ADHD in Athletes and Implications for Play

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Disclosures

No disclosures

Objectives

- Vulnerable populations
- Diagnosis of ADHD in athletes
- Treatment considerations
- Sports injuries and impact of ADHD
  - Head injury
  - Musculoskeletal injury

Prevalence of ADHD in Athletes

- General population: 5-9% children and 2.5% adults
- Exact rates in athletes unknown
  - 4 -8 % among athletes 15-19 years old
- ADHD influences participation in sport

(Poysophon et al 2018)

Diagnostic Criteria

Inattention:

- Fails to give close attention to details, makes careless mistakes
- Difficulty sustaining attention
- Doesn’t listen when spoken to
- Problems organizing tasks/activities
- Avoids task that require sustained mental effort
- Loses things necessary for tasks/activities
- Easily distract
- Forgetful

Hyperactivity and Impulsivity:

- Fidgets with hands and feet
- Leaves seat when its inappropriate
- Excessively active or feelings of restlessness
- Difficulty engaging in quiet leisure actives
- Talks excessively
- Blurts things out while in conversation
- Can’t wait turn
- Interrupts others in activities or discussions

Diagnostic Criteria

- Six or more symptoms of either type for children up to age 16
- Five or more symptoms of either type for adolescents 17 and older and adults
- > 6 months
- Present before age 12
- Not developmentally appropriate
- In multiple settings
- Not due to another cause

Medical treatment for athletes with ADHD

- Stimulants are mainstay therapy
- Evidence based guidelines for stimulant use
  - American Academy of Pediatrics
  - Canadian ADHD Practice Guidelines
- World Anti-doping Agency Guidelines for stimulant use in athletes with ADHD
    - Regular, stable dosing is best
    - PRN and short acting use not necessarily recommended
    - https://www.wada-ama.org/sites/default/files/resources/files/wada_tpg_adhd_6.0_en.pdf
- Monitoring for side effects

Factors dictating stimulant use in athletes

- Fair play and performance enhancement
- Negative side effects of stimulants
- Quality of life for athletes with ADHD
- Stigma and perception

Therapeutic Use Exception

- NCAA, WADA, and IOC ban stimulant use
- TUE may be issued in the case of ADHD
  - Documented history and diagnosis
  - Treatment history
  - Medication name, route, dosing and frequency
  - Duration of treatment

Interest in ADHD in athletes

- ADHD may increase risk of sports injuries
  - impulsivity
  - risk taking behavior
  - accidents
  - injuries
- ADHD represents a treatable condition

Original Investigation

Injury Prevention by Medication Among Children With Attention-Deficit/Hyperactivity Disorder

A Case-Only Study

Rafael Mikolajczyk, MD, PhD; Johannes Horn, Dipl Biomath; Niklas Schmedt, MA; Ingo Langner, PhD; Christina Lindemann, MSc; Edeltraut Garbe, MD, PhD

Table. Estimated Risk Reduction Associated With the Use of ADHD Medication[a]

Age Range for the Period at Risk, y	All Injuries			Brain Injuries		
	Person-time Exposed to Medication (in 100 000 d)[b]		Incidence Rate Ratio (95% CI)	Person-time Exposed To Medication (in 100 000 d)[b]		Incidence Rate Ratio (95% CI)
	Not Exposed	Exposed		Not Exposed	Exposed	
3-17 (Total cohort)	29.06	6.47	0.87 (0.74-1.02)	10.85	3.05	0.66 (0.48-0.91)
5-14	22.28	5.49	0.87 (0.73-1.03)	8.64	2.59	0.70 (0.50-0.97)
6-13	19.22	4.93	0.84 (0.69-1.01)	7.46	2.31	0.66 (0.46-0.93)
7-12	15.11	4.09	0.81 (0.66-1.00)	5.86	1.90	0.60 (0.40-0.88)
8-11	9.77	2.77	0.83 (0.64-1.07)	3.77	1.29	0.64 (0.34-1.04)

- Youth with active ADHD are at greater risk for sustaining injury
- In brain injury, 34% risk reduction when ADHD symptoms were controlled

Association between ADHD and Concussion

- ADHD is associated with 2.93 times the prevalence of 3+ concussions

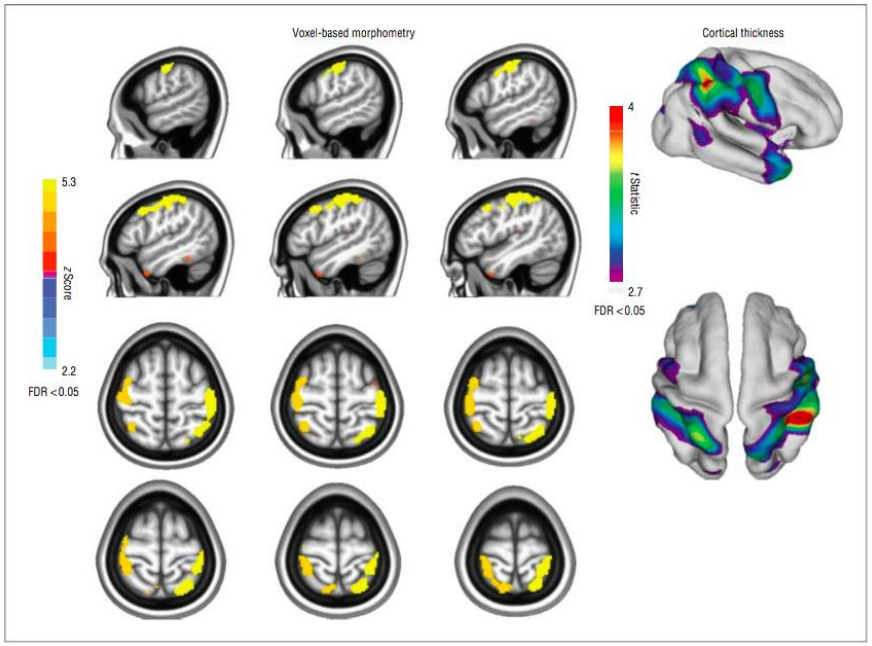
TABLE 1. Prevalence Ratio for Prior Concussions by ADHD and LD Status

Concussions	n	ADHD (% of Sample)	Prevalence Ratio (vs 0)	95% CI	LD (% of Sample)	Prevalence Ratio (vs 0)	95% CI
0	5940	3.6	—	—	3.5	—	—
1	1426	3.8	1.05	0.83-1.34	4.0	1.11	0.88-1.41
2	406	5.9	1.63	1.10-2.42	5.7	1.58	1.06-2.36
3+	284	10.6	2.93	2.05-4.19	7.4	2.08	1.36-3.18

(Nelson et al, 2016)

Structural Brain Abnormalities in ADHD

- White matter abnormalities (Davenport et al 2010)
- Low gray matter density (Ellison-Wright et al 2008)
- Reduced total brain volume (Ivanol et al 2010, Hoogman et al 2012)
- Reduced cortical thickness in adults (Makris et al 2007)
- Delayed cortical maturation in children (Shaw et al 2012)



Proal et al *Arch Gen Psychitry 2011*

Neurocognition and ADHD

- Poysophon et al 2018
  - Systematic review
  - 17 studies of neurocognitive deficits in athletes with ADHD
  - Lower scores on neurocognitive testing
  - Greater concussion symptom reporting (baseline and post injury)
  - Greater risk of concussion
  - Insufficient evidence on influence of stimulants

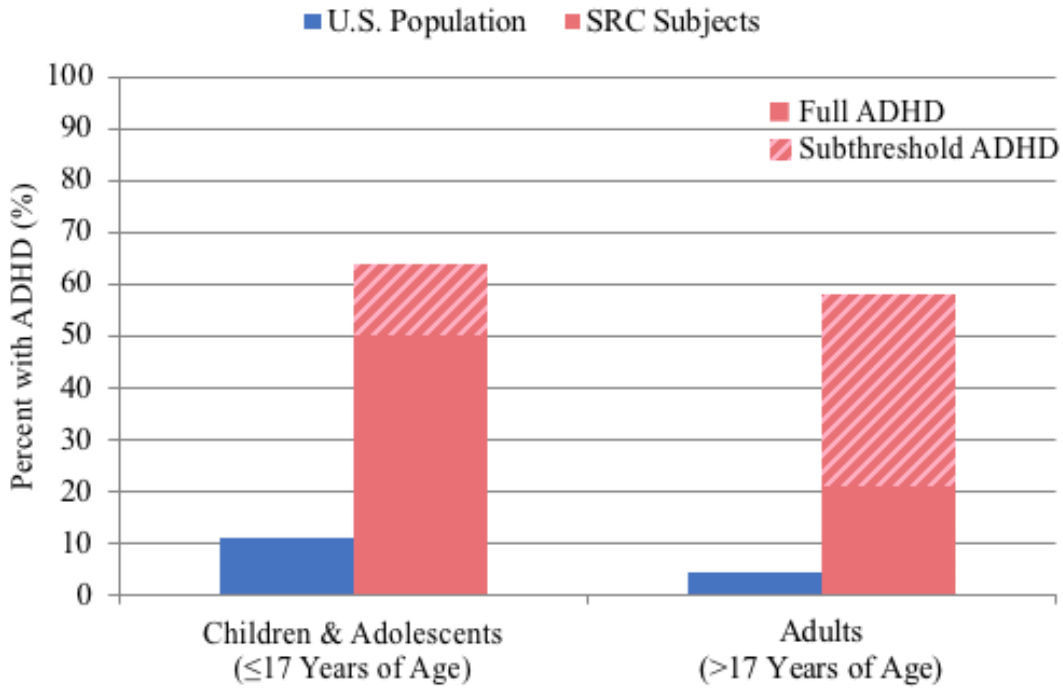
ADHD and Concussion: Clarifying the association

- Pilot study of 79 student athletes with concussion
- Symptom of ADHD, concussion severity, cognitive function
- Diagnosis of ADHD verified through clinical interview with athlete/parent

ADHD and Concussion: Clarifying the association

Student athletes had a higher rate of ADHD than the general population

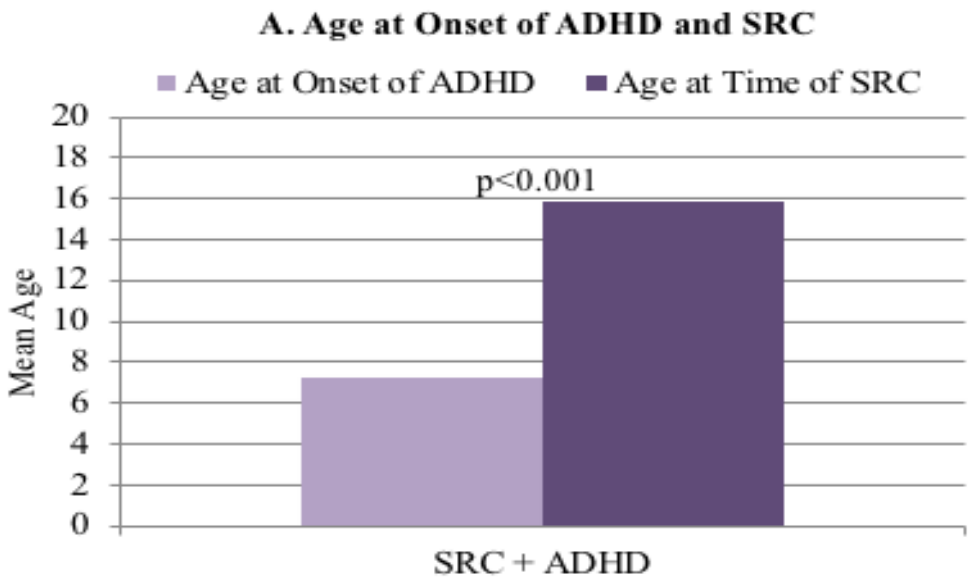
Figure 1. Rates of ADHD in the U.S. population and the SRC subjects from the current study.



Iaccarino et al, *submitted*

ADHD and Concussion: Chicken or the Egg

Mean age of onset of ADHD symptoms was lower than age of first concussion



Iaccarino et al, *submitted*

Baseline symptom reporting in athletes with ADHD

Baseline (pre-concussion) symptoms reporting is higher in athletes with ADHD

TABLE 2. Item-Level Baseline Symptom Endorsement by ADHD Status

	ADHD Only (%), n = 162	All Others (%), n = 5778	*P*
Difficulty concentrating	**34**	**10**	**<0.001**
Fatigue	**31**	**22**	**0.007**
Trouble sleeping	**25**	**13**	**<0.001**
Headache	26	22	0.193
Drowsiness	25	20	0.173
Difficulty remembering	**21**	**8**	**<0.001**
Sleeping more	16	11	0.064
Nervous	15	11	0.166
Balance problems	**14**	**7**	**0.004**
Nausea	10	8	0.334
Feeling slowed down	11	8	0.165
Sensitive to light	9	5	0.076
Sadness	9	5	0.061
Numbness/tingling	6	4	0.231
Feeling like "in a fog"	6	3	0.034
Vomiting	3	2	0.578

(Nelson et al, 2016)

ADHD and Concussion: Clarifying the association

- Although limited in size, there is preliminary evidence for:
  - ADHD as an antecedent risk factor for TBI
  - Lack of acquired ADHD
  - ADHD as a risk factor for concussion symptom severity
  - Subthreshold ADHD having similar patterns to ADHD

Neuromuscular Control: The Brain and Body

- Risk of injury to athletes with ADHD might be mediated by:

  1. Impairment of motor functions
  2. Developmental coordination difficulty

Neurocognition and Musculoskeletal Injury

- Emerging evidence that cognition may impact neuromuscular control

Concussion Increases Odds of Sustaining a Lower Extremity Musculoskeletal Injury After Return to Play Among Collegiate Athletes

M. Alison Brooks,[*†‡] MD, MPH, Kaitlin Peterson,[§] BS, Kevin Biese,[‖] BS, Jennifer Sanfilippo,[‡¶] MS, ATC, Bryan C. Heiderscheit,[†‡] PT, PhD, and David R. Bell,[†‡‖] PhD, ATC

Investigation performed at University of Wisconsin–Madison, Madison, Wisconsin, USA

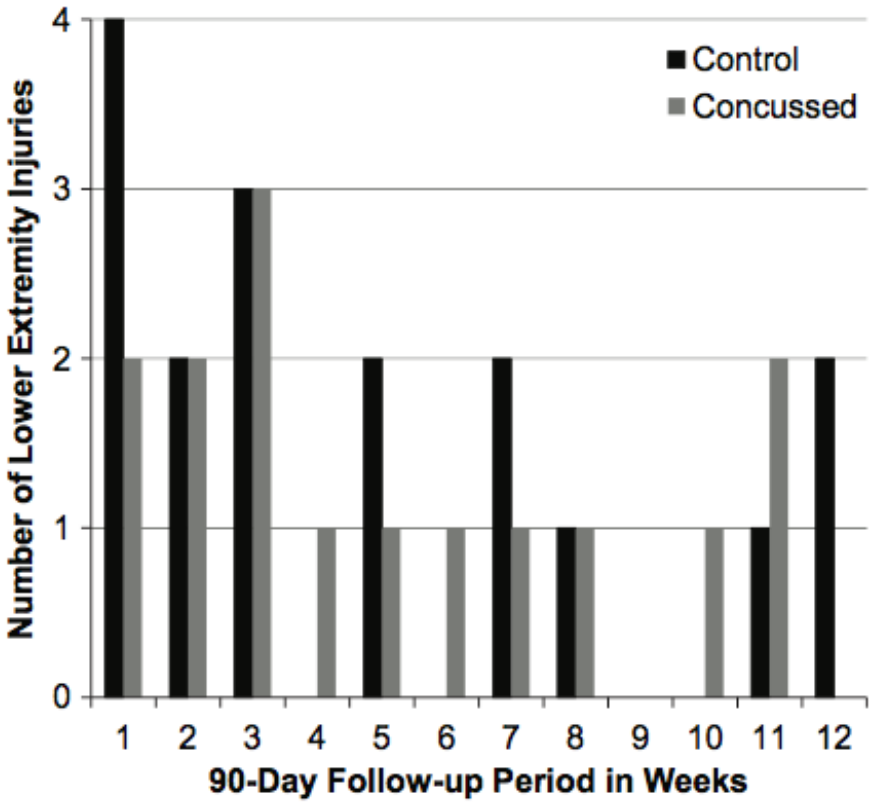
Am J Sports Med 2016 44: 742

- 87 cases of concussion among 75 athletes
- 58 men; 17 women
- NCAA Division I football, soccer, hockey, softball, basketball, wrestling, and volley ball
- Acute non-contact lower extremity injury within 90 days of concussion
- Age, sex, and sport matched controls

TABLE 2
Acute Lower Extremity Musculoskeletal Injury Occurrence in Concussed and Control Athletes

	Lower Extremity Musculoskeletal Injury, n		
Concussion	Yes	No	Total
Yes	15	72	87
No	17	165	182
Total	32	237	269

OR 2.48



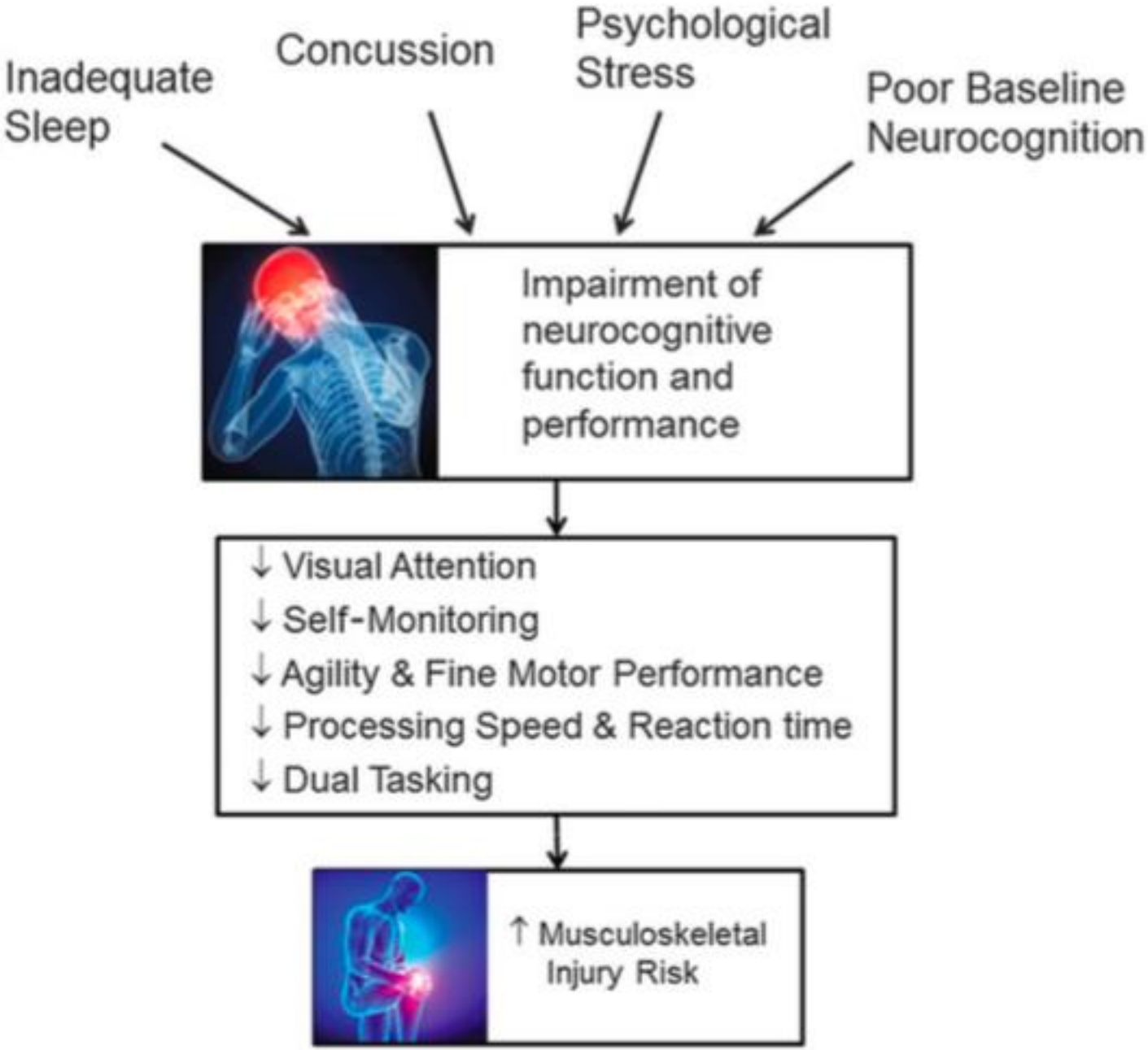
No difference was observed in days to lower extremity injury between groups

Sports-related concussion increases the risk of subsequent injury by about 50% in elite male football players

Anna Nordström,[1] Peter Nordström,[2] Jan Ekstrand[3]

- Concussion was associated with
  - an increased risk of subsequent injury
  - A progressively increased risk of injury
    - 0 to <3 months, HR=1.56
    - 3 to <6 months, HR=2.78
    - 6–12 months, HR=4.07

Nordström A, et al. *Br J Sports Med* 2014



Herman et al. *Curr Sports Med Rep*. 2015 ; 14(3): 194–199

- 37 Healthy subjects
  - Neurocognitive testing
  - Jump Landing Task

Herman and Barth *Am J Sports Med* 2016 44: 2347-53

TABLE 2
Neurocognitive Testing Results[a]

CRI Subtest	HP Group	LP Group	*P* Value
Simple Reaction Time (percentile)	67.1 ± 9.1	24.5 ± 14.3	<.01[b]
Complex Reaction Time (percentile)	80.6 ± 9.5	33.5 ± 15.9	<.01[b]
Processing Speed (percentile)	85.8 ± 7.2	65.5 ± 16.1	<.01[b]

[a]Data are reported as mean ± SD. CRI, Concussion Resolution Index; HP, higher performers; LP, low performers.
[b]Statistically significant difference between groups.

- 31% higher peak vertical ground-reaction force
- 26% higher peak proximal anterior tibial shear force

TABLE 3
Jump-Landing Test Results[a]

	HP Group	LP Group	*P* Value
Kinetics results			
Peak vertical ground-reaction force (BW)	1.38 ± 0.37	1.81 ± 0.53	<.01[b]
Peak anterior shear force (BW)	0.72 ± 0.22	0.91 ± 0.17	<.01[b]
Knee abduction moment (BW × BH)	0.03 ± 0.64	0.47 ± 0.56	.03[b]
Kinematics results, deg			
Knee abduction angle	1.3 ± 5.6	6.1 ± 4.7	.03[b]
Knee flexion angle	24.8 ± 6.3	27.8 ± 4.4	.15
Trunk lateral bending angle	1.1 ± 1.5	0.7 ± 0.7	.26
Trunk flexion angle	16.4 ± 11.2	9.6 ± 9.6	<.01[b]

[a]Data are reported as mean ± SD. BH, body height; BW, body weight; HP, higher performers; LP, low performers.
[b]Statistically significant difference between groups.

Herman and Barth *Am J Sports Med* 2016 44: 2347-53

Summary

- ADHD is common in athletes
- Evaluation and treatment of ADHD in athletes is important for safety and quality of life
- Stimulant treatment may be appropriate for some players
- ADHD may increase the risk of musculoskeletal injury and sport concussion

- Thank you
- Questions

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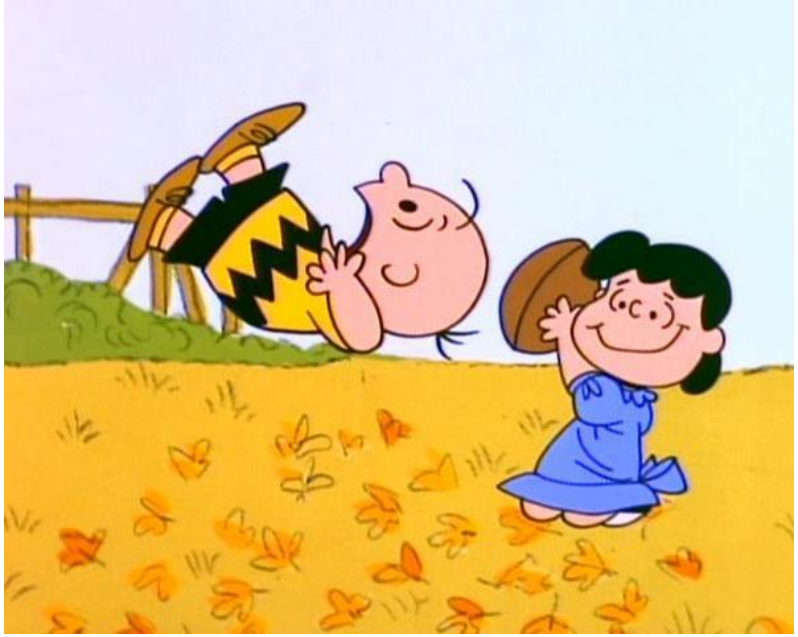

ADHD and Concussion: Clarifying the association

Concussion symptoms were more severe in athletes with comorbid ADHD and concussion than concussion alone

TABLE 3. British Columbia Post-Concussive Symptom Inventory in mTBI+ADHD and mTBI–ADHD

	mTBI+ADHD ($N = 11$)	mTBI−ADHD ($N = 18$)	Statistic	p Value
Average	2.4 (±0.8)	1.8 (±0.9)	$t = 1.5$	0.1
Number of symptoms above 0	6.4 (±5.6)	4.8 (±4.8)	$t = 0.8$	0.5
More than 4 severe (sev >2)	7 (100%)	5 (38.5%)	Fisher	0.015**

Biederman et al, 2015