Disclosures

• I have none

Objectives

• Understand what micronutrients are important in athletes
• Understand the effect of iron deficiency on the athlete
• Understand iron deficiency screening and iron replacement
• Understand the effectiveness of the top selling sports supplements
Vitamins and Minerals

- Micronutrients play an important role in:
  - Energy production
  - Hemoglobin synthesis
  - Maintenance of bone health
  - Immune function
  - Protection from oxidative damage
  - Synthesis and repair of muscle tissue

Vitamins and Minerals

- Vitamin or mineral supplementation is usually not required if an athlete is consuming a regular diet from a variety of foods
- Supplementation may be appropriate if an athlete is pregnant, dieting, eliminating food groups, or has a specific micronutrient deficiency

Vitamins and Minerals

- The most common vitamins and minerals of concern in athletes are:
  - B vitamins
  - Vitamin D
  - Antioxidants (vitamins C and E, beta carotene, selenium)
  - Calcium
  - Iron
  - Zinc
  - Magnesium
The B Vitamins

• Thiamine
• Riboflavin
• Niacin
• Vitamin B6
• Pantothenic acid
• Biotin
• Folate
• Vitamin B12

Important for energy production, the synthesis and repair of muscle tissue, the production of red blood cells, and CNS tissue repair and maintenance

Frequently low in female athletes’ diets, especially vegetarians or those with disordered eating

Limited research on the impact of deficiencies on athletic performance

Deficiencies of vitamin B12, folate, or both can result in anemia and subsequent reduced endurance performance
Vitamin D
• Required for adequate calcium absorption
• Regulates development and maintenance of skeletal muscle and the nervous system
• Low levels associated with increased risk of stress fractures
• Athletes in northern attitudes and indoor athletes are at risk for low levels.

Vitamin D
• Recommended daily allowance for ages 1-70
  – 600 IU
• Ages 71+
  – 800 IU

Antioxidants
• Play important roles in protecting cell membranes from oxidative damage
• Hypothesized that exercise produces an oxidative stress leading to lipid peroxidation of membranes
• Habitual exercise results in an augmented antioxidant system and reduced lipid peroxidation
Antioxidants

- Little evidence that antioxidant supplementation enhances performance
- Athletes at risk are those that consume a low-calorie diet, low-fat diet, or limit fruits and vegetables

Calcium

- Important for growth and repair of bone
- Involved in muscle contraction, nerve conduction, and blood clotting
- Recommended daily allowance
  - 1,200 mg, 1500 mg for athletes with disordered eating, amenorrhea, or other risks for early osteoporosis

Iron

- Iron is required for the formation of oxygen carrying proteins, hemoglobin and myoglobin
- Iron depletion is one of the most prevalent nutrient deficiencies observed in athletes, especially females
- Iron deficiency with or without anemia, can impair muscle function and limit work capacity
Iron

- The incidents of iron depletion in athletes is usually due to inadequate energy intake
- Other causes are: periods of rapid growth, training at high altitudes, menstruation, intravascular hemolysis, and foot strike hemolysis
- Women, endurance athlete's, and vegetarian's should be screened periodically (ferritin, H/H)

Iron

- Reversing deficiency anemia can take 3-6 months
- Supplementation for known iron deficiency is 100mg/day for 3 months

Zinc

- Zinc plays a role in growth, building, and repair of muscle tissue. It is also utilized in energy production and maintaining a healthy immune status
- Decreases in cardiorespiratory function, muscle strength, and endurance have been associated with poor zinc status
### Zinc

- **Recommended daily allowance in males 14+**
  - 11 mg
- **Recommended daily allowance in males 9-13 and females 9+**
  - 8 mg
- Excessive zinc intake can interfere with iron and copper absorption

### Magnesium

- Magnesium plays a variety of roles in cellular metabolism
  - Glycolysis
  - Fat and protein metabolism
- Deficiency may decrease endurance by increasing oxygen requirements
- No evidence for supplementation without known deficiency

### Ergogenic Aids

- Substances, devices, or practices that enhance performance
- Mechanical
- Pharmacological
  - Supplements, anabolic steroids, diuretics, beta-blockers, EPO, stimulants, human growth hormone, etc
- Physiological
- Psychological
Pharmacological

• OTC supplements
  – American spent 32 billion dollars on supplements in 2012 ($23 billion in 2006, $11 billion in 2000)
  – 38-50% of the general population
  – 76% of collegiate athletes
  – 100% of bodybuilders
• Natural does not equal safe

Top selling supplements

• Creatine
• Whey protein
• Branched chain amino acids (BCAA)
• Arginine
• Glutamine
• Caffeine
• Beta-hydroxy-beta-methylbutyrate (HMB)
• Nitric oxide (NO)
• L-carnitine
• Testosterone boosters

Creatine

• Most widely used supplement
• During brief high intensity exercise, ADP is rephosphorlalized to ATP by muscle phosphocreatine
• Creatine is absorbed intact by the gut
• Increasing muscle stores of phosphocreatine results in faster regeneration of ATP
• Allows decreased rest time between activities and increased energy for repeated bouts of exercise
• Buffers lactic acid and delays fatigue and soreness
Creatine

• The evidence
  – Generally positive results, showing gains in strength and mass
  – Studies in men and women showed benefit in strength and mass
  – Studies in older individuals (>60) did not show any change in body composition or strength
  – Lab studies have shown improvements in sprinting performance in men (running, cycling, and swimming), but no improvement were noticed in women
  – Studies used loading dose of 20 grams for 5-7 days, then 5 grams daily
  – Most of the benefit was gained during the loading phase

Creatine

• The bad
  – Weight gain from muscle hypertrophy and water retention (may be more detriment than benefit in sports requiring speed)
  – Studies were not performed on high school aged athletes
  – Studies showed no changes in electrolyte concentrations, muscle cramps, strains, or renal function despite reports
  – Most research was limited to 3 months, so questions on long-term safety are unanswered
  – Anecdotal reports (n=1) of renal insufficiency, GI effects, muscle cramping, and dehydration have not been confirmed in studies

Creatine

• Legality
  – Legal OTC supplement
  – Not on World Anti-doping prohibited list (there’s an app for that)
  – OK per NCAA, but schools cannot provide it
Protein

• Nearly as popular as creatine, with whey protein being the most popular
• Protein and AA are the building blocks of muscle
• Inadequate protein intake does cause a negative nitrogen balance, which slows muscle growth and cause fatigue
• Most experts agree that sufficient protein can be obtained from diet
• Protein supplements are often used due to convenience
• Whey protein is the most popular and is higher in BCAA

Protein

• The Evidence
  – Studies of resistance training athletes showed that those consuming the recommended daily allowance for protein (0.8mg/kg) had a negative nitrogen balance
  – Zero balance was found at 1.4-1.6 mg/kg, with no additional benefit over 1.8 mg/kg
  – Protein powders confer more benefits than AA supplementation
  – No difference between whey, soy, and casein

Protein

• The bad
  – GI side effects were the only reported adverse effects of protein supplementation in healthy individuals
  – Caution in those with renal insufficiency or failure
  – Excessive protein intake is stored as fat
• Legality
  – Legal at all levels of competition

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Branched Chain Amino Acids (BCAA)

- Leucine, isoleucine, and valine
- Muscles have a high BCAA content
- BCAA are used as fuel in endurance exercise
- BCAA inhibit tryptophan transport across the BBB, leading to decreased serotonin and decreased central fatigue
- Supplementation replaces BCAAs used as fuel, increases protein synthesis, shift leucine metabolism to fat metabolism

BCAA

- The evidence
  - Most studies show no beneficial effect
  - No evidence of reduced overtraining symptoms or reduced chronic fatigue
- The bad
  - Some studies demonstrated side effect of fatigue
- Legality
  - Legal at all levels

Arginine

- Said to acutely improve exercise capacity
- Chronic use improves performance by increasing muscle mass
- Soy protein is high in arginine
- May promote secretion of endogenous GH
- Precursor in the synthesis of creatine
- Augments the production of NO (discussed later)
Arginine

- The evidence
  - No evidence of increased performance
  - IV arginine did increase GH levels, but not oral
- The bad
  - No reported adverse effects
- Legal

Glutamine

- The most abundant AA in the body
- Important fuel for immune cells (lymphocytes and macrophages)
- Used for wound healing, immune function, and for mucositis resulting from chemo
- Athletes use it to prevent immune impairment during training and overtraining
- During prolonged exercise, plasma glutamine may drop
- Muscle glutamine also drops to sustain anabolic state

Glutamine

- The evidence
  - Some data shows enhancement of immune function
- The bad
  - No adverse effects reported
- Legal
Caffeine

• Naturally occurring plant alkaloid found in coffee, tea, and colas
• Classified as a CNS stimulant
• Over 50% of adult Americans drink coffee daily
• Average coffee drinker drinks 3 cups per day
• Energy drinks supplemented with caffeine was a $53 billion industry last year and are marked towards the younger population
• Caffeine levels: cup of coffee=100mg (Starbucks grande=372mg), Coke=35mg, energy drink=80-280mg

Caffeine

• Rapidly absorbed, peak levels in 30-60 minutes
• Half-life of 5 hours
• Causes vasoconstriction (except in renal afferent artery)
• Increases lipolysis in adipocytes, and gastric secretion
• Potentiates calcium release from sarcoplasmic reticulum

Caffeine

• The evidence
  – Many studies have shown improved endurance times with doses of 3-3.5 mg/kg
• The bad
  – Restlessness, tremor, insomnia, diuresis, HA, tacharythmias,
    – Legality
      • Banned by IOC in 1962, removed from list in 1972
      • Now limited to urine concentration of 12ug/L (requires dose of 13.5 mg/kg)
      • NCAA limit is 15ug/L
**Beta-hydroxy-beta-methylbutyrate (HMB)**

- HMB regulates protein synthesis and is theorized to decrease catabolism
- Thought to increase lean muscle mass and strength and is used in bodybuilding
- Mechanism is not fully understood
- Metabolite of leucine and may regulate enzymes responsible for protein breakdown

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**HMB**

- The evidence
  - Studies in livestock support decreased catabolism
  - One study in humans showed increased strength
- The bad
  - One study in humans
  - No adverse effects
- Legal

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**Nitric Oxide (NO)**

- Relatively new
- Thought to increase muscle strength and endurance
- Marketed with the claim that vasodilation improves muscular perfusion
- The evidence
  - Few studies, no evidence of increased strength or muscular perfusion
- The bad
  - No reported adverse effects
- Legal

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L-Carnitine

- Said to increase aerobic and anerobic capacity and promote fat loss
- Increases long-chain fatty acid oxidation
- The evidence
  - No evidence of benefits
- The bad
  - Nausea, vomiting, abdominal cramps, diarrhea
- Legal

Testosterone Boosters

- DHEA (dehyroepiandrosterone)
- Androstenedione
- Tribestan (tribulus terrestris)
- Various newer herbal concoctions that claim to increase testosterone production and block aromatase activity and conversion to DHT

DHEA and Androstenedione

- Precursors to gonadal steroid pathway
- Increased precursor is supposed to shift production of testosterone
- The evidence
  - Testosterone levels were unchanged in men
  - Testosterone levels were increased in women
  - No change in strength or muscle size in men (no studies in women)
- The bad
  - Decreased HDL
  - Increased estradiol and gynecomastia
- Banned by IOC, NCAA, and NFL
Tribulus Terrestris

- Herb claiming to "naturally" increase testosterone levels
- Supposed to increase LH, indirectly increasing testosterone
- The evidence
  - No studies support claims of increased strength or change in body composition
  - No studies showed increased testosterone, but one study showed increased androstenedione
- The bad
  - Photosensitivity in animals, no reported adverse effects in humans
- Legal

Supplements Perform as Claimed

- Creatine
- Caffeine
- Protein
- Sports drinks, gels, and bars
- Maybe HMB

Thank you!

Thank you!

• Nutritional Supplements Flexing Muscles As Growth Industry. *Forbes.com*