Supplements and Steroids in Sports

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Introduction

• ~89 brands of sports supplements; Many forms of anabolic products; 235 supplements claim to enhance muscle growth and/or performance.
  – $14 billion dollar industry.

• Supplement market unregulated after 1994 “Dietary supplement health and education act”.

• Encouraged by marketing, availability, and reports of famous athletes using.

• Physicians need working knowledge of common ergogenic aids used by their patients.
“Don’t eat the hard thing on its back, they make you fart!”
Overview

- Discuss prevalence of use of common ergogenic aids among athletes.
- Review substances commonly used by athletes to enhance performance.
- Provide “talking points” for discussion with athletes regarding theory, dosing, side effects and current science.
- Discuss drug testing.
Prevalence of Supplement Use

• Little info on prevalence, patterns change.
• 94’ meta-analysis (10,274 athletes, 15 sports, all levels) – prevalence of 46%.
  – More common among elite > college > HS.
  – Women > Men; Athletes > General population.
• 2001 NCAA survey revealed 53% had used. (creatine and protein most).
• 2006 study of Nebraska HS athletes showed 25% taking supplements.
• Most athletes try supplements & steroids for the first time in high school.

Prevalence of Steroid Use

- Recent meta-analysis (2014) showed global lifetime prevalence of 3.3%:
  - 6.4% for males
  - 1.6% for females
- Most prevalent among recreational sportspeople and athletes, followed by prisoners and arrestees, drug users, high school students and non-athletes

Sagoe, Ann Epi, 2014
Prevalence of Steroid Use

• 2013 CDC report 3.2% of HS students used steroids;
  – 4% boys, 2.2% girls tried.
  – 42% first used in high school.
  – 15% in junior high or before.

• 1995 survey of 198 elite and Olympic athletes:
  – 195 would use banned drug if sure to win and not detected.
  – $\frac{1}{2}$ would still do it even if resulted in death in 5 yrs.

Kann, MMWR Supp; 2013       Goldman, Elite Sport Pub; 1992
263 Division III Football Players
87% admitted to previous use of 24 different substances. Most common were:

- Creatine (78%)
- Protein powder (44%)
- Antioxidants (37%)
- Amino acids (32%)
- Caffeine (19%)
- HMB (16%)
- Chromium (15%)
- Androstenedione (13%)
- Ephedrine (13%)
- DHEA (8%)
- L-Carnitine (7%)
- Pyruvate (4%).
Creatine

- Amino acid derivative.
  - Synthesized in the liver, pancreas and kidneys.
  - Found in meats and fish.
- **Theory:** joins with phosphate (PCr).
  - Can rapidly combine with ADP to make ATP.
  - Creates energy bank.
- **Dose:** body needs 2 g daily; Makes 1g.
  - Loading dose 20 g/day for 5-7, then 2-5 g/day.
  - “Slow load” 3 g/day for 28 days can be used.
  - Both increase intracellular creatine by 20%.
  - Carbohydrate may increase uptake.
Creatine (Continued)

• **Side effects**: short-term appears safe.
  – Weight gain (water + lean), nausea, bloating, diarrhea, and abdominal cramping.
  – Potential to increase compartment pressures.
  – Increase urine creatinine 90-fold and serum 20%.

• **Science**: improves short duration (<30 sec.), repetitive, high intensity exercise.
  – Helps power sports; Football and sprinting.
  – No effect on aerobic training or performance.
  – Possible role in elderly (improve muscle mass).
  – *Value* appears limited in those with saturated baseline creatine stores.
Protein Supplements

• Taken as powders, tablets or liquids.
  – Absorption same as natural sources (Beef, chicken, fish, legumes, or nuts).
  – RDA is 0.8 g/kg/day (non-athlete).
  – Athletes need ~1.2-2.0 g/kg/day.
  – Strength athletes require more than endurance athletes.
  – Diet supplies ~1.4 g/kg/day (~ 119 g).

• **Theory:** aid in synthesis of new muscle proteins and thus enhance strength.

• **Dose:** up to 10-20g taken 1-3 times daily.
Protein Supplements (Continued)

- **Side effects**: minimal; GI upset; ? renal.
  - Concern that excess dietary protein may displace carbohydrate from diet and reduce glycogen stores.
  - Excess protein converted to fat, not muscle.

- **Science**: no evidence that protein beyond RDA is ergogenic.
  - Athlete’s needs can be met by increasing dietary sources.
  - May be helpful in female athletes consuming low protein diets over concern for body weight.
Protein Supplements (Continued)

- Studies suggest timing of protein intake may be important:
  - Small meal (protein + carbs) immediately before or after strength training led to greater gains in muscle mass & strength (? “anabolic window”).
  - For aerobic exercise, immediate post-exercise supplementation appeared beneficial (pre-exercise was not).
  - Consuming within 5 minutes after exercise appears better than 2-3 hrs.
  - May help offset muscle loss of aging.
Amino Acids

• Building blocks of protein. Available in tablet or powder form.

• **Theory**: 2 common formulations:
  
  – **Essential and Non-Essential AA’s**: raise protein synthesis by providing substrate.

  – **Branched chain AA’s (leucine, isoleucine, valine)**: help endurance by competing with tryptophan to ward off fatigue (Central Fatigue Hypothesis).

• No evidence either formulation can enhance athletic performance.
Caffeine

• Most widely consumed drug in world. First studies on athletes in early 1900’s

• **Theory:** both central and peripheral effects.
  – Improves reaction time and perception of fatigue.
  – Enhanced fat oxidation (spares glycogen).

• **Dose:** single dose of 3-15 mg/kg (210 to 1050 mg in 70-kg man) before exercise.
  – 60-150 mg per cup brewed coffee.
  – 40-110 mg for instant coffee.
  – 40-50 mg per 12-oz cola beverage.
  – Vivarin tablets contain 200 mg.
Caffeine (Continued)

• **Side Effects:** HA, palpitations, GI upset, tremors, dizzy, and diuresis.
  – Only supplement with threshold rather than ban.
  – **Testing** – urine threshold for NCAA 15 mcg/ml.
    ~9 mg/kg (~5-6 cups of coffee).

• **Science:** Low to mod. doses are clearly ergogenic for aerobic activity.
  – Increased time to exhaustion for cycling and running; improved swimming and tennis results.
  – Benefits less in untrained or recreational athlete.
  – Best results in those who abstain for few days.
Ephedrine

- CNS stimulant, like amphetamine.
  - Now banned by FDA (reversed in Utah able to April 05’ for low dose tabs ≤10 mg)
  - Sold as Ma Huang and Ephedra Sinica.
  - In wt-loss products and decongestants.

- **Theory**: energy booster for workouts.
  - Increases speed, strength and performance.
  - Fat burner to maintain or improve leanness.

- **Dose**: 25 mg/100 lb, 45 min. before workout.
  - Used 3-6 days per week for 10-12 weeks.
  - Often with caffeine and ASA (“ECA stack”).
Death by Ephedrine?

- Rashidi Wheeler; Northwestern U.
- Kory Stringer; Minnesota Vikings
- Steve Bechler; Baltimore Orioles
Ephedrine (Continued)

• **Side effects:** banned by NFL, NCAA, IOC. Also banned by FDA (12/03).
  - Increased HR and BP, nervousness, insomnia, irritability, and psychosis. Stroke and Sz reported.
  - Tolerance and dependence effects.
  - Multiple reports of death and disability.

• **Science:**
  - No study to prove ephedrine alone ergogenic.
  - With caffeine, shown to decrease run time, increase time to exhaustion, and decrease RPE.
  - No studies to show ephedrine will act as a fat burner in athletes who are non-obese.
Anti-Oxidant Vitamins
C and E

• Known scavengers of free radicals; Important in variety of body functions.
  – Deficiency can impair performance
  – Little evidence they are ergogenic taken in excess.

• At best:
  – Daily Vit C decreased incidence of post-race URI’s (up to 33%) in endurance athletes.
  – Daily Vit E may increase anaerobic threshold and time to exhaustion at high altitude.
  – More study needed.
Nitric Oxide

• Variety of agents used to increase nitric oxide and aid endurance performance.
  – Beetroot juice, converted to NO in mouth.
  – Arginine (non-essential AA) supplements also used to increase synthesis of NO.

• **Theory:** promotes vasodilation and increases blood flow for events lasting 5-30 min.
  – Increase time to exhaustion in cycle sprint (~3%).
  – Lowers SBP (~5-10 mmHg)

• **Dose:** ~500 ml of BR juice (two 70 ml shots).
  – Peaks ~2-2.5 hours after ingesting.
  – Avoid after mouthwash or gum.
Nitric Oxide (Continued)

• **Side effects:**
  – Causes staining of lips and gives urine and stool a red color which is harmless.
  – High in oxalate so may cause kidney stones.

• **Science:**
  – Both acute and chronic ingestion slightly improved endurance performance for events 5-30 min duration.
  – More recent studies have shown no effect in elite endurance athletes.
Androstenedione (Andro)

- Described as “prohormone” because it is in conversion path to testosterone.
  - Not part of normal diet.
  - Made in small amounts by gonads and adrenals.

- **Theory**: claims to raise testosterone level, thus increasing strength and performance.

- **Dose**: 50-100 mg up to 3x daily in pill form.
  - Many athletes are far exceeding this dose in belief “more is better”.
Testosterone Synthesis Pathway

Cholesterol

↓

Pregnenolone → Progesterone

↓

17-OH Pregnenolone → 17-OH Progesterone

↓

DHEA → Androstenedione

↓

Androstenediol → Testosterone

↓

→ Estradiol
Andro (Continued)

• **Side effects:** currently no good studies.
  – If it increases testosterone, then potentially similar side effects.
  – Side effects from increased estrogen.
  – Banned by IOC, NCAA, NFL – pos. drug test.

• **Research:** 300 mg/d may increase serum testosterone and estradiol *levels*.
  – Increase normalizes in 24 hrs.
  – No difference in either strength or lean body mass after resistance training.
Mark McGwire – *Did* Andro do this?
Anabolic Steroids

- Synthetic analogues of testosterone.
  - Oral & injectable (water and oil based) forms.
  - Tetrahydrogestrinone (THG) designer steroid.
- **Theory**: Used in supra-physiologic doses to:
  - Increase lean body mass and muscle strength.
  - Create “anti-catabolic effect”, thereby preserving muscle mass and speeding recovery.
  - Increasing RBC mass and endurance.
  - Increasing aggression.
- **Dosing**: Use high dose, with cycling (6-10 wks on, 10-12 off) and stacking (more than 1).
Anabolic Steroids: Side Effects

- Side effects are wide ranging
  - Acne, baldness, gynecomastia, elevated lipids & LFT’s (oral), testicular atrophy, and sex dysfunct.
  - Psych issues “roid rage” and depression (suicide).
  - Women: virilization effects (irreversible), menstrual irregularities and early menopause.
  - Kids: early growth plate closure (short stature).
  - Prolonged & hi-dose use linked to CAD, cardiomyopathy and sudden death.
  - Infections (hepatitis and HIV) with shared needles.
  - Banned from use in all competitive sports.
Anabolic Steroids: Science

- High dose steroid use, coupled with vigorous resistance training results in increased protein synthesis and lean muscle.
  - Stimulates production of growth hormone.
  - Decreases perception of fatigue.
  - Only ~30% experience subjective side effects and most are mild.
Perhaps the Worst Adverse Effect...
Gene Doping -- The Future?

- **Belgian Blue Cattle**
  - Deletions in the myostatin gene results in immense growth of muscle in these cattle.
  - Gene therapies in humans could do the same.
  - How long will it be before this is tried in athletes?
Conclusion

- Steroids, creatine, caffeine & ephedrine (with caffeine) have ergogenic effects.
- HMB, Vitamins C (endurance sports) and E (high altitude) and protein may benefit in certain settings.
- No benefits amino acids, chromium, andro, ephedrine (alone), or DHEA.
- Ephedrine and chromium may have serious effects. Few studies on long-term.
- Supplements cannot be seen as key to athletic success or substitute for hard work.
Thank You!