Performance-Enhancing Substances

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WHAT ABOUT YOUR PRACTICE? (ROUND NUMBERS FOR EASY MATH)

- Primary care pediatric panel size: 2,000
  - Adolescents ~20%
    - 400 adolescents

- Numbers of patients who have used:
  - Protein supplements: 110
  - Creatine: 65
  - Anabolic steroid: 25

EAT 2010, University of Minnesota; Monitoring the Future 2013, University of Michigan; and Partnership Attitude Tracking Study 2013, Partnership for Drug-Free Kids.
OVERVIEW

- Definitions
- Epidemiology
  - Risk factors
- Substances in most common use
- Prevention/treatment
- Resources
TERMINOLOGY

- **Performance-enhancing substances (PES)**
  - Includes supplements and drugs
  - Used for enhancement of
    - Athletic performance
      - “Traditional” use of PES
    - Cognitive performance
      - More recent
UPDated Terminology

- Appearance- and performance-enhancing substances (APES) or appearance- and performance-enhancing drugs (APEDS)
  - Recognition that many of these substances are used in efforts to improve appearance
    - Weight loss
    - Increased muscul arity
Sports nutrition market will reach $37.7 billion in 2019
Sept 23, 2014  Nasdaq newswire

Analysts forecast the Global Sports Nutrition market to grow at a CAGR of 8.10% in terms of revenue over the period 2014–2019
January 15, 2015  MarketWatch

Study looks at criminal element of performance-enhancing drug market among bodybuilders
September 7, 2016  News-medical.net

ABA removes previous energy drink marketing restrictions.
Reaches into adolescent sports market
“Buzz Kill” executive summary 2014: Senators Rockefeller, Durbin and Markey
PERFORMANCE ENHANCEMENT
WHO USES THIS STUFF?

- Higher rate in athletes than in non-athletes
  - Odds ratio: 1.5

- Body dissatisfaction
  - Body dysmorphia
    - May have disordered eating component
  - Higher body mass index
WHO USES THIS STUFF?

- Exposure to appearance-focused fitness media
  - Not sport-reporting media
- Training in commercial gym
  - “Gateway hypothesis”
PATTERNS OF USE

- By sex: Boys with much higher rates of use of strength and muscularity supplements
  - Girls with much higher rates of nonprescription diet pills
- By race/ethnicity: Several studies with increased rates of anabolic use in certain Asian and Hispanic populations
- By sexual orientation: Gay and bisexual adolescent boys with 6x higher rates of anabolic steroid use than heterosexual boys

SUBSTANCES OF INTEREST

- Protein supplements
  - “Weight gainers”
  - Amino acids
- Creatine
- Stimulants
  - Caffeine
  - Other
- Anabolic steroids and prohormones
- Human growth hormone
- Other
DSHEA & CO.

- Dietary Supplement Health and Education Act
  - 1994
    - Defined “supplement”
    - Restricted FDA oversight

- Anabolic Steroid Control Acts
  - 1990
  - 2004
  - 2014
Dietary Supplement Health and Education Act of 1994
Public Law 103-417
103rd Congress

“The term “dietary supplement” means a product (other than tobacco) intended to supplement the diet that bears or contains one or more of the following dietary ingredients: a vitamin; a mineral; an herb or other botanical; an amino acid; a dietary substance for use by man to supplement the diet by increasing the total dietary intake; or a concentrate, metabolite, constituent, extract, or combination of any ingredient described above.”
The New York Times

- Analyzed content of popular herbal supplements at
  - Walmart
  - GNC
  - Target
  - Walgreens

- Overall, 80% of products do not contain any of the listed herb
  - Unlisted fillers are almost universal
NEW YORK INVESTIGATION

- These practices are not isolated to these retailers
  - Findings consistent with:
    - Prior investigations
    - "Inadvertently positive" drug tests
    - Prior medical sequela of tainted product
  - Indicative of industry-wide problem

**WARNING!**

**BUYER BEWARE**
DSHEA & CO.

- Dietary Supplement Health and Education Act
  - 1994
    - Defined “supplement”
    - Restricted FDA oversight

- Anabolic Steroid Control Acts
  - 1990
  - 2004
  - 2014
DRUGS

- Anabolic steroids/prohormones
  - Schedule 3

- Most stimulants/attention-deficit/hyperactivity disorder (ADHD) medications
  - Schedule 2

- Many adolescents are not aware of the legal consequences of non-prescribed possession and use of these agents
PES EVOLUTION

- Typical cycle
  - Claims of performance enhancement
  - Initial studies demonstrate significant benefit
    - Usually small, less scientifically rigorous
  - Marketing is based upon these initial studies
  - Subsequent studies fail to support earlier claims

- Very difficult to stay current
  - Important to remember: The basics don’t change.
PROTEIN
PROTEIN SUPPLEMENTATION

- Most recent survey on supplement use rates in adolescents
  - Data abstracted from the EAT 2010 study
    - Almost 2,800 middle and high school students
    - Survey/anthropometric measurements
    - Minneapolis/St. Paul metropolitan area

How often have you done each of the following things in order to increase your muscle size or tone during the past year?

- Changed my eating
- Exercised more
- Used protein powder or shakes
- Used steroids
- Used other muscle-building substance (such as creatine, amino acids, hydroxymethylbutyrate [HMB], dehydroepiandrosterone [DHEA], or growth hormone)
MUSCLE ENHANCING BEHAVIOR

- Boys
  - Change diet: 69%
    - Sometimes/often: 43%
  - Exercise more: 90%
    - Sometimes/often: 80%

- Girls
  - Change diet: 62%
    - Sometimes/often: 43%
  - Exercise more: 80%
    - Sometimes/often: 63%

PROTEIN SUPPLEMENTATION

- Boys who report any use of protein supplements
  - Middle school: 29.7%
  - High school: 38.8%

PROTEIN SUPPLEMENTATION

- Girls who report any use of protein supplements
  - Middle school: 24.7%
  - High school: 18.2%

PROTEIN SUPPLEMENTATION

- Percent who report any use of protein supplements
  - Sports teams
    - Boys: 39.6% athletes vs 25.5% non-athletes
    - Girls: 24.2% athletes vs 18.2% non-athletes

OTHER MUSCLE-ENHANCING SUBSTANCES

- Percent reporting any use in the past year:
  - “Steroids”
    - Boys: 5.8%
    - Girls: 4.4%
  - “Other”
    - Boys: 10.4%
    - Girls: 5.5%

WEIGHT GAINERS
WEIGHT GAIN SUPPLEMENTS

- Most are protein supplements with added
  - Carbohydrates
  - Fat
- Typically 600 to >1,000 kcal/serving
- Directions are often for several servings per day
  - After working out
  - Between meals
  - Meal replacement
WEIGHT GAIN PRINCIPLES

- Increased lean mass is the usual goal
  - Not so many are interested in gaining fat per se

- Top limit of lean mass gains:
  - ~1.5% body weight/week
    - 2 lbs in a 150 lb kid
HOW TO GAIN 2 POUNDS IN 1 WEEK**

- Increase calories by 550–700 kcal/day
- Adequate protein
- Appropriate intensity of strength training
  - Sets of 6–12 repetitions
  - 3–6 sets/exercise
  - 6–9 exercises total

**Only applies after pubertal onset.
FOOD vs WEIGHT GAINER

- Full fat chocolate milk
  - 420 kcal and 16 g protein/16 oz

- Carnation Instant Breakfast
  - 560 kcal and 26 g protein/16 oz

- Optimum Nutrition Serious Mass
  - Best selling weight gainer at Amazon and at Bodybuilding.com
  - 1,250 kcal and 50 g protein with 24 oz water
  - $2.90/serving (sale price)
AMINO ACID SUPPLEMENTATION

- Individual amino acids fall in and out of favor
  - Leucine stimulates muscle protein synthesis
    - Reason for popularity of whey protein
    - Metabolite hydroxymethylbutyrate (HMB) is believed to enhance repair of damaged tissue
      - Studies on adolescent volleyball players vs placebo
        » 11% vs 4% increase anaerobic power
AMINO ACID SUPPLEMENTATION

- Individual amino acids fall in and out of favor
  - Arginine and citrulline reportedly increase nitric oxide production
- Potential toxicity of high doses of individual amino acids
- Imbalance of remaining amino acids
CREATINE
CREATINE

- Primarily male phenomenon
  - Female use rates ~10% that of males at each age
- Peak rates in 2001
  - Creatine use in 2000–2001
    - 8th grade males: 5%
    - 10th grade males: 15%
    - 12th grade males: 22%

Monitoring the Future Annual Survey, University of Michigan.
CREATINE

- 2013 Monitoring the Future date for creatine use in males during 2012–2013:
  - 8th grade: 3%
  - 10th grade: 11%
  - 12th grade: 18%
CREATINE

![Graph showing energy systems during exercise duration]

- **Immediate system (ATP-PCr)**
- **Long-term system (aerobic)**
- **Short-term system (glycolysis)**

Percent capacity of energy systems

- 100%
- Exercise duration: 10 s, 30 s, 2 min, 5 min
CREATINE

- Daily turnover creatine ~1–2 g/day

- Sources
  - Ingested from meat sources
    - 3.5 oz meat ~0.5 g creatine
      - Restaurant steaks ~8 oz
      - Hamburgers
        - Fast food ~3 oz
        - Chain restaurants ~6 oz
  - Endogenously synthesized from amino acids
CREATINE

- Muscles hold a finite amount of creatine
  - Carrying capacity

- Many meat-eating individuals are already “fully loaded”
  - May account for “responders” vs “non-responders”
  - Vegetarians tend to have lower creatine levels
CREATINE: PERFORMANCE EFFECTS

- Many studies with small, limited performance benefit
  - Only in short-duration, high-intensity efforts
  - Resistance training
    - Usual gains with creatine: 3–5%
    - Far less than the 30% gains in youth resistance training program of 8–20 weeks

CREATINE

- Most common side effect is 2–3 lb weight gain
  - Water
    - Enhances athlete’s perception of effect

- Polypharmacy, particularly in younger users
  - Creatine users who also use prohormones or anabolic steroids
    - 8th grade: >30%
    - 12th grade: >6%
CREATINE

- Nephrotoxic metabolites
  - Avoid in athletes at risk for kidney dysfunction
  - Appears not an issue otherwise

- Other previous safety concerns not demonstrated by evidence
  - Important not to overstate risk

- Currently used in treatment for muscular dystrophies and metabolic myopathies
CREATINE

- Most commonly sold as creatine monohydrate
- Described dosing regimens
  
  **Loading phase:** 20 g/day for 4–5 days
  
  **Maintenance:** 3–5 g/day
  
  OR

  Just start with 3–5 g/day

- **Cost:** 15–50¢/5 g dose
STIMULANTS
CAFFEINE

- 73% of children consume caffeine on any given day

<table>
<thead>
<tr>
<th>Caffeine amount in mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median daily intake 12–19 yo</td>
</tr>
<tr>
<td>12 oz cola drink</td>
</tr>
<tr>
<td>8 oz brewed coffee</td>
</tr>
<tr>
<td>8 oz Red Bull</td>
</tr>
<tr>
<td>5 hour energy shot</td>
</tr>
</tbody>
</table>

CAFFEINE

- Used in attempts for athletic and academic performance enhancement
  - Primarily due to direct central nervous system stimulation
    - Athletic performance-enhancement at 1–3 mg/kg
- Studies have shown improvements in strength and endurance, but results vary
  - Variability may be due to responders vs non-responders
    - Knee extensor strength increase 4%
      - Other muscle groups do not show improvement
STIMULANT DIVERSION

- Diversion of ADHD meds appears as the dominant source
  - 12th graders in 2013 Monitoring the Future question on non-prescribed use of amphetamines
    - Lifetime: 12%
    - Monthly: 4%
  - Overall, athletes are not at higher risk for use
    - But, there are some athlete groups with higher prevalence

EFFICACY OF NON-MEDICAL STIMULANT USE

- Negatively correlated with academic achievement
- Not associated with enhanced rates of sustained weight loss
  - Herbal stimulants often marketed in combination with other substances as “thermogenic aids”
CAFFEINE/OTHER STIMULANTS

- Safety/side effects
  - Tolerance
  - Withdrawal, especially headaches
  - PVCs/other arrhythmias/blood pressure increase
  - Sleep disturbance
  - Gastric irritation
  - Increased core temperature
    - Especially with exercise in hot climates
ANABOLIC AGENTS

- Anabolic steroids
  - Reported use rates in high school students: 7%
    - 2013 Partnership Attitude Tracking Survey

- Anabolic prohormones
  - Reported use rates in 8th/10th/12th graders: <2%
    - 2014 Monitoring the Future Survey
ANABOLIC AGENTS CAN BE SCARY BECAUSE

1. They can be dangerous.

2. The patients often know more than we do.
ANABOLIC STEROIDS

- Variety of oral and injectable forms
  - Testosterone and derivatives
- Often taken in fairly complex regimens
  - Stacks: Use of multiple substances
    - Optimize benefit, minimize side effects
  - Cycles: Usually 6–12 weeks duration
ANABOLIC STEROIDS

- Increases net protein synthesis
  - Increased transcription
  - Decreased catabolism

- Increased strength and lean muscle mass
  - VERY EFFECTIVE at building muscle mass
    - Even in sedentary individuals
ANABOLIC STEROID RISKS

- Physicians often focus on
  - Liver dysfunction
    - Cholestatic jaundice
    - Tumors
  - Lipid changes
    - Decreased HDL/increased LDL
  - Cardiomyopathy
  - Aggression/mood changes
  - Long-term effects on brain remodeling
    - Unique to adolescents
ANABOLIC STEROID RISKS

- Of greater concern to users
  - Acne
    - Especially severe on back
  - Gynecomastia
    - Irreversible
    - May be using estrogen blockers to prevent
  - Male pattern baldness
    - Irreversible
  - Premature physeal closure
    - Decreased final adult height
TREATMENT FOR ANABOLIC STEROID USE

- No established treatment protocol
  - Area of active investigation

- Abrupt discontinuation is dangerous
  - Severe depression/suicide risk

- For most, treatment should include:
  - Mental health
  - Endocrine
ANABOLIC PROHORMONES

- Androstenedione, dehydroepiandrosterone (DHEA), and related substances

- Purported to
  - Enhance testosterone concentration
  - Direct anabolic effects

- But, these effects have not been demonstrated

ANABOLIC PROHORMONES

- DHEA is still available as an over-the-counter supplement
- Remainder are now scheduled drugs
- Common contaminants in dietary supplements
  - Common cause of doping violations with testing
HUMAN GROWTH HORMONE (hGH)

- 2013 PATS survey with 11% high school students report prior use of hGH
  - Mostly single episode of use

- Most common forms are injectable recombinant hGH or insulin-like growth factor 1 (IGF-1)

- Goal is to replicate physiologic effects of hGH
  - Increased lean muscle mass
  - Decreased fat mass
  - Reviews do not support athletic performance benefit
HUMAN GROWTH HORMONE (hGH)

- Variety of risks: Insulin resistance, sodium retention/edema/benign intracranial hypertension
  - Certain risks are irreversible
    - Acromegaly
    - Gynecomastia
    - Growth arrest or other effects on linear growth?
SEVERAL OTHERS TO KNOW...
NITRIC OXIDE BOOSTERS

- Arginine, beet root juice, NOX-labelled supplements
  - Vasodilators
  - No performance benefit in trained athletes
    - Better “muscle pump”
BUFFERS

- Sodium bicarbonate, sodium citrate, carnosine, beta-alanine
  - Buffers metabolic acidosis of high-intensity activity
  - Studied in adolescent swimmers
    - ~3% benefit in 1–4 minutes of activity
BLOOD DOPING

- Goal is to increase oxygen delivery to working muscle

- Common techniques:
  - Erythropoietin
    - Recombinant
    - Synthetic
  - Auto-transfusion
    - Stored blood/red cells
BLOOD DOPING

- Common in some professional and elite sports
- No data in pediatric population
  - Use rates likely very low
    - Expense and logistics
- Major risk is thrombotic/embolic events
  - Increase cardiac afterload
APPROACH IN OFFICE
OPPORTUNITIES

- Preparticipation examination
  - Do you drink alcohol or use other drugs?
  - Have you ever taken anabolic steroids or used any other performance supplement?
  - Have you ever taken any supplements to help you gain or lose weight or improve your performance?

- Other questions on body dissatisfaction
OPPORTUNITIES

- Routine health maintenance examination
- Problem office visits
  - Musculoskeletal/sport-related injury
  - Other medical concerns
    - Anxiety/headaches
- Social opportunities
  - Coach’s pulpit
  - Sidelines
PRACTICE APPROACH

- Ask-tell-ask
  - Request permission to discuss
    - e.g. “Do you mind if I tell you...”
  - Share information
  - Inquire about impact
    - e.g. “What do you think about that?”
PES VS “OTHER” SUBSTANCE USE

- PES use is goal-directed
  - Different approach than for recreational drug use
- Potential benefit significantly outweighs dissuasive factors
- More effective to focus on lack of benefit
  - Rather than potential adverse consequences

DEVELOPMENTAL VIEWPOINT
PEAK HEIGHT VELOCITY (PHV)

- Correlates with increases in:
  - Total body balance
  - Limb movement speed
  - Trunk strength
  - Explosive strength
  - Cardiorespiratory endurance
  - Upper-body muscular endurance
  - Running speed
  - Agility
  - Anaerobic capacity

INDIVIDUALIZED ADVICE: BEFORE HEIGHT TAKEOFF

- Supplements and training won’t speed up the calendar

- Recognize frustration of “late bloomer”
  - Especially in boys
  - Particularly in combination with a relative age effect (RAE)
    - i.e. “young” for the age group
INDIVIDUALIZED ADVICE: BEFORE HEIGHT TAKEOFF

- Planting seeds for internal motivation
  - Enjoyment of physical movement
  - Encourage child-led deliberate play

- Quality of movement fundamentals
  - Focus on physical literacy
  - Integrated neuromuscular training

- Variety motor inputs/outputs
  - Sport sampling
INDIVIDUALIZED ADVICE: TAKEOFF TO PHV

- May experience “adolescent awkwardness” as proportions change
  - Skill development not linear

- Basic athletic “capacity” begins to develop more rapidly (i.e. strength, speed)
  - Supplements do not increase or accelerate this

- Good basic training principles optimizes future benefit
  - Rest/recovery
  - Nutrition
INDIVIDUALIZED ADVICE: PERI-PHV

- Clearer delineation of talent and potential
  - Maturation of physical attributes
  - Continued mental/emotional development

- Time of more rapid performance gains
  - Correlates with time of increased supplement use
  - Large improvements are expected and physiologic
    • Often mistakenly attributed to supplements
INDIVIDUALIZED ADVICE: LATE ADOLESCENCE

- Skills will continue to emerge
  - Game sense/strategy/emotional control
  - Technical development
  - Continued gains in strength/speed but slower rate of improvement
    - Adherence to fundamentals
    - Training/recovery balance
    - Nutrition
    - Lure of PES
THE “YES” MESSAGE

- Improved strength and muscle gains rely upon:
  - Good nutrition
  - Resistance training
    - Including high intensity
  - Adequate rest/recovery
    - Muscle growth occurs during this time
      - Especially 36–48 hours after a hard workout
    - Importance of sleep for athletic performance, as well as injury prevention, is increasingly recognized
KEY NUTRITION POINTS: CARBOHYDRATES

- Carbohydrates serve as:
  - Energy source
  - Protect muscle

- Carbo-rich meal several hours before working out

- Carbohydrate snack after workout
  - Enhances glycogen for next day’s workout
    - ASAP after working out
    - A little bit of protein may enhance muscle protection
KEY NUTRITION POINTS: PROTEIN

- Protein provides
  - Building blocks for muscle synthesis during recovery
- Needs typically met in varied meat-eating diet
  - Up to 1.7 g protein/kg body weight in athletic adolescent
    - 150 lb athlete may need up to ~115 g protein/day
      - Most meat contains ~25 g protein/3 oz serving
      - Milk contains ~1 g protein/fluid ounce
KEY NUTRITION POINTS: PROTEIN

- No benefit to more protein than body can utilize
- Timing of protein may be more important than previously thought
  - Intermittent ingestion of protein throughout the day
    - Particularly days following a hard workout
ADVICE FOR PARENTS

- Get involved and stay connected
  - Aware of pressures as athletes progress through different levels
  - Aware of social climate at school, on team, and at gym
  - Aware of media impact (websites, magazines)
  - Ask directly about use
  - Use news stories as starting point
ADVICE FOR PARENTS

- Become knowledgeable about PES
  - No shortcuts to peak performance
    - Share alternative options
  - Focus on health
  - Know warning signs of PES use

- Engage health care provider
  - May call ahead of time to request that issue is addressed at upcoming exam
  - Seek other outside help
RESOURCES
Use of Performance-Enhancing Substances

Michele LaBotz, MD, FAAP, Bernard A. Griesemer, MD, FAAP, COUNCIL ON SPORTS MEDICINE AND FITNESS

Released July 2016
pediatrics.aappublications.org/content/138/1/e20161300
Welcome

Welcome to the Council on Sports Medicine and Fitness (COSMF) website... the home for information on taking care of active young children and adolescents.

August 2016 Case Study

Now available to members.

Learn more about this

Patient Education

Articles and audio for patients and families regarding sports training and injury prevention.

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LATEST POLICY

Reducing Injury Risk From Body Checking in Boys’ Youth Ice Hockey
Free full text online
  - www.acsm.org
    - Public information link
      - Position stands

Nutrition/supplement/training overview
  - Information geared for adults
    - Appropriate for middle-late adolescents

- Series of articles in BJSM
- Very comprehensive
UNITED STATES ANTI-DOPING AGENCY (USADA)

- www.truesport.org
  - Resources link
    - Parents
Sports Supplements

In the competitive world of youth sports, particularly at the high school level, many teenaged athletes are looking for an edge that might help them cross the finish line a little sooner or hit the baseball a little harder. And that has led some of them to turn to dietary supplements whose manufacturers promise greater strength and endurance—but often deliver only potential health risks.

These so-called performance-enhancing pills, powders, bars, and drinks are widely available in drugstores, gyms, and health food stores. They also are sold at many gyms and are advertised in bodybuilding magazines. But because they are supplements, not drugs, the Food and Drug Administration does not require them to be tested for safety or effectiveness, nor are their claims as tightly regulated.
ONE OF THE FIRST THINGS ADULTS SHOULD DO IS REALIZE THERE IS A VERY REAL POSSIBILITY YOUR CHILD/STUDENT COULD BE USING APEDS (OR OTHER ILLEGAL DRUGS) AND COME TO GRIPS WITH HOW YOU ARE GOING TO DEAL WITH THIS. DENIAL AND WISHFUL THINKING CAN QUICKLY LEAD YOU DOWN THE PATH TO DESTRUCTION.

OUR GOAL IS TO PROVIDE EDUCATIONAL CONTENT THAT WILL HELP YOU MAKE INFORMED DECISIONS ON HOW TO TALK TO YOUR CHILD/STUDENT AND ENCOURAGE THEM TO FIND HEALTHY ALTERNATIVES.

HOW MANY HIGH SCHOOL STUDENTS USE ANABOLIC STEROIDS?

1993...1...1 in 45
TAKE HOME MESSAGES

- PES/APED use is common during adolescence
  - Not just in athletes
- Muscle-enhancing activity is very common
  - Diet/exercise/protein supplementation
- Most ergogenic aids without significant performance benefit in young athletes
  - Starting an appropriate nutrition/training regimen can result in up to 30% gains in 8–12 weeks
TAKE HOME MESSAGES

- Non-medical use of stimulants
  - Very common, especially into the college age group
  - Correlates negatively with academic performance
  - Not associated with successful weight loss

- Recognize developmental frustrations/limitations
TAKE HOME MESSAGES

- Inform on alternative methods for reaching goals
  - Nutrition/training
  - Sleep

- Recognize that this is an area of perpetual rapid change
  - Keeps coming back to basics
  - Refer families to appropriate resources for further information
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