Nutrition in Athletes: Vitamins and Supplements

Background
1. Sports supplementation and vitamin use:
   - Micronutrients important for:
     - Energy production
     - Hemoglobin synthesis
     - Bone health
     - Immune function
     - Muscle building and repair
   - Exercise stresses metabolic pathways
     - May increase/alter vitamin, mineral requirements
   - Very common
     - Estimates of use range from 6-100% of all athletes
     - Most surveys: 30-60% of collegiate athletes take supplements
     - US supplement market $16.7 billion in 2000

2. Vitamin
   - Organic compound
     - Required as nutrient in tiny amounts
   - Cannot be synthesized in sufficient quantities by human body
     - Must be obtained from diet

3. Nutritional Supplement
   - Any product added to diet and taken by mouth
   - Usually contains a vitamin, mineral, herb, amino acid, enzyme, or trace element

4. Ergogenic Aids: not regulated by FDA
   - Supplements claim to increase work output or performance
   - Often "prohormones" of testosterone
   - Multimillion dollar business
   - In US, manufacturers allowed to make claims regarding effect of products on structure/function of body as long as they do not claim to "diagnose, mitigate, treat, cure, or prevent" a specific disease
     - Must list all ingredients
     - Should evaluate supplements on:
       - Basis of validity of claim
       - Quality of evidence
       - Health and legal consequences of claim
   - Majority of ergogenic aids:
     - Insufficient evidence of efficacy
     - Do not perform as claimed
     - Dangerous, banned, illegal

General Supplementation Guidelines
1. Current RDAs and Dietary Reference Intakes usually adequate for athletes
2. Supplementation with single micronutrients-discouraged without clear medical, nutritional, public health indication
3. Athletes at risk for vitamin or mineral deficiency if:
   - Restrict energy intake or use severe weight loss practices
   - Female Athlete Triad
• Eating Disorders
  o Eliminate one or more food groups from diet
  o Consume high carbohydrate, low micronutrient-dense diets

4. Health Care Professional should:
  o Assess athlete's typical dietary and supplement intake during training, competition, off-season
    ▪ Complete food diary with nutrition evaluation
  o Evaluate any vitamin/mineral, herbal supplement, ergogenic aid, performance-enhancing drugs athlete wants to use
    ▪ Athlete should bring supplement in for evaluation

Special Populations
1. Older athletes
  o Do not respond to creatine supplementation to same extent as young adults

2. Female Athletes
  o Often low in calcium, iron, and zinc
    ▪ See Special Supplements
  o Low vitamin D and calcium
    ▪ Decreased bone mineral density
    ▪ Greater risk of stress fracture
  o Highest risk are female athletes
    ▪ Restrict energy (calorie) intake
    ▪ Do not consume dairy products
    ▪ Have menstrual dysfunction
  o Recommendation: supplement with vitamin D if live at northern latitudes, train indoors throughout the year (SOR:C)
    ▪ Gymnasts, skaters
    ▪ May supplement with D-fortified foods (milk, yogurt, cheese) or 200IU of Vitamin D/day

3. Vegetarian Athletes
  o See Special Supplements
  o Vegetarian diets have poor iron bioavailability
  o Consider supplementation with iron, zinc, calcium, riboflavin, vitamin B-12, vitamin D

Special Supplements
Antioxidants
B-complex vitamins
Branched-chain amino acids
Caffeine
Chromium
Creatine (Cr)
DHEA
Ephedra
HGH
Erythropoietin
Glutamine
HMB
Iron
Ribose
Sodium bicarbonate
Zinc

1. **Antioxidants: Vitamins A, E, C, beta-carotene, selenium**
   - Protect cell membranes from oxidative damage
   - Exercise may increase "oxidative stress"
     - Habitual exercise causes augmented endogenous antioxidant system
   - Supplementation with antioxidant nutrients:
     - No clear consensus
   - Can test blood levels to assess status
     - Consider supplementation if athlete:
       - Has low-fat diet
       - Restricts energy intake
       - Has limited intake of fruits and vegetables

2. **B-Complex Vitamins**
   - Energy production during exercise
     - Thiamine
     - Riboflavin
     - Vitamin B 6
     - Niacin
     - Pantothenic acid
     - Biotin
   - Production of red cells, protein synthesis, tissue repair and maintenance
     - Folate
     - B-12
   - Exercise may increase the need for B-6, riboflavin, and thiamine to 2x current RDA
     - Increased needs generally met by higher dietary energy (calorie) intake
   - Routine supplementation not necessary

3. **Branched-Chain Amino Acids (BCAA)**
   - Proposed to enhance performance by delaying central nervous system fatigue or serving as energy substrate
   - Human studies inconsistent
     - Use not advocated

4. **Caffeine (stimulant)**
   - Banned by NCAA
     - 3 cups of strong coffee or equivalent considered a doping offense (15 mcg/ml of urine)
   - Removed from Olympics banned list prior to the 2004 Olympic Games in Athens by the World Anti-Doping Agency (WADA)
     - Performance-enhancing effects judged to be insignificant
   - After ban dropped by WADA, use common
     - 33% of elite track and field athletes and 60% of cyclists surveyed consumed caffeine to enhance performance
   - Efficacy of caffeine
     - Continued athlete perception of performance enhancement
     - Measurements of performance (double-blinded, placebo-controlled studies of cyclists):
• Expectation or placebo effect of caffeine likely accounts for majority of small improvement in performance

5. Chromium
- Essential trace element
  • Hypothesized to assist weight loss and muscle development
- Chromium picolinate typical supplement (100x more chromium than dietary)
- No significant effect on body composition
- Safety: associated with anemia, thrombocytopenia, renal failure, motor dysfunction; also mutagenic

6. Creatine (Cr)
- Commonly used supplement
  • In 2000, 5.5 million pounds of Cr were sold worldwide
  • Up to 50% of college athletes in 2001 used Cr
- Up to 70% of football players
- Non-essential dietary element
  • Synthesized primarily in liver
  • Cr ingestion down-regulates endogenous production
  • Creatine is converted to phosphocreatine (PCr)
  • Source of ATP energy in skeletal muscle
- Efficacy
  • Most studies demonstrate that Cr improves exercise performance for short periods (<90 sec) of extremely powerful activity
    • Power cycling
    • Sprinting
    • Jumping
    • Sprint swimming
    • Weight lifting
  • Cr supplementation does not enhance aerobic performance
  • Different Cr forms or other additives do not enhance effect
  • 3 g/day of Cr produces same increase in total muscle concentrations of PCr as 20 g/day
- Safety: anecdotal reports of GI, CV, muscle problems
  • Evidence insufficient to determine safety

7. DHEA or dehydroepiandrosterone
- See Banned Substances
- Current available evidence does not support theory that DHEA supplementation improves muscle strength or body composition

8. Ephedra and ephedrine (stimulants)
- See Banned Substances
- Effects on athletic performance
  • Not adequately assessed in general population
- Safety
  • 2-3x risk of nausea, vomiting, anxiety, autonomic excitation, and palpitations
  • Possible small risk of death, CVA, seizure

9. Human Growth Hormone or HGH
- See Banned Substances
10. Erythropoietin (EPO), also darbepoietin
   - See Banned Substances
   - Hormone produced by kidney to stimulate proliferation/differentiation of red cell progenitors
     - Increased red cell count
     - Increased oxygen carrying capacity
   - Recombinant EPO available late 1980's
   - Safety: associated with hyperviscosity, thrombosis and hypertension
     - May cause death

11. Glutamine
   - Non-essential amino acid stored in muscles
     - Intense endurance exercise depletes glutamine stores
   - Oral glutamine supplementation may:
     - Decrease illness
     - Increase muscle glycogen stores
   - Food sources: meat, fish, uncooked beets, cabbage
   - Supplement of 3-5 g/day likely unnecessary if adequate dietary intake

12. HMB or beta-hydroxy beta-methylbutyrate
   - Metabolite of leucine
     - Claims to build muscle and strength
   - Studies conflicting
     - Likely no change in body composition or strength in trained individuals
     - May benefit untrained individuals just beginning resistance training
   - Safety: appears safe for short-term use

13. Iron
   - Required for:
     - Formation of hemoglobin and myoglobin (bind oxygen)
     - Energy-production enzymes.
   - If progresses to iron deficiency anemia/low hemoglobin levels
     - Exercise performance decreased
     - Iron deficiency anemia in 9-11% of female athletes
   - Low iron usually associated with dietary restrictions
     - Low global intake
     - Avoidance of meat
   - Transient decrease in ferritin and hemoglobin can occur with training due to increased plasma volumes
     - Recommendation: Females, vegetarians, long-distance runners should be screened periodically (biannually to annually) to assess iron status (SOR:C)
       - First low ferritin levels occur (ferritin <20-30) followed by:
         - Low serum iron concentrations
         - Low hemoglobin and hematocrit
   - Complete reversal of iron-deficiency anemia can take 3-6 months

14. Ribose
   - Necessary to regenerate ATP
   - Beneficial in CAD patients
   - No evidence of ergogenic or athletic performance benefit
15. **Sodium Bicarbonate**
   - Used as alkaline solution to buffer acidosis caused by anaerobic glycolysis
   - May enhance performance in short duration/high intensity exercise
   - Safety: potential for GI distress

16. **Zinc**
   - See Female Athletes
   - Important for building and repair of muscle tissue, energy production
   - Zinc intake below RDA in:
     - 90% of men (RDA 15 mg)
     - 81% of women (RDA 12 mg)
   - Plasma zinc concentrations may not reflect whole body zinc status
   - Recommendation:
     - Assess the diets of athletes for adequate zinc intake (SOR:C)

**Banned Supplements**

1. **NCAA Banned Substances**
   - Caffeine (15 mcg/ml of urine or 3 strong cups coffee)
   - Ephedrine and ephedra
   - All anabolic steroids including DHEA
   - Diuretics (commonly masking agents)
   - Growth hormones, including Human Growth Hormone
   - EPO

2. **WADA Banned Substances**
   - Rules of International Olympic Committee (IOC)
   - Similar to NCAA list, excludes caffeine

**Contaminated Supplements**

1. "Supplements" not monitored by the Food and Drug Administration
   - Frequently contaminated with harmful and/or banned substances
   - In 2006-2007 study of purchased supplements
     - 25% contained steroids
     - 11.5% contained banned stimulants
   - Most commonly contaminated supplements marketed as:
     - "Testosterone booster"
     - "Weight loss"
     - "Muscle builder"
   - Study of supplements by IOC from 2000-2002
     - 18.8% contained steroids

**Patient Education**

1. MD Consult: Medication and Supplement Use by Athletes

**References**

   - Glutamine Supplements
   - Sports Supplements and Athletic Performance
   - Sports Nutrition Basics from Training to Competition

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