



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

The B Vitamins

- 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

The B Vitamins

- 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 rephosphorized 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

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 \$3 billion industry last year and are marketed 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, tachyarrhythmias,
 - 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

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

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

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 (dehydroepiandrosterone)
- 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 gynocomastia
- 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!

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