

Update on Supplements and Ergogenic Aids

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Disclosures

- None



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Overview

- Define PEDs
- PED statistics/timeline
- WADA regulations
- Individual PEDs
- Further Research



PEDs – 1995 Survey

- Poll of 198 Olympic-level power athletes
- Offered banned substance with 2 guarantees:
 - You will not be caught
 - You will win
- **195** answered they would take the substance
- Then proposed the same substance would lead to victory in every competition for the next five years but then would kill you
- **More than half** reported they would still use the substance



PEDs in Family Medicine

- Supplements and ergogenic aids are widely publicized
- Utilized by competitive athletes as well as recreational athletes and non-athletes
- AAS associated with dependence on other illicit substances
- Must be able to answer questions
 - Efficacy
 - Potential side effects
 - Legality



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PEDs - Definitions

- Pharmacologic agents that athletes and non-athletes use to enhance performance
- “Doping” refers to the use of PEDs in competitive sports
- “Stacking” refers to the use of multiple different PEDs (commonly AAS and hGH)
- “Pyramiding” refers to increasing and decreasing PED concentrations in cycles



PEDs - Statistics

- At least 3 million PED users in U.S. alone
- 2-3x more common in males than females
- PED use in high school athletes varies from 10-23%
- 56% of AAS users reported they have never disclosed AAS use to physician

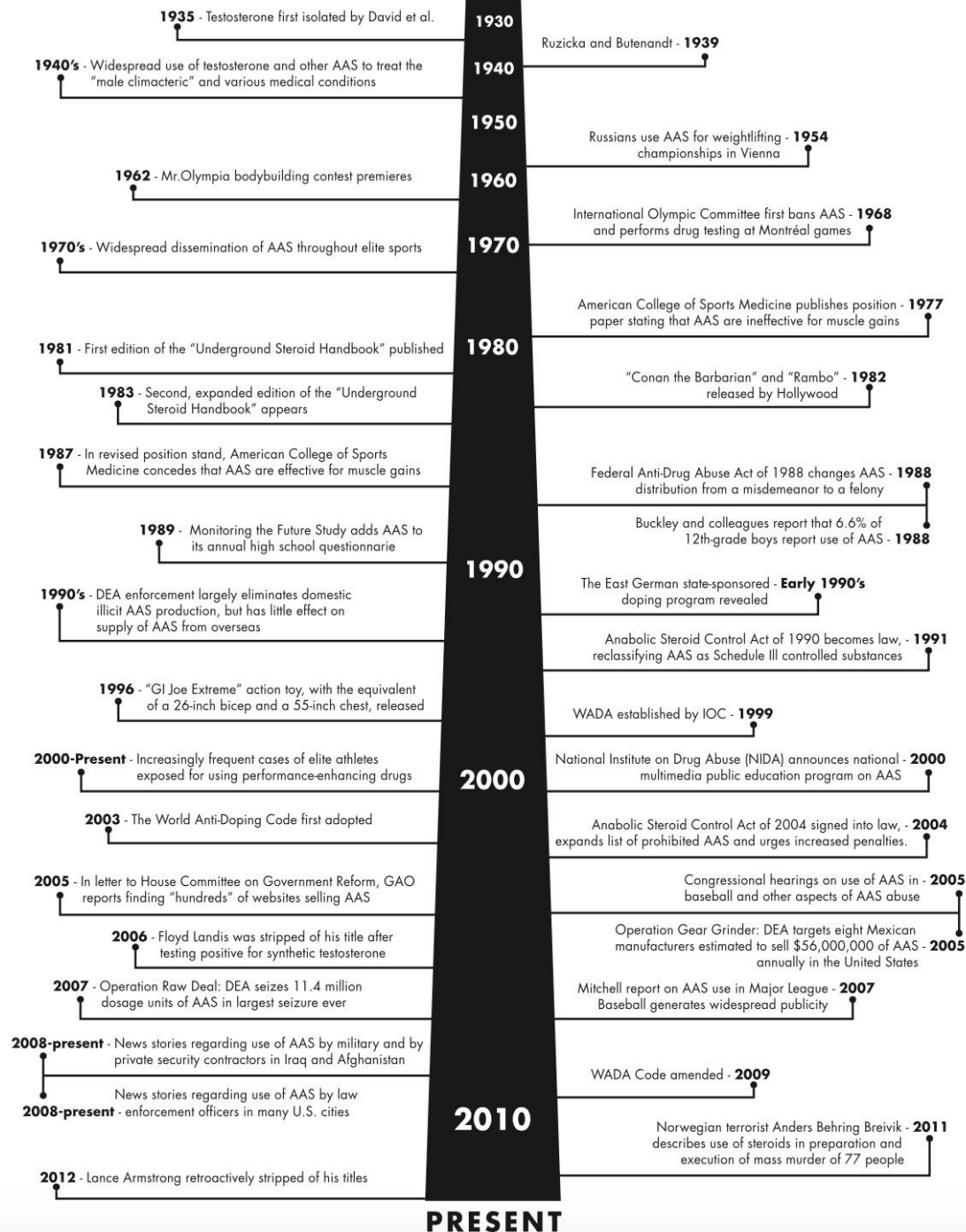


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PEDs - Timeline

- 1975 – IOC prohibited AAS
- 1980s-1990s – Widespread illicit PED use in general population
- 1990 – U.S. Congress designated AAS as schedule III controlled substance
- 1990s – Various androgen precursors available
- 1999 – WADA founded
- 2004 – Anabolic Steroid Control Act amended





World Anti-Doping Agency

- Foundation initiated by the IOC in 1999
- Goal is to promote, coordinate, and monitor the fight against drugs in sports
- Aims to harmonize anti-doping regulations in all sports and countries
- Updates the “Prohibited List” annually
- Current 2017 list available on website
 - <https://www.wada-ama.org/en/what-we-do/the-prohibited-list>



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Therapeutic Use Exemption

Box 1

WADA TUE conditions

- The prohibited substance or method is needed to treat a medical condition and withholding such treatment would result in a significant impairment to the athlete's health
- The therapeutic use of the substance or method is highly unlikely to enhance performance beyond returning the athlete to a normal state of health
- That there is no reasonable, permitted alternative must be clinically justified
- The need to use the substance or method is not a consequence of prior doping

Adapted from WADA. World Anti-Doping Program. Therapeutic use exemption guidelines. Montreal: World Anti-Doping Agency; 2012.



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PEDs

- Anabolic Steroids
- Steroid Precursors
- Growth Hormone
- EPO
- Stimulants
- HMB
- Creatine
- Protein



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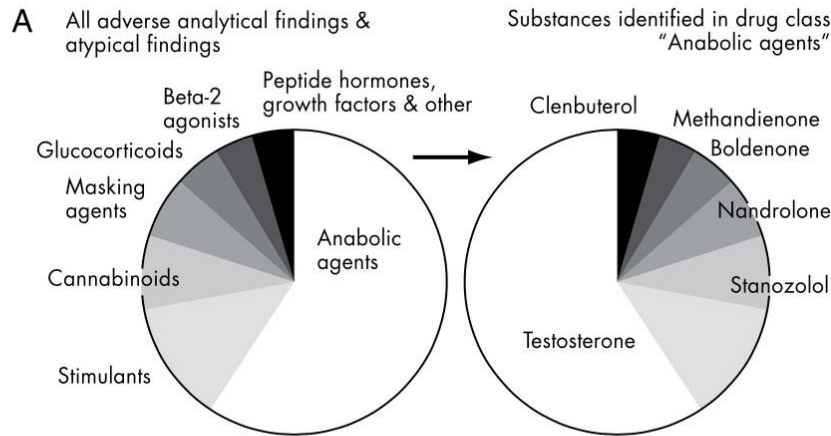
Anabolic-Androgenic Steroids (AAS)

- Chemically modified analogs of testosterone, the endogenous hormone primarily responsible for muscle anabolism and male sexual characteristics
- Substances used include:
 - Exogenous testosterone
 - Synthetic androgens (danazol, nandrolone, stanozolol, tetrahydrogestrinone)
 - Androgen precursors (androstenedione, dehydroepiandrosterone)
 - Selective androgen receptor modulators

Anabolic-Androgenic Steroids (AAS)

- Leads to increase protein production, increased muscle fiber production, muscle hypertrophy, possible faster recovery times
 - Less data on precursors, mixed results
- Oral, **injectable**, and transdermal forms
- Often “stack” or “pyramid”
- Among non-athlete weightlifters, use of AAS represents higher proportion of overall PED use than all other PEDs combined





B

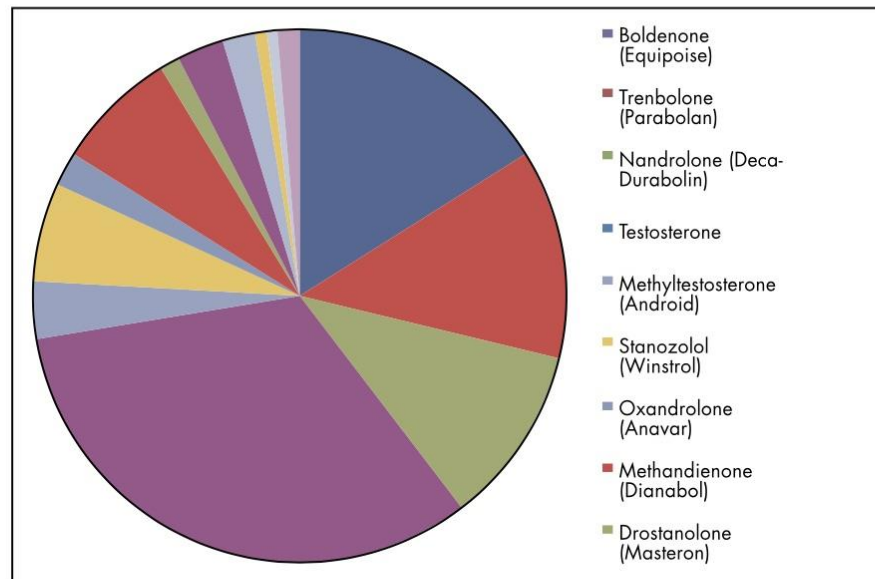


Figure 4. The types of PEDs used by competitive athletes based on the WADA's 2011 testing data (A) and by nonathlete weightlifters from a recently published study by Dr Pope (B). A, The types of PEDs used by competitive athletes based on WADA's 2011 testing data. B, The types of PEDs used by nonathlete weightlifters. Because WADA tests only athletes participating in certain competitive sports events, the data in A do not provide information about the frequency of use of various PEDs by nonathlete weightlifters. The distribution of AAS use by nonathlete weightlifters shown in B differs substantially from that among athletes tested by WADA in A. Although testosterone, stanozolol, and nandrolone were the AASs most frequently found in WADA's tests of athletes, testosterone, boldenone, trenbolone, and nandrolone were the AAS most frequently found in nonathlete weightlifters (19).

Anabolic-Androgenic Steroids (AAS)

- Studies reporting prevalence of side effects vary from 30-90%

Table 3
Adverse effects from anabolic androgenic steroid use

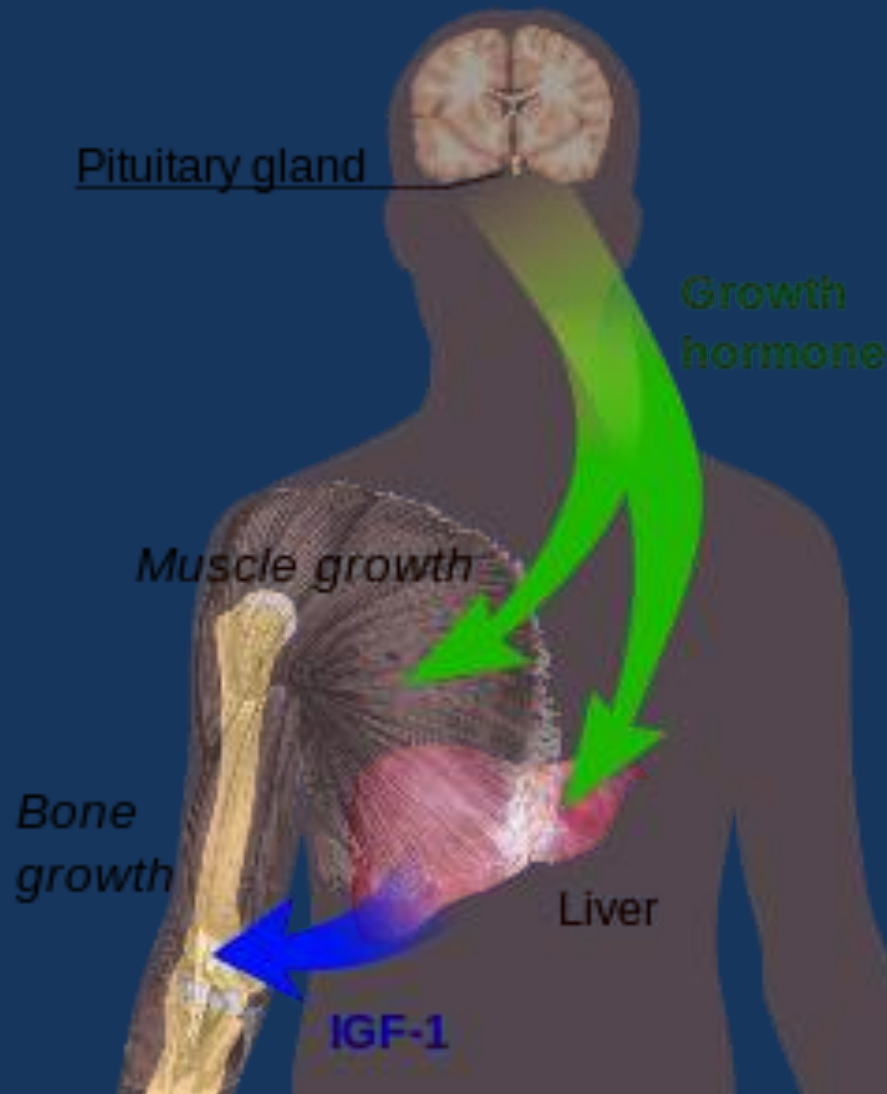
Self-Reported	Reproductive	Cardiovascular	Psychiatric	Hepatic
Acne	Testicular atrophy	Elevated blood pressure	Depression	Cholestasis
Increased body hair	Gynecomastia	Arrhythmia	Irritability and hostility	Impaired liver function
Male pattern baldness	Infertility	Atherogenesis, stroke, and pulmonary embolism	Muscle dysmorphism	Liver cancer
Fluid retention	Clitoromegaly	Cardiomyopathy	Insomnia	

Growth Hormone

- Human growth hormone is secreted by anterior pituitary, stimulates IGF-1
- Cause net increase in lipolysis and protein anabolism
- Often used in combination with AAS
- Available as injectable



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Growth Hormone

- Leads to muscle hypertrophy
- NO increase in muscle strength or performance benefit
- \$\$\$\$\$ - One month supply \$3,000-5,000

Table 4

Adverse effects of human growth hormone use

Soft tissue edema	Irreversible facial, jaw, and skull bone growth	Impaired glucose tolerance and diabetes mellitus
Fatigue	Coarsened facial features	Hyperlipidemia
Arthralgias	Carpal tunnel syndrome	Cardiomyopathy
Muscle weakness	Erectile dysfunction	Death

Erythropoietin (EPO)

- Hormone produced by kidneys that stimulates red blood cell production in bone marrow
- \uparrow hgb \rightarrow \uparrow O₂ in blood \rightarrow \uparrow VO₂ max
- Rationale behind athletes sleeping at high altitudes and training at low altitudes
 - \downarrow oxygen tension \rightarrow \uparrow RBC mass



Erythropoietin (EPO)

- Autologous blood doping
 - Remove 2u blood
 - Relative anemia stimulates RBC production
 - Blood thawed and re-infused 1 week before event
- Increases VO₂ max and endurance
- 2000 study showed 7% increase in hgb leads to 5% increase in VO₂ max, 34% increase in time to exhaustion



Erythropoietin (EPO)

- In 1987, first year of EPO release: 5 Dutch cyclists died of unexplained reasons
- Between 1997-2000, 18 cyclists died from stroke, MI, or PE
- Adverse Effects
 - Decreased training and exercise capacity prior to injection
 - Decreased cardiac output
 - Intravascular thrombosis
 - CVA and MI
 - PE
 - DVT
 - Phlebitis
 - Septicemia
 - Transfusion-associated lung injury
 - Multiple morbidities associated with mismatched blood types

Stimulants - Ephedrine

- Commonly abused in baseball
- Stimulant related to amphetamine
- Derived from herb ma huang
- Enhances release of NE, stimulates sympathetic response
- Improves reaction time, acceleration, alertness



Stimulants - Ephedrine

- Common side effects:
 - Restlessness, agitation, GI upset, headaches, rebound fatigue
- Serious adverse reactions:
 - Impaired heat tolerance, cardiac arrhythmias, MI, CVA, hypertension, dyskinesia, seizures, anxiety, hallucinations, tolerance leading to dependence and abuse



Stimulants - Caffeine

- Increase alertness by blocking adenosine receptors
- Increases exercise capacity
 - Delays fatigue by increasing use of fatty acids
 - Increases calcium translocation, increasing availability for muscle contraction
 - Stimulates adrenaline release
 - Alters CNS perception of fatigue



Stimulants - Caffeine

- For performance enhancement, most often used dose is 6mg/kg (420mg for 70kg adult) one hour prior to event

Table 7
Caffeine content in common foods, drinks, and over-the-counter drugs

Fixx Energy Drink	400 mg/16 oz.	Espresso	107 mg/16 oz.
Starbucks Breakfast Blend Coffee	327 mg/16 oz.	No Doz (Australia)	100 mg/1 Tab
Nos Energy Drink	260 mg/16 oz.	Mountain Dew	72 mg/16 oz.
Full Throttle Energy Drink	200 mg/16 oz.	Coca-Cola	62 mg/16 oz.
No Doz (USA) & Vivarin	200 mg/1 Tab	Dark chocolate	55 mg/2 oz. piece
Ammo Energy Shot	170 mg/1 oz.	Dr. Pepper	53 mg/16 oz.
Starbucks iced coffee	165 mg/16 oz.	Pepsi	48 mg/16 oz.
Brewed coffee	160 mg/16 oz.	Jolt Gum	33 mg/1 stick
Red Bull, Monster, Amp, Rock Star, and Jolt drinks	160 mg/16 oz.	PowerBar sports gel	25 mg/16 oz.
Instant coffee	120 mg/16 oz.	Tea	20–100/16 oz.
Frappuccino	114 mg/16 oz.		

Stimulants - Caffeine

- IOC – Not banned
- WADA – Not banned
- NCAA – Limit is 15 microgram/milliliter
 - Equivalent to 500mg



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Beta-hydroxy-beta-methylbutyrate (HMB)

- Metabolite of leucine
- Recently gained popularity as “anti-catabolic”
- Marketed to suppress protein breakdown in recovery phase after workout
- Exact mechanism unknown



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Beta-hydroxy-beta-methylbutyrate (HMB)

- One study looked at effect of HMB supplementation compared to placebo
 - 6 week trial
 - Measured CPK and LDH levels before/after exercise
 - HMB group led to lower levels of both
- Another large study looked at HMB use over 8 week period
 - Measured dozens of blood levels
 - No negative effects on blood chemistry



Beta-hydroxy-beta-methylbutyrate (HMB)

- Mixed results: some evidence HMB may suppress protein breakdown but little evidence that it translates to ergogenic advantage
- Safe!
- Not banned, available OTC



Creatine

- Naturally occurring non-protein amino acid compound
- Synthesized in liver and kidneys, almost 50% obtained from diet (red meat and seafood)
- Found primarily in skeletal muscle
- Converted to phosphocreatine, provides energy to muscle – specifically in maximal effort non-aerobic exercise



Creatine

- Loading phase: 5g - 4x/day for 5 days to fully saturate muscle stores
- After loading phase: performance of high intensity and/or repetitive exercise generally increased 10-20%
- Maintenance phase: 2g/day
- Anything extra is excreted by kidneys
 - Important to drink 6-8 glasses of water/day

Table 1 Potential ergogenic benefits of creatine supplementation

- Increased single and repetitive sprint performance
- Increased work performed during sets of maximal effort muscle contractions
- Increased muscle mass & strength adaptations during training
- Enhanced glycogen synthesis
- Increased anaerobic threshold
- Possible enhancement of aerobic capacity via greater shuttling of ATP from mitochondria
- Increased work capacity
- Enhanced recovery
- Greater training tolerance



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Creatine

- Not banned by any sports or anti-doping organization
- No study has reported any adverse effect of short- or long-term creatine supplementation
- International Society of Sports Nutrition concluded that “creatine is the **most effective** ergogenic nutritional supplement currently available to athletes in terms of increasing high-intensity exercise capacity and lean body mass during training”



Protein

- Contain essential and non-essential amino acids
 - Essential are those our bodies cannot make
- Average individual: 10-35% of daily calories, or 0.8g/kg
- When to ingest protein?
 - 2007 study by Tipton compared pre- to post-workout, no difference in muscle protein uptake
 - 2001 study by Esmarck compared immediate post-workout to 2hr post-workout, increase muscle mass with immediate ingestion

Protein

- General consensus:
 - Whey enhances protein synthesis
 - Should be taken at meals/bedtime
 - Casein decreases protein degradation
 - Should be taken pre- and immediately post-workout
- 2017 BJSM systematic review and meta-analysis
 - Resistance exercise training ≥ 6 weeks
 - Dietary protein supplementation significantly enhances muscle hypertrophy and strength
 - Protein intake $> 1.7\text{g/kg/day}$ does not contribute to further gains



Limited Knowledge of Adverse Effects

- Majority of public attention focused on elite athletes and competitive advantages
- Researchers cannot ethically conduct controlled studies of long-term adverse effects in normal volunteers
- Widespread illicit PED use began in 1980s-90s, most are still under the age of 50-60
- PED users often do not trust physicians



Addressing the Problem

- Adolescents Training and Learning to Avoid Steroids (ATLAS)
- Classroom training sessions
- Ten 45-minute sessions
- Led by coach and “squad leaders”
- Studied 31 high school football teams (over 3,200 athletes)
 - Led to decreased intention to use and actual use of anabolic steroids

Summary

- PEDs are commonly used by both athletes and non-athletes
- Be aware of popular and new PEDs
- Ask about PED use and look for signs and symptoms
- Counsel patients, especially at-risk populations



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Questions?

