Nutritional Supplements

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Objectives

• Review use of supplements by athletes
• Review (proposed) mechanism of action for common supplements
• Review safety and efficacy of selected supplements
Nutritional Supplements

• Common use by athletes
  – 1994 meta-analysis, 10,274 athletes, 15 sports
  – Prevalence of 46%.
    • more common among elite, followed by college, and then high school athletes.
    • use by women was greater than men
    • use by athletes greater than the general population.
Nutritional Supplements

• 2001 NCAA athlete survey
  – 53% of all athletes surveyed (from multiple sports) had used nutritional supplements
  – most common creatine, protein products
Nutritional Supplements

• $22B market
• Over 300 products available, over 200 of which claim to increase muscle mass or performance
Nutritional Supplements

• Historical
  – Greek Olympians
    • Dung of a wild boar used as restorative by ancient chariot racers
    • Runners ate mushrooms for endurance
  – Zulu warriors drank a fermented beverage made of grape skins called “dop” to enhance battle
  – Aztec athletes
    • Ate human heart for strength
Sports Supplements

Modern Olympians

- Thomas Hicks ran to victory in the Olympic marathon of 1904 in Saint Louis with the help of raw egg, injections of strychnine, and doses of brandy administered during the race.
- "Icteric Ben" Johnson, many others...
Elite Athletes

• Bob Goldman, MD, in a 1995 survey of Olympic and other elite athletes
  – 195 out of 198 would use a performance-enhancing substance if it could not be detected and would guarantee they win every race
  – If it were later discovered that substance would cause death in 5 years, more than half surveyed said they would still take it.
Caveats

- Nearly unregulated
- Sometimes adulterated
- All that work have potential adverse effects
- Never try anything for the first time before completion
Eichner

• “And remember my ditty for Supplements: 30 too many, 5 too few, 10 sounds right but still hard to do...”
Carbohydrate

- **Claimed Effects:** Replaces/spares glycogen stores
- **Evidence:** Supports in activities lasting longer than 60 min
- **Side Effects:** Diarrhea in 5-10% who use fructose
- **Fructose, ribose not superior to sucrose**
- **Legality:** Legal
Creatine

- **Claimed Effects:** Increases creatine phosphate pool; Increases muscle energy, endurance, strength and lean muscle mass
- **Dietary sources:** meat, fish
- **Evidence:** Supports anaerobic performance, no apparent benefit in aerobic performance; insufficient data on long-term use
- **Side effects:** weight gain, muscular cramping, possibly increases risk for heat illness
- **Legality:** Legal

\[ 	ext{PCr} + 	ext{ADP} + 	ext{H}^+ \xrightleftharpoons{\text{CK}} \text{ATP} + \text{Cr} \]
Creatine

- **Dose:**
  - Body normally uses 2 g of creatine daily. The liver, kidneys, and pancreas produce about 1 g
  - Loading dose 20 g/day for 5-7 d, followed by a 2-5 g daily dose
  - “Slow load” of 3 g/day for 28 days can be used
  - NO safety data on pediatric use
    - Metz et al found similar use rates in grades 6-12 to those of college athletes
Sodium Bicarbonate

• Claimed Effects: Buffers lactic acidosis, delays fatigue
• Evidence: May be effective in both short-term and long-term high intensity exercise
• Dose: 0.3mg/kg
• Side effects: diarrhea, abdominal cramps, bloating, acid-base disturbance (metabolic alkalosis) (~10% of athletes do not tolerate)
• Legality: Legal
Glycerol

- **Claimed Effects:** Improves hydration and endurance; osmotic properties result in $\text{H}_2\text{O}$ retention; “hyperhydration”
- **Evidence:** Limited, mixed, some support, overall equivocal
- **Dose:** 1gm/kg in 1.5 l 60-120 min prior to activity
- **Side Effects:** Mild gastrointestinal (bloating, nausea, diarrhea)
- **Increases the risk of voiding during competition**
- **Legality:** Legal (oral)
Multivitamins

• Claimed Effects: Increases energy, endurance and aerobic capacity, enhances recovery
• Evidence: No benefit unless preexisting deficiency
• Useful for vegans, junk food junkies, eating disordered
• Side Effects: None at RDA, some toxicities at high doses
• Legality: Legal
Caffeine (and Guarana)

- Claimed Effects: Increases muscle contractility and aerobic endurance, enhances fat metabolism
- Evidence: Supports
- Side Effects: Mild
- Legality: Legal to urine level of 12 to 15 µg caffeine per mL; consumption of ~7mg/kg (16 oz Starbucks = 320 gm; just over 3 cups for 150-lb athlete)
Protein

• Claimed Effects: Optimizes muscular growth and repair
• Evidence: Supports; increased need for protein with activity
• Side Effects: None unless underlying medical condition (hepatic, renal disease risk probably overestimated) Excess converted to fat. Excess may lead to increased urinary excretion of Ca++
• Legality: Legal
Protein

- Do athletes need protein supplements?
  - Some do
    - Females with low total caloric intake
    - Adolescent athletes with high training demands superimposed on growth needs
    - Athletes with limited time to eat balanced diet due to educational, training, work or other demands
    - Vegans may be deficient in lysine
Protein

• Do athletes need protein supplements?
  – RDI = 0.8 g/kg/d
  – Endurance athletes may need up to 1.5 g/kg/d
  – Anabolic training may need 1.8-2.2 g/kg/d
  – Typical American diet provides 1.2 gm/kg/d
Amino Acid Supplements

• Specific amino acid supplements and combinations have been evaluated
  – Arginine, Ornithine, Lysine
  – Branched-Chain AAs
    • Leucine, isoleucine, valine
  – Aspartate
Arginine, Ornithine, Lysine

- **Claimed Effects:** Stimulate growth hormone release
- **Evidence:** No significant increase in GH secretion and no strength benefits when taken orally
- **Side Effects:** Diarrhea at large doses
- **Legality:** Legal
Branched-Chain Amino Acids

- Leucine, isoleucine, and valine
  - Claimed Effects: Improve strength training and endurance
  - Evidence: Mixed; may help performance at altitude and in heat; may induce significant and preferential losses of visceral adipose tissue in calorie-restricted athletes in training
  - Side Effects: None at doses used
  - Legality: Legal
Aspartate

- **Claimed Effects:** attenuation of exercise-induced hyperammonemia and increase in exercise endurance
- **Dietary sources:** Animal sources: luncheon meats, sausage meat, wild game; vegetable sources: sprouting seeds, oat flakes, avocado, asparagus.
- **Evidence:** has not been shown to increase muscle endurance or strength
- **Legality:** Legal
BCAA

• Small studies (8-30 subjects)

• BCAA vs placebo
  – Higher testosterone
  – Lower cortisol, CPK
  – Improved self-reported DOMS sx, muscle fatigue
• Good evidence that caffeine can improve single-sprint performance, while caffeine, creatine and sodium bicarbonate ingestion have all been demonstrated to improve multiple-sprint performance.

• Current evidence does not support the ingestion of ribose, branched-chain amino acids or β-hydroxy-β-methylbutyrate, especially in well
Anabolic/Androgenic Steroids

- **Claimed Effects:** Increase protein synthesis, muscle mass, aggressiveness
- **Evidence:** Effective
Anabolic/Androgenic Steroids

- Reversible side effects
  - Sexual effects
    - Increased or decreased libido
    - Decreased sperm production
    - Testicular atrophy (sometimes does not reverse)
  - Cutaneous effects
    - Acne
    - Hirsutism
    - Edema
- Psychiatric effects
  - Euphoria
  - Nervousness
  - Aggression
  - Personality disorders
- Other
  - Increased transaminases
  - Nausea
  - Increased urination
Anabolic/Androgenic Steroids

• Serious and irreversible side effects
  – Hypertension from mineralocorticoid effects
  – Dysplastic changes in collagen fibrils, resulting in severe tendon ruptures
  – Liver tumors (hepatocellular carcinoma, hepatic adenoma, hepatic cholangiocarcinoma)
  – Psychosis (i.e., "steroid rage")
  – Gynecomastia (typically irreversible)
  – Irreversible hirsutism, clitoral hypertrophy and deepening of voice in women
  – Premature closure of growth plates, causing shorter stature in adolescents

• Legality: Illegal
Androstenedione

- Claimed Effects: Increase strength, lean muscle mass and motivation; immediate precursor of testosterone and estrone
- Evidence: Refutes, no benefits
- Side Effects: possible prostate stimulation
- Legality: Banned by WADA, NCAA
DHEA

• Claimed Effects: Increases endogenous steroid production
• Evidence: No benefit in healthy athletes
• Side Effects: acne (50%), increased facial hair (18%), and increased perspiration (8%) breast tenderness, weight gain, mood alteration, headache, oily skin, and menstrual irregularity in some women. Possible prostate stimulation
EPO, Blood doping

- Claimed Effects: Increases aerobic capacity
- Evidence: Supports
- Side Effects: Polycythemia, CVA, transfusion reaction, death
- Legality: Illegal
Human Growth Hormone

• Claimed Effects: Anabolic effect on muscle growth, increases fat metabolism, hastens muscle repair/recovery

• Evidence: Supports both endurance and resistance exercise

• Side Effects: glucose intolerance, acromegaly, myopathy, hypothyroidism

• Legality: Illegal
Amphetamines

• Claimed Effects: Improve concentration, decrease fatigue and appetite

• Evidence: Mixed, some positive, psychologic effects mimic ergogenesis

• Side Effects: Significant, including dysrhythmias, hyperthermia, increased risk for heatstroke, hypertension, addiction

• Legality: Illegal without TUE
Summary

• Sound nutrition and training techniques are effective
• Most supplements provide no benefit, and those that do give minimal benefit
• Most supplements that are legally available are harmless
• Most athletes are better served spending the $$ on a healthy, balanced diet
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Bibliography


