CLINICAL REPORT Guidance for the Clinician in Rendering Pediatric Care

American Academy of Pediatrics

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Use of Performance-Enhancing Substances

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Performance-enhancing substances (PESs) are used commonly by children and adolescents in attempts to improve athletic performance. More recent data reveal that these same substances often are used for appearance-related reasons as well. PESs include both legal over-the-counter dietary supplements and illicit pharmacologic agents. This report reviews the current epidemiology of PES use in the pediatric population, as well as information on those PESs in most common use. Concerns regarding use of legal PESs include high rates of product contamination, correlation with future use of anabolic androgenic steroids, and adverse effects on the focus and experience of youth sports participation. The physical maturation and endogenous hormone production that occur in adolescence are associated with large improvements in strength and athletic performance. For most young athletes, PES use does not produce significant gains over those seen with the onset of puberty and adherence to an appropriate nutrition and training program.

INTRODUCTION

The American Academy of Pediatrics (AAP) has published position papers, a subject review, guidelines, and textbook chapters regarding the use of performance-enhancing substances (PESs) by children and adolescents.[1–3] This clinical report updates and consolidates information on this topic. For the purposes of this report, the term "performance-enhancing substances" will be used to describe the spectrum of dietary supplements, as well as legal and illegal drugs that often are used by athletes for the purpose of improving athletic performance.

Over the last 2 decades, the availability of PESs has increased with access to Internet suppliers, proliferation, and marketing of stimulant-containing beverages, and increasing use of topically applied anabolic androgenic steroids. Although the overall use of many PESs may have declined over the past 15 years, reviews of multiple studies have prompted concern that the onset of use may be occurring increasingly in the pediatric population.[4]

abstract

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EPIDEMIOLOGY OF PES USE IN THE PEDIATRIC POPULATION

Several national studies have been tracking adolescent use of PESs. Monitoring the Future (MTF) is an annual survey of 50 000 students in eighth, 10th, and 12th grade.[5] Figs 1, 2, 3, and 4 outline results and trends of PES use as noted in MTF. The Youth Risk Behavior Surveillance System (YRBSS) is a biennial survey that includes a representative cross-section of high school students in the United States. The 2013 YRBSS included surveys from more than 13 500 students and revealed prevalence rates for nonprescribed steroid use that were a bit higher than those in MTF, with 3.2% reporting lifetime use of anabolic androgenic steroids.[6] The reported number was higher in boys (4.0%) than in girls (2.2%) and indicated a significant decrease over the previous 12 years, from a high of 5.0% overall use in 2001.

The Partnership Attitude Tracking Study (PATS) is an annual survey of parents and high school students regarding behaviors and attitudes about drugs and substance abuse.[7] The 2013 PATS survey included responses from more than 3700 students. Steroid use increased slightly from 5% to 7% as compared with 2012. However, use of synthetic human growth hormone (hGH) almost doubled, from 5% to 11%, after being fairly stable from 2009–2012. The report stated that most of this increase included teenagers who reported a single episode of hGH use and that the number of teenagers who report having used hGH more often has remained consistent.

Several studies have demonstrated polypharmacy among users of PESs, with elevated rates of use of both recreational drugs and multiple PESs.[5,8,9] MTF has demonstrated a strong association between use of androstenedione, creatine, and anabolic androgenic steroids. Approximately 80% of androstenedione users and more than one-third of steroid users also use creatine. Between 2010 and 2012, approximately half of androstenedione users also were using anabolic androgenic steroids; however, this decreased to 15% in 2013. Younger creatine users are much more likely to be using multiple PESs than their older counterparts (Table 1).

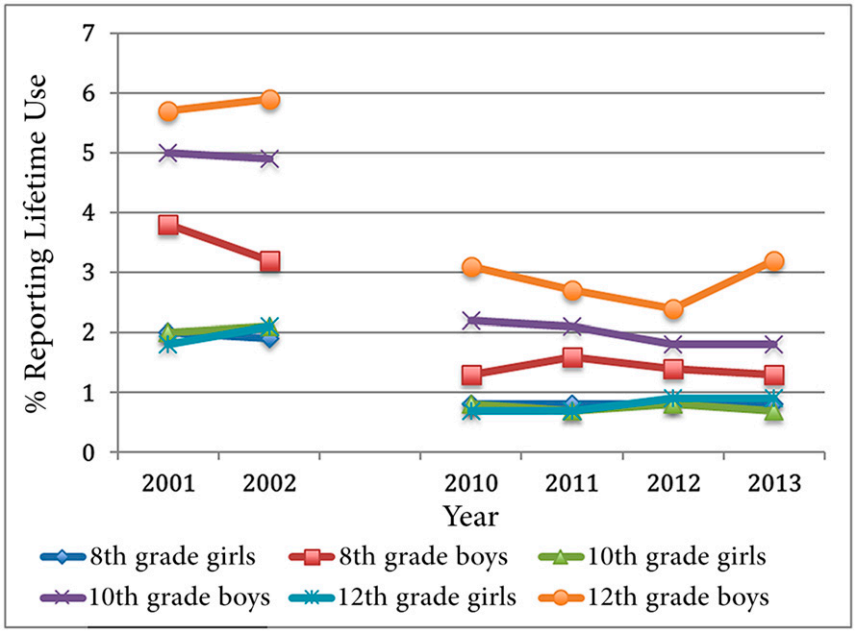

FIGURE 1
Percentage of eighth, 10th, and 12th graders reporting any lifetime use of anabolic androgenic steroids by year and sex (data from MTF, 2014).[5]

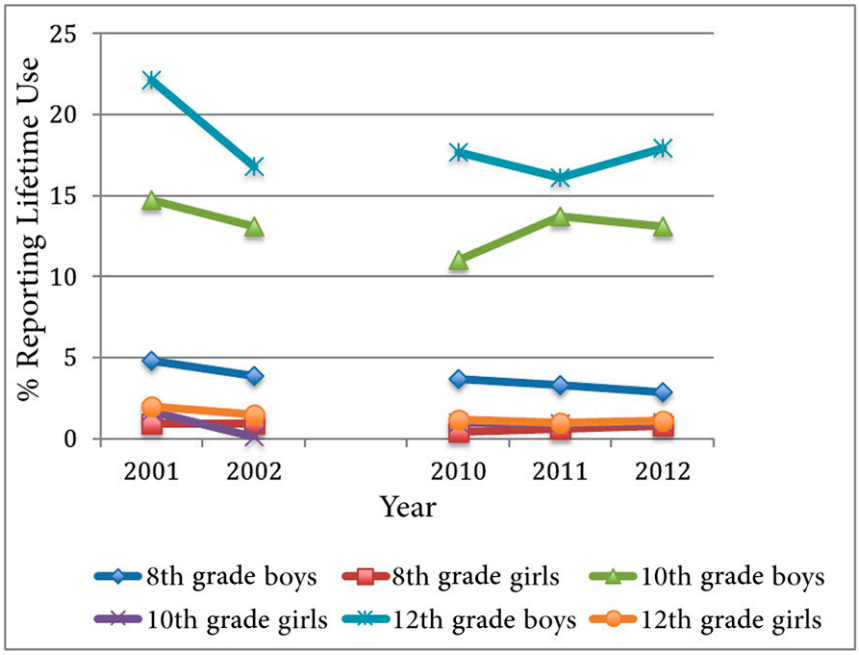

FIGURE 2
Percentage of eighth, 10th, and 12th graders reporting any lifetime use of creatine by year and sex (data from MTF, 2014).[5]

TABLE 1 Polypharmacy in PES Use[5]

Grade	Creatine Users Who Also Use Androstenedione, %	Creatine users Who Also Use Anabolic Androgenic Steroids, %
8th	29	14
10th	12	8
12th	6	6

For many adolescents, use of PESs is an attempt to enhance appearance rather than performance, and many users are not actively involved in organized athletic activity. Terms such as "performance- and image-enhancing substances" and "appearance- and performance-enhancing drugs" emphasize their broader appeal.[10–13] A Minnesota study evaluating various muscle-enhancing behaviors revealed that in an urban high school population, 38.8% of boys and 18.2% of girls reported a history of protein supplement use.[11] The same study revealed rates of use in middle school for boys and girls as 29.7% and 24.7%, respectively. Although students participating in team sports were more likely to use protein supplements (24.2%), it is worth noting that use of protein supplements still was fairly high in students who were not involved in sports (18.2%).[11]

Corroborating this higher use of PESs in an athletic population, a 2012 meta-analysis revealed higher rates of steroid use in athletes than in nonathletes (odds ratio, 1.5).[14] In addition to sports participation, other correlates of PES use include body dissatisfaction,[12] higher BMI,[11] training in a commercial gym,[15] and exposure to appearance-focused media.[13] The latter was particularly true for the genre of "fitness" media, which tends to have a large focus on muscle development, as opposed to the genre of more traditional sports-reporting media. Multiple studies have revealed correlations between PES use and alcohol and drug use, as well as other risk-taking behaviors.[15–17]

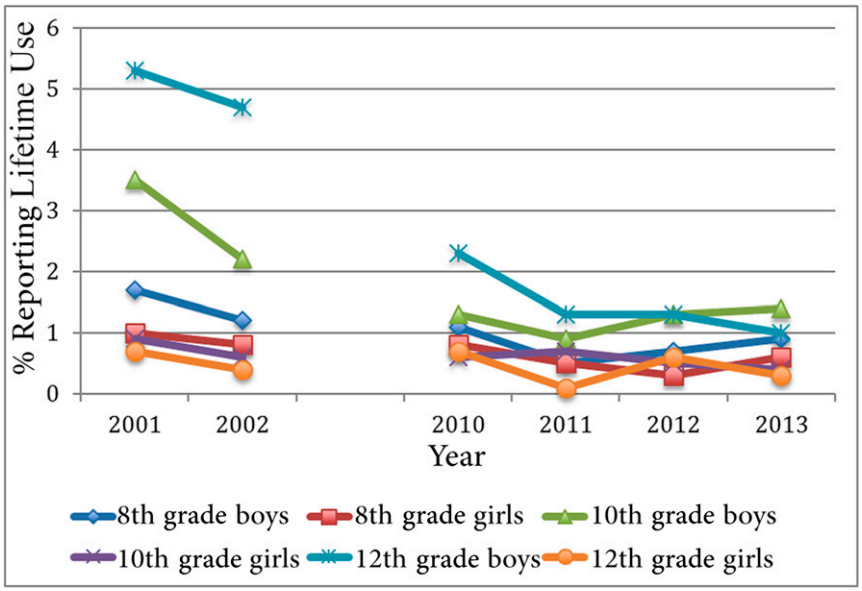

FIGURE 3
Percentage of eighth, 10th, and 12th graders reporting any lifetime use of androstenedione by year and sex (data from MTF, 2014).[5]

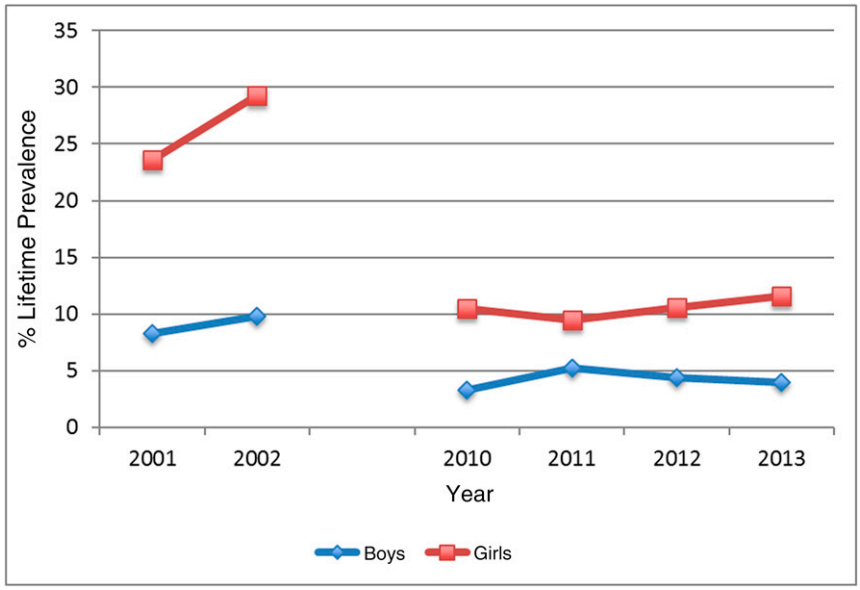

FIGURE 4
Percentage of eighth, 10th, and 12th graders reporting any lifetime use of nonprescription diet pills by sex (data from MTF, 2014).[5]

Different patterns of use have been identified between boy and girl PES users. Girls report much lower rates of using substances that are generally associated with gains in strength and muscle mass, such as creatine, androstenedione, and anabolic androgenic steroids, and these differences grow larger with age.[5] Conversely, girls report much higher rates of using nonprescription diet pills. Although this is consistent with traditional perceptions of male pursuit of muscularity and female pursuit of thinness, it is important to note that in 2013, 4% of boys reported use of diet pills in 2013, and 1% to 2% of 12th-grade girls

reported use of creatine and anabolic androgenic steroids.[5,6]

It is unclear how race and ethnicity may correlate with PES use. YRBSS data revealed higher rates of steroid use in 2013 among Hispanic students (4.2%) as compared with students who identified themselves as white (2.8%) or African American (2.3%).[6] These differences were not noted for 12th graders in the 2013 MTF data, in which steroid use rates within these groups were all just under 2.0%.[5] One study revealed increased rates of steroid use among Asian students (primarily Hmong) as compared with white students, with odds ratios of 3.51 and 3.37 for boys and girls, respectively.[11] The PATS revealed that hGH use was significantly higher in African American and Hispanic teenagers as compared with white teenagers, with use rates of 15%, 13%, and 9% respectively.[7]

REGULATION OF PESs

The most commonly used PESs in the adolescent population generally are sold over the counter as dietary supplements. The Dietary Supplement Health and Education Act of 1994 (Pub L No. 103-417) created supplements as a category not subject to US Food and Drug Administration (FDA) approval for safety or efficacy before coming to market. Supplements often are intermingled with foods, beverages, and over-the-counter medications on retail shelves, and it is difficult for the consumer to differentiate products with ingredients subject to strong FDA oversight from products that are subject to the looser controls, as allowed by the Dietary Supplement Health and Education Act.

Given the lack of manufacturing oversight, consumers of these goods risk using products that are contaminated or missing ingredients. Several studies that tested protein supplements revealed that 8% to 20% of these products were contaminated with significant amounts of heavy metals.[18] An analysis of supplements obtained from US retailers in 2007 revealed that 25% of these were contaminated with anabolic androgenic steroids, and 11% were contaminated with stimulants.[18] In 2015, the New York attorney general sent cease-and-desist letters to 4 national retailers after an investigation revealed that only 5 of 20 herbal supplement products tested consistently contained active ingredients as listed.[19]

Caffeine is unique in that it is ingested as a dietary supplement but also is contained in many foods that are common in the American diet. Although the FDA does regulate the amount of caffeine in foods (eg, soft drinks are allowed a maximum of 71 mg of caffeine/12 oz), the amount of caffeine in energy drinks and other dietary supplements is not regulated. Additional information on caffeine can be found in Fig 3, as well as the AAP clinical report "Sports Drinks and Energy Drinks for Children and Adolescents: Are They Appropriate?" which specifically states that energy drinks containing stimulants should never be consumed by children and adolescents.[20]

The Anabolic Steroid Control Acts of 1990 (Pub L No. 101-647) and 2004 (Pub L No. 108-358) classified anabolic androgenic steroids, as well as certain precursors that were previously marketed as supplements (such as androstenedione), as Schedule III drugs. The Designer Anabolic Steroid Control Act of 2014 (Pub L No. 113-260) further expanded the definition of "anabolic steroid" in part to address the expansion of synthetic prohormones that were developed after passage of the 2004 act. These prohormones are all now classified as Schedule III anabolic steroid drugs, and possession or use of any of these substances without a physician's prescription is prohibited by state and federal laws.

SUMMARY OF PES MECHANISMS AND EFFECTS

A vast number of substances are purported to have ergogenic (ie, performance-enhancing) effects. Claims of performance enhancement with different drugs and supplements are constantly evolving. Initial claims of significant performance enhancement are often made on the Internet as well as in body-building and fitness magazines. These claims most often are unsubstantiated or based on findings from single or poorly designed studies. As these substances undergo further scrutiny, it is common for these initial claims to be debunked, and the evidence often does not support earlier assertions of performance benefit. Although it is not possible to provide a fully comprehensive list of PESs, Table 2 provides an overview of substances that are most widely known and studied in the pediatric population.

Any potential ergogenic effects of PESs can be contrasted to the great improvements in strength and athletic performance often observed in child and adolescent athletes attributable to the combined effects of training and development. Typical strength gains of approximately 30% are reported in youth resistance training programs of 8 to 20 weeks' duration.[43] Supplements or nutritional interventions that are currently available and legal cannot rival this rate of gain. The best advice for performance-related concerns in young athletes is to focus on the basics of appropriate training and nutritional practices as outlined in Table 3. PESs are not "shortcuts" to higher levels of athletic performance, and they cannot compensate for athletes who do not adhere to the basic principles of good training and nutrition.

TABLE 2 Summary Table of PES Prevalence, Effects, and Safety Concerns in Children and Adolescents

Substance	Available Prevalence Data	Usual Form of Intake	Purported Mechanism of Performance Effect	Data on Performance Effects	Potential Adverse Effects
Creatine	See Fig 1	Creatine is found in meat and fish. Approximately 3–5 g/kg uncooked meat or fish. Cooking can degrade some creatine in food. Generally ~1 g/day found in omnivore diet. Orally ingested creatine monohydrate supplement.	Delays onset of muscle fatigue during high-intensity training by adenosine triphosphate production in high intensity activities that rely upon phosphocreatine shuttle.	Performance benefit in most studies is small and primarily seen in short-duration, maximum-intensity resistance training.[21] No benefit generally shown in aerobic activities or with "on-field" athletic performance.	Short-term use at usual doses appears safe in normal adults, but has not been evaluated specifically in the pediatric population. Potential concern with impact on kidneys because of nephrotic metabolites (methylamine and formaldehyde), and specific recommendation against use for athletes at risk for kidney dysfunction.[22] May impair performance in endurance activities.
Anabolic agents	See Fig 2	Variety of testosterone derivatives. Schedule III drugs. Oral, injectable, buccal, and transdermal forms. Multiple forms often taken in "stacks" in 6- to 12-wk cycles.	Enhances net protein synthesis by increasing transcription and decreasing catabolism.	Increased strength and lean muscle mass.	Possible long-term effects on brain remodeling with adolescent AAS exposure. Premature physeal closure with decreased final adult height. Acne. Gynecomastia (irreversible). Hair loss/male pattern baldness (irreversible). Hypogonadism. Dependence. Behavior change (hypomania, irritability, aggression). Cardiomyopathy. Increased low-density lipoproteins/decreased high-density lipoproteins. Cholestatic jaundice, liver tumors.
Prohormones	See Fig 2	Variety of substances often taken in combination (stacks) and in cyclical fashion. All except for dehydroepiandrosterone (DHEA) are now scheduled drugs as a result of the Anabolic Control Act of 2005 and Designer Anabolic Steroid Act of 2014.	Purported to enhance testosterone concentrations after ingestion as well as potential direct anabolic effects.	Androstenedione and DHEA: repeated dosages do not appear to increase blood testosterone concentrations or increase muscle size or strength.[23]	Suppression of endogenous testosterone production, otherwise potentially same for testosterone as listed above.[24] Supplements contaminated with prohormones are a common cause of doping violations in organized sports.[23]
Caffeine/other stimulants	73% of children consume caffeine on any given day.[25]	Caffeine is ubiquitous in a variety of food and beverages, as well as over-the-counter diet pills and "stay awake" medication.	Currently believed that performance benefit primarily due to central nervous system stimulation and enhanced muscle activation.	Most studies with caffeine have examined 3–6 mg/kg, but 1–3 mg/kg has been shown to have performance-enhancing effects, particularly in endurance activity.[26] This includes 4% improvements in strength of knee extensors (note: other muscle groups did not show strength improvements with caffeine); 14% in muscular endurance; and 10% to 20% improvements in time to exhaustion studies.	Tolerance. Cardiac arrhythmias (premature ventricular contractions) increased blood pressure. Headaches, irritability, sleep disruption, tremor. Gastric irritation. Increased core temperature with exertion, particularly in hot environments. Significant toxicity has been associated with ingestion of multiple energy drinks, leading to almost 1500 emergency department visits in 2011 in the 12- to 17-y age group.[27] Increased availability of pure powdered caffeine is of particular concern and is responsible for at least 2 deaths in young people (1 teaspoon of powdered caffeine is equivalent to 28 cups of coffee; FDA warning).
	Median intake of those 12–19 y who ingest caffeine: 40.6 mg.[28]	Amphetamines often are diverted from prescription use.			
	Nonmedical use of amphetamines in 12th grade: lifetime: 12.4%; monthly: 4.4%.[5] Overall, athletes not at greater risk for use, but boys in certain sports with higher rates: lacrosse, wrestling.[29]				

TABLE 2 Continued

Substance	Available Prevalence Data	Usual Form of Intake	Purported Mechanism of Performance Effect	Data on Performance Effects	Potential Adverse Effects
Protein supplements	Middle school girls: 25%. Middle school boys: 30%. High school girls: 18% High school boys: 39%.[11]	Variety of powders/bars/shakes.	Provides "building blocks" for muscle and lean tissue growth.	No performance benefit of protein supplement if diet provides adequate protein.	Contamination.
Amino acids and related compounds		Oral supplements. Individual amino acids or in combination. Diets with adequate amounts of complete proteins are replete with essential amino acids. Hydroxymethyl butyrate (HMB) is a leucine metabolite.	Arginine and citrulline produce increases in nitric oxide (see below for further discussion). β-alanine and carnosine buffer H+ accumulation (see buffer discussion below). HMB is believed to enhance repair of damaged muscle tissue.	HMB: Meta-analysis of studies on young adults reveal untrained athletes with 6.6% gains in strength, but only trivial strength impacts in trained athletes.[30] Study on elite adolescent volleyball players anaerobic power: HMB 11% improvement vs 4% with placebo.[32]	Ingestion of single amino acids may result in imbalance of others. Short-term ingestion of HMB appears safe at 6 g/day.[31]
hGH/insulinlike growth factor 1 (IGF-1)		Injectable recombinant hGH or IGF-1.	hGH acts primarily through IGF-1, resulting in increases in lean mass, decreases in fat mass.[33]	Most recent reviews do not support performance benefit.[33]	Elevated plasma glucose/insulin resistance, sodium retention and edema, myalgia/arthralgia, benign intracranial hypertension, acromegaly, cardiovascular disease, gynecomastia.[34]
Nitric oxide boosters (arginine, beetroot juice, citrulline)		Oral supplements and high nitrate-containing foods (beets most commonly studied, but also found in lettuce, spinach, radish, celery).	Nitric oxide is a potent vasodilator. Synthesized from arginine via reduction to nitrate. Citrulline is an arginine precursor.	Any potential benefit of arginine appears minimal in healthy young athletes who ingest sufficient protein.[24] Results are mixed regarding potential benefit of high nitrate-containing foods on athletic performance.[35,36] Study on junior rowers with 1.7% improvement in rowing time after repeat 500-m efforts.[37]	Supplementation with the amino acid arginine may create imbalance between other amino acids. Inorganic forms of nitrate are associated with carcinogenesis; however, current data do not support restriction of vegetable source of nitrates.[36]
Buffers		Sodium bicarbonate or sodium citrate. Carnosine and β-alanine.	Buffers the metabolic acidosis resulting from high-intensity physical activity. β-alanine is a precursor of carnosine.	Data are variable regarding endurance exercise.[38] Studies in adolescent swimmers with sodium bicarbonate reveal some swimmers with ~1-s improvement in 200-m efforts.[39] Meta-analysis β-alanine with 2.85% median improvement in exercise lasting longer than 60 s. No benefit to exercise of shorter duration.[40]	Sodium bicarbonate with significant gastric upset in ~10%. β-alanine with paresthesias at higher doses.[38]

TABLE 2 Continued

Substance	Available Prevalence Data	Usual Form of Intake	Purported Mechanism of Performance Effect	Data on Performance Effects	Potential Adverse Effects
Blood doping		Recombinant erythropoietin and synthetic analogs.	Increases oxygen delivery to exercising muscles.	Increases maximal oxygen consumption by 6%–12%.[41]	Hyperviscosity can lead to thrombogenic or embolic events. Increased cardiac afterload.[42]

CONCERNS REGARDING PES USE

The goals of the antidoping movement in sports are to protect the health of athletes and to prevent unfair competition, and use of PESs is identified in a survey of adults as the most serious issue facing sports today.[46] Potential health risks are outlined for individual substances in Table 2. In addition, the "gateway hypothesis" of adolescent substance abuse may apply with PES use. Although causation is difficult to prove, initial use of legal ergogenic supplements appears to reduce barriers to future nontherapeutic use of anabolic androgenic steroids by increasing social contacts with other users of PESs, as well as changing perceived social norms and attitudes regarding the safety and efficacy of illicit PES use.[10,47,48]

The moral implications of PES use contribute to concerns about cheating and unfair competition and may have adverse effects on the youth sports experience.[46] The top 5 issues of importance reported by children and adolescents regarding participation in sports are, in order: having fun, doing one's best, being with friends, improving skills, and being healthy. PES use shifts the focus of athletes from the pleasure and camaraderie of sports participation to that of gaining competitive advantage.

DRUG TESTING AND SCREENING

Home

Home drug tests are aggressively marketed on the Internet to parents with concerns about drug use. In a 2014 clinical report, the AAP stated it does not endorse home drug testing because of concerns about lack of efficacy, potential misinterpretation of test results, and the potential negative effect on the parent–child relationship.[49] The AAP recommends that parents' concerns about drug testing be addressed in cooperation with health care providers.

Office Based

Use of PESs often is clinically occult in the pediatric population, without reliable changes that can be detected on physical examination. *Bright Futures* contains information regarding office assessment, as well as patient and parent education and guidance when substance abuse is a concern.[50] Suggestions include screening for substance use as part of an age-appropriate comprehensive history and asking open-ended questions about substance use at home, at school, and by peers before progressing to questions about personal use.

The Preparticipation Physical Evaluation form developed by the AAP (https://www.aap.org/en-us/professional-resources/practice-support/Documents/Preparticipation-Physical-Exam-Form.pdf) contains several questions regarding use of PESs. Although sensitivity of these questions has not been studied, the questions provide an opportunity for further discussion and guidance and are as follows:

Do you drink alcohol or use other drugs?

Have you ever taken anabolic androgenic steroids or used any other performance supplement?

Have you ever taken any supplements to help you gain or lose weight or improve your performance?

The AAP does not endorse general drug use screening by pediatric health care providers but has published guidelines for drug testing in the pediatric office when there is clinical suspicion of use.[49]

High Schools

Testing in schools often is proposed not only to provide a mechanism for detecting drug use but also to serve as a deterrent. In 1995, the US Supreme Court ruled that random drug testing of student athletes does not violate the Fourth Amendment, and in 2002, the Court rendered a parallel opinion regarding students participating in other extracurricular activities.[51] Since then, schools in a number of states have initiated mandatory-random student drug testing; however, the efficacy of these programs in detecting and preventing drug use is unclear. The University Interscholastic League in Texas runs 1 of the largest high school drug testing programs in the United States. In 2013–2014, the University Interscholastic League conducted 2633 tests for anabolic androgenic steroids with 2 positive results, 7 protocol violations (ie, student did not show up for the test), and 10 inconclusive results.[52] Given the prevalence of information available on how to avoid positive anabolic-androgenic steroid (AAS) test results, it is impossible to know whether this low rate of positive results was a true reflection of reduced AAS use in this

TABLE 3 Training Principles to Enhance Athletic Performance

1. Understand that strength increases actually occur during the recovery periods after working out. Adequate recovery may require up to 48–72 h after a hard workout.
   a. Inadequate recovery will impede optimal performance gains.
   b. Low-intensity or cross-training sessions may enhance recovery in between higher-intensity workouts.
2. Training should vary in intensity, duration, and mode to enhance performance adaptations and minimize injury risk.
3. Resistance training can be an effective way to improve strength and power.
   a. The AAP policy statement on strength training in children and adolescents provides a comprehensive overview regarding safety and basic resistance training principles in the pediatric population.[44]
      i. Emphasis on appropriate supervision, technique, and equipment selection reviewed.
   b. Policy statement by the National Strength and Conditioning Association outlines more specific information on training for specific performance goals.[43]
      i. Training for strength: choose a weight that will allow completion of the following with good form and technique:
         1. Novice (<2–3 mo' experience): 10–15 repetitions for 1 set
         2. Intermediate (3–12 mo' experience): 8–12 repetitions for 1–2 sets
         3. Advanced (>12 mo' experience): 6–10 repetitions for 2–3 sets
   c. Greatest gains from a resistance training program will likely be noted after onset of peak height velocity
4. Nutrition.
   a. Adequate carbohydrates
      i. Before exercise to fuel workout and to avoid breakdown of muscle tissue
      ii. Strong evidence that carbohydrate ingestion during exercise sessions lasting longer than 1 h help athletes maintain intensity of effort; however, there is emerging evidence that small amounts of carbohydrates may be beneficial during shorter sessions as well.[45]
      iii. After exercise to build up intramuscular fuel for the next days' workouts
   b. Adequate hydration to maintain performance level throughout the workout
      i. Ensure adequate hydration before training sessions
      ii. Replenish fluid throughout period of exercise
         1. Unrestricted access to fluid during physical exertion
         2. Young athletes should be encouraged to drink to thirst
         3. Low-carbohydrate solutions (6%–8% carbohydrate) may be beneficial for training sessions longer than 30 min
            a. Sports drinks or nonacidic fruit juice diluted 1:1
         4. Assess fluid losses during exercise with pre- and postworkout weights
            a. Replenish 16–20 oz of fluid for every pound of weight lost
            b. Alter fluid replacement strategy to minimize losses in future workouts
            c. Protein after exercise and interspersed throughout the day to provide a ready pool of amino acids for muscle building throughout the recovery period
      i. Athletes consuming a balanced omnivorous diet usually with adequate protein intake
         1. Vegetarian and vegan diets often require additional planning
      ii. Protein requirements of adolescent athletes often range from 1.0 to 1.5 g protein/kg body weight/day
      iii. General rules of thumb for food protein content
         1. 8 g of protein contained in:
            a. 1 oz meat/poultry or 1/2 cup legumes or 1 cup milk/yogurt or 1 cup cooked pasta or 2 tablespoons of almond or peanut butter
            b. Examples of portion sizes:
               i. Cooked meat or poultry: 3 oz is size of computer mouse: ~25 g protein
               ii. 1 cup milk is about the size of a baseball: ~8 g protein
         2. Examples of food-based ways to add protein to diet:
            a. Nonfat dry milk contains 12 g protein per 1/2 cup and can be used to enrich soups/sauces/beverages
            b. Switch from traditional yogurt (7 g protein/6-oz serving) to Greek yogurt (17 g protein/6-oz serving) or cottage cheese (21 g protein/6-oz serving)
            c. Peanuts contain more protein than tree nuts with 26 g protein/100-g serving
               i. Almonds and pistachios with 21 g protein/100-g serving
               ii. Cashews with 18 g protein/100-g serving
               iii. Macadamias with 8 g protein/100-g serving

population or the result of successful efforts at evading detection.

Given the association of AAS use with other risk-taking behaviors, information concerning the effects of these programs on overall rates of drug use may be pertinent. The limited number of studies evaluating school-based drug testing reveal mixed results regarding deterrent effect on use of AAS and other illicit drugs, with 1 study documenting increased rates of risk factors for future drug use.[53,54] Because of concerns regarding poor sensitivity, use of limited school resources, and potential adverse effects on student attitudes and behaviors, the AAP does not endorse widespread implementation of school-based testing.[53]

College/Elite

Athletes who are participating at collegiate, elite, or national levels are subject to specific restrictions and possible testing for a variety of ergogenic aids. Therapeutic use of certain medications by the athlete (eg, many attention-deficit/hyperactivity disorder medications, β2-agonists, diuretics) may require physician

certification. Additional information for athletes and their health care providers is available as follows:

US Anti-Doping Agency (USADA) runs the antidoping program for the Olympic/Paralympic/Pan American movements. The Web site (http://www.usada.org) includes general educational information, as well as a link to the World Anti-Doping Agency prohibited drug list.

National Collegiate Athletic Administration (NCAA) maintains Web pages providing information on its banned drug list, testing, and medical exception procedures (http://www.ncaa.org/themes/topics/drug-testing).

National Center for Drug Free Sport administers drug-testing programs for the NCAA, as well as many professional leagues and state high school associations. The Web site (http://www.drugfreesport.com) includes additional testing information, as well as a subscription-based information center.

EDUCATION AND PREVENTION

General

Opinions of and information received from family members, school professionals, teammates, coaches, and health care providers all contribute to decision-making about PES use in the pediatric population. When adolescents are considering using PESs, the potential for benefit with PES use appears to outweigh dissuasive factors significantly.[55] Therefore, prevention efforts that are directed solely at avoidance of adverse consequences of PES use (ie, getting caught, cost) are likely to be less effective than efforts that focus on the lack of realized benefit for users of PES.

Educating athletes and families on basic training principles for pursuit of peak athletic performance may be helpful and should be emphasized as an alternative to PES use (Table 3). USADA provides a comprehensive handbook on this topic for parents, which can be accessed at http://www.truesport.org/library/documents/resources/nutrition_guide/NutritionGuide.pdf.

School/Sports Team

Information contained in the AAP clinical report "The Role of Schools in Combating Illicit Substance Abuse" also is pertinent regarding PES use; however, it does not explicitly address the issue of substances that are used in pursuit of ergogenic benefit.[56] The National Institute for Drug Abuse provides teaching materials that cover use of anabolic androgenic steroids and stimulants on its Web site (http://teens.drugabuse.gov/educators/nida-teaching-guides/mind-over-matter/teachers-guide).

Adolescents Training and Learning to Avoid Steroids and Athletes Targeting Healthy Exercise and Nutrition Alternatives are programs designed to address PES use in adolescent boys and girls, respectively.[57] These structured, sport-centered programs are led by peers with coach facilitation and are considered by the World Anti-Doping Agency as the most rigorously studied and effective way to educate adolescents about doping.[58] Both of these programs were developed at Oregon Health and Science University, and additional information can be found at http://www.ohsu.edu/xd/education/schools/school-of-medicine/departments/clinical-departments/medicine/divisions/hpsm/research/index.cfm.

The Taylor Hooton Foundation provides educational resources for schools and other groups. This includes school-based presentations, as well as educational infographics and posters that can be downloaded at no cost (www.http://taylorhooton.org/education-resources/downloads/).

Home

Many resources for parents of athletes include information on how to educate and prevent their athletes from using PESs. Publications from USADA cover a variety of issues pertinent to parents of athletes (http://www.truesport.org/library/documents/resources/parent/parent_handbook.pdf). Table 4 summarizes guidance for parents provided by the Partnership for Drug-Free Kids.

ADDITIONAL RESOURCES

For Health Care Professionals

Trends in PES use are subject to rapid change, with many substances having short-lived reputations as ergogenic aids. A combination of aggressive Internet marketing efforts and the lack of regulatory oversight can make it difficult to assess reliability of information sources on this topic. General information on a broad variety of specific substances is available in the *British Journal of Sports Medicine* series "A-Z of Nutritional Supplements: Dietary Supplements, Sports Nutrition Foods and Ergogenic Aids for Health and Performance (www.bjsm.bmj.com)."

For Parents and Athletes

The USADA Web site (http://www.usada.org/substances/) contains information on specific supplements and performance-enhancing drugs and information on how to assess ergogenic claims and make informed decisions regarding dietary supplement use.

SUMMARY

1. PES use is common in adolescence, and these substances are used in attempts to enhance both physical performance and appearance.
2. Throughout adolescence, use of all PESs tends to increase with age

and is higher in athletes than in nonathletes.

3. Boys are at higher risk than girls for most PES use. Other risk factors for PES use include body dissatisfaction, higher BMI, training in a commercial gym, exposure to appearance-oriented fitness media, use of alcohol or drugs, and other risk-taking behaviors.
4. PESs most commonly used by adolescents are protein supplements, creatine, and caffeine.
5. Many PESs are sold over the counter as dietary supplements. Athletes and parents often are unaware of the lack of FDA oversight of supplements and the risk of contamination with prohibited substances or absent active ingredients in these products.
6. Onset of endogenous hormone secretion during puberty, in combination with appropriate training techniques, is associated with large gains in strength and overall athletic performance. This is particularly true after the onset of peak height velocity. For most adolescent athletes, PES use will not produce significant improvements above those attained with adherence to appropriate nutrition and training fundamentals during this time.
7. It can be difficult to keep pace with the frequent reports of newly recognized PESs. Although the majority of initial reports of PES benefit are subsequently discredited after further study, it can be helpful for pediatric health care providers to steer patients and families to reputable Web-based resources for further evaluation of PES claims.
8. There is concern that initial use of over-the-counter PESs may be associated with increased risk of future anabolic steroid use and other risk-taking behaviors.

TABLE 4 Guidance for Parents With Concerns About PES Use[59]

1. Get involved
   a. Be aware of new pressures as athletes progress through different levels of participation and competition
   b. Emphasize the basics of hard work, pushing limits, teamwork, respect for competitors
   c. Give options for alternative ways to achieve peak performance
   d. Monitor any use of supplements or shakes
   e. Do not hesitate to ask directly about supplement use
   f. Provide a counterpoint for prodrug and prosupplement messages
   g. Become knowledgeable about PES
   h. Be persistent
2. Stay connected and create a strong partnership with your child's coach
   a. Get to know the team rules
   b. Keep coach informed of any pertinent issues that may be occurring in athlete's life
   c. Respect role of coach
   d. Talk to coach before or after practice, avoid sensitive discussions on game days
3. Keep lines of communication open with the athlete
   a. Emphasize the importance of good health
   b. Use the news as a starting point for discussions on PES use
   c. Emphasize that there are no shortcuts to peak performance
4. Engage health care providers if you are concerned about PES use
   a. Call provider before check-up and request that possibility of PES use addressed during examination
5. Know the warning signs of PES use
   a. Rapid changes in body shape
   b. Aggressive behavior or atypical mood swings
   c. Extreme hair growth or acne
   d. Excessive time in weight room
   e. Voice changes (especially for girls)
6. If you discover that your child is using PES
   a. Keep lines of communication open
   b. Seek outside help

Younger PES users appear to be at greater risk of polypharmacy.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
AAS: anabolic-androgenic steroid
FDA: US Food and Drug Administration
hGH: human growth hormone
MTF: Monitoring the Future
NCAA: National Collegiate Athletic Administration
PATS: Partnership Attitude Tracking Study
PES: performance-enhancing substance
USADA: US Anti-Doping Agency
YRBSS: Youth Risk Behavior Surveillance System

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