Considerations in the Care of Athletes With Attention Deficit Hyperactivity Disorder

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Abstract

Objectives: Uncover literature pertaining to: (1) attention deficit hyperactivity disorder (ADHD) and how it impacts athletes; (2) ADHD medication effects; (3) regulations regarding ADHD medications; (4) approaches to conditions similar to, and occurring with, ADHD; and (5) use of stimulants. **Data Sources:** MEDLINE, Embase, PsycINFO, Cochrane Database of Systematic Reviews, Ovid interface. **Main Results:** ADHD can have many effects on athletes and sports participation. Exercise has positive benefits on ADHD behaviors and players' attitudes. Athletes with ADHD can have worsened ADHD symptoms after concussions. Attention deficit hyperactivity disorder is a modifier of return to play; baseline ADHD symptoms should be used to guide management. Management should include medications, behavioral/psychosocial therapy, and academic accommodations. Behavioral therapy combined with medication is superior to behavioral treatment alone. Sustained exercise as ADHD treatment should be considered mainstay in management. Sports can increase thermogenic effects of stimulants, heat injury, and cardiac arrhythmias. Increased aggressiveness, improved pain tolerance, and decreased sense of fatigue are some attributes of stimulants that are presumed to impart some advantage to athletes, but evidence is uncertain. Attention deficit hyperactivity disorder medications may lead to myocardial infarctions, cerebrovascular accidents, paranoid psychoses, seizures, insomnia, tremors, anxiety, hypertension, and death. **Conclusions:** Athletes' performance and quality of life can be negatively affected by ADHD. Risks exist for those who take ADHD medications. More research is needed on the implications ADHD may have in specific sports, and on possible advantages of medication use. Potential deleterious effects of these medications should be addressed.

Key Words: ADHD, attention deficit, hyperactivity, stimulants, athlete, WADA

(*Clin J Sport Med* 2017;00:1–12)

INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is one of the most common neurobehavioral disorders. The National Survey of Children's Health in 2011 revealed that parents of 11% of children aged 4 to 17 years reported that their child had been diagnosed with ADHD, and males are diagnosed twice as often as females.[1] ADHD is characterized by symptoms in 2 domains: inattention and hyperactivity-impulsivity. Symptoms from these domains can be present together or individually. Inattention presents as persistent difficulties with sustained attention and organization, where hyperactivity-impulsivity is marked by excessive motor activity and decision making without forethought. In recognizing advances in the understanding of ADHD, the Diagnostic and Statistical Manual of Mental Disorders fifth ed (DSM-5)[2] made important changes to diagnostic criteria. The age at which symptoms must initially be observed was increased from 7 to 12 years, whereas the requirement that symptoms must have caused clinically significant impairment in functioning was also relaxed.[3] Table 1 shows the steps of how to diagnose ADHD. Table 2 lists the core symptoms of ADHD.The DSM-5 lists the symptoms required to make the diagnosis of ADHD in those older than 17 years.[2,4]

ADHD can cause impairment in academic achievement and social functioning. Untreated ADHD is also associated with oppositional behavior, substance use, and forms of anxiety and depression that often cause social disruption. The impact of ADHD on motor functioning is not well studied, but there is some evidence that children with ADHD have deficits in gross and fine motor functioning.[5]

Stimulant medications persist as the mainstay of treatment for ADHD. Medications have been shown to improve symptoms of inattention and hyperactivity. Children receiving behavioral therapy in combination with medications also show improvement in oppositional behavior and reading achievement.[6] Physical activity has shown promise as an additive intervention for improving cognitive and behavioral outcomes for children with ADHD.[5,7]

Concerns have been raised about a possible increased risk of adverse cardiovascular effects due to the use of stimulant

Submitted for publication December 23, 2016; accepted July 22, 2017.

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G. G. A. Pujalte has received payment for lectures from American Medical Seminars and travel grants from USA Taekwondo outside of the submitted work. W. C. Taylor serves as the medical advisor to the Women's Tennis Association (WTA), for which Mayo Clinic is paid under contract. The WTA pays W. C. Taylor's travel to 2 to 3 tournaments/yr. W. C. Taylor also owns stock in Gilead Sciences, Inc, Pfizer, and Illumina, Inc, outside of the submitted work, but he has not sold them or received any money from them. No funding was received in support of the submitted work. The remaining authors report no conflicts of interest.

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Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.cjsportmed.com).

http://dx.doi.org/10.1097/JSM.0000000000000508

TABLE 1. Steps to Diagnosing ADHD

Obtain detailed medical and developmental history.	Prenatal and perinatal exposures and complications
	Family history of ADHD
	Developmental milestones
	Temporal association of symptom onset with life events
	Obtain information about nutrition and sleep
	Personal and family history of cardiac illness
Rule out general medical condition and use of psychoactive substances.	Current use of prescription or over the counter medications
	History of concussion or other traumatic brain injury
	Complete physical examination including neurological examination
	Drug screen for recreational substances
	Other laboratory work as indicated
Assess core symptoms of ADHD (Table 2).	Age of onset, severity, and pervasiveness of symptoms
	Impact of symptoms on athletic and academic performance
	Obtain educational and behavioral data from athlete, parents, teachers, coaches, and report cards
	Obtain athlete, parent and teacher ADHD rating scales.
Assess for other mental health problems that can cause attention/behavior problems or coexist with ADHD.	Assess for performance anxiety in athletes—attention problems are generally present only in test situations
	Assess depression
	Assess for use of psychoactive substances
	Assess learning disabilities
	If learning disabilities are suspected or there are doubts about ADHD being primary diagnosis, consider psychometric testing.
Carefully consider medication seeking for performance improvement.	Assess for the presence of clear external incentive
	Monitor for variability of symptoms
	Maintain fidelity to structured diagnostic criteria
	Avoid making quick diagnosis of ADHD and prescribing stimulants too close to tests

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medications. Therapeutic dosages of stimulants have been shown to increase heart rate and blood pressure, and other adverse side effects include loss of appetite, insomnia, irritability, and headache. High dosages can cause psychosis and seizures.[8] The misuse of stimulants for cognitive enhancement and recreation has been found to be a common and growing problem among college students, including athletes.[8,9]

Although the direct impact of ADHD on athletic performance has not been well studied, sustaining a minimum academic performance is often required for student athletes to maintain eligibility for athletic participation. Moreover, behavioral

TABLE 2. Core Symptoms of ADHD

DSM-5[2] diagnosis of ADHD requires the presence of six or more symptoms of inattention or hyperactivity/impulsivity for children younger than 17 years and five or more symptoms of inattention or hyperactivity/impulsivity for children 17 years or older and adults. Symptoms should be present for more than 6 mo with onset before age 12 and be present in a variety of settings.

Inattention	Hyperactivity/Impulsivity
Difficulty attending to details or making careless mistakes	Excessive fidgeting
Difficulty sustaining attention to tasks	Difficulty remaining seated when required
Difficulty listening to directions even in direct conversation	Excessive and inappropriate running etc. or feeling of restlessness
Failure to follow direction	Difficulty engaging in quiet activities
Difficulty organizing	Being “on the go”
Reluctance and/or avoidance of tasks requiring sustained effort	Talking excessively
Losing things required for completing tasks	Difficulty waiting for his/her turn
Easily distracted by minor and irrelevant external or internal stimuli	Blurting out responses
Forgetful of daily activities	Interrupting others

problems associated with ADHD can also impact participation and performance. The positive and negative impacts of stimulant use and misuse in athletes continue to be controversial.

BACKGROUND

The primary purpose of this systematic review is to discover how ADHD impacts athletes and how ADHD symptoms are affected by sports and athletic activities. As with other domains of functioning, difficulties with sustained attention, organization, and conforming to structure during school sports participation can affect participation and performance. Even mild ADHD can have an impact on elite athletes due to a greater need for control both on and off the sporting arena. The medications used to treat ADHD are known to have potential side effects that may negatively affect the individuals taking them. Moreover, competitive athletes taking these medications may be perceived as having an unfair advantage due to the stimulant nature of the drug. Sports medicine physicians should routinely follow-up with affected athletes to assess appropriate use, effectiveness of treatment, and emergence of adverse effects. If the sports physician is the treating physician for the athlete's ADHD, they should follow-up with the athlete in a longitudinal manner with frequent contact. Abuse of stimulants for recreation and performance improvement is also a growing concern. Sports physicians need to know the current evidence regarding possible effects the medications may have on athletes during important phases in sports (ie, before or after practice, before or after games, etc). In this review, we will also evaluate the literature on which sports regulatory commissions base their decisions on prohibiting medications used to treat ADHD.

Misdiagnosis, delayed diagnosis, or improper management of care may also be harmful for athletes struggling with ADHD. Sports physicians should recognize when it is appropriate to enlist resources that can help athletes diagnosed with ADHD, such as, neuropsychologists, psychologists, and counselors. The medical care of these athletes will need to be balanced with consideration of their future scholastic or athletic careers; coaches, teachers, and athletic trainers will often rely on sports physicians to chart the management of their care in a holistic manner. There are other conditions that have characteristics, which may overlap with ADHD symptoms,[10] and this review is intended to present any approaches that may help sports physicians distinguish similar conditions and manage them when treating athletes diagnosed with ADHD. This review aims to provide evidence-based best practices for diagnosis and management of athletes with ADHD.

Sports physicians must also gain a better understanding of the use of stimulant medications among school-aged athletes with ADHD because these treatments have implications on grades and school performance.

METHODS

An experienced medical reference librarian developed and ran searches in the MEDLINE, Embase, PsycINFO, and Cochrane Database of Systematic Reviews (all through the Ovid interface). Search strategies were limited by excluding certain publication types and animal studies. There were no limits to language or publication date. Search terms included MeSH and Embase terms as well as keywords including sports, athletes, attention deficit, conduct disorder, and various pharmacologic or drug therapy terms. All searches were run on August 19, 2016. The full search strategies are available in **Supplemental Digital Content 1** (see **Appendix,** http://links.lww.com/JSM/A157).

RESULTS AND DISCUSSION

Overview of ADHD in Athletes

Athletics and physical activities in general play an integral role for the promotion of health and socialization throughout the lifespan. Participation in organized sports can be a challenge for children or adolescents with ADD/ADHD as they inherently lack the ability to focus on the task and to be attentive, patient, and organized. Anecdotally, however, some athletes report this impulsivity as an asset that may improve their quickness and ability to "trick" the opponent with their "unpredictability." This is most commonly reported by players in certain positions who are required to make quick decisions, such as point guards in basketball or quarterbacks in American football.[11] However, the vast majority of athletes, parents, and coaches concur that physical exercise and sports have positive benefits on ADHD behaviors, self-confidence, and the player's overall attitude.[12]

Population studies to define the true prevalence of ADHD in athletes have not been conducted; however, researchers may extrapolate that the rate mimics that of the general population.[13] Based on a small study of a boys' gymnastics team, where 5 of 7 (71%) parents reported a current or previous diagnosis of ADHD, it is possible that the prevalence of ADHD may be higher in athletes at the collegiate and professional levels.[14] One possible cause of the disproportionate number of ADHD in athletes may be due to the innate beneficial effect of exercise and positive reinforcement offered by team sports; children with ADHD may continue to participate in sports organizations longer than other children.[11,15]

As might be expected, children with predominance of hyperactive and impulsive behaviors are more likely to draw the attention of teachers and parents, and thus, are likely to be referred to clinicians earlier. However, some athletes may go undiagnosed until late adolescence or young adulthood.[11,13] One possible reason is that some exceptional athletes may be "pushed along" despite poor school performance to be recruited to competitive athletic programs. It is also theorized that parental influence and structure in the grade school years provide the student athlete with compensatory mechanisms for academic success. Often, when the student athlete enters college, this external support is lost, and the demands of independent learning exceed the compensatory strategies. This "loss of scaffolding" may expose an underlying issue of inattention, disorganization, and distractibility and lead to poor academic achievement.[11] Health care providers who treat athletes, especially in the collegiate setting, must be aware of the symptoms of ADHD to recognize, diagnose, and initiate treatment to improve their academic performance and overall quality of life. An accurate diagnosis is important to differentiate those who truly need treatment with stimulant medication from others who may be looking for opportunistic side effects of performance enhancement from a stimulant medication.[16,17]

Several studies have investigated how ADHD may influence motor coordination in children and adolescents. Some evidence indicates delayed motor coordination and movement

in those with ADHD.[5] In a study in Korea, Cho et al[18] found significant deficits in strength, agility, and coordination in a sample of children with ADHD (mean age of 9) compared with a sample of controls. It is also suggested that poor early development of motor coordination may impact social acceptance, sports participation, and overall well-being. Cho recommends early intervention if motor dysfunction is recognized. Although abundant evidence exists on the benefits of stimulant medications on cognitive function, there is a paucity of research on the effects of pharmacologic treatment on motor function in children with ADHD.[5]

Concussion and ADHD

It is well known that athletes are at a greater risk of sports-related concussions, especially in contact sports. Given the impulsivity and the lack of fear of consequences of athletes with ADHD,[19] it may be postulated that there lies an inherent increased risk of sports-related injury. Studies also that suggest that athletes may, in fact, have a higher potential increased risk of injury, not specific to ADHD and mild traumatic brain injury (TBI), although strong reproducible evidence to this conclusion is lacking.[20–22]

Concussive cognitive symptoms of difficulty focusing, fogginess and memory concerns can mimic those of ADHD and perhaps even worsen in athletes with preexisting ADHD.[21] The term "secondary ADHD" refers to athletes who are diagnosed after a TBI, as opposed to "primary/developmental ADHD" indicating a preinjury diagnosis.

The evaluation and management of concussion often includes neurocognitive testing. It has been reported anecdotally that those with preexisting ADHD who take a postconcussion computerized neurocognitive test may not return to their baseline scores. It is believed that the repeated testing may "lose its novelty" and fail to capture the interest of players long enough to reestablish their baseline level scores.[11] Scores failing to reach the baseline level may lead to protracted time away from the sport, which may in itself have a detrimental effect on ADHD symptoms and overall mood. If a patient with known ADHD is taking stimulant medication for treatment of ADHD, and the medical provider is using computerized neurocognitive testing, both baseline and postconcussion testing should be performed after the patient has taken their typical stimulant medication to allow for consistent interpretation of the results.

A preexisting diagnosis of ADHD requires a specialized interpretation of neurocognitive testing. The 2012 Zurich Consensus Statement acknowledges ADHD and learning disabilities as "modifiers" in "return to play" consideration, possibly requiring a multidisciplinary approach.[19] It is, therefore, important that the team physician be aware of an athlete's baseline ADHD symptoms and treatment to help guide management and return to play.

ADHD Treatment

The management of ADHD in athletes includes a combination of treatment modalities including behavioral, psychological, and pharmacotherapy options. Much like other psychological illnesses in sports, a multidisciplinary approach with the involvement of psychologists, psychiatrists, and a team physician is an integral part in the diagnosis and management of ADHD. In addition, the parents, teachers, athletic trainers, and coaches play an important role in monitoring symptoms, medication side effects, and the academic/athletic performance in response to treatment.[13]

Nonpharmacologic Treatment Options

A multifaceted approach to the treatment of the athlete with ADHD includes the use of medication and behavioral and psychosocial therapy, as well as potential academic accommodations. Although stimulant medications are considered the first-line treatment for ADHD,[23] strong consideration for nonpharmacologic treatment is warranted, especially in athletes.[13,24,25]

From 2007 to 2011, ADHD medication use increased from 4.8% to 6.1%. Although there is definitely a role of pharmacotherapy in ADHD management, there is a paucity of behavioral therapy availability and usage thereof.[1] There are 2 main categories of psychosocial treatment that have been proven effective: behavior management and training interventions. Behavior management can be subcategorized into the following 3 areas of focus: behavioral parent training; behavioral classroom management; and behavioral peer interventions. Behavioral treatments seek to change behavior by manipulating disruptive incidents in a specific environment (ie, home, school, peer groups, and sport teams). They use the positive reinforcement of desired behaviors and disregard of undesired behaviors with the goal of extinguishing them. In a study investigating dose–response effect, behavior modification was as effective in decreasing intrusive ADHD symptoms as a moderate dose of stimulant medication.[25] A structured environment both at home and in school can aid the student athlete in developing coping strategies. Skills training for the parents, as well as for the athlete, in time management, social interaction, and problem solving are examples of psychosocial treatment.[13,17,26] Academic accommodations should be discussed with the school's guidance counselor, and the possible implementation of an Individualized Education Plan or 504 plan. However, Pelham et al[24] has also shown that adjunctive behavioral therapy combined with medication is superior to symptom improvement than behavioral treatment alone, reinforcing the effectiveness of stimulant medication. Training interventions seek to change behavior by improving the child's skill set and hoping for generalization across behavioral settings.[27]

Another well-studied intervention is physical activity. A physical activity program has shown enhanced cognitive performance and brain function during tasks requiring greater executive control. Although athletes may already be active, it is important as a team physician to encourage continued fitness as this form of treatment has very low risk, but a high potential for reward.[5] For some individuals, the combination of psychosocial treatment modalities and medication is optimal.[28] Berwid et al[26] summarized a number of studies on animals and human adults that have "compelling evidence that aerobic exercise can enhance neural growth and development, and improve cognitive and behavioral functioning." Therefore, a sustained routine of exercise as a form of nonmedication treatment for ADHD should be considered a mainstay in management.[29]

Pharmacologic

Stimulant medications, including amphetamines (and combinations of its derivatives) and methylphenidate, are considered first-line treatment for ADHD. Atomoxetine was the first nonstimulant approved by the FDA for the treatment of

TABLE 3. Examples of Stimulants With Sympathomimetic Actions Banned by the World Anti-Doping Agency (WADA).[37,39]

Adrafinil adrenaline
Amfepramone
Amphetamine
Amphetaminil
Benzphetamine
Benzylpiperazine
Bromantan
Cathine
Clobenzorex
Cocaine
Cyclazodone
Dimethylamphetamine
Ephedrine
Etilamphetamine
Etilefrine
Fenbutrazate
Fencamfamin
Fencamine
Fenetylline
Fenfluramine
Fenproporex
Furfenorex
Heptaminol
Isometheptene
Levmethamfetamine
Mefenorex
Mephentermine
Mesocarb
Methamphetamine
Methylenedioxyamphetamine
Methylenedioxymethamphet.
Pmethylamphetamine
Methylephedrine
Methylphenidate
Modafinil
Norfenefrine
Norfenfluramine
Octopamine
Ortetamine
Oxilofrine
Parahydroxyamphetamine
Phendimetrazine
Phenmetrazine
Phenpromethamine
Phentermine
Prolintane
Propylhexedrine
Sibutramine
Tuaminoheptane

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ADHD in both children and adults. Clonidine and guanfacine are approved for use in the pediatric population (aged 6-17 years). Bupropion and tricyclic antidepressants are not approved by the FDA but may be used as alternatives.[30,31]

ADHD Medication Side Effects

All pharmacologic treatments offer potential side effects that may adversely affect an athlete. For example, amphetamine-based medications are associated with central nervous system and cardiovascular stimulation. The demands of sports can increase the thermogenic effects of stimulants, resulting in heat injury, and can also trigger cardiac arrhythmias.[30,31] Careful history taking and athlete screening is key to decreasing the potential for risk, paying particular attention to the following contraindications: hypertension, glaucoma, hyperthyroidism, symptomatic cardiovascular disease, structural heart disease, psychosis, stimulant hypersensitivity, history of drug dependence, and concomitant use of a monoamine oxidase inhibitor or St. John Wort.[13] Blood pressure, exertional symptoms, and heart rate, should be noted before, and monitored periodically after, initiating medication. According to the American Heart Association, obtaining an electrocardiogram before initiating stimulant and nonstimulant medications should be considered. This same sentiment has not been adopted by the American Academy of Pediatrics, as there is no evidence of increased rates of sudden cardiac death in patients taking medications for ADHD.[12,13]

Special Considerations for Team Physicians

Team physicians should be aware of the signs and symptoms of ADHD discussed above to recognize new cases that may not have been diagnosed. They should be familiar with the multidisciplinary resources in their community to help address and treat these athletes to help them succeed in both academics and sports.[13] For those already diagnosed, the team physician should be aware of which athletes on their teams are currently treated with stimulant medication. Depending on how each athlete feels the medication affects them during play, athletes may take their medication in different patterns. Some only take medication for classroom activities and enjoy the impulsivity during sporting events, whereas others take their medication during sport activities because they need the extra concentration imposed by the medication, such as in the case of an athlete in the role of a baseball pitcher.[17] There are 2 main side effects that warrant concern for athletes: risk of heat illness and cardiac arrhythmia.[21] Because of potential performance-enhancing effects of stimulant medications, there are certain regulations, depending on the level of play,

by which the athlete must abide by to take the field under the influence of these medications.

ADHD Medications and Their Status in Sports

The potential harmful effects of stimulant medications are the motivation behind the recommendation of various sports medicine committees [eg, the National Collegiate Athletic Association (NCAA), Major League Baseball, International Olympic Committee (IOC), etc.] that athletes avoid taking these medications.[30,32] Medications used for ADHD, however, have been shown to be clearly beneficial for this condition. Therefore, sports medicine physicians have to balance the need to have athletes medicated versus the need to protect them from known deleterious effects that may cause harm, especially during sports participation. Furthermore, studies have indicated that some ADHD medications may lead to advantages for athletes during competition or training.[33] The evidence is uncertain, but it is a common belief that athletes may take such medications precisely to avail some advantage. Increased aggressiveness, improved pain tolerance, and a decreased sense of fatigue are a few of the attributes of some stimulants that are presumed to impart some advantage to athletes during training and competition.[34,35] Other stimulants increase catecholamine activity, release free fatty acids from adipocytes, and increase lipid metabolism.[12,33,36] The sympathomimetic property of some stimulants is believed to give athletes an unfair advantage, causing such stimulants to be banned (Table 3).[33,37] Of note, however, is that excessive sympathomimetic stimulation can actually interfere with overall athletic performance.[33] Still, some stimulants are accepted for use by athletes if the athletes have documented ADHD and used the correct processes [ie, therapeutic use exemption (TUE)] to inform the sports committees regarding their use of medications prescribed by trained

TABLE 4. Selected Organizations Regulations on the Use of ADHD Medications

Organization	National Collegiate Athletic Association	International Olympic Committee	Major League Baseball
Prerequisites for participation	Documentation of current (annual) and comprehensive evaluation diagnosis and treatment before initiation of sport with the sports medicine staff and the athletic department.	Athletes must submit a therapeutic use exemption (TUE) form to the Therapeutic Use Exemption Committee.	Athletes must submit a therapeutic use exemption (TUE) form to the Independent Program Administrator ("IPA") on TUE applications for ADD/ADHD
		Athletes on continued therapy must undergo annual review.	Agreement to random testing, without grounds for specific suspicion (approach is "roundabout")
			Finishing "Clinical Track," a treatment program for players testing positive for the first time.
			Finishing a 25-game suspension for players testing positive for the second time.
			Finishing an 80-game suspension for players testing positive for the third time.
Recommended components of documentation	Athlete has undergone clinical evaluation to diagnose the disorder.	Symptoms, diagnosis, and testing criteria used in forming the diagnosis of ADHD	Symptoms, diagnosis, and testing criteria used in forming the diagnosis of ADHD, approved by the IPA and a different panel of medical professionals who advise the IPA.
	Athlete is being monitored routinely for the use of stimulant medications.	Connors scale, Swanson, Nolan and Pelham (SNAP) Questionnaire, or other Diagnostic and Statistical Manual of Mental Disorders, fourth Edition (*DSM-IV*) tools.	
	Athlete has a current prescription on file.		
	Description of the assessment, evaluation tools, or procedures		
	Statement of diagnosis		
	History of previous and current ADHD treatment		
	Statement that a nonbanned ADHD alternative medication has been considered if a stimulant medication is prescribed.		
	Plan for follow-up and monitoring visits.		
Other notes	Documentation may be from outside or previous health care providers.	For well-documented, longstanding ADHD, TUE can be for up to 4 yrs, with yearly reviews by an experienced clinician.	Professional baseball players are represented by a labor union that bargains with team owners over terms and conditions of employment, including any drug policies that require drug testing of the athletes.
	Consider nonstimulant medications before stimulants.		
	Team physicians should educate athletes about the proper use of medications.		Because drug tests and policies can lead to suspension or fines, the union resists agreements containing broad prohibitions and extensive testing, essentially tying the hands of team owners.
			Lifetime ban for players testing positive for the fourth time.

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TABLE 5. Results of Selected Studies Pertinent to Athletes With ADHD

Reference	Participants	Exposure	Outcome	Key Findings	Comments
Pelham et al[42]	Seventeen boys with ADHD, 15 white and 2 black, ages from 7.8 to 9.9 yrs (median = 8.3)	Double-blind, placebo-controlled, within-subject, clinical assessments of methylphenidate effects, conducted over 4 consecutive days during the final week of a summer treatment program (STP). Two groups of children played a series of 4 softball games, and measures of response to medication were taken. The first day was a practice day. On the following 3 d, children received in random order placebo b.i.d., 0.3 mg/kg methylphenidate b.i.d., and 0.6 mg/kg methylphenidate b.i.d.	Drug effects were evaluated on children's attention during the game. Judgment during batting, batting skill during the game, and performance on skill drills before the game were also assessed.	Methylphenidate showed significant effects for 2 measures of attention: ready position and game awareness ($F_{(4,62)} = 5.78$, $P < 0.001$).	Sample size was small and consisted entirely of boys referred to a day treatment program. Results need to be replicated with samples drawn from other sources and need to include naturally occurring groups of children.
				Methylphenidate apparently did not exert an effect on ADHD baseball skills when the children's attention was prompted in a skill drill ($F_{(4,62)} < 1$. The mean percentages of hits per times at bat were 78%, 78%, and 81%, on placebo, low, and high doses, respectively).	Not known whether results would generalize to children with ADHD who did not receive ready position.
		Skill drills began approximately 45 min after the morning pill ingestion, and the games followed approximately 30-45 min later and lasted 40, 40, and 50 min for the 3 study days.		There was no effect of methylphenidate on batting judgment during the game [($F < 1$), with mean percentages of good judgment being 60% on placebo, 66% on low dose, and 60% on high dose of the drug].	Nonpharmacologic means of improving children's performance during sports activities need to be used with medication.
					Stimulants might affect sports other than baseball differently, and other activities in which ADHD children typically engage
White et al, 2014[31]	Studies regarding ADHD were selected through literature searches from 3 databases from 1991 to 2011.	Key terms searched were ADD, ADHD, sports, athletes, athletics, guidelines, NCAA, WADA, IOC, college, concussion, diagnosis, management, treatment, evaluation, return-to-play, pharmacotherapy, adult, adolescent, student, screening, injury, risk, neuropsychiatry, TBI, traumatic brain injury, and epidemiology.	Review of literature search was presented focusing on diagnosis, treatment, and special considerations for athletes with ADHD.	ADHD athletes should be able to participate in all sports at all levels.	This was a level 4 evidence article.
				Exercise has also shown significant benefits.	
Ziereis et al[5]	Forty-three children with ADHD (32 boys, 11 girls). Ages 7-12 yrs. Two experimental groups (EG1 n = 13, EG2 n = 14), 1 control group n = 16.	12-wk training programs: EG1- specific training in ball handling, balance and dexterity; EG2- nonspecific sports training.	Significant improvements in working memory and motor performance in both EG1 and EG2 compared with control.	Short-term (1 wk) improvement performance ($P < 0.05$). Long-term (12 wk) improvement in executive functioning variables (working memory $P < 0.001$; digit-span $P < 0.001$; letter-number sequencing $P < 0.05$)	Physical activity is beneficial in the treatment of ADHD and motor skill, regardless of type of activity. Exercise should be considered highly as a nonpharmacologic treatment for ADHD.
		Working memory and motor performance tested 1 wk before training, after week #1, and after week #12.			

professionals; in the elite levels, this verification is most likely through psychiatric evaluation.

ADHD stimulant medications are strictly regulated by many governing bodies in sports including the NCAA and IOC who require thorough documentation of diagnosis. In 1992, the IOC instituted the concept of a TUE which is a form that allows athletes to participate in sports using substances that might otherwise be banned if not for their given documented diagnosis. If athletes are taking ADHD medications, the governing body of their sport may require that they receive an exemption to be able to use this medication in and out of competition. To obtain this exemption, the athlete must submit a TUE to the appropriate authorities who will review the documentation as to why the athlete requires this treatment; based on this information it will be determined whether an exemption should be granted for a defined period

TABLE 5. Results of Selected Studies Pertinent to Athletes With ADHD *(Continued)*

Bavarian et al[9]	Using one-stage cluster sampling, 520 students (96.3% response rate) at one Pacific Northwest University completed a paper-based, in-classroom survey on the illicit use of prescription stimulants (IUPS).	Behaviors and expected correlates: (1) its characteristics (i.e., initiation, administration routes, drug sources, motives, and experiences); and (2) theory-guided intrapersonal, interpersonal, and environmental correlates associated with use.	Study aimed to understand IUPS as a high-risk behavior of the 21st century through descriptive statistics and 3 nested logistic regression analyses guided by the Theory of Triadic Influence.	IUPS was prevalent on the campus under investigation and factors from the intrapersonal, interpersonal, and environmental domains were associated with the behavior. The prevalence of ever engaging in IUPS during college was 25.6%. Most (>50.0%) users reported initiation during college, oral use, friends as the drug source, academic motives, and experiencing desired outcomes. Intrapersonal correlates associated with the use included identifying as white, lower grade point average, diagnoses of attention deficit disorder, and lower avoidance self-efficacy. Interpersonal correlates of use included off-campus residence, varsity sports participation, IUPS perceptions by socializing agents, and greater behavioral norms. Exposure to prescription drug print media, greater prescription stimulant knowledge, and positive attitudes toward prescription stimulants were environmental correlates associated with use. In all models, IUPS intentions were strongly associated with use.	Self-reported experiences are subject to nonresponse and social desirability bias. There was a response from all 520 students). Pilot tests of the survey showed that students did not find the instrument judgmental in nature. Although it asked students engaging in IUPS whether they received the outcome they intended, students were not asked to elaborate on adverse health effects. Study was cross-sectional and took place at one university. Limited generalizability of findings to demographically and culturally similar universities. The use of a comprehensive theory to examine IUPS allows for the development of a more comprehensive strategic plan for prevention and intervention.
Nazeer et al[12]	Review article explaining the prevalence of ADHD, pathophysiology, diagnosis, ADHD and sports, treatment, and side effects thereof.	Literature search of Medline, PsychINFO, Ovid, PubMed, and Cochrane library using the following terms: ADHD, adolescents, athletes, and sports.	Epidemiology (6%-7%) of the child and adolescent population possibly higher in collegiate and professional-level athletes. More boys (13.2%) than girls (5.6%). Diagnosis using DSM-V. Review psychosocial development. Management of ADHD (pharmacologic and behavioral).	Common disorder where children may suffer from inattention, hyperactivity, impulsivity, poor self-esteem, and academic and social problems. Overall, adequate treatment of ADHD improves quality of life.	Review article discusses stimulant medication use in athletes, side effects, and TUEs.
Kaufman et al[14]	Thirty-mo time period: senior author informally interviewed all 14 parents of a boys' gymnastic team and observed the boys competing for that gymnastic team in multiple settings.	Informal interviews and observations permitted the determination of primary outcome measure: prevalence of ADHD in a boys' gymnastic team.	Diagnosis of ADHD in the past or treatment with psychotropic medications, stimulant or nonstimulant, for inattentive/hyperactive/impulsive behaviors.	Parents of boys reported that 5 of 7 (71.4%) boys were either diagnosed with ADHD in the past or had been treated with stimulant or nonstimulant medications for inattentive/hyperactive/impulsive behaviors.	Small sample size.
			Reported benefits of sports on ADHD, when applicable.	Parents described gymnastics as effective "behavioral therapy" in controlling/improving ADHD symptoms, with this effect extending into other environments (home/classroom).	Observational.

TABLE 5. Results of Selected Studies Pertinent to Athletes With ADHD *(Continued)*

			Knowledge of the World Anti-Doping Code (WADC).	Only one parent was aware of WADA stimulant prohibition.	Only parent reports. No standardized instrument to verify ADHD diagnosis.
					No data obtained on the number of gymnasts not formally diagnosed with ADHD, but nonetheless, being treated with nonstimulant medications.
					No data obtained regarding siblings without formal diagnosis of ADHD, but with symptoms of hyperactivity/inattention/impulsivity.
					No data obtained as to whether gymnastics was selected as treatment for ADHD by the parents.
Cho et al[18]	Fifty-eight children with ADHD vs 70 normal controls (ages 9.5 ± 2 yrs), 51 males, 7 females.	Motor function assessed with Bruininks–Oseretsky Test of Motor Proficiency, second ed.	ADHD lower motor composite scores in ADHD children compared with controls.	ADHD lowers total motor composite $t = -9.32$, $P < 0.001$); lowers fine manual control ($t = -3.76$, $P < 0.001$), manual coordination ($t = -6.87$, $P < 0.001$); body coordination ($t = -7.14$, $P < 0.001$); and strength and agility ($t = -8.54$, $P < 0.1$).	Study in Korean children showed lower motor function scores in ADHD vs control, indicating the importance of motor skills training, perhaps taught in sports/exercise.
Chuang et al[43]	Nineteen children with ADHD, aged 8–12 years.	A Go/No Go task for reaction time was performed after a 30-min intervention of either treadmill running or video watching on different days.	Shorter reaction times were seen after exercise compared with video watching.	Go/No Go task reaction time (RT), paired *t* test $t(18) = -2.230$, $P = 0.039$.	Exercise beneficial for children with ADHD by improving reaction time and, response preparation.
Taylor et al[44]	Within-subjects design. Each participant experienced 3 treatments (environments) in single-blind controlled trials. Seventeen children 7–12 years old professionally diagnosed with ADHD.	Three environments: a city park and 2 other well-kept urban settings. Individually guided 20-min walks. Environments were experienced 1 wk apart, with randomized assignment to treatment order.	After each walk, concentration was measured using Digit Span Backwards.	Children with ADHD concentrated better after the walk in the park than after the downtown walk ($P = 0.0229$) or the neighborhood walk ($P = 0.0072$). Effect sizes were substantial (Cohen $d = 0.52$ and 0.77, respectively) and comparable to those reported for recent formulations of methylphenidate.	20 min in a park setting was sufficient to elevate attention performance relative to the same amount of time in other settings.
					Limited sampling.
					Exposure to nature may enhance attention in children with ADHD; applicable for a wide variety of children, settings, and activities.
Choi et al, 2015[45]	Thirty-five adolescents with ADHD aged 15-16 years, compared with 30 healthy controls of similar age	ADHD adolescents were randomly assigned to methylphenidate with 6 wk of exercise vs 6 wk of education. Baseline and 6 wk scores for ADHD symptoms and DuPaul ADHD rating scale (K-ARS), Wisconsin Card Sorting Test, 3T functional magnetic resonance imaging.	A 6-wk aerobic exercise program negatively correlates with ADHD scores and enhances methylphenidate effectiveness. Brain activity increased within the right frontal and temporal cortices.	Significant difference K-ARS scores in all ADHD vs control ($z = 2.95$, $P < 0.01$). K-ARS improved from baseline in exercise group compared with education intervention ($F = 4.53$, $P = 0.04$). Right frontal cortex activity improved ($z = 2.2$, $P = 0.03$).	Exercise may enhance stimulant medication as an adjunct and may allow for lower dosing of medication.

TABLE 5. Results of Selected Studies Pertinent to Athletes With ADHD *(Continued)*

Pelham et al[25]	Forty-four boys and 4 girls, aged 5-12. Participants required to meet DSM-IV diagnostic criteria for ADHD, to have an estimated full-scale IQ of at least 80, and to have no documented adverse response to or medical conditions that would contraindicate the use of methylhenidate (MPH); 79% caucasian and 12.5% African American; one boy was native American and the remaining participants were of mixed race. One child's parents withdrew from the study after 2 d because of concerns about possible side effects. A second boy's late-afternoon dose was reduced from 0.6 mg/kg condition to 0.3 mg/kg dose because of evening side effects.	Two within-subject factors: medication (placebo, 0.15 mg/kg/dose MPH t.i.d., 0.3 mg/kg/dose MPH t.i.d., and 0.6 mg/kg/dose MPH t.i.d.) and behavior modification (no behavior modification, NBM; low-intensity behavior modification, LBM; and high-intensity behavior modification, HBM). Medication randomly assigned within each child and varied daily. Behavioral treatment was varied in 3-wk blocks with order of the 3 conditions counterbalanced. Thus, each participant had 3-4 d in each medication × behavioral treatment condition.	Activity rule violations; noncompliance; interrupting; complaining; conduct problems (lying, stealing, intentional destruction of property, and intentional aggression); and (6) negative verbalizations (verbal abuse to staff, teasing peers, and swearing).	Both behavioral and medication treatments produced highly significant and positive effects on children's behavior.	Results illustrate the importance of taking dosage/intensity into account when evaluating combined treatments; there were no benefits of combined treatments when the dosage of either treatment was high, but combination of the low-dose treatments produced substantial incremental improvement over unimodal treatment.
			IOWA Conners Rating Scale	Treatment modalities also interacted significantly.	Results limited by controlled treatment setting.
			Modified Impairment Rating Scale	Although there was a linear dose–response curve for medication in NBM, the dose–response curves flattened considerably in LBM and HBM.	Treatment period was only 9 wk, further broken down by treatment conditions.
			Daily ratings of stress of interacting with the children and their overall effectiveness in the treatment role.	Behavior modification produced effects as large as moderate doses, and on some measures, high doses of medication.	
			Pittsburgh Side Effects Rating Scale		
Pelham et al[24]	Ninety-four boys and 23 girls participating in the summer treatment programs at the University of Pittsburgh, University of California-Irvine, and University of California-Berkeley sites of the Multimodal Treatment Study of Children with ADHD (MTA).	Fifty Seven children in the combined treatment (Comb) group, who were medicated, and 60 children in the behavioral treatment (Beh) group, who were unmedicated.	Point system behavior rating, classroom measures, daily report cards, improvement ratings, parent satisfaction ratings, teacher and counselor ratings, child self-perception ratings, and peer sociometric ratings.	Comb children were significantly better than Beh on 5 measures: rule following, good sportsmanship, peer negative nominations, and STP teacher posttreatment ratings of inattention/overactivity. Groups did not differ on any of the other 30 measures, and responded similarly to the STP over time. Comparisons to normative data revealed that Comb children were more likely to fall within the normative range on 6 measures.	Had the combined group been given higher dosages of medication, there may have been a larger difference between the 2 groups.
					MTA study had begun approximately 1-3 mo before the STP, and it could be argued that children reached a ceiling of improvement with medication or behavioral treatments in the parent study before the STP, leaving little room for further improvement in the STP.
					No untreated control group or other control for changes over time (eg, a reversal condition).
					No medication alone group.
					Study was not blinded.
					Treatment literature on ADHD has made it clear for decades that individual differences are the rule rather than the exception with respect to behavioral, pharmacologic, and combined treatments.

TABLE 5. Results of Selected Studies Pertinent to Athletes With ADHD *(Continued)*

Vancampfort et al[27]	Fifteen adolescents with antipsychotic treatment (8♂, mean age 15.57 ± 1.3 yrs).	Adolescents treated with antipsychotic medication, antipsychotic-naive age and sex-matched adolescents with mental health problems, and age and sex-matched healthy controls.	Differences in physical fitness and physical activity levels. All participants completed the Physical Activity Questionnaire for Adolescents, the Positive-and-Negative-Affect-Schedule, and performed the Eurofit test battery.	Adolescents with mental health problems (irrespective of antipsychotic medication) were significantly (P 0.05) less physically active and had an impaired whole body balance, running speed and cardiovascular endurance compared with healthy controls (n = 15, 8♂, 15.9 ± 1.3 yrs).	Given the overwhelming deleterious impact of physical inactivity and low physical fitness on physical and mental health outcomes, interventions specifically targeting physical activity and physical fitness among adolescents experiencing mental illness, both treated with, and not treated with antipsychotic medication are warranted as a priority.
				Adolescents treated with antipsychotic medication (n = 15, 8♂, 15.5 ± 1.3 yrs) were less physically active and had an impaired whole body balance compared with antipsychotic-naive adolescents (n = 15, 8♂, 15.7 ± 1.4 yrs).	Antipsychotic medication should be considered as a risk factor for physical inactivity and poor physical fitness.
					Cross-sectional design.
					Subjective questionnaire. PAQ-A does not accurately capture the time spent in physical activity
					Sample sizes were limited.
					No data on possible confounding factors (previous substance abuse, smoking pack years, socioeconomic status, educational level and duration of treatment).
					No specific antipsychotic medications.
					No correction for multiple testing.

of time. If the athlete is to be continued on the medication beyond the end date of that TUE, the athlete and their physician must reapply to continue the exemption. Organizations such as the NCAA, IOC, and World Anti-Doping Agency require stringent documentation and recommend yearly reviews in order for the athlete to continue the use of stimulants.[12] A comparison of various regulations put forth by selected sports organizations is shown in Table 4.[31,38,39]

The Food and Drug Administration (FDA) is responsible for investigating adverse medication reactions in the United States.[40] So far, incidents reported involving ADHD medications include adverse effects such as myocardial infarctions, cerebrovascular accidents, paranoid psychoses, seizures, insomnia, tremors, anxiety, arrhythmias, hypertension, and death.[33,38] The FDA has placed dosage limits and black-box warnings, but sale of stimulants and ADHD medications continues to register in billions in the United States alone.[41] Table 5 lists the results of studies mentioned within this article which may be pertinent to the care of athletes with ADHD.

CONCLUSIONS

The unique impact of ADHD on athletes is still relatively poorly understood, and must be followed by health professionals who have a solid understanding of the medications that such athletes may be prescribed, in addition to the influence of these medications on the athletes' overall health and athletic performance. Attention deficit hyperactivity disorder treatments may provide advantages in athletics. Accurate diagnosis, by careful history taking and screening, is the key to differentiating athletes needing treatment from those hoping for performance enhancement. Trained professionals should be engaged with athletes who manage ADHD, from diagnosis through treatment; psychiatric evaluation is likely needed, especially at more elite levels of sports. Sports physicians must also be aware of the regulatory guidelines of each athlete's particular sport and organization.

References

1. Tatlow-Golden M, Neary M, Farrelly N, et al. ADHD young adult service innovations: a combined child and adult psychiatry-led pilot university-based ADHD service. *Eur Child Adolesc Psychiatry*. 2015;24:S88–S89.
2. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*. 5th ed. Arlington, TX: American Psychiatric Publishing; 2013.
3. Catala-Lopez F, Hutton B, Nunez-Beltran A, et al. The pharmacological and non-pharmacological treatment of attention deficit hyperactivity disorder in children and adolescents: protocol for a systematic review and network meta-analysis of randomized controlled trials. *Syst Rev*. 2015;4:19.
4. Seidman LJ. Neuropsychologically informed strategic psychotherapy in teenagers and adults with ADHD. *Child Adolesc Psychiatr Clin N Am*. 2014;23:843–852.

5. Ziereis S, Jansen P. Effects of physical activity on executive function and motor performance in children with ADHD. *Res Dev Disabil*. 2015;38: 181–191.
6. Kehoe WA. Treatment of attention deficit hyperactivity disorder in children. *Ann Pharmacother*. 2001;35:1130–1134.
7. Emmerson NA. Monitoring patterns of physical activity, problematic behaviors, and moods in children with and without ADHD using electronic diaries. Dissertation Abstracts International: Section B: The Sciences and Engineering. 2011;71:7066.
8. Lakhan SE, Kirchgessner A. Prescription stimulants in individuals with and without attention deficit hyperactivity disorder: misuse, cognitive impact, and adverse effects. *Brain Behav*. 2012;2:661–677.
9. Bavarian N, Flay BR, Ketcham PL, et al. Illicit use of prescription stimulants in a college student sample: a theory-guided analysis. *Drug Alcohol Depend*. 2013;132:665–673.
10. Conant-Norville DO, Tofler IR. Attention deficit/hyperactivity disorder and psychopharmacologic treatments in the athlete. *Clin Sports Med*. 2005;24:829–843. viii.
11. Parr JW. Attention-deficit hyperactivity disorder and the athlete: new advances and understanding. *Clin Sports Med*. 2011;30:591–610.
12. Nazeer A, Mansour M, Gross KA. ADHD and adolescent athletes. *Front Public Health*. 2014;2:46.
13. Putukian M, Kreher JB, Coppel DB, et al. Attention deficit hyperactivity disorder and the athlete: an American Medical Society for Sports Medicine position statement. *Clin J Sport Med*. 2011;21:392–401.
14. Kaufman KR, Bajaj A, Schiltz JF. Attention-deficit/hyperactivity disorder (ADHD) in gymnastics: preliminary findings. *Apunts Medicina de l'Esport*. 2011;46:89–95.
15. Broshek DK, Freeman JR. Psychiatric and neuropsychological issues in sport medicine. *Clin Sports Med*. 2005;24:663–679.
16. Kutcher JS. Treatment of attention-deficit hyperactivity disorder in athletes. *Curr Sports Med Rep*. 2011;10:32–36.
17. Perrin AE, Jotwani VM. Addressing the unique issues of student athletes with ADHD. *J Fam Pract*. 2014;63:E1–E9.
18. Cho H, Ji S, Chung S, et al. Motor function in school-aged children with attention-deficit/hyperactivity disorder in Korea. *Psychiatry Investig*. 2014;11:223–227.
19. Elbin RJ, Schatz P, Lowder HB, et al. An empirical review of treatment and rehabilitation approaches used in the acute, sub-acute, and chronic phases of recovery following sports-related concussion. *Curr Treat Options Neurol*. 2014;16:320.
20. Marzbani H, Marateb HR, Mansourian M. Methodological note: neurofeedback: a comprehensive review on system design, methodology and clinical applications. *Basic Clin Neurosci*. 2016;7:143–158.
21. Reardon CL, Factor RM. Considerations in the use of stimulants in sport. *Sports Med*. 2016;46:611–617.
22. Esfandiari A, Broshek DK, Freeman JR. Psychiatric and neuropsychological issues in sports medicine. *Clin Sports Med*. 2011;30:611–627.
23. Corrigan B. Attention deficit hyperactivity disorder in sport: a review. *Int J Sports Med*. 2003;24:535–540.
24. Pelham WE, Gnagy EM, Greiner AR, et al. Behavioral versus behavioral and pharmacological treatment in ADHD children attending a summer treatment program. *J Abnorm Child Psychol*. 2000;28:507–525.
25. Pelham WE, Burrows-MacLean L, Gnagy EM, et al. A dose-ranging study of behavioral and pharmacological treatment in social settings for children with ADHD. *J Abnorm Child Psychol*. 2014;42:1019–1031.
26. Berwid OG, Halperin JM. Emerging support for a role of exercise in attention-deficit/hyperactivity disorder intervention planning. *Curr Psychiatry Rep*. 2012;14:543–551.
27. Vancampfort D, Probst M, Daenen A, et al. Impact of antipsychotic medication on physical activity and physical fitness in adolescents: an exploratory study. *Psychiatry Res*. 2016;242:192–197.
28. Weyandt LL, Janusis G, Wilson KG, et al. Nonmedical prescription stimulant use among a sample of college students: relationship with psychological variables. *J Atten Disord*. 2009;13:284–296.
29. Putnam SC. *Nature's Ritalin for the Marathon Mind: Nurturing Your ADHD Child with Exercise*. Hinesburg, VT: Upper Access, Inc; 2001.
30. Hatton CK, Green GA, Ambrose PJ. Performance-enhancing drugs: understanding the risks. *Phys Med Rehabil Clin N Am*. 2014;25:897–913.
31. White RD, Harris GD, Gibson ME. Attention deficit hyperactivity disorder and athletes. *Sports Health*. 2014;6:149–156.
32. Pai S, McLatchie GR. Drugs and sport. *Scottish Med J*. 2010;55.
33. Greydanus DE, Patel DR. Sports doping in the adolescent: the Faustian Conundrum of Hors De Combat. *Pediatr Clin North Am*. 2010;57: 729–750.
34. Hughes D. The world anti-doping code in sport. *Aust Prescr*. 2015;38: 167–170.
35. Sjoqvist F, Garle M, Rane A. Use of doping agents, particularly anabolic steroids, in sports and society. *Lancet*. 2008;371:1872–1882.
36. Jenkinson DM, Harbert AJ. Supplements and sports. *Am Fam Physician*. 2008;78:1039–1046.
37. Docherty JR. Pharmacology of stimulants prohibited by the world anti-doping agency (WADA). *Br J Pharmacol*. 2008;154:606–622.
38. Tynes JR. Performance enhancing substances. *J Leg Med*. 2006;27: 493–509.
39. World Anti-Doping Agency. *The World Anti-doping Code International Standard Prohibited List*. 2017. Available at: https://www.wada-ama.org/sites/default/files/resources/files/2016-09-29_-_wada_prohibited_list_2017_eng_final.pdf. Accessed December 12, 2016.
40. *Food and Drug Administration Modernization Act (FDAMA) of 1997*. 1997. Available at: http://www.fda.gov/RegulatoryInformation/Legislation/SignificantAmendmentstotheFDCAct/FDAMA/default.htm. Accessed August 19, 2016.
41. Sharma A, Gerbarg PL, Brown RP. Non-pharmacological treatments for ADHD in youth. *Adolesc Psychiatry (Hilversum)*. 2015;5:84–95.
42. Pelham WE Jr, McBurnett K, Harper GW, et al. Methylphenidate and baseball playing in ADHD children: who's on first? *J Consult Clin Psychol*. 1990;58:130–133.
43. Chuang LY, Tsai YJ, Chang YK, et al. Effects of acute aerobic exercise on response preparation in a Go/No Go Task in children with ADHD: an ERP study. *J Sport Health Sci*. 2015;4:82–88.
44. Taylor AF, Kuo FE. Children with attention deficits concentrate better after walk in the park. *J Atten Disord*. 2009;12:402–409.
45. Choi JW, Han DH, Kang KD, et al. Aerobic exercise and attention deficit hyperactivity disorder: brain research. *Med Sci Sports Exerc*. 2015;47: 33–39.