

Why is this taking so long: Understanding persisting symptoms after pediatric concussion

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Disclosures

- Grant funding for concussion research



DEPARTMENT OF THE AIR FORCE
59TH MEDICAL WING (AETC)
JOINT BASE SAN ANTONIO - LACKLAND TEXAS



- Team physician stipend



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Objectives

1

Define
persisting
symptoms after
concussion

2

Understand
contributing
factors to
persisting
symptoms

3

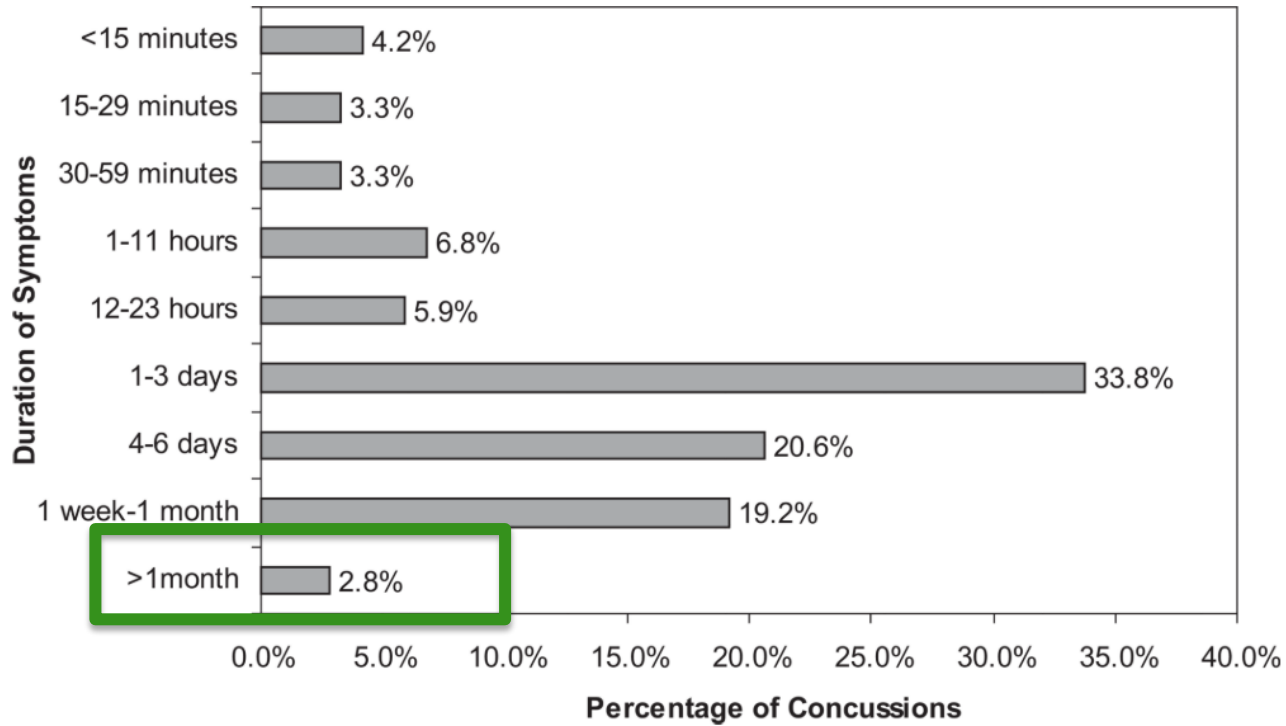
Highlight role of
multi-disciplinary
team in managing
persisting
symptoms



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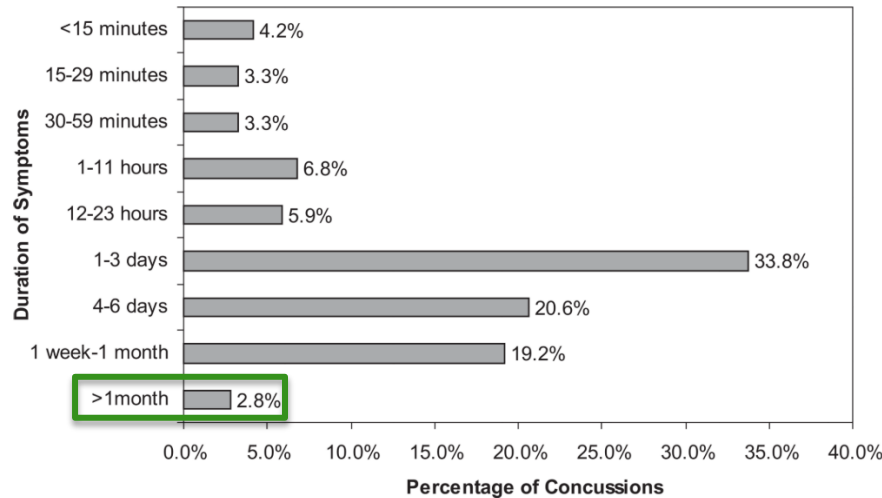
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Persisting Symptoms

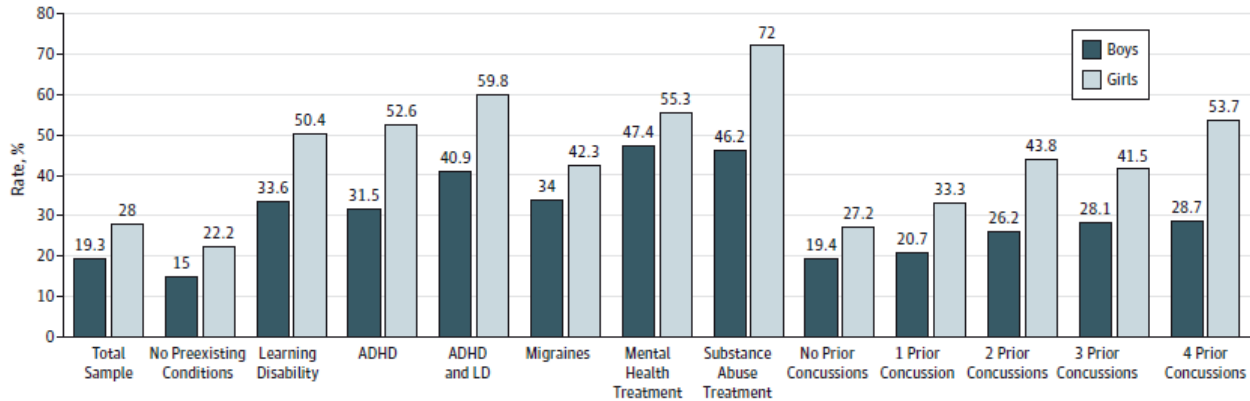
- Used for symptoms that persist **>4 weeks**



Persisting symptoms

- May be pre-existing, concussion-related, or both

Figure. Rates of *International Classification of Diseases, 10th Revision (ICD-10)*, Postconcussional Syndrome Classification in High School Athletes With No Recent Concussion (Mild or Greater Symptoms in Each Domain)



Original Investigation

Factors Associated With Concussion-like Symptom Reporting in High School Athletes

Grant L. Iverson, PhD; Noah D. Silverberg, PhD; Rebekah Mannix, MD, MPH; Bruce A. Maxwell, PhD; Joseph E. Atkins, PhD; Ross Zafonte, DO; Paul D. Berkner, DO

JAMA Pediatr. 2015;169(12):1132-1140.

Clinical Risk Score for Persistent Postconcussion Symptoms Among Children With Acute Concussion in the ED

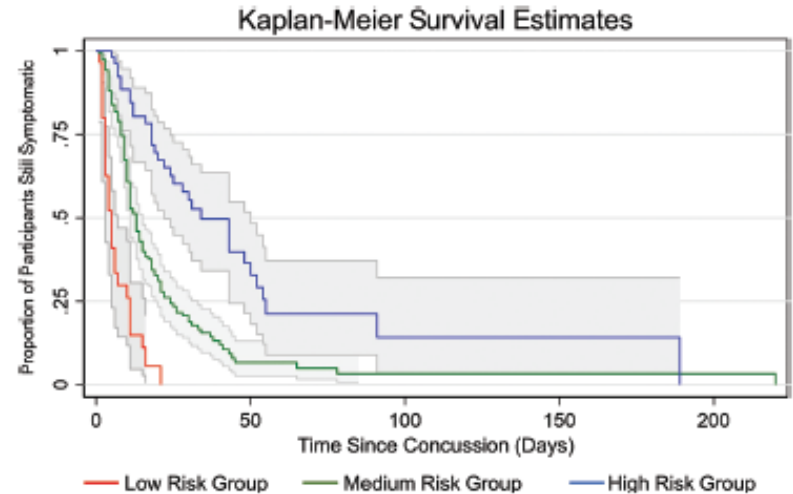
Zemek R, et al. JAMA 2016.

Category		Risk Points
Age group (yrs)	5-7	0
	8-12	1
	13-<18	2
Sex	Male	0
	Female	2
Prior concussion / symptom duration	None/Sx duration <1 wk	0
	Sx duration ≥1 wk	1
Diagnosed migraine history	No	0
	Yes	1
Answering questions slowly	No	0
	Yes	1
BESS tandem stance errors	0-3	0
	≥4 or unable to perform	1
Headache	No	0
	Yes	1
Sensitivity to noise	No	0
	Yes	1
Fatigue	No	0
	Yes	2

Utility of a Clinical Prediction Tool for Persisting Postconcussive Symptoms in a Multicenter Sample of Youth Athletes With Concussion

The Sport Concussion Outcomes in Pediatrics (SCOPE) Study

Miller SM, et al. AJSM 2023.



Factors Affecting Recovery Trajectories in Pediatric Female Concussion

Natasha Desai, MD, CAQSM,* Douglas J. Wiebe, PhD,† Daniel J. Corwin, MD,‡ Julia E. Lockyer, MS,§
Matthew F. Grady, MD, CAQSM,§¶ and Christina L. Master, MD, CAQSM§¶

- Female patients with concussion presented later to specialty care evaluation than male patients (15 vs 9 days, $p=0.018$) and took longer to recover.
- Sex-based recovery differences disappeared when controlling for time to presentation to specialty care




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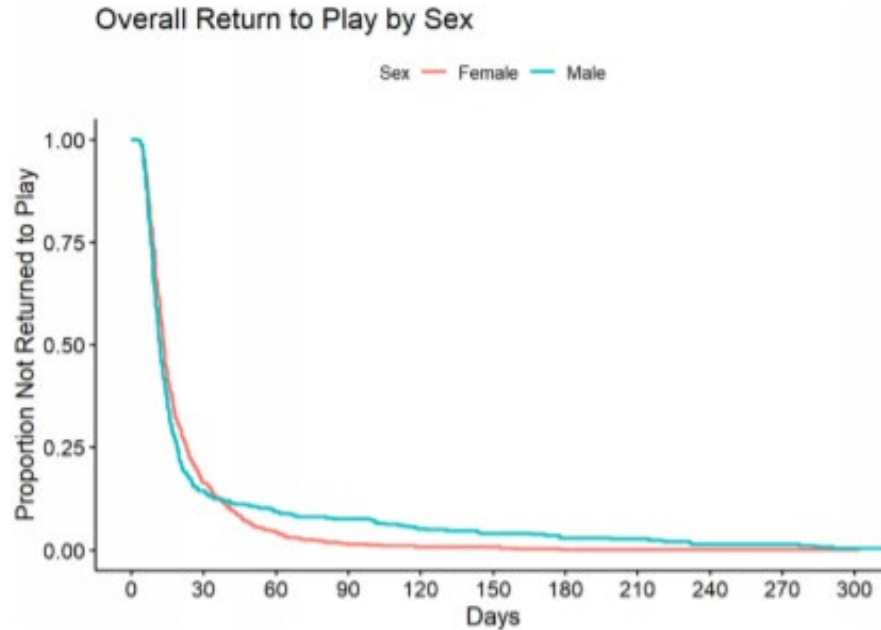
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Differences in sport-related concussion for female and male athletes in comparable collegiate sports: a study from the NCAA-DoD Concussion Assessment, Research and Education (CARE) Consortium

Christina L Master ,^{1,2,3} Barry P Katz,⁴ Kristy B Arbogast,^{2,3} Michael A McCrea,⁵ Thomas W McAllister,⁶ Paul F Pasquina,⁷ Michelle Lapradd,⁴ Wenxian Zhou,⁴ Steven P Broglio ,⁸ CARE Consortium Investigators



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Paediatric post-concussive symptoms: symptom clusters and clinical phenotypes

Todd W Lyons ,^{1,2} Rebekah Mannix,^{1,2} Ken Tang,³ Keith Owen Yeates,^{4,5} Gurinder Sangha,^{6,7} Emma CM Burns,^{8,9} Darcy Beer,¹⁰ Alexander S Dubrovsky,^{11,12} Isabelle Gagnon,¹³ Jocelyn Gravel,¹⁴ Stephen B Freedman,¹⁵ William Craig,¹⁶ Kathy Boutis,¹⁷ Martin H Osmond,^{3,18} Gerard Gioia,¹⁹ Roger Zemek ,^{3,18} The Pediatric Emergency Research Canada (PERC) 5P Concussion Team²⁰

- Fatigue - #1 persisting symptom
- Headache - #2 persisting symptom
- Physical symptoms occurred in two distinct clusters: vestibular-ocular and headache.
- Emotional and cognitive symptoms occurred together more frequently and with higher symptom severity than physical symptoms.
- Fatigue was more strongly associated with cognitive and emotional symptoms than physical symptoms.



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Slide courtesy of Wendy Pierce, MD



Headache



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Post traumatic headache* causes

*Defined as HA onset \leq 7 days of injury

- Axonal injury
- Altered cerebral metabolism or hemodynamics
- Neuroinflammation
- Underlying genetic predisposition
- Medication overuse
- Patient's expectations of developing headache after head injury
- Sleep disturbances
- Mood disturbances
- Psychosocial and other stressors

Cephalagia 38(1) 2018



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Slide courtesy of Wendy Pierce, MD

Common headache phenotypes after concussion

- 1
Migraine
- 2
Tension
- 3
Cervicogenic

Headache Treatment – What’s the Evidence?

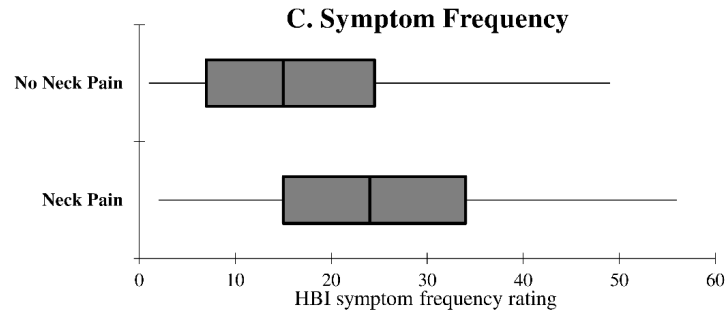
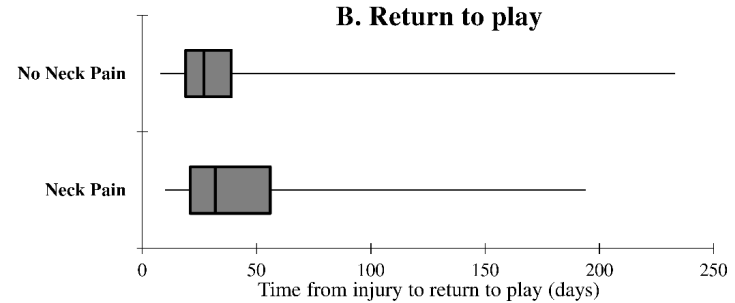
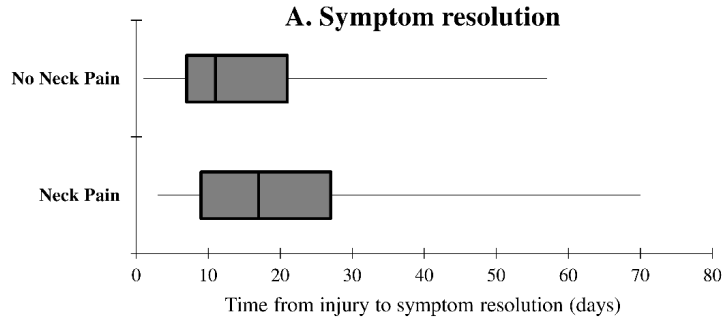
Current evidence for pharmacological management of pediatric concussion: a systematic review

Damla Hanalioglu^{1,2} · Sahin Hanalioglu^{3,4} · Jorge I. Arango¹ · P. David Adelson⁵

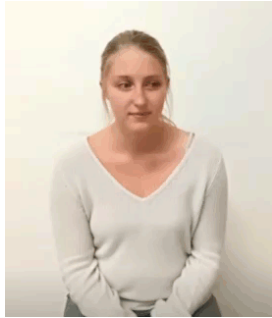
Drug	#	Risk of bias	Symptom (effective for)
Acetaminophen	1	●	Acute headache
Amantadine	1	●	Cognitive symptoms
Amitriptyline	4	●●●●	Persistent headache
Flunarizine	1	●	Inconclusive
Gabapentin	1	●	Persistent headache
Hypertonic saline	1	●	Acute headache
Ibuprofen	1	●	Acute headache
Ketorolac	1	●	Acute headache
Lisdexamphetamine	1	●	Attention deficit
Magnesium	1	●	Acute symptom burden
Melatonin	3	●●●	Only for sleep and depression
Metoclopramide	2	●●	Likely no benefit for headache
Nortriptyline	1	●	Persistent headache (short-term)
Prochlorperazine	1	●	Inconclusive
Ondansetron	3	●●●	Likely no benefit for PCS
Topiramate	2	●●	Likely no benefit for PTH



Influence of Cervical Involvement



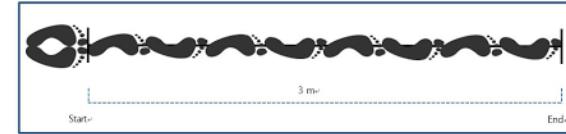
Visual and Vestibular Function and Concussion Recovery



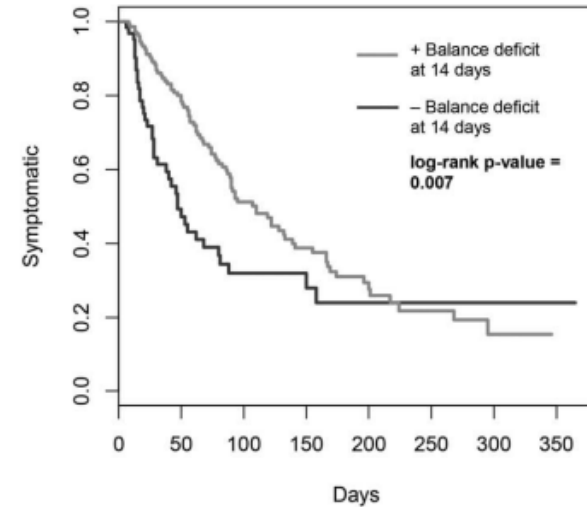
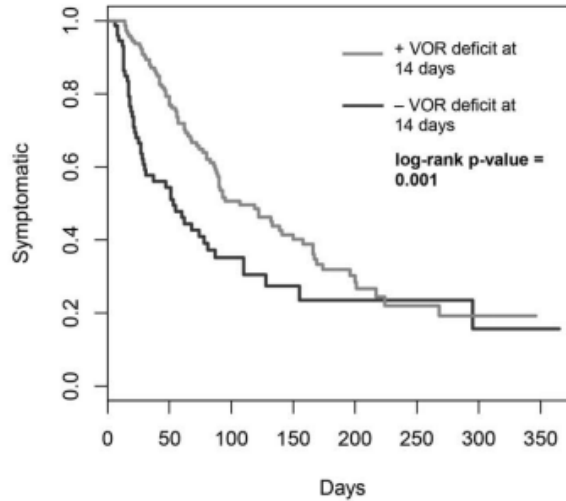
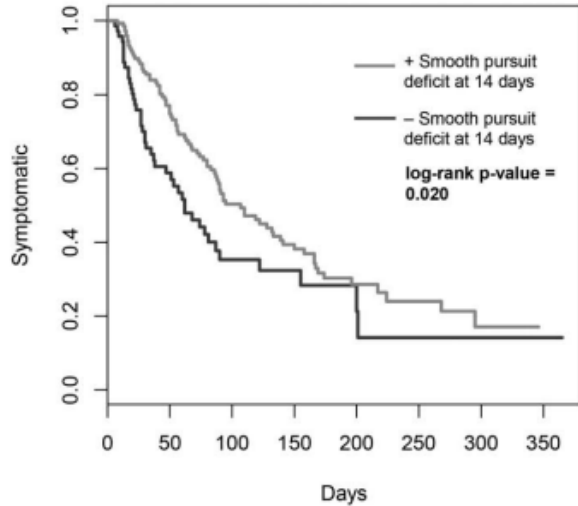
Smooth Pursuit



VOR



Balance Deficit



Cervicovestibular rehabilitation in sport-related concussion: a randomised controlled trial

Kathryn J Schneider,^{1,2} Willem H Meeuwisse,^{1,3} Alberto Nettel-Aguirre,^{2,3,4}
Karen Barlow,² Lara Boyd,⁵ Jian Kang,¹ Carolyn A Emery^{1,2,3}

Treatment group **3.91x** (95% CI 1.34, 11.34)
more likely to be medically cleared by 8 wks

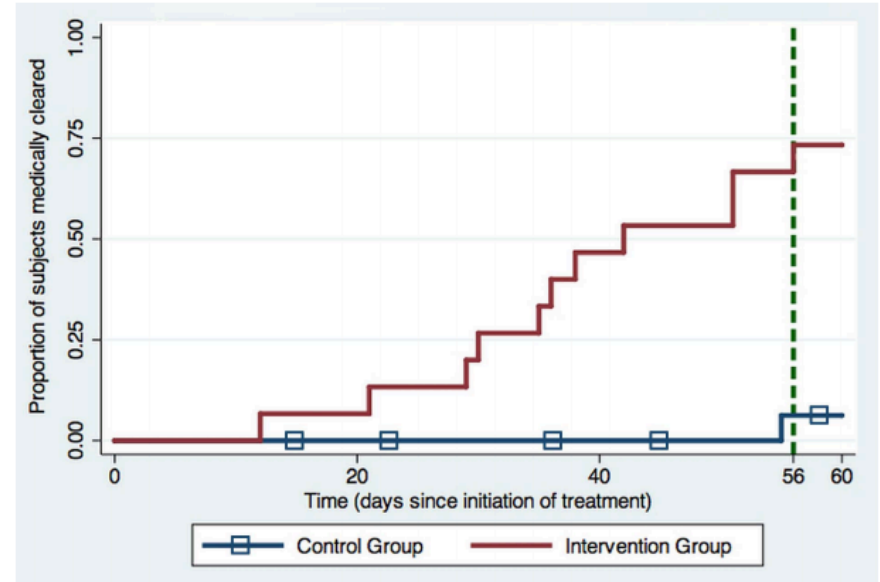


Figure 1 Proportion of patients medically cleared over time.

Fatigue



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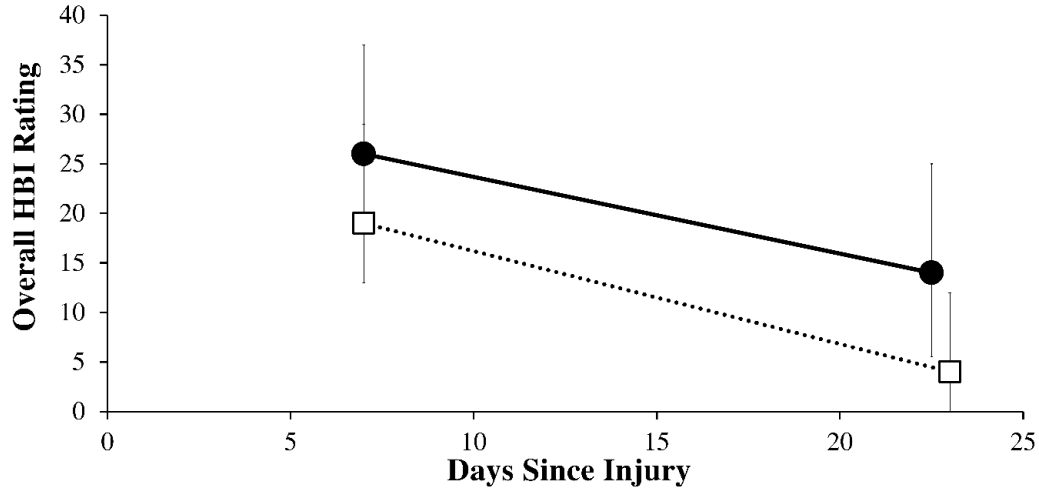
Sleep outcomes in pediatric mild traumatic brain injury: a systematic review and meta-analysis of prevalence and contributing factors

Suzana Djukic, Natalie Lynette Phillips , and Suncica Lah 

BRAIN INJURY
2022, VOL. 36, NOS. 12-14, 1289-1322

- Post-injury sleep disturbance is common
 - 51% within 1 week
 - 40% 1-4 weeks
 - 9% 1-3 months
 - 21% >3 months
- Sleeping more than usual most common within 1 week of injury
- Sleeping less than usual common 1-4 weeks post-injury

Sleep Problems after Concussion

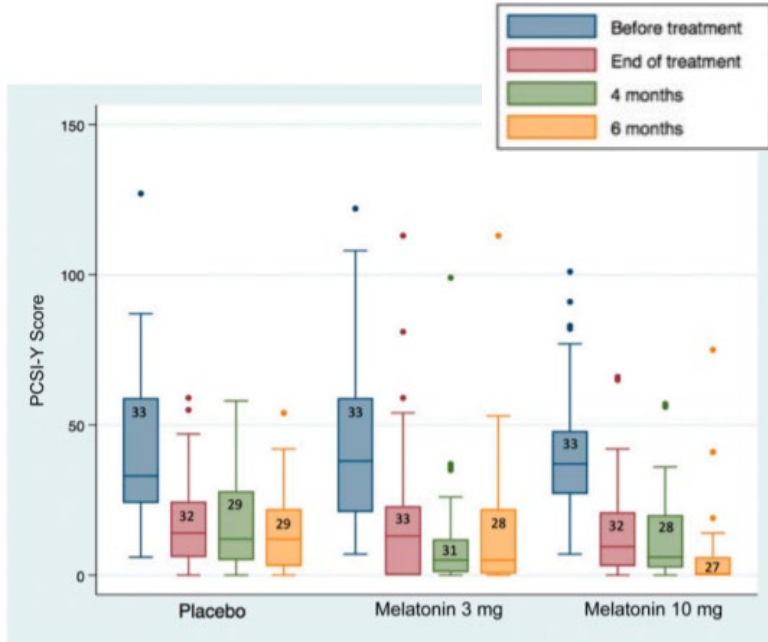


Patients with sleep problems took 7 days longer to recover

● Patients with sleep problems □ Patients without sleep problems

Efficacy of Melatonin in Children With Postconcussive Symptoms: A Randomized Clinical Trial

Karen M. Barlow, MBChB,^{1,2,3,4,5} Brian L. Brooks, PhD,^{2,3,4,5} Michael J. Esser, MD,^{2,3} Adam Kirton, MD,^{2,3,7} Angelo Mikrogianakis, MD,^{2,7} Roger L. Zemek, MD,⁸ Frank P. MacMaster, PhD,^{2,3} Alberto Nettel-Aguirre, PhD,^{2,1} Keith Owen Yeates, PhD,^{2,3,4} Valerie Kirk, MD,² James S. Hutchison, MD,^{1,9} Susan Crawford, MSc,² Brenda Turley, BA,² Candice Cameron, BA,¹ Michael D. Hill, MD,² Tina Samuel, MBChB,² Jeffrey Buchhalter, MD,² Lawrence Richer, MD,¹ Robert Platt, PhD,¹⁰ Roslyn Boyd, PhD,² Deborah Dewey, PhD^{1,1}



Journal of Neurotrauma, VOL. 38, NO. 8 | Original Articles

normal

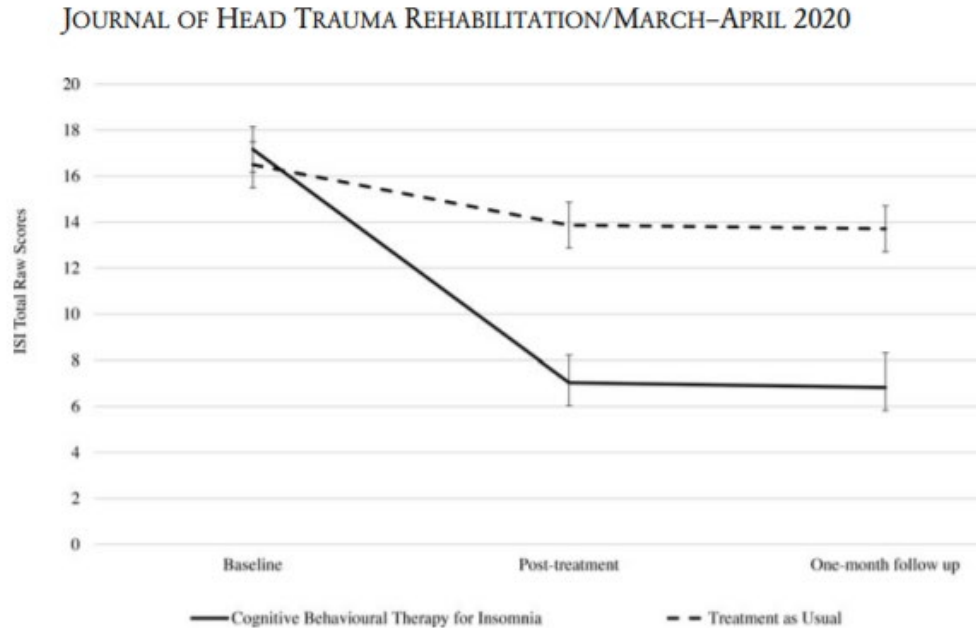
Efficacy of Melatonin for Sleep Disturbance in Children with Persistent Post-Concussion Symptoms: Secondary Analysis of a Randomized Controlled Trial

Karen Maria Barlow ✉ Valerie Kirk, Brian Brooks, Michael Joachim Esser, Keith Owen Yeates, Roger Zemek, Adam Kirton, Angelo Mikrogianakis, Frank MacMaster, Alberto Nettel-Aguirre, James Hutchison, Brenda Turley, Candice Cameron, Michael Hill, Roslyn Boyd, and Deborah Dewey

- Melatonin
 - ↓ sleep-related problems (3 mg)
 - ↓ depressive symptoms (3 mg)
 - ↑ sleep duration (3, 10 mg)

A Pilot Randomized Controlled Trial of Cognitive-Behavioral Therapy for Insomnia in Adolescents With Persistent Postconcussion Symptoms

Tomfohr-Madsen, Lianne PhD; Madsen, Joshua W. PhD; Bonneville, Dominique BA; Virani, Shane MSc; Plourc
Vickie PhD; Barlow, Karen M. MBChB, MSc, MRCPCH (UK); Yeates, Keith Owen PhD; Brooks, Brian L. PhD



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Cognitive and Emotional Symptoms



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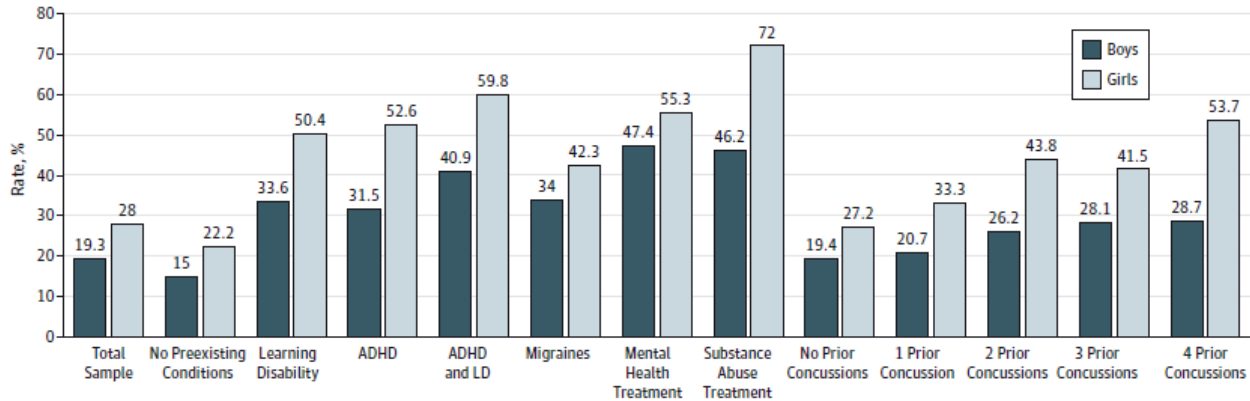
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Figure. Rates of *International Classification of Diseases, 10th Revision (ICD-10)*, Postconcussional Syndrome Classification in High School Athletes With No Recent Concussion (Mild or Greater Symptoms in Each Domain)

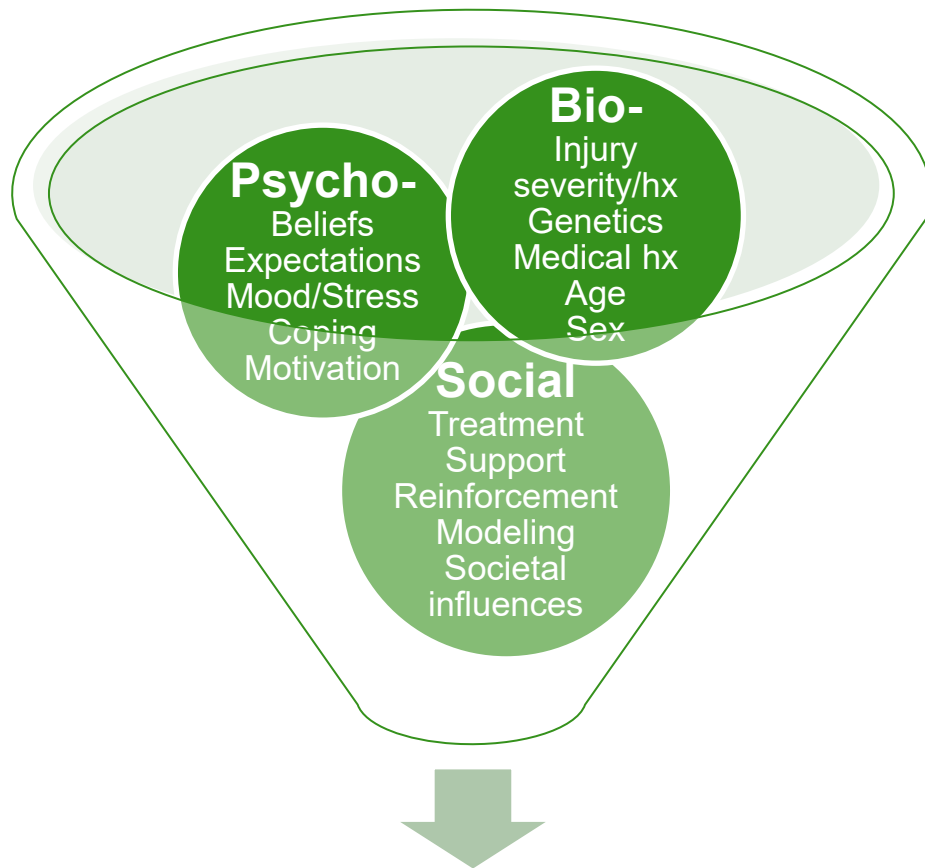


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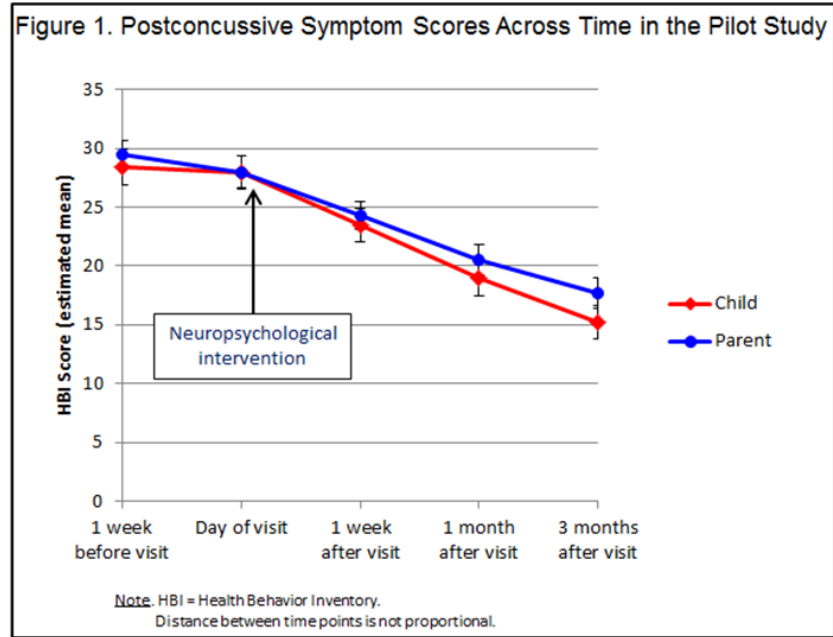
JAMA Pediatr. 2015;169(12):1132-1140.



Persisting Symptoms

A Pilot Study Investigating Neuropsychological Consultation as an Intervention for Persistent Postconcussive Symptoms in a Pediatric Sample

Michael W. Kirkwood, PhD¹, Robin L. Peterson, PhD¹, Amy K. Connery, PsyD¹, David A. Baker, PsyD¹, and Jeri Forster, PhD^{1,2}



Slide courtesy of Mike Kirkwood, PhD

Brief cognitive behavioral intervention for children and adolescents with persistent post-concussive symptoms: A pilot study

Kelly A. McNally^{a,b}, Kristina E. Patrick^a, Jacob E. LaFleur^c, Jana B. Dykstra^a, Kerry Monahan^a and Kristen R. Hoskinson^{b,c}

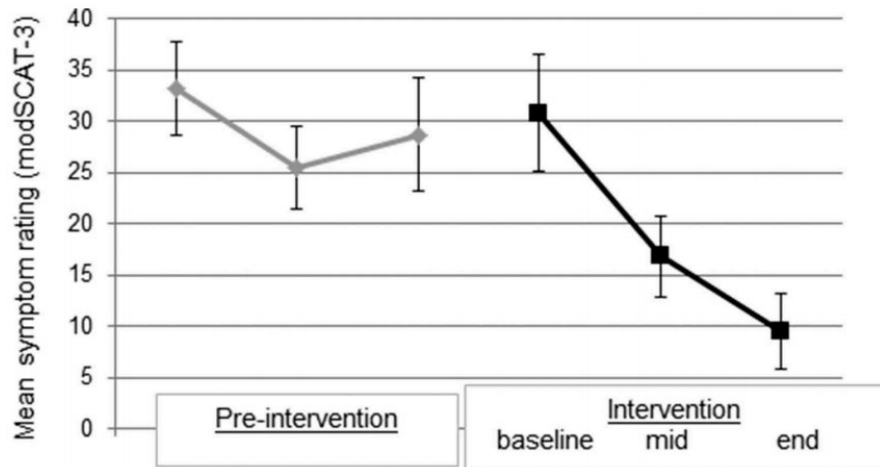


Figure 1. Mean self-reported concussion symptom ratings pre- and post-intervention.

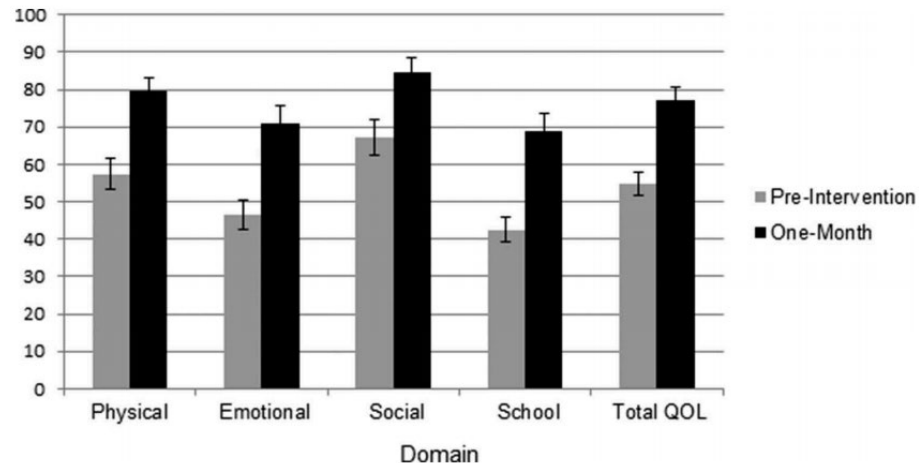


Figure 2. Quality of life mean scores at pre-intervention and one month.

Key Points for Improving Outcomes

1

Identify and address factors that may impact recovery trajectory (5P risk score)

2

Optimize sleep, introduce aerobic exercise and cervico-vestibular rehab when appropriate

3

Consider referral to specialty concussion program



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Panel Discussion

1

Ann Lantagne,
PhD

Rehab Psychology

2

Robin Peterson,
PhD

Neuropsychology

3

Nicki Remington,
DPT

Physical Therapy

4

Julie Wilson,
MD

Sports Medicine



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JN – 17 yo F soccer player

- Hit in the face by soccer ball kicked at close range – immediate onset HA, dizziness, nausea, light sensitivity
- Initial visit to CHCO ~3 weeks from injury
 - Feels 65% recovered
 - Continued HA, significant dizziness (motion sensitivity, positional, associated nausea), sleep disturbance
 - Symptoms impacting school tolerance but trying to attend full-time



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Prior Concussion History

- 3 prior concussions
 - 2016 and 2017– soccer-related injuries, full recovery took 2-4 wks
 - 2018 – basketball-related injury – recovery took several months, took 2 years off sports after this injury
 - Played HS soccer in 2021 and 2022 without injury
 - Reports intermittent HA (every 2-3 weeks) since 2018 injury. Maternal relatives with migraines.



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Physical Exam

- HR ↑ (58 to 91) with orthostatic VS
- Symptom provocation with all VOMS components (dizziness)
- Positive Romberg (exaggerated loss of balance)
- Slow single (32 sec) and dual-task (54 sec) tandem gait



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Initial plan

- Improve hydration and nutrition (Zofran, increase fluid/electrolyte intake)
- Headache management plan
- PT for vestibular rehab
- Sub-symptom threshold exercise
- School support plan



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