

[Primary Care]

Attention Deficit Hyperactivity Disorder and Athletes

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Context: Attention deficit hyperactivity disorder (ADHD) is common in the general population, and many individuals with this condition participate in sports activity at all competition levels.

Evidence Acquisition: Related studies were selected through literature searches of PubMed, MEDLINE, and Cochrane databases for the years 1991 to 2011. Key search terms 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.*

Study Design: Literature review.

Level of Evidence: Level 4.

Results: ADHD usually has an early onset, with delayed diagnosis in some patients due to heterogeneous presentations. Suspected cases can be evaluated with available diagnostic tools and confirmed clinically. Athletes with ADHD may participate at all competition levels.

Conclusion: Athletes with ADHD are able to participate at all competition levels by following published guidelines and requirements. Exercise benefits many athletes with ADHD. The relationship between ADHD and concussion syndromes is currently under investigation.

Keywords: attention deficit, hyperactivity disorder, athletes

Attention deficit hyperactivity disorder (ADHD) is common in our society and now approaches 10% of children.²⁵ While some patients stabilize over time, many individuals require treatment into adolescence and adulthood. Interventional therapy often benefits patients, including athletes. With proper management, athletes with ADHD may participate in sports at all competitive levels.

ADHD is a disorder of chronic and impairing behavioral patterns that results in abnormal levels of inattention, hyperactivity, or their combination.^{4,5} ADHD is a deficit in behavioral inhibition.¹² ADHD is usually diagnosed in childhood, but some cases persist into adulthood or are diagnosed later.^{3,23,42,92}

Proper diagnosis of ADHD in adults is based on a detailed patient history and assessment of current behavior and level of functioning using the same *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (*DSM-IV*), criteria in adults and children. The criteria stipulate that symptoms must be present before 7 years of age. However, many adults do not recall early symptoms or did not have a diagnosis of ADHD made in childhood, often making the diagnosis of ADHD in adults less of a consideration.^{57,58}

ATTENTION DEFICIT HYPERACTIVITY DISORDER

Epidemiology

ADHD is one of the most common neuropsychiatric disorders of childhood, and its classification has been debated.^{6,11,13,28,72,73,75,83} According to the Centers for Disease Control and Prevention, rates of ADHD in US children continue to trend upward. Akinbami et al¹ reported that the percentage of American children diagnosed with ADHD increased from 6.9% in 1998 to 2000 to 9.0% in 2007 to 2009.^{1,14,64,74,94} During this study time interval, the prevalence was higher among boys than girls. For boys, ADHD prevalence increased from 9.9% in the study period 1998 to 2000 to 12.3% in the study interval 2007 to 2009, and for girls from 3.6% to 5.5% during the same study period. In this group and time frame, prevalence varied by race and ethnicity, but the differences between most groups narrowed. Although some of the symptoms of ADHD diminish or disappear with maturation, 60% to 85% of children with ADHD continue to meet *DSM-IV* criteria as teenagers or young adults.^{2,3,18,19,28,49,92} ADHD may persist into adulthood in 30% of patients.^{15,47,52,61,63,80}

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Clinical Presentation

The causes and risk factors are unknown, but genetic factors seem to play a role.^{16,18,19,20} ADHD comprises inattentive and impulsive-hyperactive subtypes. The symptoms include poor attention span; difficulty with waiting one's turn, managing time, organizational skills, and initiating or completing tasks; and increased risk-taking behaviors.⁶⁷ Common comorbidities include anxiety, depression, disruptive behavior, learning disorders, substance abuse, and psychotic disorders.^{45,54} ADHD can present in a heterogeneous symptom pattern that is compounded by the variable presence of comorbid conditions including affective and substance use disorders.⁵⁴

Diagnosis

ADHD is a clinical diagnosis supported by laboratory results, imaging tests, and careful clinical evaluation.^{46,74} Accurate patient evaluation requires gathering pertinent information from not only the patient and parent but also from others who interact with the patient, for example, teachers. This is especially important since children and adolescents may not be good historians of overall function. Several tools are available to assist with diagnosis and monitoring of those with ADHD, including the Connors Questionnaire, NICQH Vanderbilt Assessment Tool, *DMS-5* criteria, Special Needs Assessment Profile (SNAP), SNAP-IV (Teacher and Parent Rating scale), SNAP-IV-C (condensed version), and Swanson, Kotkin, Angler, M-Flynn, and Pelham (SKAMP) Scale.^{30,34-36,70,80,81,87,90-92}

Treatment

Outcomes for individuals with ADHD are as variable as the diverse patterns of behavior presentations.^{56,66} Ideally, early indicators of poor outcomes should be identified so that appropriate resources can be allocated for support.^{55,56}

Several long-acting medications have been approved specifically for use in adolescents.²⁴ These include extended-release dexamethylphenidate, transdermal methylphenidate, osmotic-release oral system methylphenidate, extended-release mixed amphetamine salts, lisdexamfetamine, and the nonstimulants atomoxetine, extended-release guanfacine, and extended-release clonidine.⁶⁸

ATHLETE WITH ADHD

Level of Competition

Young Athletes

Young athletes (children and adolescents) may experience problems with specific movement required in competitive sports and may manifest problems with balance or coordinated activity.⁸ At the same time, exercise may decrease lack of attention or impulsive behavior.⁴⁴ One study demonstrated improvement in anxiety/depression symptoms in those who participated in sports.^{28,53} Thus, competitive sports may benefit those with ADHD.³²

Middle School/High School Athletes

The coaching staff and team physician should be aware of and note common potential side effects experienced with prescribed specific medications both during practice and in competition, with careful attention paid to the environment (eg, ambient temperature, humidity, wind, direct sunlight), the fatigue level of the athlete, and the athlete's performance.^{60,65} In particular, athletes treated with amphetamines (which increase heat production) or tricyclics (which decrease sweat production) require careful monitoring.^{65,84} Young athletes may not recognize medication side effects such as decreased appetite, sleep problems, stomachache, or headache.³⁹

Collegiate Athletes

As of August 1, 2009, collegiate athletes who are diagnosed with ADHD and receive stimulant medication must supply documentation of diagnosis and treatment for National Collegiate Athletic Association (NCAA) competition (participation) prior to initiation of the sport activity. This required documentation must provide evidence (1) that the athlete has undergone clinical evaluation to diagnose the disorder, (2) is being monitored routinely for use of the stimulant medication, and (3) has a current prescription on file.⁶⁹ This often requires documentation from outside or previous health care providers. If documentation is no longer available, a current comprehensive evaluation must be completed. Furthermore, the NCAA requires yearly clinical evaluation and documentation with the sports medicine staff and the athletic department.^{69,74} This documentation requires (1) description of the assessment, evaluation tools, or procedures; (2) statement of diagnosis; (3) history of previous and current ADHD treatment; (4) statement that a nonbanned ADHD alternative medication has been considered if a stimulant medication is prescribed; and (5) plan for follow-up and monitoring visits.^{15,69,74}

The NCAA requires that physicians consider nonstimulant medications before prescribing stimulants.^{16,18,71} In addition, team physicians should educate NCAA athletes about proper use of medications in the treatment of ADHD. It is crucial that the team physician explain to the athlete that while stimulant medications are allowed in the management of ADHD, certain rules do apply.

Olympic Athletes

Athletes competing at the Olympic level may participate and continue medical treatment with prohibited drugs for their ADHD as governed by the International Olympic Competition (IOC) and World Anti-Drug Agency (WADA).^{50,96} Many athletes may compete simultaneously at both the NCAA and Olympic levels but must be aware of specific guidelines for each organization.

Olympic-level athletes must submit a therapeutic use exemption (TUE) form to the Therapeutic Use Exemption Committees detailing the symptoms, diagnosis, and testing criteria utilized in forming the diagnosis of ADHD.^{50,95} These

criteria often include the Connors scale, SNAP, or other *DSM-IV* tools.^{6,27,33,44,65,69} The diagnosis is then confirmed clinically.

Athletes maintained on continued therapy must undergo annual review. In the case of a well-documented, long-standing diagnosis, a TUE can be granted for up to 4 years. However, yearly reviews by an experienced clinician are still recommended.^{74,95}

ADHD Effect on Performance

ADHD can manifest in many ways, including lack of focus and concentration, oppositional behavior in team sports, argumentative attitude, frustration, poor self-esteem, and mood lability.⁸⁹ In addition, anxiety, depression, substance abuse, and psychotic disorders may coexist,⁸⁹ each of which directly affects team sports and participant interaction. Academic difficulties may also arise that could threaten the student athlete's qualification to participate in sports. For these reasons, athletes with ADHD often perform better with medical treatment in both the classroom and the sporting venue.

Treatment

The treatment of ADHD in sports requires a combination of behavioral, psychosocial, and medication modalities.⁸⁰ The coordinated treatment often involves all members of the medical and athletic staff. With a coordinated effort, the abnormal, disruptive behavior can often be controlled.

Medication

Medications are often central to the treatment of ADHD (Table 1). Stimulants (amphetamines) and nonstimulants (atomoxetine and bupropion) are commonly used.³² While tricyclic antidepressants may be useful in select patients, they are not first-line agents.³⁸ Many agents can potentially mitigate symptoms in patients with ADHD.

Performance Effects

Stimulant medications are beneficial to patients with ADHD and constitute the first treatment option selected.³⁸ These effective medications are ergogenic in athletes but are approved by the NCAA, WADA, and IOC with proper documentation. Potential performance enhancement includes a subjective sense of euphoria, improved concentration, increased aggression, and decreased pain.²² Consequently, these agents may improve athletic performance.

Other medications less commonly utilized in athletes with ADHD include tricyclic antidepressants, bupropion, and clonidine, which are effective in treating ADHD but show increased side effects such as drowsiness, anorexia, and heat injury.

Side Effects

Two particular areas of concern are the risk for heat injury and cardiac arrhythmias. While the potential for both problems exists, occurrence in older, mature athletes is very low.

Habel's⁴³ study in athletes up to age 64 years revealed a 1- to 3-mmHg increase in diastolic blood pressure and a 2- to 5-mmHg increase in diastolic blood pressure overall with no increased incidence of complications. Careful monitoring of the athlete's weight, observing for possible heat-related illnesses, and checking for extreme fatigue is paramount.

The risk for cardiac arrhythmias is not increased compared with patients not receiving these medications.^{43,77,85,86} The greatest risk lies in younger athletes with symptoms of cardiovascular disease, an underlying structural heart defect, or preexisting heart disease.^{29,35,43} Team physicians should not prescribe stimulants to these patients.^{36,43}

Schelleman et al explored cardiovascular risks of stimulant treatment in adolescents.^{77,78,84} The rate of sudden death or ventricular arrhythmia was no greater for children receiving medications compared with those who were not. Recent studies also suggest no increased risk of serious cardiovascular events.^{29,32}

Careful history and examination should be performed prior to initiation of these agents. Electrocardiogram (ECG) testing is controversial.^{3,4,42,71,74,88} The team physician should assess the athlete's blood pressure, heart rate, and exertional symptoms prior to initiating ADHD therapy and monitor these parameters periodically.

The specific side effects of medical treatment vary with the chemical class of agents. Many of the side effects can adversely affect the athlete's performance (Table 1).

CONCUSSION AND ADHD

Concussion is defined by the Zurich Consensus Statement as a complex pathophysiologic process affecting the brain induced by traumatic biomechanical forces.⁶² Common symptoms include headache, dizziness, fatigue, irritability, insomnia, poor concentration, difficulty with memory, intolerance of stress, and emotional lability.²⁶ The cognitive symptoms of impaired attention and memory and the behavioral symptoms that arise after a concussion can mirror those of a patient with ADHD.

Traumatic brain injury (TBI) in children can worsen ADHD symptoms.⁵⁷ A study comparing children (5-15 years of age) with mild, moderate, and severe TBI showed that children with pre-injury ADHD had more significant and longer lasting symptoms of inattention and hyperactivity after TBI than controls.⁵⁷ The symptoms of ADHD can worsen, and it may be more difficult to treat ADHD after a concussion.²¹ College football players with learning disabilities had a prolonged return to baseline function on neuropsychologic testing after concussion.³¹ Asplund et al⁹ examined factors associated with prolonged return to play. Athletes with a history of learning disorders or ADHD did not have a difference in outcome or prolonged return to play.⁹ The Zurich Consensus Statement does list learning disorders and ADHD as modifying factors in return to play after concussion.⁶² Individuals with a modifying factor such as ADHD may need additional management and a multidisciplinary approach rather than a standard return-to-play protocol.⁶² At this time, it seems reasonable to take a

Table 1. ADHD medications⁶⁷

	Generic Name	Trade Name	Chemical Class	Comments	Side Effects
Stimulants	Methylphenidate	Concerta, Ritalin, Metadate	Amphetamine	MOA: release and/or inhibit reuptake of D and NE Increased attentiveness, decreased disruptiveness	Decreased appetite, nervousness, weight loss, sleep difficulties, irritability, hypertension, tachycardia
	Mixed dextroamphetamine-amphetamine salts	Adderall	Amphetamine	MOA: release and/or inhibit reuptake of D and NE	Decreased appetite, nervousness, weight loss, sleep difficulties, irritability, hypertension, tachycardia
	Dextroamphetamine	Dexedrin, Dextrostat (labeled Adderall in Canada)	Amphetamine	Not commonly used	Decreased appetite, nervousness, weight loss, sleep difficulties, irritability, hypertension, tachycardia
	Modafinil (“cognitive enhancer”)	Provigil	Wakefulness-promoting agent	MOA: possible alpha-1 agonist and inhibition of GABA release centrally Indicated for sleep apnea, narcolepsy, fatigue due to multiple sclerosis Caution in those with cardiac disease, liver or renal insufficiency, psychosis	Hypertension, arrhythmias, tachycardia, syncope, nausea, diarrhea, headache, insomnia, nervousness
Nostimulants	Atomoxetine HCL	Strattera	Selective NE reuptake inhibitor	MOA: selective inhibition of the presynaptic NE transporter Reduce symptoms of ADHD and anxiety Must increase dose slowly	Upset GI, sedation, fatigue, dry mouth, increased sweating, hypertension, rarely hepatotoxic, increased suicidality
	Bupropion	Wellbutrin, Zyban	Aminoketon	MOA: D and NE reuptake inhibitor Reduce irritability, impulsivity, and improve attention dysfunction Not commonly used as monotherapy but may be useful as adjuvant	Drowsiness, anorexia, tics, potential seizures
	Antidepressants 1. Imipramine 2. Nortriptyline 3. Amitriptyline 4. Desipramine	1. Tofranil 2. Pamelor 3. Elavil 4. Nopramin	Tricyclic	MOA: block reuptake of D and NE Usually not recommended for competitive athletes due to side effect profile FDA “Black Box” warning for use in adolescents	Anticholinergic effects (eg, dry mouth, sweating abnormalities), ECG changes, drowsiness/sedation, increased suicidality
	Clonidine	Catapres	Alpha-2 agonist	MOA: alpha-2 agonists Not commonly used as monotherapy but may be useful as adjuvant Consider patch for smooth drug release	Sedating postural hypotension, dry mouth, fatigue, dizziness, aggravation of preexisting cardiac arrhythmias, profound withdrawal effects

MOA, mechanism of action; D, dopamine; NE, norepinephrine; GABA, γ -aminobutyric acid; HCL, hydrochloric acid; FDA, Food and Drug Administration; ECG, electrocardiogram. Adapted with permission from the American Medical Society of Sports Medicine.⁶⁷

cautious approach with return to play in athletes with a prior diagnosis of ADHD.

Increased Risk of Injury or Prolonged Symptoms

Children with ADHD are more likely to be injured than children without ADHD in free play activities.³⁷ The underlying problem of injury risk in children with ADHD is that they anticipate fewer negative consequences, expect less severe injury, and report greater likelihood of participating in risky behavior even though they recognize hazards at similar levels compared with control children.⁴¹ Five- to 14-year-old children with ADHD were more likely to have severe head injuries than children without ADHD. However, children with ADHD had fewer sports-related injuries.³⁷ However, Clendenin et al²⁹ showed a positive correlation between ADHD and sports-related injury in children 5 to 13 years of age. Currently, it is unclear whether ADHD predisposes children to sports-related injuries.

At this time no studies demonstrate patients with ADHD are at an increased risk of suffering from a sports-related concussion. However, individuals with low attention levels may be more prone to participate in fast-paced, unpredictable sports, therefore increasing the opportunity for head injury.⁴⁰ Because of the common symptoms of ADHD and concussion, good baseline assessment of cognitive factors should be conducted to assist in making return-to-play decisions for an athlete with ADHD after concussion.

Secondary ADHD in Traumatic Brain Injury

Secondary ADHD (SADHD) develops after TBI. SADHD can follow severe TBI but has only been seen after moderate TBI in patients with pre-injury ADHD traits.⁵⁹ There are no conclusive studies that demonstrate brain injury following mild TBI as the primary factor for SADHD.⁵⁹

Utility of Neuropsychologic Testing

Individuals with ADHD show deficits in executive functions (cognitive processes that maintain an appropriate problem-solving set to attain a future goal).¹⁰ There are differences in pen-and-paper neuropsychologic testing results when comparing individuals with TBI and ADHD.^{7,82} To differentiate

neuropsychiatric findings in TBI and ADHD patients, neuropsychologic evaluations were used with 90 children.⁸² Thirty children (mean age, 10.7 years) after moderate to severe TBI had significantly lower focus factor scores, while 30 children with ADHD (mean age, 10.6 years) had lower sustained scores. Both groups had lower encode factor (attention, concentration, and numeric reasoning) scores than controls (mean age, 11 years).

Adults with TBI or ADHD had more difficulty with attention tasks than controls.⁷ Those with mild TBI had slower responses while those with ADHD had higher levels of impulsivity.⁷ Based on these studies, differences do exist between moderate TBI and ADHD on neuropsychologic testing, but there are no studies examining patients with mild TBI or concussion versus patients with ADHD.

Neurocognitive testing was computerized to make neuropsychologic testing more widely available. Adolescents (ages 13-19 years) with self-reported ADHD tested lower on visual memory, processing speed, and right-left orientation and inhibition than controls without ADHD on Immediate Post-concussion Assessment and Cognitive Testing (ImPACT).⁵¹ There was no significant difference for verbal memory or reaction time.^{42,51} Baseline ImPACT testing showed a difference in symptoms, verbal memory, motor, and reaction time in Division I collegiate athletes with self-reported ADHD compared with normal controls.^{48,76} However, computer-based neuropsychologic tests should not be used to diagnose a learning disability or ADHD. If the results of baseline testing cause suspicion of a learning disability, referral to a neuropsychologist may be needed.⁵⁶ Since normative data may not apply to those with ADHD, having a quality baseline evaluation to compare with postinjury testing may be best for treating athletes with ADHD after a head injury.¹⁴

CONCLUSION

Many athletes with ADHD can participate at all levels of competition while undergoing treatment. The team physician should be current on the diagnosis and proper medical management and aware of the potential side effects of effective treatment. The relationship between ADHD and concussion injuries is currently unknown.



Clinical Recommendations

SORT: Strength of Recommendation Taxonomy

A: consistent, good-quality patient-oriented evidence

B: inconsistent or limited-quality patient-oriented evidence

C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
The diagnosis of ADHD is made after exclusion of other potential diagnoses and fulfillment of delineated <i>DSM-IV</i> criteria.	A
The gold standard of treatment of ADHD involves of stimulant medication and behavioral modification.	C
Exercise may improve ADHD symptoms in the athlete with ADHD.	C
Team physicians must be aware of the regulations and requirements for the pharmacologic management of ADHD based on the athlete's level of competition. Therapeutic Use Exemption forms may be required.	A
Exercising in hot environments while taking specific medications for ADHD may pose an increased risk for heat injury.	C
Withholding stimulant medications for the treatment of ADHD due to fear of abuse is not justified. Treatment of the athlete with ADHD reduces the risk of subsequent substance abuse.	A

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