Nutritional Ergogenic Aids Evaluated

HNF 610: Nutrition & Fitness
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Carbohydrate Loading

- Popular nutritional modification to increase glycogen reserves
- Combining a specific dietary regimen with exercise produces significant “packing” of muscle glycogen.
- Normally, each 100 g of muscle contains about 1.7 g of glycogen.
- Carbohydrate loading packs up to 5 g of glycogen per 100 g of skeletal muscle.
Classic Loading Procedure

- First, reduce the muscle’s glycogen content with prolonged exercise about 6 days before competition.
- The athlete then maintains a low-carbohydrate diet (about 60–100 g/day) for several days to further deplete glycogen stores.
- Glycogen depletion increases formation of intermediate forms of the glycogen-storing enzyme glycogen synthetase in the muscle fiber.
- At least 3 days before competing, the athlete switches to a high-carbohydrate diet (400–700 g/day) and maintains this regimen up to the precompetition meal.
Negative Aspect of Carbohydrate Loading

- Only benefits intense aerobic activities lasting more than 60 minutes
- Causes a person to feel “heavy” due to the addition of 2.7 g of water with each gram of glycogen stored
- This effect of extra weight may negate any potential benefits from increased glycogen storage.
- Could negatively affect individuals susceptible to type 2 diabetes and heart disease or those with muscle enzyme deficiencies or renal disease.
Modified Loading Procedure

- Reduces some of the negative effects associated with the classic procedure
- 6-day protocol
- Does not require prior exercise to exhaustion
- The athlete exercises at about 75% of VO$_{2\text{max}}$ for 1.5 hours and then, on successive days, gradually reduces or tapers exercise duration.
- During the first 3 days, carbohydrates supply about 50% of total calories.
- Three days before competition, the diet’s carbohydrate content then increases to 70% of total energy intake.
Gender Differences

- During submaximal exercise at equivalent percentages of $VO_{2\text{max}}$, women derive a smaller proportion of total energy from carbohydrate oxidation than men.

- With similar endurance-training protocols, both women and men decrease glucose use during a given submaximal power output.

- At the same relative workload after training, women show an exaggerated shift toward fat catabolism, whereas men do not.
Amino Acid Supplementation

- Many use amino acid supplements believing they boost the body’s natural production of the anabolic hormones.
- Research on healthy subjects does not provide convincing evidence for an ergogenic effect of a general dietary increase of oral amino acid supplements on:
  - Hormone secretion
  - Training responsiveness
  - Exercise performance
Effect on Hormones

- The normal hormonal milieu in the period following resistance exercise stimulates the muscle fiber’s anabolic processes while inhibiting muscle protein degradation.

- Specific dietary modifications that increase amino acid transport into muscle, raise energy availability, or increase anabolic hormone levels would theoretically augment the training effect by:
  - Increasing the rate of anabolism
  - Depressing catabolism
L-Carnitine

- A short-chain carboxylic acid containing nitrogen
- Vitamin-like compound with well-established functions in intermediary metabolism
- Found mostly in meat and dairy products
- Liver and kidneys synthesize L-carnitine from methionine and lysine.
- Vital to normal metabolism
L-Carnitine as an Ergogenic Aid

- Few data suggest that healthy adults require carnitine above levels in a well-balanced diet.

- Research shows:
  - No ergogenic benefits
  - No positive metabolic alterations (aerobic or anaerobic)
  - No enhanced recovery effect
  - No body fat–reducing effects
Benefits of L-Carnitine

- Acts as a vasodilator in peripheral tissues
- May enhance regional blood flow and oxygen delivery
- Might improve oxygen supply to injured tissue and promote clearance of muscle damage byproducts, thus reducing delayed-onset muscle soreness (DOMS)
Chromium

- Occurs widely in soil as chromite
- Concentration averages 250 μg per kg of soil
- Serves as a cofactor (as trivalent chromium) for a low-molecular weight protein that potentates insulin function
- Chronic chromium deficiency increases blood cholesterol and decreases sensitivity to insulin.
Chromium Supplements

- For athletes with chromium-deficient diets, modifications to increase chromium intake or prudent use of chromium supplements seem appropriate.
- Poor intestinal absorption of chromium chloride is a main hindrance to effective supplementation.
- Chromium picolinate is absorbed better by the body.
Negative Effects of Chromium

- Competes with iron for binding to transferrin
- Excessive dietary chromium inhibits zinc and iron absorption.
- Studies in which human tissue cultures received extreme doses of chromium picolinate show eventual chromosomal damage.
Coenzyme Q$_{10}$

- Found primarily in meats, peanuts, and soybean oil
- Functions as an integral component of the mitochondrion’s electron transport system of oxidative phosphorylation
- Lipid soluble
- Exists in high concentrations within myocardial tissue
- Has antioxidant properties
Coenzyme Q$_{10}$ as an Ergogenic Aid

- Research has found that coenzyme Q$_{10}$:
  - Does not improve aerobic capacity
  - Does not improve endurance performance
  - Does not improve plasma glucose
  - Does not improve lactate levels at submaximal workloads
  - Does not improve cardiovascular dynamics
Creatine

- Meat, poultry, and fish provide rich sources of creatine.
- The body synthesizes about 1-2 g daily, primarily in the kidneys, liver, and pancreas, from the amino acids arginine, glycine, and methionine.
- Creatine supplements, sold as creatine monohydrate (CrH$_2$O), come as a powder, tablet, capsule, and stabilized liquid.
- Governing bodies (including the IOC) do not consider creatine an illegal substance.
Creatine as an Ergogenic Aid

- Creatine supplementation at recommended levels exerts the following three effects in individuals involved in power-type physical activities:
  - Improves repetitive performance in muscular strength and short-term power activities
  - Augments short bursts of muscular endurance
  - Provides for greater muscular overload to enhance training effectiveness
Creatine Risks

- Limited research exists about the potential dangers of creatine supplementation in healthy individuals.
- Short-term use in healthy men has produced no detrimental effect on blood pressure, plasma creatine, plasma CK activity, or the renal response as measured by glomerular filtration rate and total protein and albumin excretion rates.
- Individuals with suspected renal malfunction should refrain from creatine supplementation.
Creatine Loading

- Involves ingesting 20-30 g of creatine daily for 5-7 days
- A maintenance phase follows the loading phase where the person supplements daily with as little as 2-5 g of creatine.
- Rapid creatine loading involves ingesting 20 g of creatine monohydrate daily for 6 days and then switching to a reduced dosage of 2 g/day to keep levels elevated for up to 28 days.
Research supports the common belief among athletes that consuming creatine with a sugar-containing drink increases creatine uptake and storage in skeletal muscle.

Caffeine diminishes the ergogenic effect of creatine supplementation.

In one study, consuming caffeine totally negated creatine’s ergogenic effect.
Ribose

- The body synthesizes ribose.
- The diet provides small amounts through ripe fruits and vegetables.
- Serves as an energy substrate for ATP resynthesis
- Recommended ribose doses range from 10-20 g/day.
- Limited experimentation exists to assess the ergogenic potential for ribose.
Inosine

- Nucleic acid derivative
- Found naturally in brewer’s yeast and organ meats
- The body synthesizes inosine from precursor amino acids and glucose.
- Participates in forming purines such as adenine, one of the structural components of ATP
- Some people supplement with inosine believing that it increases ATP stores.
Choline

- All animal tissues contain choline.
- Important compound for normal cellular functioning
- Must be obtained in the diet
- Choline functions as a lipotrophic agent as part of the lecithin molecule either to depress accumulation of fat in the liver or to increase fatty acid uptake by the liver.
Medium-Chain Triacylglycerols

- Provide a rapid source of fatty acid fuel
- Marketed to sports enthusiast as a “fat burner,” “energy source,” “glycogen sparer,” and “muscle builder”
- The water-solubility of MCFAs enables them to move across the intestinal mucosa directly into the bloodstream.
- They pass into the mitochondria largely independent of the carnitine–acyl-CoA transferase system.
Medium-Chain Triacylglycerol Supplements

- MCTs elevate plasma FFAs rapidly.
- Supplements of these lipids might spare liver and muscle glycogen during high-intensity aerobic exercise.
- Conflicting research exists about their use in exercise.
- Cramping and diarrhea often accompany excess intake of this lipid form.
Hydroxycitrate

- A principal constituent of the rind of the fruit of *Garcinia cambogia* used in Asian cuisine
- Promoted as a “natural fat burner” to facilitate weight loss and enhance endurance performance
- Research findings indicate that increasing plasma HCA availability with supplementation exerts no effect on skeletal muscle fat oxidation during rest or exercise.
Vanadium

- A trace element
- Exhibits insulin-like properties by facilitating glucose transport and use in skeletal muscle, stimulating glycogen synthesis, and activating glycolytic reactions
- Administering 50 mg of vanadium twice daily for 3 weeks improved hepatic and skeletal muscle insulin sensitivity in type 2 diabetics, partly by enhancing insulin’s inhibitory effect on fat breakdown.
- Research does not support an ergogenic role for vanadium supplements.
Pyruvate

- Three-carbon end product of the cytoplasmic breakdown of glucose in glycolysis
- Exogenous pyruvate allegedly augments endurance exercise performance and promotes fat loss.
- Several reports indicate beneficial effects of exogenous pyruvate on endurance performance.
- Pyruvate intake also augments body fat loss when accompanied by a low-energy diet.
Glycerol

- A component of the triacylglycerol molecule
- An important constituent of the cell’s phospholipid plasma membrane and an osmotically active natural metabolite
- Effective in reducing excess accumulation of fluid (edema) in the brain and eye
- When consumed with 1-2 L of water, glycerol facilitates water absorption from the intestine and causes extracellular fluid retention, mainly in the plasma fluid compartment.