Performance-Enhancing Substances and Methods
Chapter Objectives

• Provide reliable and up-to-date information to athletes on the risks and benefits of performance-enhancing substances, including anabolic steroids.

• Distinguish between those performance-enhancing supplements that mimic the effects of hormones in the body and those that improve performance through some other means.

• Determine which performance-enhancing supplements are beneficial for strength/power performance, endurance performance, or both.

• Understand the efficacy and adverse effects of over-the-counter dietary supplements marketed to athletes for enhancing sport and exercise performance.
Key Term

• **Ergogenic aid:**
  – Any substance, mechanical aid, or training method that improves sport performance; for the purposes of this chapter, the term refers specifically to pharmacologic aids.
Why Care about Ergogenic Drug Use?

- Health And Safety Issues
- Integrity of the Sport
- Ethical Fair Play
World Anti-Doping Agency (WADA) Criteria for Inclusion on the Banned Substance List

Must fulfill two of three:

1) Evidence that it has the potential for or enhances performance
2) Evidence that use poses an actual or potential health risk
3) Use violates the “spirit of sport” according to WADA
WADA 2015 Prohibited Substances

S1. Anabolic Agents (eg, Anabolic Steroids)
S2. Peptide Hormones (eg, Human Growth Hormone)
S3. Beta-adrenergic agonists (eg, Clenbuterol)
S4. Hormone Antagonists and Modulators - anti-estrogenic agents (eg, tamoxifen) - blocks production or utilization of estrogens to inhibit undesirable side effects of anabolic steroids and mask their presence
S5. Diuretics and Masking Agents of Anabolic Steroids And other substances with similar chemical structure or similar biological effects
WADA 2015 Prohibited Substances

In competition only
S6. Stimulants (eg, amphetamines - raises levels of physiological or nervous activity in the body)
S7. Narcotics (eg, Heroin - drug or other substance affecting mood or behavior)
S8. Cannabinoids- natural & synthetic (eg, marijuana)
S9. Glucocorticoids-systemic (eg, corticosteroids to decrease inflammation, or increase high intensity exercise by reducing the initial rate of muscle fatigue)

And other substances with similar chemical structure or similar biological effects
WADA 2015 Prohibited Substances In Particular Sports

P1. Alcohol

P2. Beta Blockers
Key Term

• Doping:
  - the use of performance enhancing drugs or methods by athletes to gain a competitive advantage. Blood oxygenation enhancement is a type of doping that artificially increases an individual's hemoglobin concentration above normally occurring levels.

• Danish cyclist, Knut Jensen, was the first athlete to die in Olympic competition due to doping. He died August 26, 1960 at the Summer Olympics in Rome during the 100km team time trial race where he collapsed during the race, fracturing his skull. His autopsy revealed traces of an amphetamine in his system, which are used by athletes for increased energy & concentration.
Key Term

• **Doping:**
  – The IOC 1st classification of doping was in 1967 and included amphetamines & narcotics, which were tested for the first time at the 1968 Olympics (1 positive test)
  – World champion cyclist Tom Simpson died in July of 1967 during the thirteenth stage (13 July) of the 1967 Tour de France secondary to an amphetamine overdose, creating pressure on sporting agencies to take action against doping in sports.
Key Term

• Doping:
  – 2\textsuperscript{nd} classification of doping included anabolic steroids in 1975
    • Anabolic steroids tested for the first time at the 1976 Olympics.
    • The modern age of drug testing essentially started at the 1983 Pan Am Games in Caracas, Venezuela. A team of scientists developed a new method for steroid testing in anticipation of two large international sporting events that year, the Pan Games and world track & field championships.
    • The Pan Am unannounced drug testing caught a lot of athletes by surprise. A dozen American athletes in various events suddenly withdrew from the competition and returned to the U.S., and at least another dozen athletes from other countries also left without explanation.
    • 19 athletes failed drug tests at the 1983 Pan Am Games
Key Term

• **Doping:**
  – 3rd classifications of doping included beta blockers & diuretics in 1985
  – 4th classifications of doping included probenecid & Human Chorionic gonadotropin (hCG) in 1987
  – 5th classifications of doping included & HGH & other peptide hormones, such as Erythropoietin (EPO), in 1989.
    – The presence of EPO and HGH can only detected by blood tests, which were not allowed in the Olympics until 2000, not allowed in professional baseball until 2010 ((minor league baseball) and 2012 (major league baseball), and not allowed in the NFL until 2011. There is no blood testing in the NBA & NHL, and in NCAA sports – only urinalysis.
  – EPO was tested for the 1st time at the 2000 Olympics
  – HGH was tested for the 1st time at the 2004 Olympics
Key Point

• An athlete’s first priority should be to apply sound principles of training, including adequate nutrition, before using any nutritional supplement or ergogenic aid. Before purchasing or consuming a product, an athlete should seek guidance from qualified professionals to make sure the choice is both legal and effective.
Types of Performance-Enhancing Substances

• Natural Occurring Hormones and the Drugs that Mimic Their Effects
• Dietary Supplements
Hormones

• Anabolic steroids
  – The synthetic (man-made) derivatives of the male sex hormone, testosterone.
  – In 2004 President Bush signed into law the “Anabolic Steroid Control Act of 2004”, banning hundreds of steroid-based drugs and precursors from over-the-counter sales without a prescription.
  – Because of their widespread use by athletes, synthetic derivatives of anabolic steroids are the most important ergogenic aids that strength and conditioning professionals should be knowledgeable about.
  – With appropriate resistance training (primarily high intensity strength/power training) elevations in testosterone concentrations stimulate protein synthesis, resulting in improvements in muscle size, lean body mass, strength, and power, and enhance recovery.
**TABLE 11.1 Types of Anabolic Steroids Used by Athletes**

<table>
<thead>
<tr>
<th>Generic name or category</th>
<th>Examples of trade names</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orally active steroids</strong></td>
<td></td>
</tr>
<tr>
<td>Methandrostenolone</td>
<td>Dianabol</td>
</tr>
<tr>
<td>Oxandrolone</td>
<td>Anavar</td>
</tr>
<tr>
<td>Stanozolol</td>
<td>Winstrol</td>
</tr>
<tr>
<td>Oxymetholone</td>
<td>Anadrol 50</td>
</tr>
<tr>
<td>Fluoxymesterone</td>
<td>Halotestin</td>
</tr>
<tr>
<td>Methyltestosterone</td>
<td>Metandren</td>
</tr>
<tr>
<td>Mesterolone</td>
<td>Proviron</td>
</tr>
<tr>
<td><strong>Injectable steroids</strong></td>
<td></td>
</tr>
<tr>
<td>Testosterone esters*</td>
<td>Depo-Testosterone</td>
</tr>
<tr>
<td>Nandrolone esters*</td>
<td>Deca-Durabolin</td>
</tr>
<tr>
<td>Stanozolol</td>
<td>Winstrol</td>
</tr>
<tr>
<td>Methenolone enanthate</td>
<td>Primobolan Depot</td>
</tr>
<tr>
<td>Boldenone undecylenate</td>
<td>Equipoise</td>
</tr>
<tr>
<td>Trenbolone acetate</td>
<td>Finaject</td>
</tr>
</tbody>
</table>

*These are generic categories of substances; many different preparations of each are available.

1st Anabolic Steroid - created and FDA approved in US in 1958

(Renal Excretion in 4-10 days)

(Excreted in 14-50 days)
Types of Anabolic Steroids Used by Athletes

• THG, know as “The Clear” or Tetrahydrogestrinone
  – Known or suspected to be used by Track & Field athletes and baseball players in late 1990’s & early 2000’s
  – Resembles synthetic steroids trenbolone & gestrinone
  – Reported anonymously to US anti doping agency (USADA) by track coach Trevor Graham in Oct 2003, who turned over to them a syringe containing THG.
  – Trevor Graham reported THG was distributed by Bay Area Laboratory Co-Operative (BALCO), a nutrition company utilized by numerous professional athletes.
  – Unknown how long THG was used by athletes given it was undetectable by current drug testing methods.
  – THG was banned by the FDA on 10/28/2003.
Changes in lean body mass with anabolic steroid administration and following drug cessation

• Even though fat-free mass decreases when steroid use stops, it still remains elevated well above baseline values for several weeks or months.

• This same study also showed decreases in fat mass with steroid use which remained below baseline levels for several weeks or months after steroid use stops.

• This illustrates the importance of unannounced year round drug testing to prevent an unfair advantage secondary to drug use.
Hormones

• Anabolic steroids
  – Dosing
    • Athletes typically use anabolic steroids in a “stacking” regimen, in which they administer several different drugs simultaneously with typical dosages between 10-100 mg/day.
      – There is documented annual steroid dosages of >1-4g in East German female Olympic medal winners.
      – Higher doses are more effective than lower doses for strength
    • The potency of one anabolic agent may be enhanced when it is consumed simultaneously with another anabolic agent.
    • Most users use the drugs for several weeks or months and alternate these cycles with periods of discontinued use – a cycle is typically 6-16 weeks.
    • Often athletes administer the drugs in a pyramid, step-up pattern in which dosages are steadily increased over several weeks. Toward the end of the cycle, the athlete “steps down” to reduce likelihood of negative side effects.
**Example of “stacking” anabolic steroids for a 6-16 week Cycle**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Therapeutic Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methandrostenolone (Dianabol)</td>
<td>75 mg orally every other day</td>
<td>5 mg per day</td>
</tr>
<tr>
<td>Methenolone (Primabolan)</td>
<td>150 mg subcutaneously every other day</td>
<td>2.5-10 mg per day</td>
</tr>
<tr>
<td>Oxandrolone (Oxandrin/Anavar)</td>
<td>20 mg orally per day</td>
<td>5-10 mg per day</td>
</tr>
<tr>
<td>Oxymetholone (Anadrol)</td>
<td>100 mg orally per day</td>
<td>1.5 mg/kg/day</td>
</tr>
</tbody>
</table>
Hormones

• Anabolic steroids
  – Adverse effects
    • The medical problems related to anabolic steroids, especially lower doses with medical supervision, may be somewhat overstated given many of the side effects are reversible upon cessation, but there are higher risks associated with higher doses and multiple drugs taken at the same time for prolonged periods of time.
    • Some risks of injectable anabolic steroids include HIV, Hepatitis B, C, Endocarditis, Systemic infections, and Impurities.
Hormones

• Anabolic steroids
  – Adverse effects
    • Primary risk for women is masculinization, which includes decreased body fat, increased fat free mass, deepening of the voice, cessation of menstrual cycles, and increased facial hair, while in men decreased sperm count and testicular size, and male pattern baldness.
    • Premature epiphyseal plate closures and increased risk of tendon tears (eg, pec major, biceps brachii)
    • Liver tumors, cancer, and damage (more common with oral ingestion)
    • Cardiovascular disease (lowered HDL, atherosclerosis, hypertension)
Hormones

• Anabolic steroids
  – Psychological effects
    • Anabolic steroid use is associated with changes in aggression, arousal, and irritability, which may help enhance performance if channeled properly.
      – However, mood swings and uncontrolled aggressiveness have also been shown to detrimental to both the user and those interacting with the user.
Hormones

• Anabolic steroids
  – Who uses anabolic steroids?
    • Olympic athletes, professional and amateur athletes, collegiate athletes, high school athletes, and recreational athletes have been reported to use steroids.
    • There are also many users who use anabolic steroids to improve appearance (eg, bodybuilders).
  – Athletic performance
    • The purported ergogenic benefits commonly attributed to anabolic steroid use are increased muscle mass, strength, power, & athletic performance, but these changes depend on the dose and type of steroids taken, on the training status of the individual, and the type of resistance training program employed.
Hormones

• Human growth hormone (HGH)
  – Secreted from anterior pituitary gland
  – One of main benefits is its action on liver to produce IGF-1
  – Stimulates bone and skeletal muscle growth (increased protein synthesis)
  – Helps maintain blood glucose levels
  – Stimulates the release of fatty acids from fat cells
  – Growth Hormone Releasing Peptides (eg, Ipamorelin) has been shown to increase HGH levels
  – Efficacy
    • Little research has been done with athletes.
    • Research with healthy elderly persons, as well as children and adults with growth hormone deficiencies, shows improvements in lean body tissue with decreases in body fat.
Hormones

• Human growth hormone (HGH)
  – Adverse effects
    • Excess HGH after puberty may cause acromegaly - a disfiguring disease characterized by an increase a widening of the bones, arthritis, organ enlargement, and metabolic abnormalities.
    • Excess HGH during childhood may result in “gigantism” with exaggerated bone growth and abnormal increase in height with abnormal bone growth.
    • Abuse of HGH can also lead to insulin resistance and diabetes in prone individuals; cardiovascular dysfunction; muscle, joint, and bone pain; hypertension; abnormal growth of organs; accelerated osteoarthritis.
Human Growth Hormone (HGH) History in Sport

- Reports of use of human cadaveric pituitary extract (only source of HGH available until 1986) – very expensive
- Pharmacologic recombinant HGH available since late 1980’s– relatively cheaper than cadaveric pituitary extract.
- 1988 Ben Johnson combined anabolic steroids with HGH
- 1998 discovery of HGH in Tour de France support vehicle
- 1998 HGH found in Chinese swim team luggage in Sydney
- 2005 Study of AS users reveals 25% also use HGH and insulin (Parkinson AB, MSSE 2005;37(5):S37-8)
- 2011 Professional baseball player Mike Jacobs becomes the 1st pro athlete in the US to test positive for HGH (minor league started tested in 2010 and major league in 2012)
- 2013 Tour De France winner Lance Armstrong admitted using HGH
- HGH use increased due to improved testing for Steroids
  - HGH cannot be detected by current urine tests, & some blood tests can only detect use in past 24-36 hrs, which may help explain the 0 positive tests during the inception of HGH testing in 2004 Olympics
  - Improvements in HGH testing continue (best tests can detect use within the past 2 weeks) & 2 positive HGH tests were reported at the 2012 Olympics & 6 more track & field athletes were suspended for positive HGH tests before the 2012 Olympics.
Hormones

• Testosterone precursors (prohormones)
  – Theorized to increase the body’s ability to increase testosterone levels.
    • Example: androstenedione, which is what Mark McGwire used during his 1998 home run record season (but he also admitted using anabolic steroids!)
  – Scientific evidence is limited and somewhat mixed although the overall consensus seems to imply testosterone precursors are not affective in enhancing strength and performance
  – Although performance changes may not occur with prohormone use, athletes may be at higher risk for experiencing adverse side effects similar to those associated with anabolic steroid use.
Hormones

• HCG (human chorionic gonadotropin)
  – Comes from placenta of pregnant women and structurally and functionally similar to luteinizing hormone
  – When injected into men, HCG can increase testicular testosterone production.
  – Efficacy
    • Cited anecdotally as useful for males who take anabolic steroids.
    • Endogenous testosterone production is suppressed at the end of an anabolic steroid cycle. If HCG is used by athletes, it is likely used by those who are finishing a cycle of anabolic steroids and are looking to activate their own endogenous testosterone production.
Hormones

• HCG
  – Adverse effects
    • There is very little research on the side effects of HCG injections.
    • The side effects that are common to injection are pain, swelling, and tenderness around the injection site.
Hormones

• Insulin
  – Facilitates the uptake of glucose and amino acids into the cells
  – Increases protein synthesis, thus considered an anabolic hormone
  – Efficacy
    • There are several reports that postworkout carbohydrate ingestion suppresses muscle protein breakdown and enhances protein synthesis via the anti-catabolic effects of insulin.
    • Theoretically, if protein breakdown is suppressed over several weeks to months, gains in lean muscle mass could be realized.
Hormones

• Insulin
  – Adverse effects when injected
    • Immediate death
    • Coma
    • Possible development of insulin-dependent diabetes in a previously healthy athlete
Hormones

- **Erythropoietin (EPO)**
  - Endogenous EPO production is stimulated by ↓ O₂ levels in the blood and is naturally produced & secreted by the Kidneys to stimulate the production of new RBC’s - as RBC production ↑ so does the body’s ability to deliver O₂ to the working muscles.
  - Prior to the 1980’s autologous blood transfusions were commonly done to increase RBC production, but exogenous EPO (produced by recombinant genetically engineered DNA technology) has become more popular since its production in the 1980’s & used for performance enhancement.
  - Six weeks of injections of exogenous EPO are associated with increases in hematocrit (~50%) & hemoglobin (~10%), aerobic capacity (~6-8%), and exercise time to exhaustion (~15-20%).
  - Health risks include increased risk of blood clotting from increased blood viscosity, elevations in systolic blood pressure, stroke, cardiovascular risks, a compromised thermoregulatory system, & dehydration during aerobic exercise.
Hormones

• **Beta-adrenergic agonists** (stimulates sympathetic nervous system)
  
  – Chemically related to epinephrine
  – An example is Clenbuterol - a $\beta_2$ agonist that when administered by injection or tablet form may cause an increase in aerobic capacity, muscle mass, CNS stimulation, blood pressure, oxygen transportation, and body fat metabolism. It is commonly used for smooth muscle-relaxant properties as a bronchodilator (inhaled $\beta_2$ agonists, such as what an asthmatic would take, have not been shown to aid performance.

• **Beta-blockers** (stimulates parasympathetic nervous system - opposite effect of Beta-adrenergic agonists)
  
  – Blocks beta adrenergic receptors thus prevent catecholamines (norepinephrine and epinephrine) from binding
  – Beta-blockers reduce anxiety, tremors, & HR during performance.
    • Have shown to improve slow and fast shooting accuracy (archers and marksman).
Early Use and Abuse of Anabolic Hormones in Sport During the 1950’s through the 1970’s

• Olympic Weightlifters
  – Some of the earliest reports of testosterone use among athletes involve accounts of systematic use by the Soviet Weightlifting Team during the 1952 and 1956 Olympics.
  – The 1st anabolic steroid Dianabol (FDA approval in US in 1958) was created by Dr. John Bosley Zieglar, who initially used it as an experiment on US Weightlifters to determine its effective on muscle size & strength gains.
  – Prior to the 1970’s, most scientists didn’t understand the muscle building, strength enhancement, and performance improvement potential that anabolic steroids offered, and thought any improvement in performance that did occur was as much due to a placebo effect as anything else (and the scientific literature supported this understanding of anabolic steroids).
  – Beginning in the 1970’s, athletes, and those who worked with athletes in helping them improve their performance (eg, physicians, chemists in Eastern Bloc countries), began using high doses of anabolic steroids on athletes and through anecdotally began observing the positive effects of anabolic steroids on muscle size, strength, & performance.
Several Research Studies involving the Anabolic Effects of Anabolic Steroids Were Initiated in the 1960’s and into the 1970’s

• From most of the research studies involving the anabolic effects of anabolic steroids that were conducted in the 1960’s and 1970’s, scientists concluded that for the most part anabolic steroids were *NOT* very effective in building muscle, enhancing strength, or improving athletic performance.

• One conclusion made was improvements in strength and performance was thought to be from the “placebo effect”.
• Why did many of the research studies of the 1960’s and 1970’s not produce the same results that athletes in this era swore by (enhanced strength and performance) and that more current research since then substantiated?
  – In part it has to do with the fact that human subjects were only given physiologic doses of anabolic steroids rather than the supra-physiologic doses (several times the physiologic doses) typically taken by athletes.
Olympic Competition

– With no clear answers forthcoming from research regarding the efficacy of anabolic steroids, starting in the 1960’s and continuing into the 1970’s and 1980’s, Eastern Bloc Countries (eg, Soviet Union, East Germany, Czechoslovakia) conducted their own anabolic steroid research studies using athletes as “guinea pigs”.

– The best documented case of steroid abuse comes from the State-Sponsored German Democratic Republic (East Germany) in which scientists, chemists, physicians, and sport & government officials annually used several hundred of even thousands of adolescent (children often told they were taking vitamin pills) and adult level elite athletes as anabolic steroid research subjects (Franke & Berendonk, Clinical Chemistry, 1997).

– East German Sports Scientists found that proper administration of anabolic steroids allowed athletes to perform high intensity training >20% longer and enhance performance, especially among females where steroids had a greater impact compared to males.
### Women’s Swimming at 1972 & 1976 Olympics

<table>
<thead>
<tr>
<th>East Germany Medals</th>
<th>1972 Olympics</th>
<th>1976 Olympics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Gold</td>
<td>0</td>
<td>10 of 11</td>
</tr>
<tr>
<td>Individual Silver</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Individual Bronze</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Team Gold</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Team Silver</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>World/Olympic Records</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

**Note:** In December, 1991, 20 former East Germany swimming coaches admitted that the stunning domination of international swimming by East German women throughout the 1970’s & 1980’s was build upon an organized state-sponsored system of anabolic steroid use. In 2007 a study of 52 German athletes who were given anabolic steroids during the 1970's and 1980's without their knowledge or consent revealed serious health consequences for those athletes and their children. A quarter of the athletes have some form of cancer and one-third report thoughts or attempts of suicide. Of the 69 children that survived, 7 have physical deformities & 4 are mentally handicapped. More than a quarter of the children have allergies and 23 percent have asthma.
Rica Reinisch – 15 year old swimmer for the German Democratic Republic who won 3 gold medals and set 3 world records in the 100 m backstroke, 200 m backstroke, & 4 x 100m Women’s Medley Relay at the 1980 Olympics

• “My coach came up to me and gave me a tablet. He told me: Take it. It's good for you. It will make your body regenerate more quickly”
• “The coaches and doctors were our guardians, the people we trusted at sports school. I’ll never know how good I could have been [without drugs].”
Another interesting comparison between 1972 & 1976 Olympics

1972 Olympics
Helena Fibingerová
Czechoslovakia

1976 Olympics
<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Nationality</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nadezhda CHIZHOVA</td>
<td>SOV</td>
<td>21.03</td>
</tr>
<tr>
<td>2</td>
<td>Margitta GUMMEL</td>
<td>GDR</td>
<td>20.22</td>
</tr>
<tr>
<td>3</td>
<td>Ivanka HRISTOVA</td>
<td>BUL</td>
<td>19.35</td>
</tr>
<tr>
<td>4</td>
<td>Esfir DOLZHENKO</td>
<td>SOV</td>
<td>19.24</td>
</tr>
<tr>
<td>5</td>
<td>Marianne ADAM</td>
<td>GDR</td>
<td>18.94</td>
</tr>
<tr>
<td>6</td>
<td>Marita LANGE</td>
<td>GDR</td>
<td>18.85</td>
</tr>
<tr>
<td>7</td>
<td>Helena FIBINGEREROVA</td>
<td>CZE</td>
<td>18.81</td>
</tr>
<tr>
<td>8</td>
<td>Elena STOYANOVA</td>
<td>BUL</td>
<td>18.34</td>
</tr>
</tbody>
</table>

Note: Helena Fibingerova improved by over 6 feet between the 1972 & 1976 Olympics, & in just 2 months following the 1976 Olympics she improved another 4.3 ft & set a world record of 21.99 m (72’ 2”) in Sept 1976. She currently holds the indoor world record at 22.5 m set in 1977. Only two women have ever throw further, Slupianek-Briesenick (best throws 1980-1983) & Lisovskaya (best throws 1984-1988), both from Eastern Bloc countries, Soviet Union & East Germany, 2 countries which dominated the Olympics in the 1970’s and 1980’s and with a known record of steroid use & abuse.
Drug Testing Effectiveness and Women’s World Records in Track & Field Events in the 1980’s

• Since the mid-1970s, the use of androgenic steroids and other hormonal performance-enhancing drugs has been officially banned by sports authorities, and until 2004 their usage has been controlled primarily through analysis of urine samples (blood samples since the early 2000’s in some sports, such as Olympic sports.
  – Urine samples are relatively ineffective (eg, cannot detect HGH, EPO) and athletes know how to go off the drugs at the right time, or use other substances (eg, diuretics) to mask the drugs.

• Relatively ineffective testing procedures throughout the 1970’s and 1980’s (and even into the 1990’s) resulted in the suspicion that numerous athletes commonly used anabolic steroids without testing positive from a drug test, especially in some Eastern Bloc countries in the 1970’s and 1980’s who had state-sponsored drug programs where athletes collaborated with chemists and physicians to enhance performance and escape drug detection.

• 10 of the 16 women’s current world records in strength/power events in track & field occurred in the 1980’s (see next 2 slides), & most by Eastern Bloc countries (eg, Soviet Union, East Germany).
  – No women has ever come close to breaking these records from 1980’s.
<table>
<thead>
<tr>
<th>EVENT</th>
<th>WOMEN’S WORLD RECORDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 m</td>
<td>Florence Griffith Joyner 10.49 s, US, 7/16/88</td>
</tr>
<tr>
<td>200 m</td>
<td>Florence Griffith Joyner 21.34 s, US, 9/29/88</td>
</tr>
<tr>
<td>400 m</td>
<td>Marita Koch 47.60 s, East Germany, 10/6/85</td>
</tr>
<tr>
<td>800 m</td>
<td>Jarmila Kratochvilova 1:53.28, Czechoslovakia, 7/26/83</td>
</tr>
<tr>
<td>100 m Hurdles</td>
<td>Yordanka Donkova 12.21 s, Bulgaria, 8/20/88</td>
</tr>
<tr>
<td>400 m hurdles</td>
<td>Yuliya Pechenkina 52.34 s, Russia, 8/8/03</td>
</tr>
<tr>
<td>400 m Relay</td>
<td>Madison, Felix, Knight, Jeter 40.82 s, US, 8/11/12</td>
</tr>
<tr>
<td></td>
<td>(Was previously held by East Germany for 27 years (1985-2012))</td>
</tr>
<tr>
<td>1600 m Relay</td>
<td>3:15.17, Soviet Union, 10/1/88</td>
</tr>
<tr>
<td>EVENT</td>
<td>WOMEN’S WORLD RECORDS</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------</td>
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<tr>
<td>High Jump</td>
<td>Stefka Kostadinova</td>
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<td></td>
<td>6-10(\frac{1}{4}), Bulgaria, 8/30/87</td>
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<tr>
<td>Long Jump</td>
<td>Galina Chistyakova</td>
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<td></td>
<td>24-8(\frac{1}{4}), Soviet Union, 6/11/88</td>
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<tr>
<td>Triple Jump</td>
<td>Inessa Kravets</td>
</tr>
<tr>
<td></td>
<td>50-10(\frac{1}{4}), Ukraine, 8/10/95</td>
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<tr>
<td>Pole Vault</td>
<td>Yelena Isinbayeva</td>
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<tr>
<td></td>
<td>16-5(\frac{1}{4}), Russia, 8/12/05</td>
</tr>
<tr>
<td>Shot Put</td>
<td>Natalya Lisovskaya</td>
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<tr>
<td></td>
<td>74-3, Soviet Union, 6/7/87</td>
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<tr>
<td>Discus</td>
<td>Gabriele Reinsch</td>
</tr>
<tr>
<td></td>
<td>251-11, East Germany, 7/9/88</td>
</tr>
<tr>
<td>Hammer Throw</td>
<td>Tatyana Lysenko</td>
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<td>253-11, Russia, 6/24/06</td>
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<tr>
<td>Javelin</td>
<td>Osleidys Menendez</td>
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<td>235-3, Cuba, 8/14/05</td>
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Track & Field

After Ben Johnson (Canada) ran the fastest 100 m time ever (9.79 s) setting a world record at the 1988 Olympics, he tested positive for the anabolic steroid Winstrol, was striped of his gold medal which was awarded to 2nd Place finisher Carl Lewis (who in 1988 may also have tested positive for a banned substance). Johnson was given a 2 year ban from competition. Johnson tested positive again for testosterone in 1993 & was banned for life.
Reported Use and abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes

• Track and Field
  – In 2006 Olympic and world champion 100 m sprinter Justin Gatlin tested positive for anabolic steroids (2nd positive drug test) & banned from competition for 4 years.
  – In 2007 world champion 100 m sprinter Marion Jones admitted to taking the anabolic steroid THG prior to 2000 Olympics, in which she won 5 medals (4 gold). She was stripped of all 5 medals, banned from competition for 2 years, and in 2008 she was sentenced to 6 months in prison for lying & deceiving federal investigators.
  – In 2013 American record holder 100 m sprinter Tyson Gay tested positive for anabolic steroids & banned from competition for 1 year.
  – In 2015 a World Anti-Doping Agency report accused Russia of a state-sponsored widespread doping program involving Russian athletics, coaches, and sport and state officials, which have been provisionally sanctioned pending an investigation. Lifetime bans have been recommended for 5 Russian athletes, and the entire Russian Track & Field team may be banned from the 2016 Olympics.
Drug Testing and Scandals involving Chinese Athletes in the 1990’s

- No drug testing, or extremely limited “In House” testing, occurred at the 1993 & 1997 National Games of China, raising suspicions that the incredible performances that occurred (especially in females) were related to performance enhancement drugs (PED’s).
  - There were also no blood tests for EPO or HGH, 2 commonly employed drugs, and no in-and-out of competition testing.
- In the 1990’s incredible performances, never seen before & never seen after, were occurring in track & field, swimmers, weightlifters, etc…
  - eg, at the 1994 World Aquatics Championships the Chinese female swimmers set 5 world records and won 12 of the 16 gold medals.
    - From 1990-1998, 28 Chinese female swimmers tested positive for PED’s, & in 1998 enough HGH was found in a Chinese swimmer’s luggage to sustain the entire 23-person Chinese team for entire upcoming World Swimming Championships in Perth, AUS.
- At 1994 Asian Games 11 Chinese athletes tested positive for PED
- In 2000, 6 of 7 female distance runners tested positive for EPO & 2 for testosterone, & were suspended from 2000 Olympics in Sydney.
Young Chinese Female Distance Runners of 1993

- In the early 1990’s Coach Ma Junren (an illiterate pig farmer) trained ~15-20 young Chinese peasant females (~16-20 years old & known as Ma’s Army”) from the Province of Liaoning in NE China using extremely rigorous training of high mileage running (excess of 1 marathon per day at altitude) combined with traditional Chinese medicine (eg, mysterious medicinal potions from worms, caterpillar fungus, & turtle's blood) and a military-style regime that outlawed long hair, boyfriends, etc…
- At the 1993 Track & Field World Championships “Ma’s Army” of female distance runners stormed onto the world scene out of nowhere, winning 6 of the 9 medals (3 gold, 2 silver, and 1 bronze) in the 1500m, 3000m, & 10,000m.
- Prior to or after 1993, Chinese females rarely ever won or even placed in the top 3 in any high level International running events such as the World Championships or Olympics.

Suspected Use and abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes
Young Chinese Female Distance Runners of 1993

3-4 weeks after the World Championships were the 1993 National Games of China, & in 6 days “Ma’s Army” annihilated 5 world records in 1500m, 3000m, & 10,000m, with 9 individual performances under the world record.

- Junxia Wang set world records in 1500m, 3000m & 10,000m & her times in the 3000m (8:06.11) & 10,000m (29:31.79) are by far the fastest times ever run. Her 10,000m was 42 s faster than the world record, 78s faster than her time at the world championships a few weeks earlier, & ~3 min faster than her previous best 1 year ago ranked 56th in the world. Wang’s 5000m pace at the 1996 Olympics, winning Gold & setting an OR in 14:59.88, was a much slower pace compared to her 1993 10,000m race!
- Zhong Huandi finished 2nd in the 10,000m (30:13.37) and her time also surpassed the current world record and was 59 s faster than her 2nd place finish at the world championships a few weeks earlier (31:12.55).
- In the 3000m final 5 Chinese women had times faster than the world record & these women hold the 6 fastest times ever run in 3000m. The 3 medalists from the world championships ran 10-16s faster at the Games.
- In the 1500m first Junxia Wang set a world record in the preliminary's and then Qu Yunxia bettered the world record in the finals.
Suspected Use and abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes

- Chinese Female Runners at the 1993 & 1997 National Games of China
  - The performances by these young Chinese females in nearly all of the women’s running events including sprints (100m, 200m, 400m), middle distance (800m & 1500m), and long distance (3000m, 5000m, & 10,000m) are to this day among the best ever.
  - The times recorded in all 8 of these events were Asian World records and good enough to win gold or silver medal at nearly every track and field world championship and Olympic competition both prior and since.
  - World records were shattered in 4 of 8 events (1500m, 3000m, 5000m, 10,000m), & world records currently remain in the 3000m & 10,000m.
    - In the 1500m, 3000m, 5000m, 10,000m, there were 12 individual performances with times under the world record times.
  - Nearly all the women who set these records & had performances among the best of all time in all 8 events were between 16-21 years old, and most disappeared on the scene as quickly as they appeared, after a few years abandoned Coach Ma due to numerous reported incidences of abuse, & rarely competed again after the National Games ended. In their short careers (most retired in their early 20’s) they never again achieved performances even close to what they accomplished at these Games.
Suspected Use and abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes

100m & 200m 1997 champion at the 1997 National Games of China

- 20 year old Li Xuemei’s 10.79s 100m and 22.01s 200m and both are among the fastest of all time. Only Marion Jones (has 5th fastest time ever run) had a better 100m time in 1997. In Xuemei’s 10 year sprinting career none of her times ever came close to her 10.79s 100m and 22.01s 200m from the 1997 National Games, with her average 100m time over her career being around 11.5s (a good college time but no where close to world class).

- Less than 2 months before her 10.79s time Xuemei ran a 11.36s in the 100m (18th place) and 23.06 in the 200m (18th place) at 1997 World Championships & didn’t make it out of the 2nd prelim round.

- One year previously at the World Junior Championships Xuemei had a 12.43s 100m (40th place) & a 25.03s 200m (37th place).

- At 2000 Olympics Xuemei had a 11.46s 100m (21st place)
- At 2004 Olympics Xuemei had a 12.21s 100m (49th place out of 63).

- Xuemei retired from competitive competition in her late 20’s
400m & 800m champions at the 1993 National Games of China

- 21 year old Ma Yuqin’s 49.81s 400m time was best in the world in 1993.
  - Most of Yuqin’s performances were in Asia and none of her 400m competition times ever came within a half second of her 49.81s.
  - Yuqin’s 400m times after her 49.81s performance in 1993 were over 1s slower than her best time.
  - Yuqin retired from competition around age 25.

- 19 year old Liu Dong’s 1:55.54 time is one of the fastest 800m ever run.
  - A few weeks earlier at the 1993 World Championships Dong ran the 1500m instead of the 800m, and won in 4:00.50 to become World Champion.
  - Dong’s best 1500m time of 3:56.31 at the 1997 National Games of China was also one of the fastest times ever run, but it only earned her 5th place at this competition.
  - Dong rarely competed after the 1997 National Games & retired from competition in her early 20’s.
1500m champions at the 1993 and 1997 National Games of China

- 20 year old Qu Yunxia’s 3:50.46 won at the 1993 National Games and was a world record performance that stood for 22 years until barely bettered in 2015. Yunxia’s time is the 2\textsuperscript{nd} best of all time.
- 20 year old Jiang Bo’s 3:50.98 won at the 1997 National Games and is the 3\textsuperscript{rd} best 1500m time ever run, just barely behind Qu Yunxia and current world record holder Genzebe Dibaba (3:50.07)
- Yunxia also finished 2\textsuperscript{nd} in 3000m in the 1993 National Games of China with a world record time of 8:12.18, the second best time of all time, and finished 2\textsuperscript{nd} in the 800m (1:56.21) with one of the fastest 800m times of all time as well.
- A few weeks prior to the 1993 National Games of China Yunxia became world champion in the 3000m with a time of 8:28.71 at the 1993 World Championships.
- Yunxia rarely competed again after the 1993 season and Bo rarely competed again after the 1997 season - both retired in their early 20’s.
- Yunxia was one of Coach Ma Junren’s star pupils
Suspected Use and abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes

• 5000m champion at the 1997 National Games of China
  – 20 year old Jiang Bo’s 14:28.09 shattered the world record and is still one of the fastest 5000m times of all time.

• The times for the 2nd place finisher 20 year old Dong Yanmei (14:29.82) and the 3rd place finisher 26 year old Liu Shixang (14:32.33) were also world record times for the 5000m.

• Interestingly, although these top 3 finishers all had world record times, none of these runners competed at the World Championships 2 months earlier, in which the winning time (14:57.68) was ~30s slower than Jiang Bo’s time.

• Bo also finished 1st at the 1997 National Games in the 1500m (3:50.98) and her time is the 3rd best of all time.

• Bo rarely competed again after the 1997 season and retired in her early 20’s.
• 3000m & 10,000m champion at the 1993 National Games of China
  – 20 year old Wang Junxia’s 8:06.11 winning time in the finals shattered the 3000m world record and is still the fastest 3000m time of all time, her 29:31.78 winning time in the finals shattered the 10,000m world record by 42s and is still the fastest 10,000m time of all time, and her 3:51.92 winning time in the 1500m prelims was also a world record for a brief period until broke by Qu Yunxia’s (3:50.46) in the 1500m finals.
  • And a few weeks earlier at the 1993 World Championships Junxia won the 10,000m in 30:49.30 and became world champion.
  • At the 1996 Olympics Junxia won gold & set a new Olympic Record in the 5000m (14:59.88) & won the silver medal in 10,000m (31:02.59).
  • Junxia retired from competition in 1996 in her early 20’s as one of the greatest female distance runners of all time.
  • Junxia was one of Coach Ma Junren’s star pupils
What is clear:

- In two track & field competitions at the 1993 & 1997 National Games of China, 15-20 young Chinese female runners suddenly appeared on the world stage out of nowhere, re-wrote the record books by setting 4 world records as well as ALL 8 Asian World records in the sprint (100m, 200m, 400m), middle distance (800m, 1500m) & long distance (3000m, 5000m, & 10,000m) events, and had performances among the very best of all time.

- Just as quickly as these females appeared & accomplished incredible feats, most of them disappeared never to be heard from again - at least in terms of the world domination they briefly experienced.

- These young Chinese female runners were never able to come close to repeating the incredible times they produced at these two events.

- Most competed primarily within Asia throughout their careers and seldom at International meets, which often have more strenuous drug testing, such as at the World Championships & Olympics.

- China has a well know record of doping in sport, especially in females.
Concluding Thoughts on Chinese Female Runners of the 1993 & 1997 National Games of China

• What is unclear:
  – How these virtually unknown Chinese females in their late teens & early 20’s accomplished such incredible feats. Exact answers will likely never be known, but we can be reasonably sure it’s some combination of the following:
    • Incredible God-Given ability – need the right “machinery” to begin with an elevated aerobic genetic ceiling.
    • Arduous, extreme training regimens with proper nutrition & recovery.
      – the extreme training and stress, both physiologic and psychologic, that these young females were subject to may partially explain the early retirement in their early 20’s of most of them. Although the mind & body can be pushed to incredible limits through training and determination, both mind & body can only take so much.
      – mysterious medicinal potions from worms, caterpillar fungus, & turtle's blood??????
    • The obvious – doping! Based on all evidence, there is a VERY HIGH probability that doping occurred, & there were few deterrents given the limited drug testing that appeared to occur at these Games
      – Drug testing appears to be even more limited, or even completely absent, at the 1993 National Games.
Olympic Doping Policy – Current

• The International Olympic Committee (IOC) currently has the strictest drug testing protocols in sport, implemented by World Anti-Doping Agency in 2004 (US anti-doping agency implements testing of US Olympic athletes starting in 2000)
  – Even so, across all Olympic sports throughout the history of Olympic Drug Testing (1968-current) less than 1-2% of athletes record positive tests on an annual basis, where in reality doping is believed to occur in greater than 20-30% of Olympic athletes in many sports, such as weightlifting, track & field, swimming, cycling, etc...

• Olympic athletes can be randomly tested 24 hours a day, 365 days a year, no exceptions. Additional random testing occurs during the season.

• Testing involves urine & blood (to test HGH, EPO, etc)

• Penalties:
  1st Positive – 2 Year Ban *(can vary by circumstances)*
  2nd Positive – Lifetime Ban *(can vary by circumstances)*
Major League Baseball (MLB)

- Steroid use was presumed or suspected starting in the 1990’s as home run hitting records were occurring at an unprecedented rate.
- Even though 2 baseball commissioners banned steroids initially in 1991 and again in 1997, the mandate was largely ignored & there were no penalties for steroid use until 2004.
- First hint of wrong-doing was by Mark McGwire and his use of androstenedione during his 1998 home run record season (hit 70 home runs breaking Roger Maris record of 61) – in 2010 McGwire finally admitted he used anabolic steroids for more than a decade.
Reported Use & Abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes

• Major League Baseball (MLB)
  – *Sports Illustrated* article in May 2002 contained admission by MVP Ken Caminiti (died of Drug overdose in 2004 at age 41 & claimed ~50% of MLB players used anabolic steroids in 1996) & later an admission of use by Jose Conseco.
  – In December 2007 the 400+ page *Mitchell Report* implicated nearly 100 MLB players regarding anabolic steroid or HGH use, including big name players such as Barry Bonds, Roger Clemens, Rafael Palmeiro, Jason Giambi, Gary Sheffield, Andy Petite, Mo Vaughn, and Miguel Tejada.
  – When the 6 baseball players who are in the top 15 home run hitters of all time are eliminated from consideration for steroids use since they all played long before the steroid era (Aaron, Ruth, Mays, Robinson, Killebrew, Jackson), of the 9 remaining all time home run hitters 6 of them have been implicated for taking steroids (Bonds, Rodriguez, Sosa, McGwire, Palmeiro, and Ramirez). The 3 that have NOT been implicated for steroid use include Griffey, Thome, and Pujols.
“I have never used steroids, Period.”
Major League Baseball (MLB) player Rafael Palmeiro testifying before Congress March 2005

Four months after Palmeiro testified before congress, in July 2005 Palmeiro tested positive for anabolic steroids (Winstrol). Under MLB new “get tough on steroid use” policy, Palmeiro was suspended 10 days (roughly 6% of the season). By way of comparison, a first positive drug test in Track & Field is a 2 year ban.
In 1992, at age 27, Major League Baseball (MLB) player Barry Bonds won his second NL MVP with the Pittsburgh Pirates, hitting .311 with 34 home runs & 103 RBIs, & a .6237 slugging percentage (total bases/total at bats), leading the Pirates to a NL division title. In 2001, at age 36, Bonds won his fourth NL MVP with the San Francisco Giants, hitting .328 with 137 RBI’s, & set several major league records, including an incredible .8634 slugging percentage & 73 home runs (all time home run record). His 5-year home run average both before & after 2001 was approx. 40, & the most home runs he hit in his 22 year major league career (excluding 2001) was 49!!
Barry Bonds Indicted of Perjury & Obstruction of Justice, but Charges were Dropped or Overturned in 2015

In 2007 Major League Baseball all time home run leader Barry Bonds was indicted for perjury (charges eventually dropped) and obstruction of justice (charges eventually overturned) based on his 2005 grand jury testimony that he never knowingly took anabolic steroids (he claims he “unknowingly” took the banned substance THG - he thought it was a flaxseed oil supplement). He retired in 2007 but because of the drug scandal, he has never been elected into Baseball’s Hall of Fame.
MLB Player Alex Rodriguez Admits to Taking Performance Enhancing Drugs (PED) Banned by MLB

After years of denial, Alex Rodriguez, the highest paid MLB player of all time (350 million dollars from 1994 to 2015) & #4 on the all time home run list (687 as of 2015) just behind Babe Ruth, admitted to ESPN in 2009 that he took unspecified PED’s from 2001-2003, & admitted to the Drug Enforcement Administration that he took PED’s (anabolic steroids & HGH) from 2010-2012. His 2009 admission came 48 hours after Sports Illustrated reported that Rodriguez tested positive for 2 anabolic steroids, and was on the “list” of 104 players (~7% of the 1400+ players tested) who tested positive for banned substances in 2003 (Sammy Sosa, #8 all time with 609 home runs, was also reportedly on the “list”), the year MLB conducted anonymous drug “survey” testing, and if >5% tested positive from the survey then random drug testing would begin in 2004 (and it did). In 2013 Rodriguez received a 162 game suspension (the entire 2014 season) for taking HGH & testosterone, & 12 other pro baseball players received a 50 suspension for doping. Sosa was already long retired in 2013.
MLB Doping Policy – Current

• Starting in 2006 all players tested at spring training physicals and once during season
• Additional random testing during season
• Testing involves urine & blood (HGH only)
• Penalties (can vary by circumstances) as of 2015:
  1st Positive – 80 game suspension without pay
  2nd Positive – 162 game suspension without pay (may also include entire post-season)
  3rd Positive – Lifetime ban

Note: The MLB drug policy continues to get stronger, especially when one considers the initial proposal made in 2003 was paid counseling for a 1st positive and a 15 game suspension for a 2nd positive.
NFL Doping Policy – Current

• Random drug testing year round.
• Every player in the league gets tested at least once a year through urine sampling, and blood tests for EPO started in 2007 & HGH started in 2011.
• Penalties (can vary by circumstances):
  1\textsuperscript{st} Positive – 4 game suspension without pay
  2\textsuperscript{nd} Positive – 10 game suspension without pay
  3\textsuperscript{rd} Positive – 2 year suspension without pay
Chinese Female Swimmers in the 1990’s

- In 1992 the # of female Chinese swimmers in the top 25 world rankings more than tripled from previous years.
- In 1994 the Chinese women won 12 of the 16 gold medals at the World Aquatics Championships with 5 world records.
- 1990-1998, 28 Chinese female swimmers tested positive for performance enhancing drugs (PED), which was ~half of the world total of drug offenders in swimming and nearly 3 times more than the second closest nation.
- In 1998 in Australia enough HGH was discovered in Chinese swimmer Yuan luggage to sustain the entire 23-person Chinese team for the 11-day upcoming World Swimming Championships in Perth, AUS, where 4 female Chinese swimmers had already tested positive for PED’s.
Reported Use & Abuse of Performance-Enhancing Substances in Professional & Olympic Level Athletes

• **Cycling**
  – In 2013 five time Tour De France Winner Lance Armstrong admitted to taking anabolic steroids, Human Growth Hormone (HGH), Erythropoietin (EPO), and numerous other performance enhancing drugs.
  – In 2006 Floyd Landis wins the Tour de France but in 2007 loses title and receives a 2 year suspension when he tests positive for elevated testosterone levels.
    • In 2010 he admits to having doped most of his career.
  – In 2010 Alberto Contador wins the Tour de France but in 2012 loses title and receives a 2 year suspension when he tests positive for clenbuterol.
  – Between 1998 and 2012, 1/3rd of the top 10 finishers at the Tour De France tested positive for or admitted to doping, and many in the sport believe that a lot more were involved but never caught.
So What Do Many of the Major Doping Scandals in Sport All Have in Common?

- Soviet Bloc and German Democratic Republic 1970-1980’s
- Ben Johnson 1988 Olympics
- Major League Baseball 1990-2003
- BALCO Consortium 2000’s
- hGH use in professional sports 2000’s
- Lance Armstrong and Cycling Doping
- Russian Track Scandal 2015

All Involved Physicians collaborating with Athletes!
“Rather fail with honor than succeed by fraud.”

Sophocles, Greek Dramatist (496-406, BC)
Dietary Supplements

USA spent $28 Billion on Supplements in 2010
Time Magazine
Dietary Supplements

• Products that can be sold as dietary supplements
  – A product (other than tobacco) intended to supplement the diet
  – Must be intended for ingestion
  – Cannot be advertised for use as a conventional food or as the sole item within a meal or diet
Dietary Supplements

- Products that can be sold as dietary supplements
  - Contain one or more of the following:
    - A vitamin
    - A mineral
    - An herb or other botanical
    - An amino acid
    - A dietary substance for use by humans to supplement the diet by increasing the total dietary intake
    - A concentrate, metabolite, constituent, extract, or combination of any of the above ingredients
Survey of Nutritional Supplements

- 64 Nutritional supplements analyzed
- 12.5% contained banned substances not declared on the label
- Found Androstenedione, nandrolone, 19-norandrostenedione, testosterone, DHEA, ephedrine
- Labeled as L-glutamine, Protein powders, L-carnitine, Amino acids, BCCA

Survey of Nutritional Supplements

• Since 2002 found increased anabolic steroids in supplements
• Classic anabolic steroids: Metandienone, stanozolol, boldenone, oxandrolone
• Designer anabolic steroids: Methasterone, THG, Norbolethone, Madol
• Beta 2 agonists like Clenbuterol
• Supplements such as Vitamin C, multivitamin and magnesium tablets
• Also, obvious labeled for muscle building

Analysis of Over-The-Counter Steroid Preparations

Green G, Catlin D, Starcevic B.
Clinical Journal of Sports Medicine

Conclusion: 11/12 supplements did not contain what was on the label!
Key Point

• The distinction between a drug and a dietary supplement is linked to FDA approval for safety and effectiveness.
Dietary Supplements

• Essential amino acids, branched-chain amino acids
  – EAA can augment muscle protein synthesis in healthy human subjects.
Role of leucine in muscle protein synthesis

- Stimulus
  - Induced via resistance training
- Activation of muscle-specific genes
  - Enhanced by leucine intake
- Increase in Akt/mTOR pathway/protein synthesis
  - Synergy between resistance exercise and leucine ingestion
- Hypertrophic response
Key Point

- The branched-chain amino acid leucine is a key regulator in stimulating muscle protein synthesis. Leucine directly activates the Akt/mTOR pathway in skeletal muscle, which is a key pathway in skeletal muscle protein synthesis.
Dietary Supplements

• Arginine
  – Claims often attributed to supplementation
    • Elevation in nitric oxide levels
    • Increase in muscle blood flow
    • Improvement in exercise performance
  – Little scientific evidence supporting benefit for athletes or physically active individuals
Dietary Supplements

• Beta-hydroxy-beta-methylbutyrate (HMB)
  – HMB is a derivative of the essential amino acid Leucine.
  – Some research has shown that HMB has both anabolic and lipolytic effects, but research is limited.
  – Recent studies do not support HMB supplementation in resistance-trained athletes.
Key Point

• Beta-hydroxy-beta-methylbutyrate is most effective when an adequate training stimulus is provided. For untrained individuals, this does not likely require high-volume training. For trained individuals, a high-intensity, high-volume resistance training program is likely needed in order for benefits to be realized with HMB supplementation.
Dietary Supplements

• Nutritional muscle buffers (help regulate H⁺ concentration in muscle that accumulates from high intensity exercise)
  – Beta-alanine – limited benefits
  – Sodium bicarbonate – limited benefits, GI discomfort
  – Sodium citrate – benefits unclear

• L-carnitine
  – Studies examining L-carnitine’s role as an ergogenic aid for increasing lipid oxidation have not shown clear efficacy.
  – L-carnitine may enhance recovery from high intensity resistance exercise.
Dietary Supplements

• Creatine
  • One of today’s most popular ergogenic aid
  • Used by high school, college, professional & Olympic athletes
  • Creatine first introduced as an ergogenic aid in 1992 and used by strength and power athletes at a relatively high rate
  • Throughout the 90’s sports teams distributed Creatine to NCAA athletes for free and unlimited usage, but as of August 2000 the NCAA Division I Bylaw 16.5.2.g has placed creatine supplements on the “nonpermissible” list of nutritional supplements, meaning that universities are prohibited from providing creatine to student-athletes (BUT student-athletes are still allowed to use it on their own)
  • Recent NCAA Study reported 13.3% of college athletes use creatine
    • 2015 Study reports higher use (30-45%) among strength & power athletes (football, track & field) – Judge et al, JSCR, 2015)
Dietary Supplements

• Creatine
  – During brief explosive-type exercises, energy supplied to resynthesize ATP (basic form of energy used by cells) is determined by the amount of phosphocreatine stored in muscles
  – As phosphocreatine stores become depleted, performance is likely to deteriorate, due to inability to resynthesize ATP at rate required
  – Importance of creatine to exercise
    • The ability to rapidly rephosphorylate ADP back to ATP is dependent on the enzyme creatine kinase and the availability of creatine phosphate (CP) within the muscle.
  – Creatine supplementation
    • Increases the creatine content of muscles by approximately 20%, but there is a saturation limit.
  – Ergogenic benefits
    • Since 1992 studies have consistently shown significant ergogenic benefits.
Dietary Supplements

• Creatine is purported to:
  – Increase muscle strength
  – Produce greater and faster lean-tissue muscle gains
  – Increase energy during high intensity training
  – Improve sprint performance
  – Delay fatigue
  – Aid in fat loss

• Creatine loading may improve high intensity exercise performance in a variety of sports: (e.g., football, sprint and field events in track & field, weight lifting, sprints in cycling & swimming)
Key Point

- Creatine supplementation has been shown to increase maximal strength, power, and lean body mass in both trained and untrained populations. Additionally, creatine supplementation is safe and relatively inexpensive.
Dietary Supplements

• Creatine
  – Body mass changes
    • Prolonged creatine supplementation has been generally associated with increases in body weight, especially increases in fat-free mass but may also include water retention.
      – 2-5 pound Increases in 1-2 weeks often reported
  – Adverse effects
    • Controlled studies have been unable to document any significant side effects from creatine supplementation.
    • Concerns include gastrointestinal disturbances and strain on the kidneys
Dietary Supplements

• Creatine Monohydrate Usage
  – Initial loading phase: 5 g four times per day (20 g/day total) for 5 consecutive days
  – Maintenance phase: approximately 5 g/day
  – Most athletes ingest 2-10 g/day
  – Research shows it may most effective (and safe) to cycle creatine (e.g., 3 months on creatine, 1 month off creatine)
Key Point

• Despite certain media and anecdotal reports linking creatine supplementation to dehydration, cramping, and muscle strains, there is no reason to believe that creatine enhances the risk for these side effects.
Dietary Supplements

• Caffeine
  – Efficacy
    • Caffeine is a direct CNS stimulate that has several performance enhancement traits, such as reduced fatigue, arousal, increased confidence, euphoria, increased strength (increased intramuscular Ca++), increased time to exhaustion, and glycogen sparing through increased fatty acid mobilization and utilization (desirable by endurance athletes).
    • Ergogenic dose believed to be at a concentration of 250-350 mg (2-3 cups of fresh brewed coffee).
    • The World Anti-Doping agency removed caffeine from the list of banned substances in sport in 2004.
Dietary Supplements

• Caffeine
  – Adverse effects
    • Diuretic effect and concomitant dehydration.
    • Anxiety
    • Gastrointestinal disturbances
    • Restlessness
    • Insomnia
    • Tremors
    • Heart arrhythmias
    • Increased risk for heat illness
    • Addiction
Dietary Supplements

• Preworkout energy drinks
  – Efficacy
    • Effective for increasing resistance training volume performance
    • Other types of anaerobic exercise (including Wingate tests and speed/agility performance) not as responsive to energy drink consumption
  – Adverse effects
    • Due to the presence of caffeine, the same potential adverse effects that exist for caffeine also exist for energy drinks.
Dietary Supplements

• Ephedrine
  – Efficacy
    • Effective only when taken in combination with caffeine
    • Improves aerobic endurance performance
    • Believed to help in weight loss
  – Adverse effects
    • Many adverse effects, including death (150 cited)
      – A medical examiner found that MLB Pitcher Steve Bechler’s use of ephedra as a weight-loss supplement contributed to his death
    • Banned by most sport governing bodies, including the International Olympic Committee
    • FDA banned Ephedrine supplements in 2003
Steve Bechler, 1979-2003
Dietary Supplements

• **Citrus aurantium**
  – Is thought to contribute to appetite suppression, increased metabolic rate, and lipolysis
  – When combined with caffeine and other herbal products, significant improvements in time to fatigue reported
  – On NCAA list of banned performance-enhancing drugs