

# Attention-deficit/hyperactivity disorder in elite athletes: a narrative review

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## ABSTRACT

Attention-deficit/hyperactivity disorder (ADHD) is a common brain developmental disorder in the general population that may be even more prevalent in elite athletes in certain sports. General population studies of ADHD are extensive and have reported on prevalence, symptoms, therapeutic and adverse effects of treatment and new clinical and research findings. However, few studies have reported on prevalence, symptoms and treatments of ADHD in elite athletes. This narrative review summarises the literature on symptoms, comorbidities, effects of ADHD on performance and management options for elite athletes with ADHD. The prevalence of ADHD in student athletes and elite athletes may be 7%–8%. The symptoms and characteristics of ADHD play a role in athletes' choice of a sport career and further achieving elite status. Proper management of ADHD in elite athletes is important for safety and performance, and options include pharmacologic and psychosocial treatments.

## INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is a common brain developmental disorder with a worldwide prevalence ranging from 2.5% to 7.2%.<sup>1</sup> Its essential features are a persistent pattern of age-inappropriate inattention and/or hyperactivity-impulsivity causing dysfunction in multiple settings (which may include academic, work or sport settings) and interpersonal relationships since prior to the age of 12.<sup>1</sup>

The purposes of this narrative review are to (1) synthesise the literature on the diagnosis, prevalence, effect on performance and management of ADHD in elite sport and (2) provide recommendations based on what is currently known. One of the authors (MH—an experienced librarian) searched key databases (PubMed, SportDiscus, PsycINFO, Scopus and Cochrane) and repeated the searches in November 2018 (3 months before intended submission). Search terms relating to ADHD, sports participation and the elite nature of participation were combined. Reference lists of identified articles, which must have been available in English, were then used by the other authors to identify related references. Other literature was also reviewed, where there were gaps in athlete-specific literature, for guidance on diagnosis, prevalence, functional impairment and management. Elite athletes were defined as those competing at professional, Olympic or collegiate/university levels.

## Diagnosis, prevalence and comorbidity of ADHD in elite athletes

A formal diagnosis of ADHD may be made based on an athlete's symptoms and history using the criteria in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)<sup>2</sup> (table 1). Patients with ADHD show a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, and includes at least 6 months of at least six symptoms from the 'inattention' or 'hyperactivity and impulsivity' category (combined type ADHD includes at least six symptoms from each of these categories).<sup>2</sup> Additional tests that may support a diagnosis, rule out other conditions, or both, include neurocognitive and laboratory testing. In a meta-analysis, children with ADHD showed deficits of executive functions, including planning, spatial and verbal working memory, response inhibition and vigilance.<sup>3</sup> These may be apparent and supportive of an ADHD diagnosis during neurocognitive testing of individuals suspected of having this disorder.<sup>3</sup>

Laboratory testing can help to rule out substance use, which can mimic ADHD symptoms.<sup>4</sup> Neuroimaging as a diagnostic tool for ADHD is controversial, with inconclusive evidence to support its use,<sup>1</sup> and protocols do not routinely recommend use of neuroimaging for this purpose. This is despite MRI studies that reveal volumetric and brain connectivity patterns associated with ADHD (table 1). Specifically, brain volumetric measurements reported volume reduction within the basal ganglia,<sup>5</sup> cerebellum<sup>6</sup> and frontal lobe.<sup>7</sup> Further, Shaw *et al.* demonstrated evidence of delayed rates of thinning in cortical thickness, suggesting that children with ADHD showed a delay in brain maturation.<sup>8</sup>

There are few studies regarding the prevalence of ADHD in elite athletes. Stigma against both mental health assessment and treatment among elite athletes can be strong,<sup>9</sup> and makes it difficult to estimate the true prevalence of ADHD in elite athletes. In a meta-analysis of ADHD in adults, 30% of those diagnosed with ADHD in childhood continue to meet ADHD criteria as adults.<sup>9,10</sup> Based on this rate, the prevalence of ADHD in adults may range from 0.8% to 2.4% in the general population.

ADHD may be more common in elite athletes than in the general population, since children with ADHD may be drawn to sport due to the positive reinforcing and attentional activating effects of physical activity.<sup>9,11</sup> In a systematic review of 17 studies of ADHD, the prevalence of ADHD in athletes aged 15–19 years ranged from 4.2% to 8.1%.<sup>12</sup> In Parr's observation, 50 of 701 elite athletes (7.1%) at one



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**Table 1** Clinical symptoms, neurocognitive testing findings and brain imaging findings in attention-deficit/hyperactivity disorder (ADHD)

Clinical symptoms <sup>2</sup>	
Inattention (note: only five or more symptoms from this category required in individuals aged ≥17 years)	Hyperactivity and impulsivity
<ul style="list-style-type: none"> <li>▶ Often fails to give close attention to details or makes careless mistakes</li> <li>▶ Often has difficulty sustaining attention in tasks or play</li> <li>▶ Often does not listen when spoken to directly</li> <li>▶ Often cannot follow through on instruction and fails to finish schoolwork, chores or workplace duties</li> <li>▶ Often has difficulty organising tasks and activities</li> <li>▶ Often has difficulty engaging in tasks that require sustained mental effort</li> <li>▶ Often loses things</li> <li>▶ Often easily distracted by extraneous stimuli (in older adolescents and adults, by unrelated thoughts)</li> <li>▶ Often forgetful in daily activities</li> </ul>	<ul style="list-style-type: none"> <li>▶ Often fidgets or taps hands or feet or squirms in seat</li> <li>▶ Often leaves seat in situations when remaining seated is expected</li> <li>▶ Often runs about or climbs in situations where it is inappropriate</li> <li>▶ Often unable to play or engage in leisure activities quietly</li> <li>▶ Often 'on the go', acting as if 'driven by a motor'</li> <li>▶ Often talks excessively</li> <li>▶ Often blurts out an answer before a question has been completed</li> <li>▶ Often has difficulty waiting for their turn</li> <li>▶ Often interrupts or intrudes on others</li> </ul>
Neurocognitive testing findings supportive of a diagnosis of ADHD <sup>1,8</sup>	
Attention	Errors of omissions and commissions
Memory	Decreased function in verbal/visual memory
Motor	Decreased function in visual motor and reaction time
Others	Decreased function in working memory, set shifting, response inhibition, intelligence, achievement and planning/organisation
Brain imaging findings (research findings but not used for diagnostic purposes)	
Anatomic MRI <sup>81</sup>	<ul style="list-style-type: none"> <li>▶ Decreased volume in basal ganglia, cerebellum, frontal, parietal and occipital lobe</li> <li>▶ Delayed maturation of cortex (delayed rate of cortical thinning)</li> </ul>
Functional MRI (fMRI)	<ul style="list-style-type: none"> <li>▶ Decreased activity within frontobasal ganglia network, occipital, parietal and temporal areas in response to motor response, interference inhibition and switching task</li> <li>▶ Decreased activity within frontoparietal area in response to working memory task</li> <li>▶ Decreased synchrony between anterior and posterior parts of default mode network (DMN) (resting-state fMRI)</li> <li>▶ Reduced anticorrelations between DMN and attention network</li> </ul>

US university during the 2009–2010 academic year were taking stimulant medication for ADHD.<sup>13</sup> Major League Baseball (MLB) in the USA annually publishes the number of players who receive a Therapeutic Use Exemption (TUE)—a process that allows athletes to request permission to take a medication that is on the World Anti-Doping Agency (WADA) Prohibited List—for stimulants prescribed for ADHD. For the 2017–2018 off-season to the end of the 2018 season, 101 players (approximately 8.4%) were granted TUEs for ADHD.<sup>14</sup>

Of the four major American professional sports leagues (ie, MLB, National Football League, National Basketball Association and National Hockey League), only MLB publishes an annual report on TUEs. However, the 8.4% prevalence noted in the MLB 2018 annual report potentially underestimates the prevalence of ADHD in this population for at least two reasons.<sup>15</sup> First, the clinical standards that are required to attain a TUE within the MLB policy are significantly higher than a community standard to establish a diagnosis. There are athletes who have been diagnosed and prescribed stimulants in the community who do not meet the standards of the MLB policy, and thus would be excluded from the total numbers. Second, there are athletes who have been diagnosed with ADHD, but have been treated with a non-stimulant medication or no medication, and thus would not be reported to the league's Independent Program Administrator for inclusion in the report.

Making a differential diagnosis and assessing comorbidities are important in diagnosing and managing ADHD whether in the general population or elite athletes. Conditions that might be comorbid or that might also explain ADHD-like symptoms include mood disorders (eg, major depressive and bipolar disorders), anxiety and related disorders, intellectual and learning disorders, oppositional defiant disorder, autism spectrum

disorder, substance use disorders and concussion. Shared features of these diagnoses are summarised in [table 2](#). In particular, concussion is frequently reported in athletes as a comorbidity with ADHD, with the core symptoms of poor concentration, possible deficits in memory, easy fatigue, mood fluctuation and anxiety frequently observed in both.<sup>16–18</sup> Collegiate athletes with ADHD are more likely to report a past history of concussions than those without ADHD,<sup>19</sup> and ADHD is associated with prolonged recovery following sport-related concussion in athletes.<sup>20</sup> A final diagnostic consideration is that the common and normative sport-related hyperactivity seen in some athletes may be hard to distinguish from ADHD.<sup>21</sup>

### The negative effects of ADHD on performance and safety in elite athletes

The symptoms of lack of focus and concentration, oppositional behaviour, argumentative attitude, frustration, lowered self-esteem and labile mood found in ADHD may impair athletic performance.<sup>22</sup> The neurocognitive symptoms of ADHD, including poor concentration and memory deficits, may cause academic difficulties that could threaten the academic eligibility of collegiate athletes.<sup>22</sup> Compared with implicit (procedural) learning and implicit memory, deficits in explicit learning and explicit memory have been reported in adults with ADHD.<sup>23</sup> Similarly, implicit learning was reported to be spared in children with ADHD.<sup>24</sup> However, while Pedersen and Ohrmann<sup>25</sup> have reported that adults with ADHD showed unimpaired implicit learning performance, they also showed reduced efficiency of the inhibition of incorrect response in implicit sequence learning. These results might explain why some elite athletes

**Table 2** Differential diagnosis of attention-deficit/hyperactivity disorder (ADHD)<sup>23 14</sup>

Disease	Shared features	Differences
Oppositional defiant disorder (ODD)	Resisting work or school tasks	Due to negativity, hostility and defiance (ODD) Due to difficulty in sustaining mental effort, forgetting instruction and impulsivity (ADHD)
Intermittent explosive disorder (IED)	High level of impulsive behaviour	Serious aggression towards others; no attention problems (IED) Less aggression; prominent attention problems (ADHD)
Autism Spectrum Disorder (ASD)	Dysfunctional motor behaviours	Fixed and repetitive stereotypic movements (ASD) Fidgetiness and restlessness (ADHD)
Specific learning disorder (LD)	Learning problems	Not impaired outside of academic work (LD) Due to inattention due to frustration or lack of interest (ADHD)
Intellectual disability (ID)	Inappropriate and low intellectual ability in academic setting	In all other life activities (ID) Not evident during non-academic tasks (ADHD)
ASD	Inattention, social dysfunction and behavioural outbursts	Due to inability to tolerate a change from their expected course of events (ASD) Due to impulsivity or poor self-control (ADHD)
Reactive attachment disorder (RAD)	Social disinhibition	Lack of enduring relationships; no full ADHD symptom cluster (RAD) No lack of enduring relationships; full ADHD symptom cluster (ADHD)
Anxiety disorders (Anx)	Inattention	Due to worry and rumination (Anx) Due to attraction to external stimuli, including new or enjoyable activities (ADHD)
Depressive disorders (Dep)	Inability to concentrate	Prominent only during depressive episode (Dep) Always present (not episodic) (ADHD)
Bipolar disorder (BD)	Increased activity, poor concentration and impulsivity	Accompanied by elevated mood and grandiosity occurring in episodes that last a minimum of several days; rare in preadolescence (BD) Significant mood change within same day (ADHD)
Personality disorders (PD)	Disorganisation, social intrusiveness, emotional dysregulation and cognitive dysregulation	Other clinical feature of borderline, narcissistic and other personality disorders (PD) No fear of abandonment, self-injury or extreme ambivalence (ADHD)
Concussion (CC)	Poor concentration, memory deficits and mood fluctuation	Decline in neurocognitive testing after head injury compared with baseline (CC) No change of neurocognitive function in tests (ADHD)

make frequent and successive errors of the same type in complex sports situations.

In a study of Korean professional baseball rookies over three seasons from 2009 to 2011, elite players with a high draft ranking showed better working memory (complex attention memory) and increased brain activation in response to the Wisconsin Card Sorting Test, compared with players ranked in the lower 30% of all players drafted.<sup>26</sup> These results suggest that elite players may employ flexible shifting via increased brain activation within the prefrontal cortex in response to complex situations, and that athletes with ADHD might be less able to use this flexible shifting.<sup>26</sup>

Additionally, commonly described comorbid conditions such as depression, anxiety and substance use disorders in ADHD may impair sports performance.<sup>22</sup> Along with functional impairment, including that in social functioning, individuals with ADHD have a higher risk of developing mood (such as depression) and anxiety disorders.<sup>27 28</sup> A literature review found that of ADHD, mood disorders and substance use disorders, co-occurrence of two of these disorders was commonly reported in adult athletes with ADHD.<sup>29</sup> The impulsivity in ADHD is thought to increase the risk of substance misuse or substance use disorders.<sup>29</sup> Overlapping symptoms between ADHD, mood, anxiety and substance use disorders may present barriers to effective diagnosis and treatment.<sup>30 31</sup> Unstable emotions or emotional dysregulation can be one of the distinctive features of ADHD in adults, and may be misdiagnosed as a mood disorder.<sup>30 31</sup> Most clinicians are more familiar with mood and anxiety disorders than ADHD, which can lead to misdiagnosis, underdiagnosis and undertreatment of ADHD in adult populations.<sup>32 33</sup> Based on studies in the general population, ADHD symptoms such as impulsive and aggressive behaviours in elite athletes could be misunderstood as manifestations of substance use.<sup>34</sup> Conversely, high stress,

depressive mood and anxiety in elite athletes could manifest as a consequence of undiagnosed and untreated ADHD.<sup>35</sup>

The negative consequences of ADHD may compromise health and safety of adults with ADHD. Adults with ADHD are reported to drive cars more recklessly and have a higher incidence of traffic citations and vehicle accidents.<sup>36</sup> In Japan, adults with ADHD were reported to visit the emergency room 10 times more than non-ADHD adults, and were hospitalised three times more than non-ADHD adults.<sup>37</sup> Additionally, adults in Denmark with ADHD showed lower life expectancy and double the risk of death compared with non-ADHD adults.<sup>38</sup> Thus, while the influence of ADHD on athletic performance warrants consideration, clinicians must keep in mind the substantial risks of this disorder for an individual's overall health and safety.<sup>25</sup>

### The positive effects of ADHD on performance in elite athletes

Common symptoms of ADHD may enhance athletic performance. Some athletes with ADHD naturally excel in baseball and basketball, which involve quick movements and reactive decision-making, due to these athletes' inherent impulsivity.<sup>13</sup> Many children with ADHD were reported to 'hyperfocus' (highly focus) on their own enjoyable activities without being distracted by regular life activities.<sup>39</sup> The 'hyperfocus' traits in elite athletes with ADHD may block out distractions during practice and competition. However, positive effects of ADHD in athletes have not been systemically studied. In personality studies, patients with ADHD are known to have higher scores in novelty seeking (NS).<sup>40</sup> In a 5-year cohort study of Korean professional baseball players, starting team members had a higher NS and reward dependence scores compared with non-starter members.<sup>41</sup> The trait of NS was associated with impulsivity

and hyperactivity,<sup>40 42</sup> as well as exhilaration and excitement in response to novel stimuli or cues for potential rewards.<sup>42</sup>

ADHD may play an important role in career choice for athletes with this disorder. For example, spared implicit memory and deficits in explicit memory have been reported in adults with ADHD.<sup>23 24</sup> Explicit learning and memory are associated with academic abilities.<sup>43</sup> Consequently, children with ADHD may focus more on areas where they are successful, possibly including sports, since physical activity disproportionately requires implicit memory.

### The effects of sports and exercise on symptoms of ADHD

Physical activity and sports may improve the symptoms of ADHD and symptoms often comorbid with ADHD, specifically inattention, depressive mood, anxiety and impaired cognition. Children with ADHD who participated in three or more sports activities were reported to have fewer anxiety and depressive symptoms, compared with those who participated in two or fewer sports activities.<sup>43</sup> Sports participation itself can be a physical outlet for intense emotions and stress, and therefore may help reduce ADHD symptoms.<sup>44</sup> Additionally, improved clinical symptoms of ADHD via physical activity and sports may relate to increased brain activity within the prefrontal cortex and increased brain functional connectivity from anterior to posterior brain regions.<sup>45 46</sup> The combination of 6 weeks of aerobic exercise and methylphenidate treatment greatly increased brain activity within the prefrontal cortex in adolescents with ADHD, and improved attention and perseverative errors, compared with 6 weeks of education and methylphenidate treatment.<sup>45</sup> Similarly, 4 weeks of equine-assisted activity and training improved inattention, gait balance and brain connectivity from frontal lobe to cerebellum in children with ADHD.<sup>46</sup>

### ADHD management in elite athletes

Considerations in ADHD management include (1) symptom reduction; (2) functioning improvement (eg, social, academic, interpersonal and athletic); (3) quality of life; (4) improvement of comorbid conditions and (5) safety and tolerability of medications.<sup>47</sup> ADHD management can be generally divided into two domains: psychosocial interventions (which include psychotherapy) and medications. In general, the consensus among sports providers is that psychosocial interventions should be the foundation of management of ADHD, with medication management if necessary.<sup>9 48</sup>

### Psychological interventions

Psychosocial interventions for ADHD must account for the age and educational level of the athlete. These interventions include behaviour therapy, cognitive behavioural therapy, individual education plans, parent teaching and training, caregiver support, mental skills training and education for athletes, families and coaches.<sup>11</sup> Cognitive behavioural therapy in group settings include brief group therapy,<sup>49</sup> metacognitive therapy<sup>50</sup> and cognitive behavioural group rehabilitation.<sup>51</sup> Dialectical behavioural group therapy consists of an interpersonal skills module, hyperactivity and disorganisation in the tolerating discomfort module, emotional instability and impulsivity in the regulation of emotions module and inattention in the mindfulness module.<sup>52</sup> There are several reasons why psychosocial treatments for ADHD are important: (1) patients with ADHD face problems beyond ADHD's core symptoms of inattention, hyperactivity and impulsivity; (2) patients with ADHD have daily life dysfunctions in various areas including academic achievement

and behaviour at school, and relationships with peers and family members and (3) these areas of dysfunction may predict poor long-term outcomes for children with ADHD.<sup>52</sup> Psychosocial interventions provide an avenue to focus on such problems in addition to the core symptoms of ADHD.<sup>53</sup>

Psychosocial interventions may be as effective as medications in athletes with mild functional impairment.<sup>54</sup> Some clinicians recommended managing athletes with ADHD via psychosocial interventions as an *alternative* to medication.<sup>9 21 55-57</sup> In a meta-analysis, psychosocial interventions were recommended as a high-value treatment for core clinical symptoms and global function in adults with ADHD.<sup>11 48 53 56</sup>

Preliminary research demonstrates that neurofeedback or electroencephalogram biofeedback may have utility for the management of ADHD symptoms in those who experienced adverse effects from medications for ADHD treatment.<sup>14</sup> The working mechanism of neurofeedback may relate to operant conditioning theory,<sup>58</sup> which is a method of learning with rewards and punishments for regulating behaviours. In neurofeedback, self-regulation of brain activity may be derived from operant conditioning.<sup>59</sup> However, the biological processes at the cellular level are not understood,<sup>60</sup> and no research on this modality has been conducted with athletes.

### Medication management

Medication management for ADHD is usually divided into stimulants and non-stimulants. Stimulants (methylphenidate and amphetamine compounds) are the primary pharmacologic treatments for ADHD in the general population and in elite athletes.<sup>9 21 28 56 61</sup> While mechanisms are not fully understood, stimulants may work via activation of dopamine and noradrenergic systems.<sup>61 62</sup> This activation may lead to improved attention and concentration. However, these medications may also cause side effects including increased heart rate and blood pressure, abdominal pain, headache, anorexia, sleep impairment, weight loss, jitteriness and constipation. If not addressed clinically, these side effects can impair performance and/or threaten athlete safety.<sup>63 64</sup>

Overall, child and adult athletes with ADHD treated with stimulants reported better outcomes in attention to task, balance and acceleration compared with non-stimulant-treated athletes with ADHD.<sup>9 65</sup> However, adult athletes with ADHD taking stimulants have also reported different side effect profiles compared with those with ADHD in the general population, including lack of creativity, lack of spontaneity, palpitations, sweating and irritability.<sup>61</sup> Additionally, prescribers must be cautious in prescribing stimulant medications if the athlete is participating in endurance events in hot temperatures because of an increased risk of heat illness.<sup>66</sup> Stimulants appear to interfere with thermoregulation, leading to higher core temperature when exercising in hot environments.<sup>67 68</sup> Prescribers must also be cautious if an athlete has risk factors for cardiovascular disease.<sup>9 54 55</sup> Sudden cardiac death has been described in elite athletes taking stimulants, possibly as a result of lowered threshold for cardiac arrhythmias.<sup>69</sup>

Sometimes, stimulants are misused by athletes because of the perception of performance enhancement.<sup>9 55 61 70 71</sup> For example, athletes who are taking stimulants may be able to exercise to higher core body temperatures without perceived thermal stress.<sup>68</sup> Like ergogenic effects experienced with classic stimulants, the psychostimulant modafinil can mask symptoms of fatigue.<sup>72</sup> Athletes in leanness sports (eg, distance running, gymnastics, diving and figure skating) or in sports with weight

classes (eg, wrestling and lightweight rowing) sometimes misuse stimulants for weight loss or for a performance advantage.<sup>21 61</sup>

Stimulants are prohibited by WADA in competition.<sup>73</sup> If stimulants are prescribed for elite athletes, a TUE must be applied for and approved.<sup>73</sup> Long-acting formulations should be considered first as they are more convenient and less likely to be misused.<sup>54 55</sup> Specifically, long-acting formulations have a slower rise and fall of stimulant levels in the brain,<sup>74</sup> which might explain their decreased drug misuse potential.<sup>74</sup> Short-acting formulations can be used during study periods, team meetings or film review and not during practices and competition if coaches/clinicians have concerns about safety and effects on performance.<sup>54 55 61</sup>

A key component of the medical management of the elite athlete with ADHD who is prescribed stimulants is a close collaboration between the psychiatrist (or other prescriber), athletic trainer and primary care sports physician. Nutritionists are another important collaborator in some situations. This team approach allows for safer use of the stimulant medications while being able to monitor blood pressure, hydration and nutritional needs during both training and competition.<sup>54 55 67 68</sup> Education and counselling around the dangers of stimulant stacking and alcohol and drug misuse while taking stimulants are also key components of the medical management of the elite athlete with ADHD.<sup>75</sup>

Another important consideration is for the involved providers to have or acquire knowledge of the sport in which the individual competes.<sup>15</sup> Knowledge of the training and competition schedules and associated physical demands are important considerations when individualising a pharmacologic regimen.<sup>15</sup> For example, many elite athletes may have very long days that may begin with family responsibilities in the morning hours prior to arriving at the practice or competition venue, with their sport-related work day then extending until late in the evening. Medical management of these athletes to optimise ADHD symptom control can require split dosing of a long-acting stimulant or one long-acting stimulant followed by a short-acting one with careful attention to not suppress appetite or exacerbate sleep difficulties.<sup>15 75</sup>

If medications are clinically necessary for an elite athlete with ADHD, non-stimulant medications should be considered.<sup>21 55 61</sup> Atomoxetine may be the most recommended medication for ADHD treatments among sports psychiatrists, due to the regulatory and safety drawbacks of stimulants.<sup>21</sup> However, atomoxetine also has side effects that limit its use, including gastrointestinal discomfort, weight loss, sedation, acute liver injury and increased suicidality.<sup>61 76</sup> In addition, it takes a significantly longer time (eg, 3–6 weeks) to get full benefit from atomoxetine compared with stimulants.<sup>13 21</sup>

Bupropion, an antidepressant with some stimulant properties via dopamine and norepinephrine reuptake inhibition, is sometimes used off-label for ADHD,<sup>9 77</sup> especially for individuals with comorbid depression. In addition, the alpha-2 agonists clonidine and guanfacine in extended-release formulations are approved in some countries for use in children under the age of 18 with ADHD.<sup>78</sup> In a systematic review and meta-analysis of 12 studies of ADHD, alpha-2 agonist monotherapy improved overall ADHD symptoms of hyperactivity, impulsivity and inattention, as well as comorbid oppositional defiant disorder symptoms.<sup>78</sup> However, there are possible side effects, including sedation and cardiac side effects such as hypotension, bradycardia and QTc prolongation.<sup>78 79</sup> Tricyclic antidepressants are also sometimes used as off-label medications for ADHD,<sup>80</sup> but side effects including sedation, weight gain, cardiac arrhythmias and dry mouth may be absolute barriers for use in elite athletes.<sup>22</sup>

## CONCLUSION

The symptoms and characteristics of ADHD may play a salient role in a person choosing a career in sport and competing at elite levels; the overall impact may be positive or negative. The management of ADHD in elite athletes may have important effects on safety and performance. Clinical collaboration with team physicians and athletic trainers are crucial to reduce safety concerns and to ensure the athlete does not violate anti-doping rules. The focus of management should be on long-term outcomes for elite athletes in sport and life.

### What is already known

- ▶ The prevalence of attention-deficit/hyperactivity disorder (ADHD) in elite athletes may be as high or higher than in the general population.
- ▶ ADHD may limit sport performance of elite athletes.
- ▶ If stimulants are prescribed for elite athletes, prescribers must be aware of the safety and tolerability issues and anti-doping rules relevant to this population.

### What are the new findings

- ▶ The positive and negative aspects of ADHD may play a role in choosing a career in sports.
- ▶ Sports activity may reduce ADHD symptom frequency and severity in elite athletes.
- ▶ Psychosocial interventions may be as effective as medications to manage ADHD. These are recommended, with or without medications, for elite athletes with this disorder.

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