Mental health and sleep: A neuropsychology perspective

PRESENTED BY: Tyler Duffield, Ph.D.

OHSU Teacher Workshop - 2022

Defining Concussion…

Review

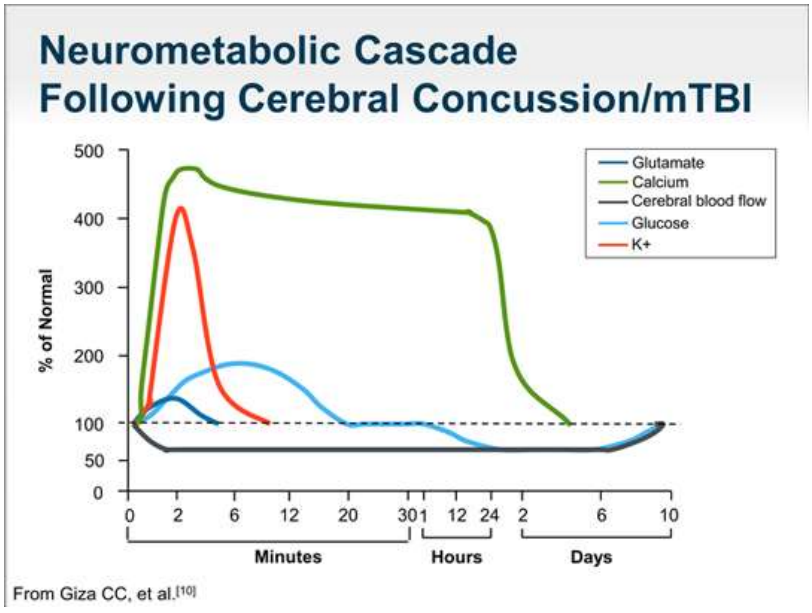
What is the definition of sports-related concussion: a systematic review

Paul McCrory,[1] Nina Feddermann-Demont,[2,3] Jiří Dvořák,[3,4] J David Cassidy,[5,6,7] Andrew McIntosh,[8,9] Pieter E Vos,[10] Ruben J Echemendia,[11,12] Willem Meeuwisse,[13] Alexander A Tarnutzer[2,3]

Defining Concussion…

- 1601 articles screened, 36 studies included
- 14 reported on criteria for Sports Related Concussion (SRC) definitions
- 22 on biomechanical aspects of concussion
- 6 different operational definitions

- **Summary/Conclusions:** SRC is a TBI that is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces with several common features that help define its nature.



General Symptom Resolution Trajectory

- Resolution of clinical symptoms from self-report and objective testing typically 1-2 weeks with age moderation
- Physiologic recovery as demonstrated by MRS, fMRI, qEEG, etc. is variable and outlasts clinical recovery, but is 45 days to 3 months typically.
  - Kamins et al., 2017
- As a provider or a teacher:
  - Linear/sequential recovery process, symptoms do not wax and wane outside of acute and to a lesser degree sub-acute period (7 days – 3 months)
    - Consideration of premorbid/concomitant factors for prolonged recovery
    - Exception is symptom exacerbation with physical exertion in acute recovery period
  - Symptom report in acute recovery period is most reliable

Clin Sports Med. 2011 January ; 30(1): 19–vii. doi:10.1016/j.csm.2010.08.009.

Biomechanics of Concussion

David F. Meaney, PhD[a,*] and **Douglas H. Smith, MD**[b]

[a]Department of Bioengineering, University of Pennsylvania, 240 Skirkanich Hall, 210 South 33rd Street, Philadelphia, PA 19104-6392, USA

[b]Department of Neurosurgery, University of Pennsylvania, 105D Hayden Hall, 240 South 33rd Street, Philadelphia, PA 19104-6392, USA

Biomechanics of Concussion

- Direct or Impulsive forces
- Linear and rotational forces
- 70 – 100 g of force
  - Equates car hitting wall at 25 mph
- Hitting your head does not equate concussion

- 5 subtypes:
  - Cognitive
  - Ocular-motor
  - Headache/migraine
  - Vestibular
  - Anxiety/mood
- Also considered sleep disturbance and cervical strain as associated conditions

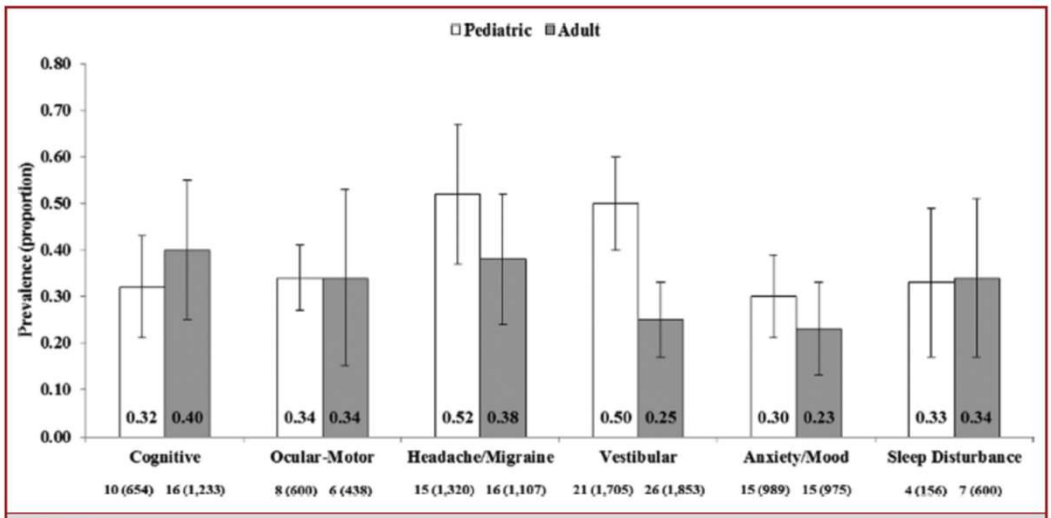


FIGURE 2. *Prevalence of concussion subtypes and sleep disturbance in concussion patients. Bars are 95% CI. Values below each subtype/associated condition are study N (sample N).*

Review

OPEN ACCESS

Predictors of clinical recovery from concussion: a systematic review

Grant L Iverson,[1,2] Andrew J Gardner,[3] Douglas P Terry,[1,2] Jennie L Ponsford,[4] Allen K Sills,[5] Donna K Broshek,[6] Gary S Solomon[7]

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Best Predictors of Outcome in Concussion

- **Age**: mixed findings
- **Sex**: mixed findings
- **Prior Concussions**: mixed findings
- **Migraine**: mixed findings
- **ADHD, LD, etc.:** minimal support
- **LOC**: minimal support
- **PTA**: minimal support
- **Headache (post-injury)**: worse outcomes
- **Total symptom report**: strong evidence of worse outcomes
- **Mental health history**: strong evidence of worse outcomes

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Symptoms of concussion usually fall into four categories:

Thinking/ Remembering	Physical	Emotional/ Mood	Sleep
Difficulty thinking clearly	Headache	Irritability	Sleeping more than usual
	Fuzzy or blurry vision		
Feeling slowed down	Nausea or vomiting (early on)	Sadness	Sleep less than usual
	Dizziness		
Difficulty concentrating	Sensitivity to noise or light	More emotional	Trouble falling asleep
	Balance problems		
Difficulty remembering new information	Feeling tired, having no energy	Nervousness or anxiety	

https://www.cdc.gov/traumaticbraininjury/symptoms.html

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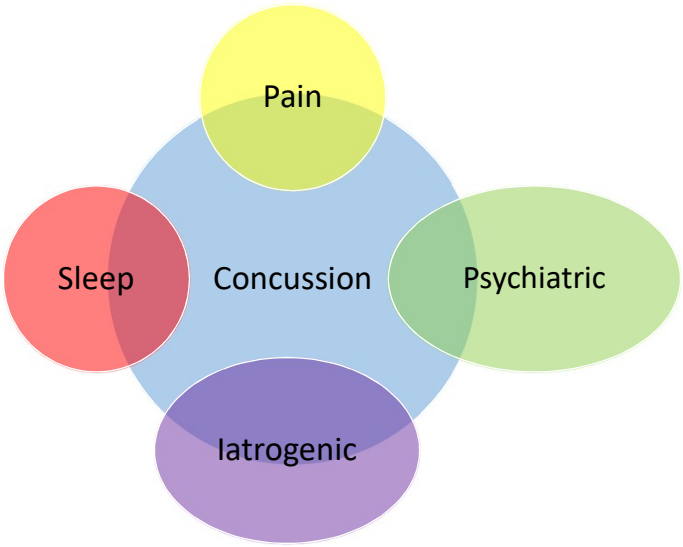
Non-specific Symptoms

- Symptoms of concussion have large overlap with:
  - Sickness (e.g., cold)
  - Poor sleep
  - Stress
  - Anxiety
  - Depression



Neuropsychology
2009, Vol. 23, No. 3, 283–296

0894-4105/09/$12.00 DOI:10.1037/a0015268

Neurocognitive Outcomes and Recovery After Pediatric TBI: Meta-Analytic Review of the Literature

Talin Babikian and Robert Asarnow
David Geffen School of Medicine at UCLA

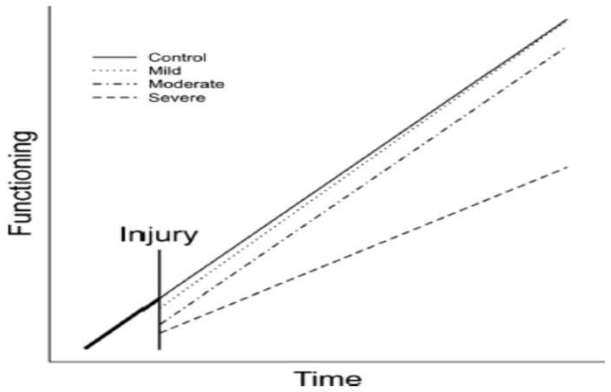


Figure 2. Summary diagram of trends in neurocognitive outcomes and recovery over time.

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Neuropsychology
2014, Vol. 28, No. 3, 321–336

0894-4105/14/$12.00 DOI: 10.1037/neu0000037

The Neuropsychological Outcomes of Concussion: A Systematic Review of Meta-Analyses on the Cognitive Sequelae of Mild Traumatic Brain Injury

Justin E. Karr, Corson N. Areshenkoff, and Mauricio A. Garcia-Barrera
University of Victoria

- Single mTBI vs. multiple mTBI very small differences (d = .06)
  - Limited to trivial cumulative impact
- Executive functions most susceptible to multiple mTBI
  - White matter maturation occurs last in frontal lobes
- Yet to identify threshold (e.g., 5th concussion) that predicts longstanding neuropsychological impairment

- The long term cumulative effects of concussion regarding cognition is a contentious research topic:
  - Some reviews find negligible impairments or inconclusive findings
    - Karr, Areshenkoff, & Garcia-Barrera, 2014;
    - Solomon, Ott, & Lovell, 2011;
    - Yumul & McKinlay, 2016
  - While others show long-term cognitive effects from repeated concussion primarily related to elite athlete status
    - Manley et al., 2017
    - Vos, Nieuwenhuijsen, & Sluiter, 2018
- Accumulation of sub-concussive impacts in contact and collision sports as a function of years of play may be more relevant for long-term cognitive consequences.
  - Tsushima et al. (2016, 2017) & Alosco et al., 2017

Concussions vs. Repetitive Sub-Concussive Impacts

- High contact athletes (football) perform worse than low contact athletes (basketball, baseball, soccer, wrestling, volleyball, paddling, and cheerleading) on ImPACT testing.
  - Tsushima et al. (2016)
- High contact (lineman) youth football players perform worse than low contact (receivers and defensive backs) players on ImPACT testing.
  - Tsushima et al. (2017)

Concussions vs. Repetitive Sub-Concussive Impacts

- Exposure to <u>contact</u> football before or after age 12
  - >2 times increased odds for problems with behavioral regulation (e.g., easily angered), apathy, and executive function (e.g., organizing/planning)
  - >3 times increased odds for depression
    - Alosco et al., 2017

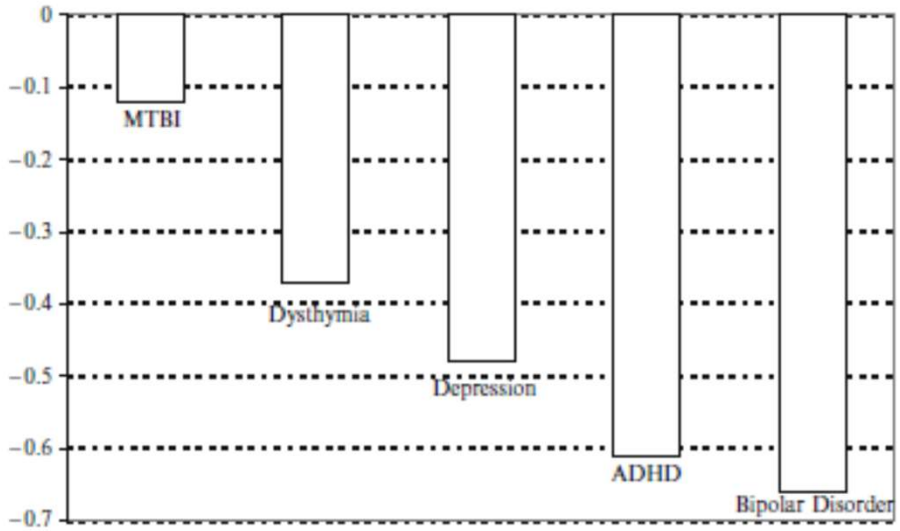


Fig. 22.3 Effects of MTBIs and various psychiatric conditions on neuropsychological functioning. MTBI (Binder et al. 1997), 11 studies, $n=314$ MTBI, $n=308$ controls; Dysthymia, Depression, and Bipolar Disorder (Christensen et al. 1997), 3 comparisons for dysthymia, 97 comparisons for depression, and 15 comparisons for bipolar disorder; ADHD (Frazier et al. 2004), based on Full Scale IQ, 123 studies

Journal of the International Neuropsychological Society (2022), **28**, 177–187

doi:10.1017/S1355617721000412

Comorbid Affective Symptomatology and Neurocognitive Performance in College Athletes

Garrett A. Thomas , Erin T. Guty , Kaitlin E. Riegler and Peter A. Arnett
Department of Psychology, The Pennsylvania State University, University Park, PA, USA

(Received November 2, 2020; Final revision January 30, 2021; Accepted March 12, 2021; First Published Online May 5, 2021)

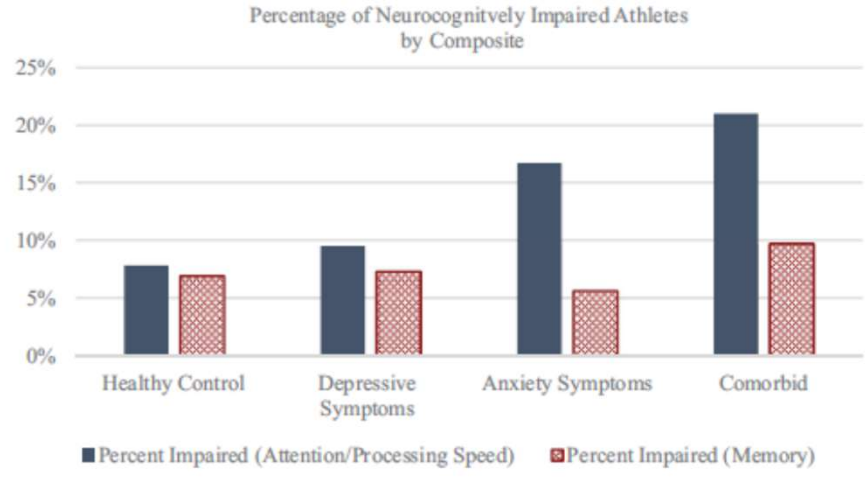
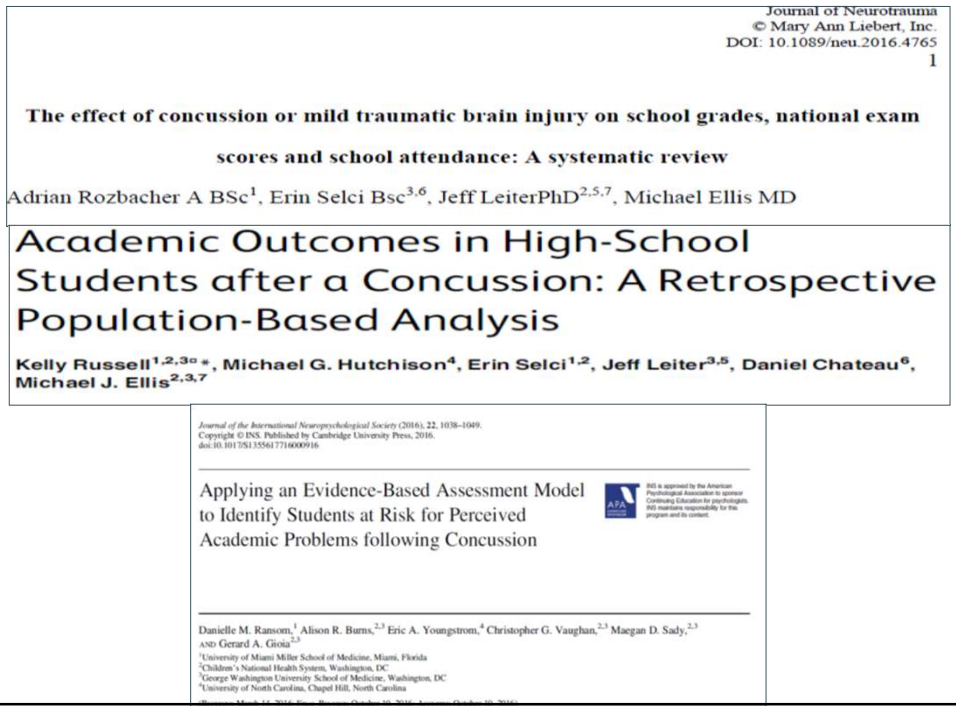


Fig. 2. Percentage of neurocognitively impaired athletes at baseline as determined by the separate composite algorithms. Specific percentages are found in Table 4.



Journal of Neurotrauma
© Mary Ann Liebert, Inc.
DOI: 10.1089/neu.2016.4765

The effect of concussion or mild traumatic brain injury on school grades, national exam scores and school attendance: A systematic review

Adrian Rozbacher A BSc[1], Erin Selci Bsc[3,6], Jeff LeiterPhD[2,5,7], Michael Ellis MD

Academic Outcomes in High-School Students after a Concussion: A Retrospective Population-Based Analysis

Kelly Russell[1,2,3c]*, Michael G. Hutchison[4], Erin Selci[1,2], Jeff Leiter[3,5], Daniel Chateau[6], Michael J. Ellis[2,3,7]

Journal of the International Neuropsychological Society (2016), 22, 1038–1049.
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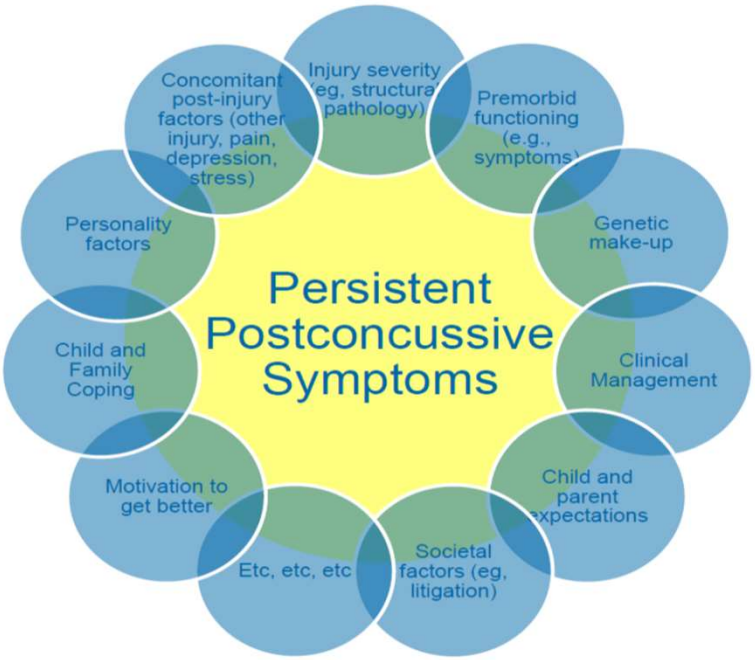
doi:10.1017/S1355617716000916

Applying an Evidence-Based Assessment Model to Identify Students at Risk for Perceived Academic Problems following Concussion

Danielle M. Ransom,[1] Alison R. Burns,[2,3] Eric A. Youngstrom,[4] Christopher G. Vaughan,[2,3] Maegan D. Sady,[2,3] AND Gerard A. Gioia[2,3]
[1]University of Miami Miller School of Medicine, Miami, Florida
[2]Children's National Health System, Washington, DC
[3]George Washington University School of Medicine, Washington, DC
[4]University of North Carolina, Chapel Hill, North Carolina

- Minimal impact on school grades, national exam scores, and graduation rates at a group level.
- PCS symptoms and self-reported executive dysfunction more predictive of poor school performance than cognitive testing.
- Concussion team at school still very important for reintegration into school following rest.
- How much does missed school matter?



Adapted from Iverson et al. (2008)

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Article

Prolonged Activity Restriction After Concussion: Are We Worsening Outcomes?

Marc DiFazio, MD[1], **Noah D. Silverberg, PhD**[2,3], **Michael W. Kirkwood, PhD**[4,5], **Raquel Bernier, MD**[1], **and Grant L. Iverson, PhD**[6,7,8,9]

Clinical Pediatrics
2016, Vol. 55(5) 443–451
 DOI: 10.1177/0009922815589914

cpj.sagepub.com

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- The most methodologically rigorous studies to date have not demonstrated benefit of an initial period of 5 to 6 days of complete rest over an earlier return to activity.

- Authors could not find studies suggesting that thinking, reading, or studying cause neurometabolic demands, or changes in the brain that could be harmful.

Harmful Effects?

- Nocebo effect
- Activity Restriction Model of Depression
- Physical Deconditioning

- **Conclusion**: Gradual/graded return to normal life activities following 2-3 days in most cases.

- Similarly, a more recent systematic review concluded 24-48 hours of cognitive and physical rest is a appropriate for most patients.
  - Schneider et al., 2017

Additional Psychological Factors Related to Recovery

- **Coping Style/Illness Perception**
  - Anderson & Fitzgerald, 2018
- **Good Old Days Bias**
  - The tendency to underestimate pre-injury problems and overestimate pre-injury health.
    - Brooks et al., 2014
- **Cogniphobia**
  - Avoidance of mental exertion out of a fear of developing or exacerbating a headache.
    - Silverberg, Iverson, & Panenka, 2017
- **Diagnosis Threat**
  - Form of stereotype threat - reduced cognitive/academic performance due to beliefs or reminders following a neurologic injury.
    - Fresson, Dardenne, & Meulemans 2018

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Clin Child Fam Psychol Rev
DOI 10.1007/s10567-017-0234-5

CrossMark

Systematic Review and Meta-analysis of Adolescent Cognitive–Behavioral Sleep Interventions

Matthew J. Blake[1] · Lisa B. Sheeber[2] · George J. Youssef[3,4] · Monika B. Raniti[1] · Nicholas B. Allen[1,5]

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Sleep and Mental Health

- 30-40% of US youth experience inadequate sleep
- 30% have a sleep disorder
  - Insomnia
  - Delayed Sleep Phase Disorder
- Pervasive in psychiatric disorders
  - Share highest % of connected symptoms within all symptoms of DSM-IV
- May precipitate and maintain psychiatric conditions
  - ↓ Sleep → ↑ Anxiety & Depression

MORE THAN

  - ↑ Anxiety & Depression → ↓ Sleep

Sleep and General Health

- Sleep deprivation increases risk of:
  - Illness susceptibility (4x increase of cold less than 6 hours)
  - Orthopedic injuries
  - <8 hours 2x increase in concussion rates in youth
  - Lifestyle disease (e.g., diabetes, obesity, heart disease)
  - Dementias
    - 60% of Alzheimer's patients have sleep disorder that preceded diagnosis by several years
  - Mortality
    - Decades decrease in life expectancy with chronic sleep deprivation

Sleep and mTBI (concussion) risk

- Sleep disturbance and deprivation hinders:
  - Reaction time
  - Judgment
  - Balance
  - Coordination
  - Proprioception
  - General cognition (learning, memory, problem solving, etc.)

Sleep Disturbance Following Concussion

- 30-70% report sleep difficulties 1-3 weeks post-injury
  - Hypersomnia is common
- Following acute phase of recovery
  - 30% report insomnia
  - Approximately 40% can have circadian rhythm shift (delayed)
  - 40-70% report fatigue
  - 30% report sleep apnea
- The pattern and time frame of sleep disturbance may vary substantially among patients who have sustained a concussion.
  - Mosti, Spiers, & Kloss, 2016

Sleep and Concussion

- Concussion has a well demonstrated bi-directional and interdependent relationship with headache, sleep disorders, and psychiatric conditions.
  - Moderate-to-severe insomnia severity or excessive daytime sleepiness two or more times per month were 3.1 and 2.9 times more likely to suffer a SRC in 1-year follow up period (Raikes et al., 2019).
  - Sleep disturbances are also among the most common complaints after concussion and are associated with prolonged recovery time, post-concussion morbidity, and long-term sequela (Mathias & Alvaro, 2012).
  - Sleep disturbance following concussion significantly increases the risk of developing or exacerbating headache and psychological conditions, which function as the two best predictors of outcome following concussion (Iverson et al., 2017).
  - Further, each of these conditions have independent negative effects on cognition, as well as compounding effects on cognition that can prolong recovery (Oyegbile et al., 2020).

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Sleep and Concussion

- Poor sleep negatively impacts baseline and post-injury ImPACT test performances and increases symptom reporting.
  - Confound RTP decisions (and RTS decisions)
- Obtaining 8 or more hours of sleep the night before taking post-injury ImPACT may reduce likelihood that reported symptoms are secondary to sleep deprivation rather than post-concussive.
  - Silverberg et al., 2016
  - Mihalik et al., 2013
  - Kostvun et al., 2015
  - McClure et al., 2014

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Generally

- Set positive and realistic expectation!
  - Expectancy effect
  - Importance of early education – well validated intervention
  - Null effects for cognitive rehabilitation per 2 systematic reviews and empirical support for vision therapy is tenuous
- Resume normal activities as soon as reasonably possible, including light exercise!
- Reinforce progress!
  - Prolonged symptom pacing recommendations = iatrogenic

Exercise as Medicine for Concussion

- Physical activity within 7 days of acute injury compared with no physical activity was associated with reduced risk of PCS at one month.
  - Grool et al, 2016
- The first RCT to show that individualized sub-symptom threshold aerobic exercise treatment prescribed to adolescents with concussion symptoms during the first week after SRC speeds recovery and may reduce the incidence of delayed recovery.
  - Leddy et al., 2019

What is CBT-I?

- Cognitive–behavioral sleep interventions are short-term, multicomponent, goal-oriented psychotherapeutic treatments. They aim to modify the patterns of thinking and behavior that may be underlying an individuals sleep disturbance, such as: poor sleep hygiene, irregular sleep–wake schedules, delayed bedtimes, pre-sleep hyperarousal, and maladaptive sleep-related cognitions.

Cognitive–Behavioral Sleep Interventions

Table 1 Components of cognitive–behavioral therapy for insomnia (CBT-I)

Component	Description
Sleep hygiene	Psychoeducation about healthy sleep behaviors and sleep promoting environmental conditions. Specific instructions include establishing regular bedtimes and rise times, limiting napping during the day, avoiding lying in bed waiting to fall asleep, maintaining predictable pre-sleep activities and establishing a wind down routine before bed, creating a quick wake up routine, avoiding stimulating or emotionally laden activities before bedtime, avoiding consuming high-energy substances in the evening, creating a comfortable sleep environment, and only using the bed for sleep-related activities
Stimulus control	Behavioral instructions aimed at reducing conditioned arousal to the bed and bedroom and re-associating the bed and bedroom with normal sleep. Instructions include only going to bed when sleepy, setting a standard rise time, leaving the bed/bedroom after long periods of wakefulness, avoiding sleep-incompatible behaviors in the bed or bedroom, and avoiding napping
Sleep restriction	Behavioral instructions aimed at restricting time in bed as a way of increasing homeostatic sleep drive. Time allowed in bed is initially restricted to the average time perceived as sleep per night and then adjusted to ensure sleep efficiency remains above 85%
Relaxation	Any relaxation technique aimed at reducing physiological and cognitive arousal prior to sleep. Specific techniques might include progressive muscle relaxation, guided imagery, and/or breathing techniques
Cognitive therapy	Aims to addresses negative thought processes and unhelpful beliefs about sleep through a focus on bedtime worry and rumination. Specific techniques include identifying and challenging unrealistic expectations of sleep, fear of missing out on sleep, and overestimation of the consequences of poor sleep

Blake et al., 2017

CBT-I Efficacy in Youth

- **Subjective total sleep time**:
  - improved by 30 minutes
- **Sleep latency onset**:
  - Subjective: improved by 21 min.
  - Objective: improved by 16 min.
- **Sleep efficiency**:
  - Subjective: improved by 5.3%
  - Objective: improved by 2.8%
- Global sleep quality, daytime sleepiness, depression, and anxiety also improved.
- Gains were generally maintained over time.

Blake et al., 2017

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frontiers in Neurology

PERSPECTIVE
published: 07 October 2020
doi: 10.3389/fneur.2020.530273

Perspective: Cognitive Behavioral Therapy for Insomnia Is a Promising Intervention for Mild Traumatic Brain Injury

*Jessica R. Dietch [1,2] and Ansgar J. Furst [1,2,3,4]**

- 3P model of insomnia (development and maintenance)
  - Predisposing factors (e.g., younger athletes)
  - Precipitating factors (e.g., concussion)
  - Perpetuating factors
    - Acute hypersomnia results in poor sleep efficiency in later recovery periods
    - Negative thoughts/associations increasing hyperarousal, rumination, and worry
- Impact of CBT-I on Concussion
  - Symptom reduction, including pain and psychological conditions
  - Improving cognition increase ability to engage in general rehabilitation
  - More "approachable" than stigma of psychotherapy
- Future Questions and Directions
  - When is an appropriate/optimal timing of CBT-I delivery?
  - Increased risk of re-injury (e.g., sleep restriction protocol) or comorbid sleep disorders may require adaptions, modifications, or preclude participation?
  - Dissemination and implementation barriers and systemic level approaches?

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Practical take homes

- Pre-injury mental health and sleep quality will predict outcomes
- High acute symptom burden (particularly headache), onset of sleep dysregulation and/or activity withdrawal will prolong recovery
- Early exercise and sleep intervention will likely improve clinical outcome
- Returning to normal daily activities (physical, recreational, social) as soon as possible (2-3 days), often gradually/incrementally, will likely improve clinical outcome

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Practical take homes

- Linear/sequential recovery process, symptoms do not wax and wane
  - Consideration of premorbid/concomitant factors for prolonged recovery
  - Exception is symptom exacerbation with physical exertion in acute recovery period
- Symptom report in acute recovery period is most reliable
- Consider the person who sustained the concussion, not just persistent symptoms through the medical lens.
  - The more distal from injury, consider referring to a mental health therapist rather than a rehabilitation therapist.