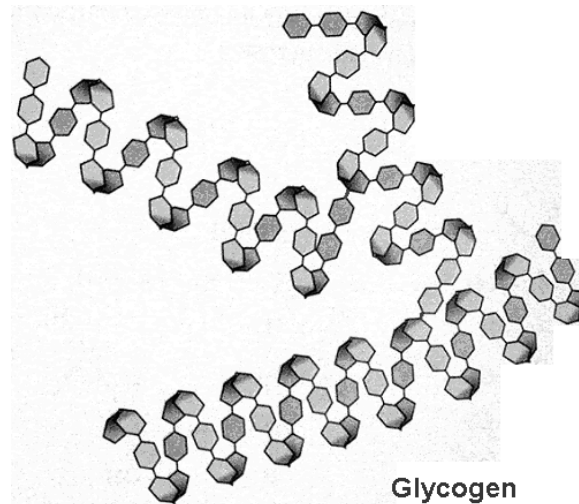


Figure 2. Glycogen Structure

Source: <http://www.chm.bris.ac.uk/motm/glucose/glycogen.gif>

Biochemistry

- Absorption
 - Small intestine → Liver → bloodstream
 - “checkpoint” all CHO → glucose (blood sugar)

- CHO used for a variety of needs.
 - Maintaining normal blood glucose
 - Stored as glycogen for later use
 - For immediate energy
 - Krebs cycle → ATP

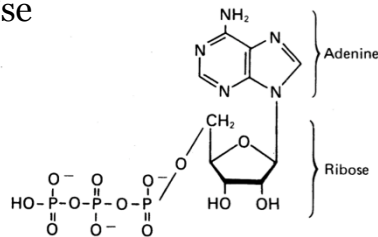


Figure 3. ATP molecule
Source: <http://www.benbest.com/cryonics/ATP.gif>

Glycemic Index + Glycemic Load

- Glycemic Index [GI]
 - how quickly CHO affects blood glucose
 - 0-100 rating
 - Based on 50g of CHO food item
 - Can be categorized as **LOW/MED/HIGH**

- Various factors in digestibility/speed
 - Other nutrients
 - How many Servings?
 - **This is known as the Glycemic Load (GL)**

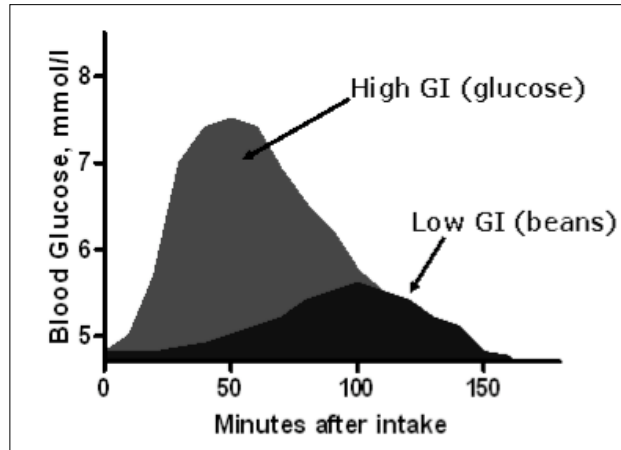


Figure 4. Varying GI and Blood Glucose effects over time.
Source: http://www.medbio.info/Horn/Time%201-2/glycemic_index.htm

Some examples of glycemic index	
Corn Flakes	112
All Bran	55
Oatmeal	70
Whole wheat bread	50-70
Pizza	85
Waffles	110
Spaghetti	50-60
Rice	110-120
Potato, cooked	80-85
Potato, mashed	104
Milk	40-50
Cola	97

Figure 5. Various food items and respective GI rating.
Source: http://www.medbio.info/Horn/Time%201-2/glycemic_index.htm

Recommended Intake

- Low CHO diets result in low glycogen
 - Decreased performance time
- Non-athlete recommendation
 - 4-5 g CHO/kg (body weight)
- General athlete
 - 5-7 g CHO/kg
- Increased performance
 - 7-10 g CHO/kg
- 132lb athlete →
 - 300-420g daily
 - 420-600g competition

Pre-Exercise Meal

- Preexisting glycogen & fat
 - fuel during a workout
- Pre-exercise meal important for an athlete
 - Especially if there is a lack of intake
 - Provides energy (esp. when workout lasts 1hr+)
 - Satiation during a workout
 - Supply muscle cells w/energy by increasing blood glucose
 - All help to increase **performance**.

Pre-Exercise Meal

- Guidelines
 - Consume 1-4 hr prior to exercise
 - Aim for 1 - 4.5 g CHO/kg
 - Consume 2nd meal/snack 1hr prior to workout
 - Aim for ~1g CHO/kg
- Athletes encouraged to experiment with **LOW/MED/HIGH** GI foods

Post-Exercise Meal + Refueling Window

- Performance can be impaired if CHO stores are not replenished.
 - Athletes strongly suggested to come prepared with a post exercise carbohydrate snack.
- Within ~30 min after workout
 - Consume 1.5g CHO/kg
 - Ex. Fruit, Starch (potato/bread), CHO drink/gel
- 2hr post workout
 - consume another 1.5g CHO/kg

Excesses

- In general
 - Weight gain
 - Hyperglycemia (Type II Diabetes)
 - Increase in triglycerides
 - Increases risk of cavities

- On athletic performance
 - GI disturbances
 - Increased gastric dumping
 - Re-directed blood flow to stomach

Deficiencies

- In general
 - Decreased energy production
 - Can lead to hypoglycemia, feeling lethargic and even syncope (fainting).
 - Decreased ability to concentrate

- On athletic performance
 - Increase in gluconeogenesis
 - Break down of protein for energy
 - Muscle wasting
 - Hypoglycemia, fatigue which leads to....
 - LOSING!!!

Controversy

- “Carbohydrates make me fat!”
- Carbs = fat
 - NOT TRUE!
 - Excess calorie consumption.
 - Lack of knowledge about carbohydrate.
 - Can't burn fat without carbohydrate.

Controversy

- “Lower Your Carbohydrate Consumption to Increase Muscle Mass”
- Article by Chris Aceto in M & F Magazine.
 - Cycle CHO day by day
 - Never over 150g
 - Do you need CHO to build muscle?
 - What is to be used for energy to lift weights?

Current Research

1. CHO Supplements & Performance (Sandra)
2. GI & GL (Armen)
3. CHO Ingestion & Soccer Performance (Vaughn)
4. Rinsing CHO solution & Running (Brian)
5. Placebo Effect (Sandra)

Article 1

- Carbohydrate-supplement form and exercise performance.
- Campbell, Prince, Braun, Applegate, & Casazza
- IJSNEM 2008

Campbell, C., Prince, D., Braun, M., Applegate, E., & Casazza, G. A. (2008). Carbohydrate-supplement form and exercise performance. *International Journal of Sport Nutrition and Exercise Metabolism*, 18, 179-190.

Article 1

- Purpose
 - 3 different supplement forms of CHO
 - Difference in cycling performance?
- Materials
 - 16 cyclists and tri-athletes
 - CHO Sport Drink
 - CHO Gel
 - CHO Sports Beans
 - H₂O

Article 1

- Methods
 - Standardized meal 1-2 hours prior to each trial
 - 10 min warm-up
 - 80 min ride (75% max VO₂)
 - 10-km time trial
 - 4 Experimental trials
 - Randomly assigned CHO supplements (0.6 g)
 - Consumption before, during, and after

Article 1

- Results
 - Maintenance of blood glucose levels
 - Improved cycling time & performance for all CHO supplements in comparison to H₂O
 - Sports beans increased power output during 10-km time trial

Article 1

- Discussion
 - Sports Beans inc. during 10-km could be due to:
 1. Delayed breakdown & absorption of outer coating allowing availability during time trial
 2. Error in using device that measures power output

Article 1

- Prior Research
 - Several studies proven CHO sports drinks improve exercise performance
 - No prior research on effectiveness of gels or jelly beans on exercise performance

Article 1

- Implications
 - Form of CHO supplement does not influence the beneficial effects of supplement
 - Variation provides athletes with convenient, portable, easy to digest options

Article 1

- Limitations
 - Small sample size
 - Sponsored by Jelly Belly Company (bias)
 - Inaccurate device measurement (power output)

Article 2

- Influence of mouth rinsing a carbohydrate solution on 1-h running performance.
- Rollo, Cole, Miller & Williams
- Medicine & Science in Sports & Exercise 2010

Rollo, I., Cole, M., Miller, R., Williams, C. (2010). Influence of mouth rinsing a carbohydrate solution on 1-h running performance. *Medicine & Science in Sports & Exercise*, 42, 798-804.

Article 2

- Purpose
 - Determine efficiency of mouth rinsing CHO solution on runners during 1hr run.
- Materials & Methods
 - 10 endurance trained male participants
 - Automated treadmill (changes speed w/o manual input)
 - 25ml - 6.4% CHO solution
 - 25ml – Placebo
 - 13 hour fast
 - 1hr run
 - Finger prick blood samples

Article 2

- Results
 - 6.4% CHO group solution ran 211 meters more than placebo
 - No change in blood glucose levels
 - No plasma insulin levels
 - Why?

Article 2

- Discussion
 - Increased performance when runners rinsed w/ 6.4% CHO solution
 1. Simple CHO was shown to have a positive effect on endurance running by swishing a sample in mouth.
 2. Blood glucose and plasma insulin levels were not effected.
 - Could be a good alternative to those who suffer from GI discomfort.

Article 2

- Prior Research
 - Previous research has shown similar effects.
 - Increased performance without impact on blood glucose or plasma insulin levels
 - Same results seen in a study done on cyclists.

Article 2

- Implications
 - Tests show that performance can be increased in endurance sports by CHO solutions, even without ingestion.
 - Research reinforces that CHO plays a vital roll in energy production for aerobic and anaerobic activities.

Article 2

- Limitations
 - Small sample size
 - Consisted of men only
 - Participants were trained endurance athletes
 - Test was only one hour
 - So what about events that last longer?
 - Same beneficial effects?

Article 3

- The Influence of Carbohydrate-Electrolyte Ingestion on Soccer Skill Performance
- Ajmol, Williams, Nicholas, & Foskett
- *Medicine & Science In Sports & Exercise* 2007

Ajmol, A., Williams, C., Nicholas, C. W., & Foskett, A. (2007). The Influence of Carbohydrate-Electrolyte Ingestion on Soccer Skill Performance. *Medicine & Science In Sports & Exercise*, 39(11), 1969-1976.

Article 3

- Purpose
 - To determine the outcome of consuming CHO-electrolyte solution in university soccer players with depleted glycogen levels.
- Materials & Methods
 - 2 main trials, 16 university soccer players
 - CHO-electrolyte & placebo solution
 - Shooting + passing recorded prior to trial
 - 30 min cycling (70% VO_{2max})
 - (3x) 50 sec sprints
 - 45 min cycling (70% VO_{2max})
 - Low CHO meal was given after reducing glycogen stores.

Article 3

- Materials & Methods
 - 1st trial
 - Ingested CHO solution
 - 2nd trial
 - Ingested placebo while performing skill tests.
 - Athletes performed
 - (6x) 15 min block tests
 - 3 min rest periods to ingest solution
 - 10-12 cycles of walking/running (95% VO_{2max})
 - Jogging (55% VO_{2max})
 - followed by sprint

Article 3

- Materials & Methods
 - After the exercises
 - 2 min rest
 - Then passing & shooting tests
 - Comparison was measured by:
 - difference in their skill display
 - body mass pre- and post-exercise
 - blood analysis for glucose, lactate, and FFA

Article 3

- Results
 - Shooting test was better in the CHO trial
 - Passing test did not show significant difference
 - Sprint was faster in CHO test
 - Blood analysis test confirmed more plasma glucose in CHO trial

Article 3

- Discussion
 - After prolonged exercise, CHO solution maintained soccer shooting skills, but made no change with shooting skills compared to placebo trials.
 1. For shooting, the body requires more energy and strength to deliver an accurate high velocity shot.
 2. For passing, the body may deliver a pass while reaching fatigue.

Article 3

- Prior Research
 - Other research indicates that fluid intake maintains glycogen levels efficiently.
 - Numerous research specifies that an intake of a carbohydrate solution maintains plasma glucose levels; thus, prolonging the use and depletion of body glycogen.

Article 3

- Implications
 - Consumption of CHO-electrolyte solutions while exercising facilitates athletic performance and skill-display to those with compromised glycogen stores.
- Limitations
 - Small sample size.
 - Limited to only 3 specific soccer skill performance tests.
 - A better analysis will be made with tests applied on a diversity of skilled based performances from different sports.

Article 4

- Effect of Preexercise Meals With Different Glycemic Indices and Loads on Metabolic Responses and Endurance Running
- Chen, Wong, Wong, Lam, Huang, Siu
- IJSNEM 2008

Chen, Y. J., Wong S. H., Wong C. K., Lam, C. W., Huang, Y. J., & Siu, P.M. (2008). Effect of Preexercise Meals With Different Glycemic Indices and Loads on Metabolic Responses and Endurance Running. *International Journal of Sport Nutrition and Exercise Metabolism*, 18, 281-300.

Article 4

- Purpose
 - To examine the effect of ingesting 3 isocaloric meals with different GI and GL 2 hr before exercise on metabolic responses and endurance running performance
- Materials & Methods
 - 8 male runners
 - 3 randomized trials
 - Separated by at least 7 days
 - 1hr run @ 70% VO_{2max} +10km performance run

Article 4

- Materials & Methods
 - 3 isocaloric meals [CHO%, GI, GL]
 1. High GI/High GL [65%, 79, 82]
 2. Low GI/Low GL [65%, 40, 42]
 3. High GI/Low GL [36%, 78, 44]
 - Blood samples to determine glucose conc.
 - Air samples examined at 20 min. intervals
 - Total CHO & FFO calculated via stoichiometry

Article 4

- Results
 - Low-GL induce smaller changes in metabolism during exercise than High-GL
 - Higher rates of FFO found in low-GI meals
- Discussion
 - High-GI meals induced an insulin response which was found to decrease FFO
 - Crucial for athletes to know:
 - relationship of different types of dietary CHO
 - respective GI/GL
 - benefits in sustaining energy during competition

Article 4

- Prior Research
 - Findings on Low-GI & FFO relationship are supported by prior research articles.
 - Effects of insulin and FFO observed prior.
- Implications
 - “Ingesting a low-GI high-CHO meal, with reduced postprandial glycemia and insulinemia, might provide the CHO required during subsequent exercise without depressing fat oxidation...”

Article 4

- Limitations
 - Factors of control
 - Timing of food ingestion
 - Quantity of CHO ingested
 - Type of exercise
 - Performance measurement method
 - Absence of data on preexisting glycogen
 - Results attributed to basal glycogen content or glucose/FFO metabolism during experiment

Article 5

- No placebo effect from carbohydrate intake during prolonged exercise.
- Hulston & Jeukendrup
- IJSNEM 2009

Hulston, C. J., & Jeukendrup, A. E. (2009). No placebo effect from carbohydrate intake during prolonged exercise. *International Journal of Sport Nutrition and Exercise Metabolism*, 19, 275-284.

Article 5

- Purpose
 - To examine the likelihood of a placebo effect on exercise performance after participants ingested a CHO solution before exercise.
- Materials & Methods
 - Random double blind cross-over study
 - 10 male cyclists
 - Participants were informed CHO vs. H₂O

Article 5

- Materials & Methods
 - 600ml of either solution:
 1. Only H₂O
 2. 6% CHO + electrolyte solution
 3. Colored & flavored H₂O
 - Given every 15min and at start of 120 min trial
 - Participants completed a 60 minute time trial as fast as they could immediately after they finished.

Article 5

- Results
 - No placebo effect was observed for participants who believed they consumed carbohydrate solution
 - The participants who consumed the CHO solution increased their cycling performance for the Time Trial (TT) by 10.6%.

Article 5

- Discussion
 - CHO ingestion improved performance compared to Only H₂O and Colored-flavored H₂O.
 - Mechanism by which CHO improve performance were confirmed in this study.

Article 5

- Prior Research
 - In contrast to previous studies:
 - there was no placebo effect
 - Participants showed an improvement in performance when they believed they ingested CHO
- Implications
 - “believing that one has received CHO does not improve performance during prolonged exercise”

Article 5

- Limitations
 - Small sample size
 - Reliability of performance testing:
 - Participants might pick up on subtle cues
 - Uncertainty of trial order can alter performance
 - One of the references listed in the reference section was not cited in the text (title: Validity, reliability, and sensitivity of measures of sporting performance)

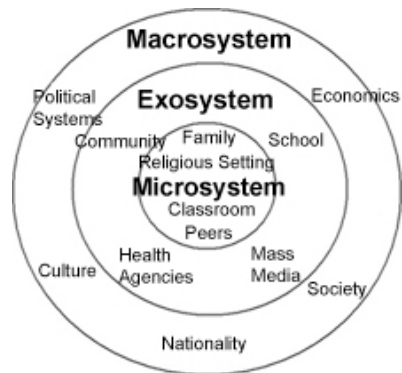
Take Home Message

CHO have a positive influence on exercise performance.

The Human Ecological Theory

Important for educator:

1. Understand why a person has developed such beliefs
2. To try to help them modify or develop different beliefs



IMG Source: http://www.sasked.gov.sk.ca/branches/psych_portal/images/ecological_model1.jpg

The Human Ecological Theory

- CHO topics for an Educator:
 - RDA for activity level (training, competition, & recovery phases)
 - Pre-exercise meal
 - Consumption during practices and games
 - Post-exercise refueling window
 - Complex versus simple
 - Glycemic index
- Constantly reassure athlete that you want to help improve their athletic performance so they believe that your goal is their goal

Conclusion

- Humans have relied on grains historically
- CHO remain the main staple for all
- Research confirms CHO are ideal energy source
- Educators: debunk myths & pass the grains!

