Introduction

- Carbohydrates (C, H, and O)
  - Growth, metabolism, and other body functions.
- Glucose $\rightarrow$ Immediate energy
- Glycogen $\rightarrow$ Muscle, liver stores
- Main source of energy $\rightarrow$ body, brain, nervous system.
Carbohydrates and Exercise

- Carbohydrate → “the enemy”

- Depletion of CHO stores
  - Impair athletic performance
  - Fueling strategies
Carbohydrates and Exercise

Keys: Intake and Timing
Trends and Controversies

1. Trained vs Untrained Muscles
2. Male and Female
3. Supplements vs High-CHO Diet
4. Exercise intensity, exercise duration, participant selection criteria, and emotion altering performance results
Article 1: Effects of supplemental carbohydrate ingestion during superimposed electromyostimulation exercise in elite weightlifters.

Article 2: Does carbohydrate supplementation enhance tennis match play performance?

Article 3: Carbohydrate use and reduction in number of balance beam falls: implications for mental and physical fatigue.

Article 4: Ingesting a high-dose carbohydrate solution during the cycle section of a simulated Olympic-distance triathlon improves subsequent run performance.

Article 5: Effects of carbohydrate combined with caffeine on repeated sprint cycling and agility performance in female athletes.

**Purpose:** Investigate the effects of supplemental carbohydrate ingestion on blood parameters and total force output during SEMS of the quadriceps muscle in elite weightlifters.
Materials and Methods

- **Materials:** Solutions, transcutaneous electronic muscle stimulator
- **Methods:** Six elite resistance trained male subjects were randomly assigned to placebo (PL) or carbohydrate (CHO).
  - Experimental group vs Placebo group
  - Force output and blood glucose was measured.
Results

**Figure 3.** Plasma glucose after carbohydrate (CHO; *n = 6*) or placebo (PL; *n = 6*) supplementation. Blood was collected at PRE (before the exercise protocol begun), FAILURE (inability to maintain 50% target force output for 5 consecutive seconds), and RECOVERY (5 minutes after failure). Data are reported as mean ± SD. *p < 0.05 at a similar time point (i.e., PRE, FAILURE, and RECOVERY) between PL and CHO #p < 0.05 between PRE vs. PRE, and between RECOVERY vs. PRE in the PL condition #p < 0.05 between FAILURE vs. PRE, and between RECOVERY vs. PRE in the CHO condition $p < 0.05 between RECOVERY vs. FAILURE in the CHO condition.

**Figure 2.** Force output after consumption of carbohydrate (CHO; *n = 6*) or placebo (PL; *n = 6*). Data shown are mean ± SD. *p < 0.05.
Discussion: The Increase in growth hormone resulting from exogenous carbohydrate supplementation may increase muscular strength and decrease recovery time.

Implications: Carbohydrate supplementation – beneficial

Limitations: Limited number of subjects, homogeneity of subjects used, specific training condition, and heterogeneity in individual response to SEMS.
Article 2


**Purpose:** Assess the effect of CHO supplementation on tennis match play performance among nationally ranked young players (Brazil).
Materials and Methods

- **Materials:** CHO solution (6%) containing maltodextrin or water artificially sweetened, AccuCheck Monitor

- **Methods:** CHO or PLA beverage consumption.
  - Blood glucose and match play performance was measured.
Methods

Figure 1 Experimental design.
Results

- Results: CHO supplementation did not affect tennis match play performance and no significant difference in blood glucose.

<table>
<thead>
<tr>
<th>Table 1 Technical tennis match play analysis (%; mean±SD) during PLA and CHO conditions</th>
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<tbody>
<tr>
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<td>First serves in</td>
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<tr>
<td>Second serves in</td>
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<tr>
<td>Return first serve in</td>
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<td>Return second serve in</td>
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<tr>
<td>Return first serve in (Forehand)</td>
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<tr>
<td>Return first serve in (Backhand)</td>
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<tr>
<td>Return second serve in (Forehand)</td>
</tr>
<tr>
<td>Return second serve in (Backhand)</td>
</tr>
<tr>
<td>Baseline return in (Forehand)</td>
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<tr>
<td>Baseline return in (Backhand)</td>
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</tbody>
</table>

Figure 2 Blood glucose concentration (mean±SD) during PLA and CHO conditions.
Discussion

Discussion: Even though present study design simulated match play performance and did not improve tennis play performance, CHO supplementation may be beneficial to maintain blood glucose level and augment performance under tournament conditions.
Implications: Prolonged matches may benefit from CHO supplementation.

Limitations:
1. It did not simulate tournament conditions.
2. A high CHO diet

**Purpose:** Effect of carbohydrate supplementation on gymnastic athlete’s performance.
### Materials and Methods

#### Table 1: Scheme of the experimental design

<table>
<thead>
<tr>
<th>Experimental days/Groups</th>
<th>CG</th>
<th>FG</th>
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<tbody>
<tr>
<td>WATER DAY (DAY 1)</td>
<td>Rest</td>
<td>Rest</td>
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<tr>
<td></td>
<td>10 min Warm up</td>
<td>20 minute fatigue</td>
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<td></td>
<td>5 sets</td>
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<tr>
<td>CARBOHYDRATE DAY (DAY 2)</td>
<td>Rest</td>
<td>Rest</td>
</tr>
<tr>
<td></td>
<td>20 minute fatigue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flavored Juice</td>
<td>Maltodextrin</td>
</tr>
<tr>
<td></td>
<td>10 min warm up</td>
<td>10 min warm up</td>
</tr>
<tr>
<td></td>
<td>5 sets</td>
<td>5 sets</td>
</tr>
</tbody>
</table>
Results
Discussion: Carbohydrate supplementation was able to restore the concentration levels of the athletes.

Implications: Extra glucose supply makes a difference on performance.

Limitations: More studies need to be conducted.
Purpose: Compare results of ingesting a 2:1 maltodextrin/fructose solution with a placebo on simulated olympic-distance triathlon performance.
Materials and Methods

- **Participants:** Six males and four females ages 18-32.

- **Trials:** Swim and cycle tests that had fixed-intensities and a running section that was a timed-trial.
Ingestion of the maltodextrin/fructose solution intermittently during the cycle section of a triathlon did enhance the running performance of a triathlete.

No increase in GI discomfort was observed in the maltodextrin/fructose solution participants.
Discussion: Carbohydrate refueling is important for continued performance in athletes.

Implications: Refueling with carbohydrates during prolonged endurance exercise is beneficial to performance.

Limitations: 4 out of 10 participants were female; difficulty controlling for menstrual cycle metabolism changes.
Article 5


**Purpose:** Investigate the effects of caffeine with carbohydrate supplementation on repeated sprint exercise.

**Materials:** 6 mg/kg⁻¹ of caffeine, cellulose (placebo), .8 g/kg⁻¹ dextrose, or artificial sweetener (placebo), cycle ergometer (stationary bike)
Methods

Figure 1

10 sets of 5x4-s sprint test, 20-s interval recovery
Results

**Peak power**: greater peak power in (PLA+CHO)

**Blood lactate**: concentrations higher in (CAF+PLA) and (CAF+CHO)

**Blood glucose**: higher levels in (CAF+CHO)

**Testosterone and cortisol**: no change

**Agility**: no change
Discussion & Implications

- **Discussion**: Caffeine ingestion increases heart rate, blood glucose, and lactate concentrations.

- **Implications**: Caffeine ingestion did not show to increase performance on repeated sprint exercise while carbohydrate ingestion did.
Limitations

- GI distress after caffeine may have hindered performance
- Small sample size
- All female athletes
- More research should be done.
Summary of Results

1. Carbohydrate supplementation before and during resistance exercise may be beneficial in resistance training.

2. Previous research demonstrated that CHO supplementation improved stroke performance in match plays, however this study demonstrated no effect on tennis match play performance.
3. Supplemented carbohydrates are beneficial and it was able to supply muscle demands and improve the athlete’s focus.

4. Ingestion of the maltodextrin/fructose solution intermittently during the cycle section of a triathlon does enhance the running performance of a triathlete.

5. Ingesting caffeine with carbohydrate did not show to increase peak or mean power, total work during RSE, or improve agility.
References


