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# F-6 SLIDE CARBOHYDRATE FEED & EXERCISE

## 721 THE EFFECTS OF A CARBOHYDRATE-REPLACEMENT BEVERAGE ON CARDIOVASCULAR AND RENAL PARAMETERS FOLLOWING EXERCISE.

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Carbohydrate ingestion following exercise has been shown to elevate heart rate (HR) and systolic blood pressure (SBP), and to decrease diastolic blood pressure (DBP) in men. We evaluated the effects of a commercially available carbohydrate-replacement beverage on the renal and cardiovascular systems during recovery. After cycle exercise for 1 hour at 70% heart rate reserve, 8 men drank 1 liter of mineral water (W) or 1 liter of a commercial beverage (C) (150 gms glucose polymers, 50 gms fructose, 500 mg potassium). Order of beverage was alternated between subjects. Recovery was monitored for 2 hours post exercise. HR, SBP and rate pressure product (HR x SBP/100) were elevated following C compared to W ($P\leq.03$, $P\leq.04$, $P\leq.01$, respectively). DBP was lower at 2 hours after C ($P=.02$). Serum glucose was higher with C at 30 minutes only ($P<.001$), while insulin remained elevated at all measurements ($P<.05$). Area under the curve for serum potassium (K) was lower after C ($P=.05$). Urinary excretion of K, sodium and creatinine did not differ between treatments. Serum aldosterone tended to be lower with C ($P=.07$). No differences were observed for plasma renin.

| | 30 min | 60 min | 90 min | 120 min |
|---|---|---|---|---|
| **Heart Rate** | | | | |
| Carbo | 61±2 | 60±3 | 60±3 | 58±2 |
| Water | 58±2 | 55±2 | 54±2 | 52±2 |
| | P=.15 | P=.033 | P=.008 | P<.001 |
| **Systolic Blood Pressure** | | | | |
| Carbo | 118±4 | 122±3 | 119±4 | 122±3 |
| Water | 97±14 | 111±3 | 116±5 | 117±4 |
| | P=.14 | P=.003 | P=.035 | P=.198 |

Carbohydrate ingestion after exercise significantly delays the recovery of cardiovascular parameters. However, lower serum potassium with C may result from elevated insulin and may indicate enhanced potassium transport into the cells.

## 722 GLUCOSE-ELECTROLYTE INGESTION: INFLUENECE ON ENDURANCE FACTORS IN HIGHLY TRAINED FEMALE CYCLISTS

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The objective of this investigation was to evaluate the response of highly trained female cyclists (N=11; $\bar{X}$ Age=23.6±1.3 yrs; $\bar{X}$ Weight=59.6±2.1 kg; $\bar{X}$ $VO_2max$=50.9±1.5 ml·kg$^{-1}$·min$^{-1}$) to ingestion of different glucose-electrolyte (G-E) concentrations during three exhaustive bicycle exercise bouts (ALL, LATE and PLACEBO). In a random order, double blind protocol, subjects were given 250 ml of fluid at 15 minute intervals during exercise at 68% of $VO_2max$ until exhaustion was reached. In condition ALL, subjects drank a commercially available G-E beverage following the above schedule. In trial LATE, subjects ingested a placebo solution (color/taste matched to the G-E) on the above schedule for 90 minutes into the ride, then the G-E solution was provided. In the PLACEBO condition, the placebo solution was ingested at the identical hydration points. Oxygen consumption and heart rate were continuously monitored throughout the exercise bouts. Blood glucose (GLU) and lactate (LAC) concentrations, rectal temperature (Tre) and RPE were determined prior to, at 15 minute intervals, and immediately following the exhaustive exercise bouts. General data are below ($\bar{X}$±SEM).

| RIDE | % VO2MAX | RIDE TIME (min) | HEART RATE (beats/min) | |
|---|---|---|---|---|
| ALL | 66.91±1.06 | 168.64±11.87 | 165.07±4.10 | **Significantly* |
| LATE | 68.44±1.73 | 198.13±11.37* | 162.21±2.59 | *different from* |
| PLACEBO | 68.06±1.49 | 166.36±11.78 | 160.50±3.41 | *placebo (p<0.05)* |

GLU levels were significantly (p<0.05) higher in the LATE condition as compared to PLACEBO at minutes 165 and 180. LAC, RPE and Tre did not vary over time as a function of drink condition. Pre- and post-exercise, hematocrit and hemoglobin were measured and plasma volumes were calculated. No significant differences were noted in plasma volume shifts among conditions. The data support the LATE schedule of G-E ingestion for delay of fatigue during long term exercise in highly trained female cyclists. All ride times represent equivalent distances far greater than those sanctioned for women's competition by the Union Cycliste Internationale, suggesting a need for re-evaluation of international distance limitations for women.

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## 723 ERGOGENIC BENEFITS OF CARBOHYDRATE FEEDINGS ARE INFLUENCED BY MUSCLE GLYCOGEN CONCENTRATION

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To determine whether pre-trial muscle glycogen levels influence the ergogenic benefits derived from carbohydrate feedings, eight experienced cyclists completed four, 1680 kJ isokinetic cycling trials as quickly as possible under the following pre-trial glycogen and beverage conditions: 1) high muscle glycogen (180.2 ± 9.7 mmol/kg ww) with carbohydrate feedings (HG-CHO trial), 2) high muscle glycogen (170.2 ± 10.4 mmol/kg ww) with placebo feedings (HG-PLA trial), 3) low muscle glycogen (99.8 ± 6.0 mmol/kg ww) with carbohydrate feedings (LG-CHO trial), and 4) low muscle glycogen (109.7 ± 5.3 mmol/kg ww) with placebo feedings (LG-PLA trial). The carbohydrate beverage (9% high fructose corn syrup solution) provided 1.5 g carbohydrate/kg body weight/trial (116 ± 6 g carbohydrate/trial). The placebo beverage contained no carbohydrate. Feedings were administered at the onset of exercise and at the completion of every 240 kJ. $VO_2$ averaged 78% (±1), 76% (±1), 73% (±1), and 72% (±2) of maximum for the HG-CHO, HG-PLA, LG-CHO, and LG-PLA trials, respectively. Overall performance times were similar (P>0.05) for the two HG trials (HG-CHO = 117.18 ± 1.44 min, HG-PLA = 118.67 ± 1.84 min) and for the two LG trials (LG-CHO = 121.18 ± 1.88 min; LG-PLA = 122.91 ± 2.46 min). However, during the LG-PLA trial, heart rate (-10% vs. HG-CHO, HG-PLA , and LG-CHO trials), relative $VO_2$ (-23%), energy expenditure (-23%), and serum glucose (-31%) had all decreased (*P*<0.05) by the end of the bout with self-selected pace declining 11% (P<0.05) over the final 240 kJ. Under these low glycogen conditions, carbohydrate feedings (LG-CHO trial) restored euglycemia and elevated physiological and ergogenic responses, including overall performance time, to levels similar (P>0.05) to those observed during the HG-PLA trial. Therefore, when pre-exercise glycogen levels were low (so that performance was presumably limited by glycogen depletion), carbohydrate feedings enabled subjects to maintain their optimal pace throughout the exercise bout, but when pre-exercise glycogen levels were elevated (so that glycogen depletion was unlikely to limit performance) carbohydrate supplementation provided no ergogenic benefit.

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## 724 METABOLIC EFFECTS TO PRE-EXERCISE MEALS CONTAINING VARIOUS CARBOHYDRATES AND FAT

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Carbohydrate (CHO) ingestion before exercise alters the metabolic responses during the early portion of subsequent exercise. The purpose of this study was; 1) to examine if the classification of CHO as simple or complex defines the metabolic effects of the meal and, 2) to determine the metabolic effects of adding fat to CHO meals. On 6 separate occasions, 9 men ate various meals 30 min before exercise. All meals contained 0.7 g/kg of CHO (i.e.~50 g). Three meals contained only CHO from either mashed potatoes (P), a 20% sucrose solution (S), or boiled rice (R). Fat was added (30% additional kcal) to these foods during 3 additional trials, in the form of margarine to P (PF) and R (RF), and finally, a sucrose/fat candy bar (SF) was eaten. A 7th trial (C) was performed after a 12 h fast. Plasma glucose and insulin concentrations increased to 6.1±0.1 mM and 40.0±1.5 µU/ml respectively, during the 30 min period after eating P, S, and SF. In comparison, the concentrations of plasma glucose (5.3±0.3 mM) and insulin (27.1±0.9 µU/ml) were significantly lower (P<0.05) during R, PF and RF. With the onset of exercise at 60% $VO_2max$, plasma glucose declined in all CHO trials to values of 3.4±0.2 mM after 20 min. At this time, all CHO trials were not different from one another, but all were significantly lower than C (4.2±0.2 mM). Plasma FFA and glycerol concentrations were lower (P<0.05) than C following 30 min of exercise only during P, S, and SF. In addition, during the initial 30 min of exercise, CHO oxidation was elevated (P<0.05) above C, only during P and S. These results indicate that eating a complex CHO, such as potatoes, produces high glycemic metabolic responses which are identical to a simple CHO, such as sucrose. Also, the addition of fat to P attenuates its glycemic and insulinemic response. However, despite these different responses prior to exercise, all meals that contained CHO, regardless of the type of CHO consumed, caused plasma glucose to decline to equally low levels early in exercise, without any subjective symptoms of hypoglycemia in the subjects.

## 725 EFFECTS OF SODIUM ON EXOGENOUS CARBOHYDRATE OXIDATION FROM STARCH INGESTED DURING EXERCISE

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Perfusion studies have shown that 60-120 mmol·l$^{-1}$ of NaCl stimulates glucose absorption from the gut. On the other hand, high solute osmolality retards gastric emptying (GE). We therefore studied the effects of NaCl ingestion on the rates of serial GE & exogenous carbohydrate (CHO) oxidation from a 20 g·100 ml$^{-1}$ U-$^{14}$C-labelled starch solution ingested by six trained cyclists during two 120-min rides at 70% of $VO_{2max}$. Cyclists ingested 6 x 200 ml of starch, suspended in either $H_2O$ or 100 mmol·l$^{-1}$ NaCl, at the start of exercise and every 20-min thereafter. Despite the higher osmolality of the NaCl solution, GE was not different, but was delayed for both solutions until residual gastric volume reached ~400 ml. The $^{14}$C-label appeared in venous blood within 5-min of ingestion despite the very low initial rates of GE, and was significantly increased by NaCl for the first 60-min of exercise (p<0.05). Peak rates of exogenous CHO oxidation were the same for NaCl and no NaCl solutions (1.6 ±0.2 g·min$^{-1}$ vs 1.4 ±0.1 g·min$^{-1}$). We conclude i) that GE is not influenced by the addition of 100 mmol·l$^{-1}$ of NaCl, ii) that NaCl increases only the initial rates of CHO absorption, and iii) that the early appearance of the $^{14}$C-label in the blood suggests preferential emptying of CHO compared to $H_2O$ from starch suspensions.

## 726 STARCH INGESTION DURING WARM-UP INCREASES INITIAL RATES OF EXOGENOUS CARBOHYDRATE OXIDATION DURING EXERCISE

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This study examined how carbohydrate (CHO) ingestion during a warm-up (WU) influences fuel utilization during subsequent exercise. Five endurance-trained cyclists ingested 7 x 200 ml of U-$^{14}$C-labelled starch at 20-min intervals throughout a 30-min WU at 50% of maximum $O_2$ consumption ($VO_{2max}$), and during a subsequent 90-min ride at 70% $VO_{2max}$. In another trial 6 subjects performed a 90-min ride at 70% $VO_{2max}$ with the same CHO ingestion regimen during exercise, but without a WU or CHO ingestion prior to the ride. The WU did not induce any counter-regulatory reactive hypoglycemia. Ingestion of CHO prior to exercise significantly increased the oxidation of exogenous CHO in the first 35-min of the 90-min ride from 18 ±2 (no WU) to 36 ±3 g (WU; p<0.05). These values accounted for 17 and 34% of total CHO oxidation during this period. Peak rates of exogenous CHO oxidation were similar with or without WU (1.5 ±0.3 g·min$^{-1}$ vs. 1.8 ± 0.2 g·min$^{-1}$, respectively). Despite the higher initial rates of exogenous CHO oxidation in the WU trial, total exogenous CHO oxidation was the same during the 90-min ride (WU 110 ±5; No WU 106 ±9 g). Further, total CHO oxidation was the same for both trials (WU 272 ±4; no WU 263 ±12 g). These data show that CHO feedings during a WU increase initial rates of exogenous CHO oxidation possibly by decreasing muscle glycogenolysis at the onset of exercise.

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