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Written Into Harm: The Risks of AI-Influenced Language in Documenting Adolescent Brain Injury Across Systems

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Abstract

As artificial intelligence (AI) becomes increasingly embedded in institutional recordkeeping, the documentation practices surrounding adolescent brain injury (ABI) are undergoing a rapid transformation. Auto-summarization, predictive phrasing, and documentation templates—integrated into electronic health records, IEP platforms, and case management software—are now shaping how adolescent functioning, behavior, and eligibility for services are recorded. While these AI-influenced tools are intended to streamline workflows and standardize language, they also carry underexamined risks: specifically, the misrepresentation of brain injury–related needs in youth whose profiles are shaped by intersecting experiences of trauma, language variation, disability, and systemic marginalization.

This presentation introduces a critical, practice-informed framework for understanding the risks of AI-influenced documentation in the lives of adolescents with ABI. Drawing from early-stage document analysis, clinical experience, and interdisciplinary theory—including disability studies, raciolinguistics, and education equity frameworks—this session surfaces patterns in how auto-generated or templated institutional language can obscure executive dysfunction, misattribute trauma-related responses to character or effort, and codify racially and linguistically biased interpretations of behavior.

Rather than remaining static, documentation written in one setting often travels: language from a school-based report may shape clinical referrals, mental health care access, or even legal decision-making in child welfare or immigration proceedings. When AI-generated language flattens narrative complexity or replicates ableist and racialized assumptions, those inaccuracies can follow youth for years—impacting not only services but credibility, perceived compliance, and long-term opportunity.

This session offers an emerging analysis of these risks and invites participants to reflect on the ethical implications of automated documentation systems in interdisciplinary work. The session will highlight examples of problematic phrasing, conceptual tools to assess documentation integrity, and strategies for practitioners to intervene in AI-supported workflows. Emphasis will be placed on promoting narrative accuracy, trauma-informed practice, and raciolinguistic humility in documentation across systems of care. This presentation challenges the assumption that documentation is neutral—and equips attendees to recognize and resist patterns of harm embedded in automated record keeping.

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The association between childhood traumatic brain injury history and incarceration risk factors.

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Abstract

Background: Traumatic Brain Injury (TBI) in children is a public health problem indicated by high prevalence and long-term effects. Research shows that children who experience a TBI have increased risk for entering the justice system. This paper examines associations between childhood TBI history and select risk factors known to contribute to the likelihood of incarceration.

Methods: Data from the 2020–2021 National Health Interview Survey (NHIS) were used for this analysis. TBI symptoms, health and school functioning, and functional behaviors were examined to describe lifetime TBI history, prevalence of developmental disabilities, functional limitations, school-related services and adverse childhood experiences (ACES) to compare across subgroups.

Results: Approximately 8% of children ages 5–17 years had a lifetime history of TBI according to parent reports. Children with a history of TBI were twice as likely to have behavioral health issues, social and academic difficulties, and experience ACEs compared to peers with no history of TBI.

Conclusion: Children with a TBI history are likely to also have experienced behavioral, social, and academic difficulties than their peers without a TBI history. Preventing TBI in children and managing TBI effects may help avoid adverse outcomes and ensure health and wellness for children.

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Effect of Enriched Environment with Family Involvement on Awakening Efficacy in Children with Disorders of Consciousness After Acquired Brain Injury and Its Impact on Neurological Function Recovery: A Retrospective Case-Control Analysis

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Abstract

Background: Disorders of consciousness (DOC) after acquired brain injury (ABI) in children are hard to treat, and conventional rehabilitation often fails to meet their emotional and interactive needs.

Objective: To explore the awakening effect of an enriched environment with family involvement on disorders of consciousness (DOC) in children after acquired brain injury (ABI) and its impact on neurological function recovery.

Methods: A retrospective study was conducted, and 64 children with DOC after ABI (Glasgow Coma Scale [GCS] score ≤ 8) admitted to Children's Hospital Affiliated to Soochow University from January 2023 to March 2025 were selected. They were divided into the family-involved enriched environment group (study group) and the conventional treatment group (control group) according to the presence of family involvement. The control group received conventional medical rehabilitation treatments (medication, exercise therapy, acupuncture, etc.), while on this basis, the study group was given intervention in an enriched environment with family involvement, including multisensory stimulation, family interaction, and reproduction of familiar environments. The scores of the Revised Coma Recovery Scale (CRS-R), GCS, Functional Independence Measure (FIM), and changes in electrophysiological indicators of the brain were compared between the two groups before treatment and 8 weeks after treatment, so as to analyze the effect of the family-involved enriched environment on awakening efficacy.

Results: Before treatment, there were no statistically significant differences in CRS-R score, GCS score, FIM score, or brain electrophysiological indicators between the two groups ($P > 0.05$). After treatment, the CRS-R score, GCS score, and FIM score of the study group were significantly higher than those of the control group ($P < 0.05$), and the brain electrophysiological indicators showed that the recovery of brain function in the study group was better than that in the control group.

Conclusion: An enriched environment with family involvement can effectively promote the awakening of children with DOC after ABI, improve their activities of daily living, and enhance brain function, which is worthy of clinical promotion and application.

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Long-term outcome after shaken-baby brain injury: a 16-year longitudinal case report.

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Abstract

Background: Shaken baby syndrome (SBS) also termed Abusive Head Trauma (AHT-US)/ Non-Accidental Head Injury ((NAHI- UK) is the third leading cause of all head traumas in children under five years. Thirty five in 100,000 babies per year are affected in developed countries. AHT is the leading cause of child abuse deaths in the US with 1300 cases per year reported. There is a 25% mortality rate, with 80% of survivors noted to suffer lifelong disabilities. The psychosocial costs associated with the neurological/neuropsychological effects of AHT has yet to be established. Despite well-understood prevalence, few effective neurorehabilitation treatment approaches have been reported in the literature.

Case History: Client A (22 years) first met our team as a child aged six years with a history of AHT. Client A was living with her adopted family. MRI findings at the point of admission confirmed widespread brain damage with extensive scarring and tissue loss throughout the brain, with damage to both frontal and parietal lobes and the upper part of the right hemisphere. A Subsequent MRI scan aged 2.5 years identified that the right cerebral hemisphere was observed as smaller in volume than the left. Testing with the *Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III)* was undertaken at 6 and 9 years (Client A was unable to access the WISC) and a developmental-age was used in tracking development. More recently at 22 years we have re-tested with the WAIS-IV. Results attest to generally poor cognitive recovery but over time some observable shifts in relative strength and weaknesses can be observed, largely because of the neuroplastic response and the efforts of Client A's family in delivering rehabilitation. Despite poor cognitive scores, Client A has learned to read and has high-functioning abilities in recalling song lyrics. There has been worsening dysexecutive syndrome as Client A has matured. Client A requires 2-to-1 care, is deemed to lack capacity and lives in a supported residential setting.

Conclusions: Tracking of Client A from childhood to adulthood reveals clear and debilitating cognitive disability, consistent with the literature, but some unexpected sparing of functions. The neuroplastic response, access to timely support in education, and her dedicated family will be discussed as protective factors, alongside some of the challenges Client A has faced. We discuss how a focus upon quality-of-life measures, community access, participation and optimising independence has been beneficial, even in the context of neurologically based behaviour challenges.

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The Characteristics and Criteria Used to Define Persisting Symptoms in Children With Concussion: A Scoping Review

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Abstract

Background: Most children recover from concussion within the first month of injury, but approximately 30% will experience persisting symptoms after concussion (PSAC) lasting beyond this timepoint. PSAC is associated with negative outcomes from decreased quality of life and academic performance in children, to financial ramifications for the family and healthcare system. There is currently no standardized way to define PSAC, making it difficult to appropriately identify the condition and accurately estimate its prevalence.

Objective: To characterize the definitions and criteria used to determine PSAC in children using a scoping review methodology.

Methods: This scoping review followed a 5-step framework. After the research question was identified, four databases (PubMed, Scopus, PsychInfo, and Web of Science) were searched under the direction of a research librarian using the concepts of concussion, children, and persisting symptoms. Articles were included if they were: (1) original peer-reviewed articles (i.e. reviews, guidelines); (2) written in English or French; (3) exclusively sampled children and adolescents (≤19 years old) with PSAC diagnosed by a healthcare provider; and (4) provided an operational definition of PSAC. Two researchers independently screened the titles and abstracts from all 3991 identified references, with a senior researcher adjudicating any disagreements. The full texts were obtained for all articles included at the title/abstract stage and screened using the same process. The following data was extracted from included articles upon completion of the full-text screen: (1) author and title; (2) participant demographics; (3) persisting symptom characteristics (i.e., term, definition, citation); and (4) interpretations.

Results: Forty-seven studies were included. The term for labeling PSAC varied and evolved over time. The most common term used to describe prolonged concussion symptomology in children was ‘persistent’ post-concussion symptoms (n=26), first appearing in 2016 and peaking in the early 2020’s. PSAC, an emerging term, debuted in 2022, highlighting the transient nature of post-concussion symptoms and providing patients with hope that full symptom resolution is possible with proper care. The most used symptom change threshold to classify PSAC was reporting ≥ 1 concussion symptom (n=30), followed by ≥ 3 new/worsening concussion symptoms (n=14) relative to pre-injury. The most common minimum time since injury to classify persisting symptoms was 1-month after concussion (n=38). Other timepoints included 1-week (n=1), 10 days (n=1), 2 weeks (n=1), 3 weeks (n=3), and 3 months post-injury (n=1). Only 6 studies directly cited clinical diagnostic criteria to justify their definition of PSAC, while 12 studies cited another peer-reviewed article.

Conclusion: Current definitions used to define PSAC rely solely on self-reported symptoms but vary in relation to terms used, number of symptoms, and amount of time following concussion required. A more holistic, standardized definition for persisting symptoms should be adopted for better consistency in research and clinical practice.

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Study Protocol to Characterise Fatigue Phenotypes and their Neural Underpinnings in Children and Young People with Acquired Brain Injury

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Abstract

Background: Chronic fatigue, both physical and cognitive, is a prevalent and debilitating symptom in children and young people (CYP) with moderate to severe acquired brain injury (ABI). Fatigue is multidimensional and often interrelated with other clinical symptoms such as cognitive difficulties or sleep disturbances. Together, they significantly affect academic performance, social participation, and overall quality of life. Despite its impact, the specific phenotypes of fatigue in the context of other clinical variables are not well defined, and the underlying mechanisms of fatigue remain unclear. As a result, treatment options are limited. Structural and functional magnetic resonance image (MRI) studies in paediatric long-term conditions, including ABI, Multiple Sclerosis and Chronic Fatigue Syndrome, suggest a disruption of the Salience network (SN) in these clinical groups. SN disruptions can be associated with poor motivation, inefficient and costly processing, and cognitive and affective functioning deficits. However, its specific contribution to fatigue and other clinical symptoms in paediatric ABI remains unstudied.

Objectives:

- To characterise fatigue phenotypes in relation to cognitive and sleep variables.
- To explore neural underpinnings of these phenotypes.

Method: We aim to recruit 20 CYP with ABI (10 – 18 years), from the Birmingham Children's Hospital, UK and 20 typically developing CYP from the community. We will use a computerised cognitive battery (Cognitron) to characterise each participant’s cognitive function. Specifically, we will focus on memory, attention, executive functioning, motor control, and emotional processing. We will also use standardised batteries to assess sleep disturbances, as well as fatigue and quality of life (PedsQL-MFS). In addition, we will acquire structural MRI (T1 and T2 weighted, diffusion-weighted imaging) and fMRI data at rest to characterise the neural underpinnings of the difficulties across cognitive, sleep and fatigue dimensions.

Analysis: The characteristics of the participants will be summarised using descriptive statistics by group, with n (%) for binary and categorical variables and mean (SD)/median (IQR) for continuous variables. We will run case-control comparisons to

characterise patterns of deficits. With the MRI data, we will compute measures of functional and structural connectivity, global and regional volume in CYP with ABI and compare with the typically developing CYP. We will relate these indices to the cognitive and clinical variables to study the relationship between specific clinical phenotypes and structural and functional neural architectures.

Conclusion: This study will help us understand the relationship between the different dimensions of fatigue and related clinical symptoms and their neural underpinnings. This will support the identification of candidate neural targets for interventional trials and the definition of reliable outcome measures to assess effectiveness in such trials.

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Repetitive Transcranial Magnetic Stimulation (rTMS) for Motor Recovery in Children with Hemiplegia due to Brain Injury: A Randomized Controlled Trial

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Abstract

Background: Hemiplegia is a common sequela after acquired brain injury (ABI), affecting daily functioning and quality of life. Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive technique that modulates cortical excitability, thereby improving motor symptoms.

Objectives: To test whether combining contralesional, inhibitory rTMS followed by motor learning exercises is a safe and effective approach to enhance motor function recovery in children with hemiplegia secondary to ABI.

Methods: Patients aged between 4 and 18 years with upper or lower extremity impairment due to ABI were eligible. Exclusion criteria included severe spasticity (Modified Ashworth Scale = 4), uncontrollable epilepsy, and a history of Botulinum toxin A injection within the preceding six months. In this double-blind, sham-controlled randomized controlled trial, 18 children with hemiplegia due to brain injury were allocated to receive either inhibitory, low-frequency rTMS over contralesional motor cortex (20 min, 1200 pulses) or sham treatment followed by 1-hour PT/OT-guided motor learning exercises for 10 consecutive daily sessions with a weekend break. Motor function was assessed by an occupational therapist using the Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition (BOT-2) at baseline, immediately post-intervention (Day 10), and follow-up (Day 17). A difference-in-differences (DID) analysis was conducted to assess whether rTMS combined with training led to greater improvements in motor performance in children with hemiplegia compared to training alone.

Results: 18 patients with hemiplegia due to brain injury were enrolled (mean age at treatment 11.8 [SD 4.0] years; mean follow-up time 6.2 [SD 4.5] years). A 10-day low-frequency rTMS treatment followed by motor training led to a significant change in total motor composite (TMC) between treatment and sham groups across the three time points. From baseline to day 10, the treatment group showed a significantly greater increase in TMC compared to the sham group (DID estimate 11.95 units, *p*=.027). The effect size was large (*d* =4.46). The treatment effect persisted one-week post-treatment, with the treatment group demonstrating a significantly greater and sustained increase in TMC from day 10 to day 17 (DID estimate 11.05 units, *p*=.047). The effect size was large (*d*= 2.86). rTMS was reported to be well tolerated, with no occurrences of serious adverse events.

Conclusion: The combination of contralesional, inhibitory rTMS and motor learning exercises is safe and effective in enhancing overall motor function in children with hemiplegia after ABI.

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Risk of Autism Spectrum Disorder and Attention-Deficit Hyperactivity Disorder in Children with Hypoxic-Ischemic Encephalopathy

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Abstract

Background: Advances in neonatal medicine have increased survival rates in children with hypoxic-ischemic encephalopathy (HIE), but it remains unclear whether survivors are more susceptible to Autism Spectrum Disorder (ASD) and/or Attention-Deficit Hyperactivity Disorder (ADHD).

Objectives: To investigate the risk of ASD and ADHD in children who have survived HIE

Methods (Design, setting & participants): A population-based birth cohort study was conducted by analyzing electronic medical records retrieved from the Clinical Data Analysis and Reporting System (CDARS) in Hong Kong. Term infants born from 2004 to 2018 who have a history of HIE were included.

Exposure: Diagnosis of HIE

Main outcomes & measures: Log-binomial regression models were used to assess the relative risk (RR) of HIE on the outcomes of ASD and ADHD. Three separate models were constructed for the outcomes: Model 1 was the unadjusted model; Model 2 was adjusted for age and sex; and Model 3 was adjusted for age, sex, and socioeconomic status (SES).

Results: A total of 533,230 children were identified with a valid reference number and were still alive, of which 349 cases had a diagnosis of HIE. The RR of ADHD in HIE patients increased to 1.94 (CI 1.40-2.68, $p < 0.001$) in the unadjusted model, 1.83 (CI 1.32-2.52, $p < 0.001$) in the model adjusted for age and gender, and 1.84 (CI 1.34-2.55, $p < 0.001$) in the model adjusted for age, gender, and SES. The relationship between ASD and HIE did not reach statistical significance. A significant interaction effect was found between HIE and the age of mothers, with RR of ADHD increasing to 4.25 (CI 2.14–8.46) in mothers below 24 years of age.

Conclusion & Relevance: Children with HIE, especially those born to younger mothers, should be closely monitored for signs of ADHD to ensure timely diagnosis and interventions. The relationship between ASD and HIE remained inconclusive, suggesting the need for further research to clarify this potential association.

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Tackling Brain Health: Examining Association Between Head Acceleration Events, Sport-related Concussions and Neural Processing in Female Adolescent Rugby Players

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Abstract

Background: While organized sport provides many benefits to adolescents, sport-related concussions (SRCs) pose a significant risk, potentially leading to long-term neurological impairments. Adolescence is a critical neurodevelopmental period and female athletes are particularly vulnerable, often reporting more prolonged concussion symptoms than males. Rugby, a collision sport known for its inclusivity and supportive environment, has a high concussion rate and is rapidly growing among female athletes. However, research on the neurological impact of repetitive head acceleration events (rHAEs) and SRCs for female adolescent rugby athletes remains limited. Event-related potentials (ERPs), measured via electroencephalography (EEG) are time-locked responses to stimuli and sensitive indicators of cognitive alterations following rHAEs and concussions.

Objectives: Assess amplitude and latency changes of auditory ERPs, the N100 (auditory sensation), P300 (attention), and N400 (cognitive processing), in female high school rugby players compared to non-contact controls (swimming, track, rowing). Secondary objectives examine associations between ERP changes and cumulative rHAEs. Exploratory aims include characterizing changes post-concussion.

Methods: This prospective cohort study included 36 female high school rugby players at pre-season baseline and 32 with complete longitudinal data, along with 11 swimmers as non-contact controls. During the 2025 season, 22 rugby players wore instrumented mouthguards (iMGs) to record rHAEs. Baseline assessments included Sport Concussion Assessment Tool (SCAT) testing. Twelve concussions were diagnosed or suspected in-season. ERPs were recorded using NeuroCatch at baseline and post-season, and video analysis validated rHAEs.

Results: Pre-season analysis (n=36) showed higher symptom count was associated with shorter P300 latency (-1.97 ms per symptom, 95% CI: -3.86, -0.09, p=0.041). Sleep-related symptoms were associated with higher N100 amplitudes (β= 0.26, p=0.027) Concussion history was associated with higher P300 amplitude (2.66 µV, p=0.041). Longitudinally (rugby athletes, n=32), swimmers demonstrated larger N100 and N400 amplitudes than rugby players at both timepoints, although rates of change did not show an association. Within rugby athletes wearings iMGs (n=22), cumulative rHAE exposure was associated with N400 amplitude reduction across the season (β= -0.10, p=0.044) Athletes with in-season concussion showed relative N400 amplitude reduction compared to non-concussed athletes β=-1.33, p=0.046). No significant associations were observed for N100 or P300 measures with rHAE exposure or concussion status.

Conclusion: This study characterizes pre-season neurophysiological profiles and longitudinal ERP changes in female adolescent rugby players. The N400 component was shown to be a potentially useful biomarker for detecting neurophysiological effects of cumulative rHAE exposure and in-season concussion. These findings suggest that objective neurophysiological assessment using portable ERP systems can detect subtle changes associated with collision sport participation and in-season concussion, potentially informing monitoring and prevention strategies during a vulnerable developmental period.

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Use of an Online TBI Resource Portal to Overcome Barriers Impacting Quality of Life in School-Aged Children Following TBI

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Abstract

Background: Each year, approximately 5 million children worldwide sustain a traumatic brain injury (TBI), and 20-25% experience persistent cognitive, motor, behavioural, or functional impairments into adulthood. Pediatric TBI survivors have unmet needs in physical, cognitive, speech, mental health, and educational services. Nearly half of children hospitalized for TBI report unmet needs within 6 months to 2 years post-injury, particularly in physiatry, speech therapy, and educational support. Barriers include regional disparities in rehabilitation resources, limited outpatient follow-up, poor communication between medical and educational systems, and social determinants of health that affect access and utilization of services. Improving quality of life (QOL) for these children requires a holistic, coordinated approach addressing medical/cognitive impairments and external factors such as family dynamics, education, and access to support; without comprehensive care, children with TBI remain at increased risk for persistent disability and reduced QOL.

Objectives: To identify barriers impacting the QOL of school-aged children (5-18 years) recovering from TBI and to propose an Online TBI Portal that mitigates these barriers by uniting providers, enhancing collaboration, and connecting families to community services.

Methods: A literature review was conducted across five databases (Medline, PsycInfo, Web of Science, ProQuest, PubMed) using search terms linking children, TBI, and QOL. Inclusion criteria limited studies to English, peer-reviewed articles published between 2005-2025, focusing on moderate to severe pediatric TBI. Articles were screened using Covidence™. A thematic analysis extracted and synthesized barriers to QOL, current solutions aimed at minimizing these barriers, and the potential challenges when implementing them.

Results: Our search identified 469 articles, of which 17 were included. The literature identified six major barriers to QOL: physical and cognitive impairments, socialization and behavioural challenges, mental health issues, inadequate support services, family dynamics, and difficulties with educational reintegration. These barriers are compounded by external factors such as inadequate mental health and school supports, lower socioeconomic status, and caregiver distress, all of which further reduce quality of life. Proposed solutions include enhancing school-based and community services, implementing interventions targeting mental health and family functioning, and improving caregiver education and support; however, these are often limited by poor accessibility, lack of individualized care plans, and fragmented communication among providers. To address these challenges, the authors propose

an Online TBI Portal to centralize care, facilitate interdisciplinary collaboration, and connect families to local resources. Key features would include shared communication among care teams and families, peer support networks, a curated resource database for caregivers, and a directory of community-based support and rehabilitation services.

Conclusion: School-aged children with TBI face multifaceted barriers to achieving a high QOL. The authors propose an Online TBI Portal to bridge these gaps by centralizing communication, offering evidence-based resources, and promoting interdisciplinary, family-centred care.

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Ketogenic Diet Following Moderate to Severe Pediatric Traumatic Brain Injury: A Pilot Study

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Abstract

Background: Traumatic brain injury (TBI) is an important public health problem and a significant cause of pediatric disability and death. Moderate to severe TBI disrupts the normal function of the developing brain, potentially leading to lifelong disabilities. A reported conservative estimate of the incidence of global pediatric TBI is 50 per 100,000 population annually, or more than 3 million children. The ketogenic diet (KD) has been identified as a potential therapy to enhance recovery after TBI. The KD, a low-carbohydrate, adequate protein, high-fat diet, shifts metabolism from carbohydrates towards fats and ketones. During conditions of stress, the brain can shift its metabolism to alternative substrates such as ketones. Animal TBI studies exploring KD demonstrated neuroprotective effects and delayed damage to mitochondria in the brain, with brain mitochondria producing less hydrogen peroxide than controls. Rat models also demonstrated that younger animals achieve ketosis faster with greater cerebral ketone uptake and metabolism, compared to older animals. However, the efficacy of using the KD in pediatric acute TBI is still unknown.

Objectives: The primary aim of this study was to evaluate the feasibility and safety of using the KD in children who sustained moderate to severe TBI.

Methods: This was a prospective study enrolling children ages 2-17 at the time of TBI with a Glasgow Coma Scale (GCS) of 3-12 within 36 hours of admission to the PICU who were receiving IV fluids and not expected to start oral feedings within a few days. After informed consent, baseline lab values were obtained. If deemed clinically appropriate, subjects began the process of achieving ketosis. IV fluids were changed to dextrose-free, followed by KD tube feedings, when appropriate, to begin enteral feedings. Laboratory values were reviewed daily, and subjects were monitored for adverse events. KD tube feedings continued for a maximum of 14 days.

Results: Seven subjects were recruited (6 female, lowest GCS in first 24 hours 3-10, ages 7-15, 5 White and 2 Black). One withdrew prior to the initiation of the enteral diet as they showed rapid neurologic improvement and transitioned to an oral diet, and parents declined an oral KD for their child. Subjects were on the ketogenic diet for a variable number of days: one day to a maximum of 14 days. All subjects tolerated KD, ketosis was achieved, and there were no adverse events attributable to the ketogenic diet. Adverse events determined not related to the KD included

elevated liver enzymes (which resolved after acetaminophen discontinuation) and chylous ascites attributed to concomitant abdominal trauma.

Conclusion: KD administered as a tube feeding was tolerated in 6 subjects with acute TBI and GCS 3-12. A larger RCT needs to be completed evaluating KD effects on outcomes of children with TBI.

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5 Years of Cognitive Assessment: How Normative and Relative Impairments Help Tell The Story of Cognitive Difficulties Following Childhood Acquired Brain Injury?

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Abstract

Background: Acquired brain injury (ABI) in children causes significant long-term difficulties in cognition and behaviour. To date, literature has focussed on identifying normative impairments on standardised performance-based assessments to articulate the changes post-injury. Despite this, clinical experience suggests that it is, in fact, the relative impairments that cause the most distress and interrupt the developmental and academic progress of a child following ABI.

Case History: This review summarises 5 years of WISC-V data from a dedicated paediatric neuropsychology service within a busy London hospital providing tertiary services. A clinical audit was performed on the previous 5 years of neuropsychological assessment data gathered for children referred with acquired brain injury. Each assessment dataset was analysed for normative and relative index impairments using discrepancy analysis and the inclusion of base rate information. Relationship to "main referral concerns" was explored.

Conclusion: Across age-ranges and cognitive domains of the WISC-V, cognitive impairments in CYP with ABI were more prevalent that in the normal population, with 1/3 children with ABI demonstrating general intellectual abilities in the below average range. Notably, the youngest age-at-injury group had the highest rate of impairments, indicating poorer cognitive outcome. Discrepancy analyses revealed that relative weaknesses were most frequently observed in Processing Speed (PSI) and Working Memory (WMI), particularly in preschool and secondary-age groups. Relative strengths were most common in Fluid Reasoning (FRI) and Verbal Comprehension (VCI). Base rate analyses confirmed that most identified discrepancies were clinically significant (occurring in <10% of the normative population).

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Restructuring Post-Acute Neuropsychological Rehabilitation for Children in a Hospital Setting to Tackle Health Inequalities

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Abstract

Background: Audit data suggested significant health inequalities regarding who accesses our service and how, with factors pertaining to social disadvantage, such as race and socio-economic status associated with poorer access to, and uptake of, our hospital-based neuropsychology service. A recent restructure of our service has been implemented, to provide a differentiated offer, using the Balanced System Framework.

Objectives: To promote equitable provision for all children, young people and their families in a hospital-based service through a tiered approach, reducing our dependency on individual referrals.

Methods: We have moved from a “one size fits all” approach, to a tiered approach using the following levels; Universal, Targetted, Specialist. Universal services are designed to support all children and young people (CYP) with neurological conditions and injuries, regardless of need or referral status. For this tier, activities included training hospital staff, considering the hospital environment, the development of leaflets and a CYP patient forum. Targeted interventions are those designed with groups of children in mind who share symptoms or challenges. For this tier, activities included recording a library of webinars on YouTube on common difficulties encountered by CYP with neurological conditions and injuries, running therapeutic groups using Beads of Life and Tree of Life approaches. Specialist services are for children and young people whose needs cannot be met through universal and targeted provisions and refer to individual neuropsychology assessment and treatment by qualified Clinical (Neuro)psychologists.

Results: Outcome data from parents, CYP and hospital consultants is overwhelmingly positive and we have been able to access a patient population that is more representative of the local demographic. We are hopeful that this new approach will show evidence of tackling health inequalities in our upcoming audit. Furthermore, the flow through our service has improved such that we are responding sooner to referrals and discharging earlier.

Conclusions: The new differentiated service approach for hospital-based post-acute neuropsychological rehabilitation has been positively received and has allowed us to increase our reach to all children with neurological conditions and injuries known to the hospital, as well as those historically "hard-to-access" families in need of specific intervention.

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From Knowledge to Practice: A Mixed-Methods Investigation of School-Based Speech-Language Pathologists' Role in Student Concussion Management

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Abstract

Background: School-based speech-language pathologists (SLPs) are uniquely positioned to support students returning to academic environments following concussion, yet significant gaps exist in their preparation and involvement in evidence-based concussion management. With over 700,000 children experiencing concussion annually in the United States and current guidelines recommending rapid return to school within 2-3 days, understanding how SLPs navigate the implementation of school-based Return-to-Learn (RTL) protocols is critical for improving student outcomes.

Objective: This mixed-methods investigation examined school-based SLPs' knowledge, confidence, and implementation experiences related to concussion management, with particular focus on barriers and facilitators to evidence-based practice delivery using the integrated Promoting Action on Research Implementation in Health Services (i-PARIHS) framework.

Method: The study employed a sequential mixed-methods design. First, 74 school-based SLPs completed an electronic survey examining concussion-related knowledge, confidence, training experiences, and familiarity with current guidelines. Knowledge accuracy was assessed using 20 statements about concussion management, including items reflecting recent guideline changes. Subsequently, 10 SLPs were purposively selected representing varying confidence levels for semi-structured interviews guided by the i-PARIHS framework to explore Innovation, Recipient, Context, and Facilitation factors influencing evidence-based concussion care implementation.

Results: Quantitative findings revealed that nearly half of school-based SLPs had no relevant clinical or training experiences for serving students with concussion. Only 36.5% reported receiving concussion-related training, primarily through graduate education. Participants demonstrated lower confidence and accuracy on recently published guidelines regarding rest and activity recommendations compared to established knowledge. SLPs showed higher confidence in general concussion knowledge and interdisciplinary team participation compared to assessment abilities. Qualitative analysis identified significant implementation barriers across all i-PARIHS constructs: limited awareness of RTL protocols (only 1 of 10 participants knew district protocols), complex or large caseloads (up to 150 students), and communication gaps between medical and educational settings. However, strong facilitators emerged including professional growth mindset, recognition of existing team infrastructures, and preference for consultation-based service models. Nine of ten participants expressed confidence in providing concussion services despite acknowledging knowledge gaps, demonstrating readiness to engage in RTL implementation when appropriately supported.

Conclusion: While school-based SLPs possess strong individual characteristics supporting RTL implementation, including professional growth mindset and clinical problem-solving abilities, significant organizational and systemic barriers limit evidence-based concussion care delivery. The persistent knowledge gaps regarding recent guidelines and limited protocol awareness highlight challenges in knowledge translation from research to practice. Implementation strategies should leverage SLPs' existing strengths and consultation preferences while addressing multi-level contextual barriers through systematic training programs, improved medical-school communication protocols, and organizational support for reasonable caseloads and dedicated time for concussion team participation.

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Retiring After Concussion: Insights into Athlete Decision-Making and Post-Sport Adjustment

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Abstract

Background: Despite growing concern over the long-term effects of concussion, clinicians lack evidence-based guidelines to support medical retirement decisions for athletes. While return-to-play protocols are well established, little is known about how athletes decide to retire from contact sports due to concussion or the personal consequences of that decision.

Objectives: This study aimed to explore the decision-making process surrounding concussion-related medical retirement by conducting qualitative interviews with former athletes. Specifically, we sought to identify key factors influencing their decision to retire and to understand the physical, social, and psychological impacts of that decision on their lives.

Methods: Twenty-six athletes (ages 15–22; mean age = 19.8 years, SD = 1.9; 48% female) participated in video or phone interviews. Eligible participants had retired from a contact sport one or more years prior due to having one or more concussions. Semi-structured interviews were conducted and analyzed using consensual qualitative research methods to identify recurring themes.

Results: The decision-making process varied widely among participants. Some described collaborative decisions involving athletes, families, and medical providers, while others reported unilateral decisions made by a single stakeholder or decisions driven by institutional rules (e.g., “three concussions and you're out”). Influential factors included fear of long-term consequences, personal experiences, media portrayals of concussion-related outcomes, and, at times, misunderstanding or lack of medical information. Athletes weighed multiple considerations, including factors related to their personal identity, social pressures, future health risks, and the broader meaning of sport in their lives.

The impact of retirement was multifaceted. Many athletes reported experiencing negative emotions such as sadness, guilt, and social withdrawal, along with disruptions to relationships and loss of daily structure. However, these effects often diminished over time. Positive themes emerged, including emotional growth, development of new interests, and the discovery of new personal identities. Athletes described various coping strategies, such as staying connected to sport in alternative roles, seeking counseling, and leaning on social supports. Many expressed a desire for clearer communication from medical professionals, wanting more information about potential long-term risks, and wanting opportunities to speak with others who had faced similar decisions.

Conclusions: Concussion-related sports retirement decisions are shaped by a complex mix of clinical, emotional, and social factors. Athletes’ decisions were influenced not only by medical advice but also by fear, peer experiences, and misinformation. The transition out of sport carried significant emotional weight, yet many participants ultimately reported personal growth. These findings highlight the need for evidence-based clinical guidelines, improved communication, and specific recommendations regarding supports to help athletes navigate retirement decisions and minimize negative impacts.

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Traditional Chinese Medicine for Pediatric Brain Injury: Clinical Insights from a Retrospective Case Series

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Abstract

Background: Pediatric brain injuries, such as encephalitis, hypoxic-ischemic encephalopathy (HIE), and intracranial hemorrhage, often lead to impaired consciousness and reduced muscle tone. The management of these conditions typically requires a multidisciplinary approach involving neurology, rehabilitation, and supportive care. In Taiwan, traditional Chinese medicine (TCM)—including acupuncture, herbal therapy, and manual techniques—is frequently integrated into clinical practice. However, the role of TCM as an adjunctive therapy in pediatric brain injury remains insufficiently studied.

Objective: To evaluate the clinical effect of TCM on neurological outcomes in children with brain injury.

Methods: We retrospectively analyzed 19 pediatric patients with brain injury treated at a university children's hospital. All patients received TCM interventions, including acupuncture and herbal medicine. Patients were categorized into three etiological groups: encephalitis (n = 6), HIE (n = 5), and intracranial hemorrhage (n = 8). Intracranial hemorrhage included epidural hematoma, subdural hematoma, subarachnoid hemorrhage, and arteriovenous malformation (AVM) rupture, with both traumatic and non-traumatic causes. Neurological function was assessed using the Glasgow Coma Scale (GCS) and muscle power scores before and one month after TCM treatment. Paired t-tests were applied for statistical analysis.

Results: In the encephalitis group, females outnumbered males (2:4), while male predominance was noted in the HIE (3:2) and intracranial hemorrhage (6:2) groups. The average age of the encephalitis group was 7.8±3.1 years old, and the average hospitalization stay was 35±21 days. The average age of the HIE group was 0.9±1.8 years old, and the average hospitalization stay was 33.6±7.1 days. In addition, the average age of the intracranial hemorrhage group was 7.4±5.0 years old, and the average hospitalization stay was 33±20 days. Following one month of TCM treatment, GCS scores improved significantly (median: from 10 to 15; $p = 0.0035$). Furthermore, muscle power also significantly improved after one month of TCM treatment (median: from 12.5 to 20; $p = 0.002$).

Conclusion: This preliminary study demonstrates that integrative TCM

interventions—including acupuncture and herbal medicine—are associated with significant improvements in consciousness and motor function in children with brain injury. These findings highlight the potential of TCM as an effective adjunctive therapy, warranting further large-scale prospective studies to confirm its benefits.

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Vestibular Dysfunction and Its Impact on Balance and Dizziness in Pediatric Moderate-Severe Traumatic Brain Injury

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Abstract

Background: Traumatic-brain-injury (TBI) is among the most common causes of acquired disability in children and adolescents. Following moderate-severe TBI (msTBI), despite the severity of the injury and the well-documented balance deficits, there is limited knowledge regarding vestibular function and symptoms, as well as on their resulting impact on balance function.

Objectives: This study aimed to describe clinical vestibular function and its association with balance abilities in children and adolescents post-msTBI.

Methods: Sixty children assessed within six months following msTBI were included (46 males; median age 14.1 [6.0-18.9] years; median length of coma 5 [0-60] days; median time post-injury 68 [14-187] days). The vestibulo-ocular-reflex (VOR) was assessed using the clinical Head-Impulse-Test (cHIT), the clinical Dynamic-Visual-Acuity test (cDVA), the clinical Gaze-Stabilization-Test (cGST; horizontal/vertical), and the clinical Visual-Motion-Sensitivity-Test (VMST) which assessed VOR cancellation. Dizziness-related disability was assessed using the Dizziness-Handicap-Inventory (DHI). Standing balance was evaluated using the Pediatric-Balance-Scale (Pediatric-Berg) and walking balance using the Functional-Gait-Assessment (FGA).

Results: Forty participants (70%) demonstrated at least one VOR abnormality: five (8%) had a positive cHIT (three bilateral, one right, one left), 23 (38%) an abnormal horizontal cGST (abnormal function n=16, and/or symptom report n=12), 10 (17%) an abnormal vertical cGST (abnormal function n=4, and/or symptom report n=7), and 34 (57%) an abnormal VMST (abnormal function n=31, and/or symptom report n=8). Only 39 participants (65%) completed the cDVA, with all scoring within normal limits (<2 lines difference). The median Pediatric-Berg score was 55 (range 2-56), with 25 participants (42%) achieving the maximum score. The mean FGA score was

19.1±11.0, with 7 participants (12%) at the maximum. Participants with at least one abnormal VOR test had significantly lower FGA scores (17.3±11.9 vs 23.0±8.0, p=0.048) and approached significantly lower Pediatric-Berg scores (52 (2-56) vs 56 (4-56), p=0.075). The median DHI score was 2 (range 0-70); most participants (n=34, 57%) reported no dizziness. Notably, participants who reported dizziness on the DHI were older (16.2±3.2 vs 13.1±3.7, p=0.042) and had significantly higher FGA scores (22.2±9.8 vs 16.1±11.5, p=0.047). In addition, participants with at least one abnormal VOR test were less likely to report dizziness in the DHI than those with intact VOR function (33% vs 67%, p≈0.02).

Conclusion: Children and adolescents in the subacute stage following msTBI exhibited a high prevalence of clinical VOR dysfunction, with normal clinical VOR function associated with better walking balance. Most participants reported no dizziness that affected daily function, while paradoxically, participants who reported dizziness showed better balance, and those with VOR dysfunction were less likely to report dizziness-related disability. This dissociation between clinical findings and perceived symptom burden warrants further investigation to clarify this relationship and guide targeted rehabilitation strategies in this population.

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Treading Water in Deep Currents; The Lived Experience of Families After Childhood Acquired Brain Injury

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Abstract

Background: Acquired Brain Injury Ireland's On With Life programme provides support for families and parents of children and young people (CYP) with acquired brain injuries (ABI) in Ireland. Feedback from families frequently describes service provision as fragmented, inconsistent, and difficult to navigate. Parents describe the exhausting work of "treading water" in systems not designed for long-term disability. This is echoed in the literature, which highlights the lack of national pathways for the provision of local ongoing rehabilitation to CYP. This results in significant challenges in accessing consistent and coordinated support across the continuum of care after childhood ABI.

This is further exacerbated by the divide between health and education systems, which often operate in isolation. Families frequently report feeling isolated in managing the needs of their CYPs with ongoing, often invisible, complex needs. At critical transition points such as an increase in developmental expectations, moving to secondary school or preparing for adulthood, gaps in support/services can become even more visible. The On With Life programme receives frequent requests from parents for increased clinical support at a local level.

Case History: In response to this need, an interdisciplinary Psychology and Occupational Therapy pilot initiative was developed by Acquired Brain Injury Ireland. This pilot worked with five families, providing flexible virtual consultation sessions. Pre-consultation questionnaires were used to ensure that the sessions were focused on priority areas. Post-consultation questionnaires were gathered to tailor the provision in an iterative process of improvement based on principles of co-design.

Following each parent consultation session, a tailored suite of education offerings was provided to each family. These included education on sensory integration, building independence, and supporting behaviours, as well as educational guidance for schools. Families were empowered to select offerings which they felt best addressed their needs at that point in time.

Based on this pilot so far, it highlights what keeps them afloat: strong routines, key professionals, and practical supports like assistive technology, visual schedules, and sensory processing strategies. It also identifies what threatens to pull them under: isolation, inadequate understanding of ABI, and the absence of consistent, long-term support.

Conclusion: There is a need for integrated care across acute, rehabilitation and community services for CYP with ABI in Ireland. This type of support is essential in

managing the sequela of ABI in childhood. This presentation will describe the design, implementation, and early impact of this initiative, demonstrating how collaborative, responsive approaches can begin to address the need of ongoing local
support. This pilot demonstrates a shift in how we understand ABI recovery and family resilience, empowering parents to select support that they require in the right place, at the right time.

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Access in Action: Empowering Parents to Use Digital Assistive Technology for Children with Acquired Brain Injuries

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Abstract

Background: Acquired Brain Injury Ireland's On With Life programme provides individualised support to parents and families of children and young people (CYP) with acquired brain injuries (ABI) in Ireland. A key element of the programme is its annual parent survey, which captures the evolving priorities and challenges families face. One area consistently identified is the need for training in digital assistive technology (DAT).

DAT can play a vital role in supporting CYP post-childhood ABI. However, accessing DAT can be particularly challenging for CYP with ABI in Ireland due to complex pathways and fragmented service provision. As a result, many do not receive timely access/training to essential DAT to support them in reaching their full potential.

Case History: In response to these needs, a collaborative partnership was formed between two of Acquired Brain Injury Ireland's programmes: On With Life and creATe. The creATe programme is an interdisciplinary Speech and Language and Occupational Therapy service, which specialises in DAT for adults with ABI.

This collaboration aimed to provide meaningful and tailored education on DAT to parents of CYP with ABI through a series of educational webinars. These webinars were designed to equip parents with the knowledge and confidence to use and maximise the potential of widely available mainstream DAT.

In line with a family-centred approach, all webinars were recorded and made available for parents to access in their own time. These webinars have been made available to 109 parents linked with Acquired Brain Injury Ireland's On With Life Programme.

Pre- and post-questionnaires were developed to guide the design and evaluation of this collaboration. The pre-questionnaires were used to identify DAT priority areas for parents. These webinars covered key topics such as DAT: for planning and organising and study skills. Information gathered from parents ensured the content was tailored based on the educational settings and the level of support being received by each CYP.

Conclusion: To date, two of the four planned DAT educational webinars have been delivered. Feedback from parents indicates a positive impact on their confidence and an increased awareness of mainstream DAT solutions to support their CYP with ABI. The remaining two sessions will allow for further refinement of the educational content based on ongoing feedback. This collaboration highlights the value of proactive, family-centred education in DAT. By responding directly to parent-identified needs, these education sessions provided practical and accessible support

to parents. This initiative enables access to knowledge about the potentially transformative impact of DAT for CYP with ABI in Ireland.

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Feasibility Study of ExoAtlet Bambini for Physical Therapy Interventions Aimed at Enhancing Functional Mobility in Students with Developmental Delays in a School-Based Setting

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Abstract

Background: Children with moderate to severe traumatic brain injuries (TBIs) often present with impairments that limit their participation in school and activities of daily living. Robotic-assisted gait therapy using a powered exoskeleton has been shown to benefit users' mobility, contributing to their rehabilitative progress and overall quality of life. However, there is little information about effective use of exoskeleton-assisted therapy in school settings.

Objectives: This study, conducted by two physical therapists (PT) at the International Academy for the Brain (iBRAIN)-Manhattan campus, primarily sought to determine the safety and practicality of robotic exoskeleton usage in school-based PT sessions for students with moderate to severe TBIs and resulting mobility impairments. Secondarily, we looked for evidence of improvements in functional mobility, engagement in school activities, and ease of use of the exoskeleton among students and staff.

Methods: Six students participated in 60-minute sessions using the ExoAtlet Bambini robotic exoskeleton twice a week for four weeks. Sessions included warm-ups, sitting, sit-to-stand activities, and gait training followed by a cool down. Students' functional mobility, strength, range of motion, balance, and spasticity were assessed.

Results: Based on analysis of gait parameters recorded by the exoskeleton itself as well as clinical session notes collected by PTs and standard PT assessments, initial findings indicate that the use of a robotic-assisted exoskeleton is safe and feasible in a school setting with this population. Further, pre/post comparisons and examination of trends in the data collected indicate that students' performance did improve across the focal indicators.

Conclusion: The authors will share implications for professional development and PT program advancement for implementing exoskeleton-assisted therapy for students with moderate to severe TBIs in schools.

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Comparative Effectiveness of Exoskeleton vs. Traditional Gait Trainer for Gait Training in Severely Motor Impaired Children in a School Setting

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Abstract

Background: Children with severe motor impairments face immense challenges with mobility. Although there has been progress in pediatric gait rehabilitation, virtually no studies include the most severely impaired children for whom traditional gait training methods fall short.

Objectives: Building from an initial safety and feasibility study, in this study we aim to specifically investigate the impacts of exoskeleton-assisted gait therapy for children with the most severe impairments (GMFCS Level V or similar) for whom traditional gait training methods are insufficient.

Methods: Utilizing a quasi-experimental design, eight participants will undergo 48 gait-training sessions over six months. Participants will be assigned to the control or experimental group based on their tolerance of the ExoAtlet Bambini powered exoskeleton. Outcomes will be assessed via pre- and post-study clinical evaluation, comprising the 6-Minute Walk Test, 10-Meter Walk Test, and key gait parameters (e.g., step length, cadence, etc.). We employ mixed methods to capture objective performance data and clinical observations for a comprehensive comparison.

Results: Outcomes will be analyzed using non-parametric statistical assessments and supplemented with qualitative analysis to capture contextual factors affecting progress. Conclusion: Findings will establish preliminary evidence of the benefits of exoskeleton-assisted gait training for children with severe impairments, laying the foundation for future clinical guidance, fruitful directions for further research, and increasing access to advanced gait training therapeutic interventions in pediatric physical therapy in school settings.

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Effects of Exoskeleton-Assisted Gait Training in Children with Moderate to Severe Brain Injury: Case Series in a Special Education School Setting

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Abstract

Background: Children with moderate-to-severe traumatic brain injuries (TBIs) face profound challenges in functional walking, cognition, and overall independence. Robotic-Assisted Gait Training (RAGT) is an innovative physical therapy approach that combines robotic technology with high-repetition, task-specific movement to enhance mobility and neuroplasticity in individuals with neurological conditions.

Objectives: This study examines the effects of RAGT using the ExoAtlet II exoskeleton on gait parameters, psychosocial, and cognitive outcomes in a school setting.

Methods: A team of physical therapists (PTs) at the International Academy for the Brain (iBRAIN) - Brooklyn campus implement a four-phase intervention structure over 16-weeks in which participants gradually progress through phases of robotic-assisted gait training to build skill and confidence while ensuring safety. Phases 2-4 also incorporate a dual tasking component in which participants complete cognitive and/or psychosocial tasks while ambulating to explore the impact of robotic-assisted gait training on neuroplasticity.

Results: The investigators use standardized outcome measures (e.g., Timed Up and Go, 6-Minute Walk Test, etc.), clinical observations, daily session notes, and quantitative data from the ExoAtlet II to monitor performance and tailor therapies to student needs. Performance observations are used to assess the dual tasking component.

Conclusion: The authors will present case analyses that center individual students' experiences with exoskeleton-assisted therapy, unpack the intervention, and explore the dual tasking component to identify and discuss links between motor performance, cognitive flexibility, and school participation, addressing critical gaps in school-based neurorehabilitation research.

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A Novel Protein Panel to Predict Brain Cortical Thickness after Concussion

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Abstract

Background: Outcome after traumatic brain injury (TBI) is highly heterogeneous, especially in mild TBI (mTBI) in adolescents. A third of children have persistent symptoms after concussion but our ability to predict which children will be symptomatic several months after injury is poor. There is a wide array of potential markers of outcome, including magnetic resonance imaging (MRI) and blood biomarkers, but narrowing down which biomarkers are best, and for which subpopulation, remains a challenge.

Objectives: Determine whether we can identify proteins significantly associated with brain morphometry after adolescent concussion.

Methods: The Concussion Assessment, Research, and Education for Kids (CARE4Kids) study is a longitudinal multi-site investigation aimed at identifying and validating endotypes of persistent-post concussion symptoms (PPCS) in adolescents 11-17.99 years old. Participants were recruited from outpatient settings between 2021-2024. 185 participants within 30 days of their injury (93 F/92 M | average age = 14.9, SD = 1.9) were included in this analysis. Multiple measures/samples were collected from participants including multimodal MRI, blood samples, autonomic responses, and neuropsychological assessments. MRI data was processed through FreeSurfer version 7.4 and visually checked, with manual edits when needed. Several measures of cortical morphometry were extracted including cortical thickness and surface area. For this first analysis we focused on cortical thickness (CT) averaged within the Desikan-Kiliany regions. These measures were processed through Centile Brain (https://centilebrain.org/) to generate participant- and region-specific Z-scores relative to a normative dataset of 37,000+ individuals 3-90 years old. For each participant we counted the number of regions with a Z-score below -2 or above 2 (outlier regions). Across the sample, the average number of high CT outlier regions was 1.5 (SD=1.6) and the average number of low outlier regions was 1.2 (SD=2.6). Based on this, we identified groups of participants with a large number of outliers as mean + SD, so the cutoff for a large number of high outliers was 3.1 and for a large number of low regions was 2.6.

Results: Using Olink Explorer, we first compared 5,400 proteins in the group with a larger number of low outliers (3 or more) to those with fewer than 3. From this, we observed 380 proteins to be differentially abundant. Using area under the curve

(AUC) models, we found combinations of 10 proteins that were predictive, including an AUC of 0.97, and sensitivity and specificity of 0.95 and 0.94 respectively (CES3 + NLRP14 + PDE4C + CXADR + LIFR + LACRT + LIPF + RCSD1 + STX2). Further, protein pathway analyses found 3 key pathways including cellular signaling, neuronal sympathomorphism, and cellular metabolism.

Conclusions: Together these proteomic activity findings suggest that unique protein panels are associated with cortical morphometry after concussion in adolescents.

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Mindfulness-Based Intervention Effects on Resilience Trajectories and Functional Connectivity in Pediatric Concussion

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Abstract

Background: Psychological resilience at initial clinical assessment is associated with clinical outcomes and brain function following pediatric concussion. Lower resilience is specifically linked to greater symptom severity and protracted recovery in concussion recovery. Mindfulness-based interventions (MBIs) may foster resilience, but their effects on resilience trajectories and their ability to moderate the association between resilience and functional connectivity (FC) following pediatric concussion are unclear.

Objectives: To evaluate whether an MBI influences the resilience trajectory in adolescents with concussion, and whether it moderates the association between baseline resilience and resting-state FC at 4-weeks post-injury.

Methods: This is a substudy of a randomized clinical trial (ClinicalTrials.gov ID: NCT05105802) that assigned adolescent participants recruited within seven days of concussion to either a 4-week custom-made MBI administered via smartphone app or a cognitive sham delivered through the same platform. Resilience was measured at 1-day and 4-week post-recruitment using the Connor-Davidson Resilience Scale 10. A subset of participants also underwent fMRI at 72 hours and 4 weeks post-injury. Linear mixed effects models tested group differences in the resilience trajectory over time (from 1-day to 4-week post-recruitment). Seed-to-voxel regressions tested Group (MBI vs sham) × Resilience (Baseline) interactions on 4-week FC of the default mode network (DMN), salience network (SN), and central executive network (CEN).

Results: Ninety-five participants were included in the analysis of resilience trajectories (MBI n = 47, median age [IQR] = 14.92 [13.65–16.14] years, 40% female; Control n = 48, median age [IQR] = 15.00 [13.37–16.74] years, 43% female), while a subset of 36 participants were included in the neuroimaging analyses. There were no significant group differences with respect to resilience trajectories. However, significant Group × Resilience interactions were identified in FC across the DMN, SN, and CEN (FDR-$p < .05$). Specifically, higher baseline resilience was associated with more favorable FC patterns (i.e., patterns consistent with healthy populations) across the DMN, SN, and CEN in those receiving MBI compared to controls.

Conclusion: Although the MBI did not increase self-reported resilience over time, it significantly moderated the association between resilience and FC. This suggests that MBI may affect the neurofunctional effects of baseline resilience during recovery, and that neuroimaging metrics may be more sensitive than self-reports for detecting early intervention effects on pediatric concussion.

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Post-Concussion Symptom Assessment in Young Children: Exploring the Suitability of the REACTIONS Measure in New Zealand

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Abstract

Background: Young children have high rates of mild traumatic brain injuries/concussion, but symptoms are hard to assess due to their limited verbal and cognitive abilities. The REACTIONS – 48 (Report of Early Childhood Traumatic Injury Observations and Symptoms) was developed by Canadian researchers to address this challenge and incorporated multiple phases of caregiver, educator and health professional feedback and co-construction to ensure the relevance and clarity of the content; however, further adaptations may be necessary to use the tool in other regions.

Objectives: This study was conducted to determine if the REACTIONS measure is suitable for use in the New Zealand (NZ) context.

Methods: Parents, caregivers and early childhood educators of children aged 0-6 years completed the REACTIONS measure and took part in interviews to provide feedback on the measure. Participants were asked about: i) clarity of the instructions and if they were easily to follow (particularly for those with English as a second language); ii) if the items made sense and if additional explanation or wording change was required, and iii) was any content missing. Interviews were audio recorded, transcribed and analysed using thematic content analysis.

Results: Thirty-eight parents and early childhood educators took part (age 20-65 years; 93% female; Ethnicity: 43% NZ European, 19% Māori, 3% Pacific, 35% Other). In terms of clarity and ease of following instructions, participants recommended: i) clarifying when to use the ‘smiley face’ symptom severity ratings, and ii) including a reminder that children of the same age show individual differences in behaviour/development and the questions are focused on how their child is now compared to how they usually are.

Item level feedback included: i) using simpler language (e.g., throw up rather than vomit); ii) providing definitions in places (e.g., for fixate, amplified); iii) including Māori terms where possible (e.g., mamae for painful or sore); iv) incorporating ‘compared to usual or pre-injury’ in the wording of every question; v) including more examples of how young children might indicate that they are sick or in pain in addition to the formal descriptions (e.g., headache (holding their head) sensitivity to light (wincing, covering eyes, hiding); vi) clarifying how to answer the questions on the 0-2 year old measure if the child has limited verbal ability (e.g., memory questions) and; vii) adding other examples/terms to explain regression (e.g.,

attention seeking, being grizzly). Participants did not suggest adding any additional questions.

Conclusion: Overall participants welcomed the development of a measure of concussion symptoms in young children and appreciated the opportunity to provide feedback. The feedback will be used to develop supplementary information, including clarification of the administration instructions and alternate wording/further explanation of the items to incorporate into the REACTIONS-48 for use in NZ.

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Concussion Symptom Resolution in Children and Adolescents in New Zealand: A Comparison of Parent and Child Symptom Reports

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Abstract

Background: Concussion is a common childhood injury. Appropriate management immediately after injury is crucial so that children can return to school and their usual activities quickly. However, determining when a child is recovered is challenging due to the use of different criteria for classifying outcomes (i.e. symptomatic/recovered) and the reliance on parent reports which may under- or over-report symptoms. As part of a prospective longitudinal study of concussion recovery in young people aged 5-17 years in New Zealand (NZ), we explored parent and child reports of post-concussive symptoms up to twelve-months post injury.

Objectives: To explore the level of agreement between parent and child ratings of concussion outcomes at 1-10 days, 2 weeks, 1 month, 3 months and 6-12 months post-injury.

Methods: Participants (n=275 families; 66.6% male; mean age 11.4 years (SD=3.5); 28.4% Māori, 13.1% Pacific, 58.6% non-Māori non-Pacific) were recruited after a diagnosis of concussion at hospitals and Urgent Care clinics in Waikato and Auckland (NZ). As part of a larger assessment, parents and young people completed the post-concussion symptom inventory (PCSI) at baseline (1-10 days), 2 weeks, 1 month, 3 months and 6-12 months post-injury. We calculated the proportion of symptomatic participants at each time point (using PCSI RAPID scores with 80% CIs) based on parent and child self-reports.

Results: Levels of parent child agreement at each time point were calculated using Cohen's kappa. At 1-10 days post-injury 85.6% of the sample were classified as symptomatic based on parent reports, and 91.5% based on child reports (κ = .40, 95%CI .12 to .67). By 2 weeks post injury this had reduced to 66.2% and 66.9% for parent and child reports respectively (κ = .49, 95%CI .34 to .64). By 1 month, 47% of cases were classed as symptomatic from parent ratings and 51.7% from child ratings (κ = .55, 95%CI .41 to .69). At 3 and 6-12 months the percentage of symptomatic cases continued to decrease for parent (34.1%, 27.5%) and child ratings (40%, 29.8%) (3 months κ = .34, 95%CI .18 to .51; 6-12 months κ = .37, 95%CI .19 to .54). At each time point the proportion of cases classed as symptomatic was higher for child

compared to parent reports. The levels of agreement between scores were in the fair to moderate range.

Conclusion: Parent and child symptom ratings followed a similar trajectory over time, but at each time point, more cases were classed as symptomatic based on child ratings. These findings highlight the importance of using child self-report to assess recovery following concussion as parent report may under-estimate symptom burden. Further analysis could explore if specific symptoms are contributing to this difference and if there are age and sex related differences in ratings.

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A Qualitative Study of Early Childhood Providers' Knowledge and Practice in Supporting Young Children with Traumatic Brain Injury

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Abstract

Background: Children under the age of five are one of groups at highest risk of sustaining a traumatic brain injury (TBI), yet little is known about how early childhood professionals understand and support this population. While research has documented knowledge gaps among K-12 educators, early childhood systems including early intervention, childcare, and preschool settings remain critically understudied.

Objectives: This qualitative study explores early childhood professionals' knowledge, experiences, and training needs relating to childhood TBI.

Methods: Fifteen participants representing a diverse range of professions completed interviews via Zoom.

Results: Using grounded theory methodology, four key themes emerged: professionals 1) lack knowledge and awareness regarding childhood TBI, 2) report limited education and training on childhood TBI, 3) identify overall limitations in the availability and applicability of training and resources for early childhood educators and providers, and 4) express preferences for on-demand and multimodal resources and trainings. Participants overwhelmingly expressed a desire for timely, on-demand, practical, and developmentally appropriate trainings that are applicable to the early childhood professional and setting.

Conclusion: These findings highlight the need for system-level improvements in professional development and resource design. Findings also point to implications for educator training standards and early childhood policy.

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Adolescence and ABI: A Dyadic Case Study

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Abstract

Adolescence—the transitional stage between childhood and adulthood—is inherently complex, marked by emotional, cognitive, and social development. When an acquired brain injury (ABI) occurs during this critical period, the typical challenges of adolescence are compounded, often leading to a profound and multifaceted impact on both the young person and their family. While existing literature acknowledges long-term disruptions to education, employment, and social integration following ABI, the lived experience of navigating such disruptions during adolescence remains underexplored.

This presentation shares an intimate dyadic case study involving a 16-year-old female who sustained an ABI and her father, offering insights into the parallel yet distinct journeys of recovery, adaptation, and emotional adjustment within the parent-child relationship.

Objectives: To explore the dyadic relationship with a focus on changes to coping styles, family functioning, and feelings of loss and adjustment.

Methods: Data were drawn from a broader mixed-methods study comprising both quantitative and qualitative components. Quantitative measures included the Brief COPE, Brain Injury Grief Inventory, and Family Assessment Device. These were followed by in-depth semi-structured interviews with both dyad members, focusing on themes of coping change, loss, and adaptation. Interview transcripts were analysed using Interpretative Phenomenological Analysis (IPA) to explore subjective experiences in depth. Participant data from 23 year old female who suffered a moderate traumatic brain injury following a road traffic collision at age 16 years and her 48 year old father.

Results: The findings reveal both concordance and dissonance within the dyadic relationship. The young person described experiences of masking symptoms, anxiety around trust, and a loss of confidence. In contrast, the father expressed ongoing struggles with grief, anger, and ambiguous loss, as well as feelings of helplessness. Quantitative results failed to fully capture the complexity of these experiences, instead highlighting a disconnect between family members cohabiting yet emotionally distanced.

Conclusion: ABI during adolescence can profoundly disrupt both individual development and family dynamics. This case study underscores the importance of recognizing the dual challenge faced by parents who must not only care for an injured child but also grapple with the emotional upheaval of regression in their child’s independence. The findings highlight the need for more nuanced, family-

centred support frameworks that address the unique emotional and relational challenges of ABI in adolescence.

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Understanding Sex Differences in Communicative and Cognitive Outcomes Following Acquired Brain Injury in Young Adults Experiencing Homelessness

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Abstract

Background: Acquired brain injury (ABI) is a leading cause of disability amongst young adults. Young adults experiencing homelessness (YAEH) face an elevated risk of violence and substance abuse making them particularly vulnerable to ABI. However, the prevalence and impact of ABI in this demographic remains under-researched, despite this being a critical developmental stage for the formation of higher-level executive function essential to independent living. Current research also suggests that men and women with a history of ABI experience different recovery patterns and symptoms, underscoring the importance of examining sex related difference in this population.

Objective: The overall objective of this study is to investigate the prevalence of ABI in YAEH, their cognitive and communicative outcomes, and how these outcomes might differ by sex.

Methods: 96 participants (age 18-24) were recruited from a drop-in center serving youth experiencing homelessness. Data was collected via interviews and self-report measures. Lifetime ABI history was assessed using the OSU TBI-ID, and communication quality and cognitive functioning were measured via the La Trobe Communication Questionnaire (LCQ) and PROMIS Cognitive Function scale, respectively. Group differences were assessed using statistical analysis.

Results: A history of ABI was reported in 76% of YAEH, specifically in 82% of young men and 68% of young women.Young women were more likely to experience a hypoxic-anoxic brain injury, and young men were more likely to experience a traumatic brain injury (TBI). Among individuals with ABIs, young women expressed significantly lower ($p = 0.04$) cognitive functioning than young men, but there were no differences in self-reported communication profiles. When examining within-sex differences, injured young men demonstrated significantly lower functioning than uninjured young men across multiple domains (cognitive functioning ($p=0.005$), initiation/conversational flow ($p=0.039$), disinhibition ($p=0.012$), and overall communication quality ($p=0.006$)). Comparatively, injured young women demonstrated lower functioning than their uninjured peers in only two domains (overall cognitive functioning ($p=0.005$), and overall communication quality ($p=0.045$)).

Conclusion: ABI is highly prevalent in both male and female YAEH and is associated with ongoing cognitive and communicative challenges across sex. While young women with ABIs may experience more pronounced cognitive deficits (or are more aware of their cognitive deficits) than young men, young women's communicative

challenges may be more subtle. These findings highlight an urgent need for targeted support and intervention for this vulnerable population, though specific service needs may differ by sex.

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Development of a Prehabilitation to Rehabilitation Program for Pediatric Brain Tumor Patients

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Abstract

Background: With improvements in cancer surveillance and treatment, children with a brain tumor are living longer. However, there is a high cost of survivorship, with tumor location and treatment associated with neurocognitive impairments that contribute to reduced quality of life, which persist into adulthood. Means of strengthening brain structure and function are therefore essential to optimizing neurocognitive outcomes. This presentation describes the development of an inter-disciplinary clinical-research program that includes cognitive and physical activity interventions designed to mitigate neurocognitive impairments in pediatric brain tumor patients, serial assessment of neurocognitive functioning, and acquisition of biomarkers of brain changes via neuroimaging and blood assays.

Objectives: Over the course of this presentation we will: 1) describe the process of developing and implementing aprehabilitation-to-rehabilitation program and 2) discuss barriers and facilitators encountered during program development and early implementation.

Methods: Program development was guided by evidence on prehabilitation and rehabilitation, and informed by literature in traumatic brain injury, adult brain tumor patients, and long-term survivors of childhood cancer.

Results: We identified efficacious rehabilitative interventions utilized in acquired brain injury populations, including cognitive training and physical activity intervention, which we then overlaid on a prehabilitation-to-rehabilitation framework. An inter-disciplinary team consisting of physical medicine and rehabilitation, physical therapy, occupational therapy, speech-language therapy, neuropsychology, nursing, neuro-oncology, and radiation oncology provide coordinated medical and quality of life care to pediatric brain tumor patients beginning at diagnosis and continuing through survivorship. Clinical, logistical, institutional, and patient-level barriers are discussed, including scheduling burden, competing clinical priorities, fragmented care coordination, limited awareness or cognitive sequelae by families, and reimbursement streams for services. Strategies to address these include embedding services in the neuro-oncology clinic, providing tiered neuropsychological care, utilizing telehealth platforms, integrating sessions with existing appointments, developing standardized neurocognitive assessment batteries, educating families and providers about neurocognitive late effects early in the course of treatment, and providing psychosocial support to families and problem solving barriers to intervention adherence.

Conclusion: A prehabilitation-to-rehabilitation program has the ability to proactively strengthen the brain prior to and during cancer treatment to optimize quality of life and attenuate neurocognitive decline. Though barriers exist, there are means of rolling out such a program that enables access to interventions and clinical services for all pediatric brain tumor patients.

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A Systematic Review of Physical Activity Interventions During Early Childhood: Implications for Pediatric Concussion

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Abstract

Background: Early childhood (< 6 years old) concussion causes unique and significant physical, cognitive, sleep, and behavioural symptoms that may persist for months following injury. Current best practice guidelines for adolescents and adults with concussion recommend sub-symptom threshold aerobic exercise to promote recovery. However, these structured exercise programs are not aligned with the physical and developmental needs of young children. Understanding the parameters of physical activity (PA) interventions executed in healthy young children is a critical first step in designing an appropriate and effective PA program for young children with concussion.

Objective: To characterize the parameters of PA interventions conducted in young, typically developing children using a systematic review methodology.

Methods: Five databases (PubMed, Scopus, ERIC, Web of Science, and PsycINFO) were searched using the concepts of young children and PA interventions. Articles were included if (1) they were original research and peer-reviewed, (2) the sample had a mean age between 2-5.99 years old, (3) the sample had ≥20 participants, (4) included typically developing children (exclusively or as part of a distinct comparison group), (5) they contained a PA or exercise intervention, and (6) articles were written in English or French. Two researchers independently screened 4061 title and abstracts, with a third co-author resolving any disagreements. The title and abstract screen yielded 169 articles for the full text review, which was carried out using the same process. Data extraction consisted of (1) author and title, (2) participants demographics, and (3) PA intervention characteristics (mode, intensity, duration, frequency).

Results: One hundred and four studies covering a total of 11,313 young children (50.3% female) were included in the review. 97 (93.3%) studies randomized participants into a control or PA intervention group. Interventions were delivered on average 3.44 times per week (SD= 1.64, range= 0.5-8 sessions/week) over 21.7 ± 22.8 total weeks [range= 3-104 weeks], with most studies delivering the intervention over one academic school year (n=14) or 8 weeks (n=16). Individual intervention sessions lasted 40.3 ± 21.3 minutes in duration (range= 10-180 minutes, most frequent= 30 minutes/session (n=33)). Most studies (n=55) combined locomotion (i.e. running, jumping, hopping, skipping) and gross motor (i.e. balancing, jumping, throwing) skills as their PA mode. Other modes included organized sports (n=7), yoga (n=2) and

dance (n=3). Only 24 (23.1%) studies reported the target invention intensity, which predominantly aimed for a moderate-to-vigorous exertion.

Conclusion: PA interventions for young, typically developing children are highly variable in their frequency and duration but are more consistent in the modes and intensities performed. Identifying key characteristics of PA interventions in young, typically developing children can help inform the development of a tailored intervention for young children with concussion, which could help promote clinical recovery for these underserved patients.

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Parental Post-Traumatic Stress Symptoms and Child Adaptive Functioning After Pediatric Traumatic Brain Injury

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Abstract

Background: Pediatric traumatic brain injury (TBI) has profound effects not only on the child but also on their caregivers. Parents are particularly vulnerable to the impact of their child’s TBI. Despite growing recognition of the psychological burden parents may experience after their child’s injury, few studies have examined post-traumatic stress symptoms (PTSS) in this population, or their influence on a child’s recovery from TBI.

Objectives: This study addressed the following goals: 1) examine whether parental PTSS is related to child outcomes following TBI; 2) identify predictors of PTSS among a sample of parents of children with TBI; and 3) examine group differences in child adaptive behavior outcomes based on whether or not the parent endorsed PTSS.

Methods: Parents of children with TBI were recruited from an existing database.

Parental PTSS were assessed using the PTSD Checklist for DSM-5 (PCL-5), where a cutoff of 31 or above was used to indicate provisional post-traumatic stress disorder. Child adaptive functioning was measured via the Vineland Adaptive Behavior Scales, Third Edition (VABS-3). To address the study’s three aims, linear regression analyses examined the relationship between parental PTSS and child adaptive outcomes. A binomial logistic regression was used to examine which variables significantly predicted the probability of parental PTSS, and independent samples t-tests compared VABS-3 scores based on PCL-5 responses.

Results: Seventy-four parents of children with TBI participated in this study, the majority of whom were mothers (n = 70, 94.6%). Child’s time since injury was on average 2.8 years and most children sustained mild/mild-complicated injuries (n = 47, 63.5%). Linear regressions found that elevated parental PTSS were significantly related to lower child performance in communication (p = .010), socialization (p = <.001), and overall adaptive behavior (p = .012). A binomial logistic regression showed that injury mechanism significantly predicted the probability of PTSS (OR = 7.02, p = .006). Additionally, independent samples t-tests further revealed that children whose parents scored at or above the clinical threshold of 31 on the PCL-5 exhibited significantly reduced functioning in both communication (p = .037) and socialization (p = .015) domains compared to children of parents below the threshold.

Conclusion: These findings suggest that the psychological health of parents impacts child recovery outcomes and emphasizes the importance of identifying parent needs

in pediatric TBI care. Screenings for PTSS in parents may help identify families at risk for poorer child adaptive functioning and support early intervention. Incorporating trauma-informed approaches and family-centered care models could enhance both parent and child outcomes. Future research should explore longitudinal trajectories of parental PTSS and their influence on child rehabilitation outcomes.

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Lived Experiences of Post-Traumatic Stress Symptoms in Parents of Children with Traumatic Brain Injury: An Interdisciplinary Qualitative Study

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Abstract

Background: Parents of children with traumatic brain injury (TBI) are at risk for experiencing posttraumatic stress symptoms (PTSS), yet limited research has been conducted to understand their lived experiences. Recognizing PTSS in parents may be critical for rehabilitation professionals to identify those who could benefit from further assessment by licensed mental health providers.

Objectives: This qualitative study aimed to understand parents' lived experiences with PTSS following their child's TBI. By identifying common themes, the study seeks to equip rehabilitation professionals with insights that may help them recognize at-risk parents and facilitate timely referrals for appropriate mental health support.

Methods: A nested recruitment strategy was used to identify parents of children with varying TBI severities from a larger longitudinal study. Participants were purposefully recruited with respect to race, relationship to their child, and child's mechanism of injury and severity. Semi-structured interview questions were co-designed by a multidisciplinary team of psychologists, researchers, and rehabilitation professionals. Interviews were transcribed verbatim, checked for reliability, and analyzed using NVivo. Grounded theory guided the analytical approach. Coding reliability was ensured through dual coding, and analytical memos were maintained throughout the process to support rigor and transparency.

Results: Twenty-two parents of children with TBI were recruited for this study, a majority of whom were mothers (n = 20, 91%). Most children sustained mild injuries with persistent symptoms (n = 13), with the most common mechanism of injury being struck by or with an object (n = 9). Time since injury ranged from 0.8 years to 12.10 years. Three central themes emerged from the data. The first theme, *Parents report symptoms that align with DSM-5 criteria of PTSD*, includes descriptions of avoidance, intrusion, negative alterations in cognitions and mood, and alterations in arousal and reactivity. The second theme, *Parents describe many factors that impact their overall stress*, explores things that parents said reduced or contributed to their stress. The third theme, *Parents report many factors that support their emotional coping*, presents evidence of situational, child-related, and community factors that parents attributed to supporting their coping after their child's injury.

Conclusion: These findings highlight the presence of PTSS in some caregivers and suggest the value of recognizing and addressing these experiences within pediatric TBI care. Rehabilitation professionals, often some of the first to interact with

families, play a pivotal role in identifying signs of distress and facilitating early intervention. Training in trauma-informed care and routine screening for caregivers' mental health may enhance the quality of support provided. Integrating family-centered approaches and ensuring access to psychological resources throughout the recovery process can optimize outcomes for both children and their caregivers.

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Developing a Framework for Professional Collaboration: Nationwide Collaboration Among SLPs Treating Pediatric Disorders of Consciousness

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Abstract

Background: Speech language pathologists (SLPs) in acute care settings face a number of challenges when working with children experiencing Disorders of Consciousness (DoC). While research regarding best practices for treating patients in DoC continues to grow, it remains fairly limited with regard to the pediatric population and the acute care setting. Further, many SLPs do not receive adequate training and education regarding working with this population and may face barriers institutionally to implementing care including limited access to resources and appropriate mentorship. To address these needs, a volunteer-led virtual-based discussion group was created to allow participants to present challenging cases, share resources, and discuss research to help support education and professional development amongst group members.

Case History: Over 60 SLPs, representing more than 35 hospitals across the United States, meet quarterly to discuss topics related to assessing and treating pediatric patients in varied states of DoC. The group was established in 2023 following informal discussion among colleagues. Additional outreach was completed via social media postings and organically, through word of mouth.

To date, meetings have included review of assessment batteries, cadences of reassessment, case study presentations, informal discussion of challenges faced by participants, literature reviews and sharing of resources. Group members have reported a number of benefits of participating in these meetings including having an increased knowledge base and greater confidence when working with this population, learning about resources previously unknown or unavailable to them, and having a comfortable space to discuss challenges with others who have similar experiences. Some group members have sought input from the group to create new hospital-level protocols or educational materials for families and providers and have then shared these new resources with the group.

Conclusions: The success of this group can serve as a framework for a peer-support and professional development network for healthcare professionals working with complex patient populations who may otherwise lack access to these resources. The live, virtual, discussion based model utilized by this group has been effective in reaching a widespread group of healthcare providers across varied institutions. This in turn has led to more well-rounded discussions and group consensus for assessment and treatment of a complex population. The group has created a community of pediatric acute care SLPs to collaborate, expand clinical knowledge, and share resources related to working with children experiencing DoC. Other disciplines could utilize this framework to create similar networks of support

amongst colleagues, create opportunities for ongoing education for clinical providers, and work towards improving care for patients and their families.

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Violence-Related Mild Traumatic Brain Injuries in Children and Adolescents: A Scoping Review

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Abstract

Background: Mild traumatic brain injuries (mTBIs), also termed concussions, largely affect the pediatric population. Traumatic brain injuries occur through various mechanisms, including sports, falls, motor vehicle accidents, and violence. Although it is known that multiple mechanisms can result in mTBIs, current literature predominantly focuses on sports-related concussion. Less attention has been given to mTBIs resulting from violence. Recently, literature has emphasized the importance of identifying the mechanism of injury to better understand associated risk factors, improve diagnosis, and guide recovery. Although some studies have examined violence-related mTBIs (vrmTBI) in adults, the available literature in pediatric populations is limited. Children and adolescents can be exposed to domestic abuse, peer violence, and sexual abuse, increasing their risk for a vrmTBI. Therefore, it is important to assess how violence as a mechanism can impact recovery outcomes in the pediatric population.

Objectives: (1) to understand the current scope of vrmTBIs in the pediatric population and (2) to assess the effect of vrmTBIs on mental, physical, and psychosocial outcomes.

Methods: Using a scoping review methodology, studies including violence as a mechanism of injury were identified. Four databases, including Medline, PsychInfo, CINAHL, and Scopus, were searched. Two reviewers independently completed the screening and study selection utilizing a predefined inclusion and exclusion criteria created with a university health librarian. Studies of children and adolescents between the ages of 2 to 18 years who sustained a vrmTBI were included. Extracted data from identified studies pertained to demographic data, injury data, and health outcome data.

Results: In the final review, eight studies were included. Overall, there was a demographic difference found between individuals with a vrmTBI and a non-vrmTBI. Sex and socioeconomic status were associated with an increased risk of sustaining a vrmTBI, with females and individuals with public insurance more likely to report experiencing a vrmTBI. The effect of vrmTBIs on health outcomes was inconclusive due to the limited studies involving physical and mental health outcomes, and a majority of the studies did not separate outcome data according to injury mechanism. However, mental health outcomes showed worse reports for individuals with a vrmTBI compared to a non-vrmTBI; whereas, an effect on physical health outcomes was not apparent.

Conclusion: Violence as a source of mTBI is an understudied mechanism which is apparent in the pediatric population. Although health outcome findings are inconclusive, demographic differences may play a role in predicting vrmTBIs. Therefore, understanding risk factors and recovery related to vrmTBIs can provide optimal prevention and treatment strategies.

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“They have the rest of their life to play rugby if we keep them safe” - A qualitative study of tackle preparation following concussion in Canadian adolescent girls’ rugby

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Abstract

Background: Concussion is a common injury in rugby, and adolescent girls may experience unique challenges in recovery and return to play (RTP) due to physiological and sociocultural factors. Despite growing participation in Canadian girls’ rugby, little is known about how players, coaches, and health care professionals (HCPs) perceive and manage concussion recovery and tackle preparation. Understanding these perspectives is vital for developing safe, gender-sensitive, and contextually relevant RTP protocols and secondary prevention strategies.

Objectives: To explore the perspectives of players, coaches, and HCPs on the processes, practices, barriers, and facilitators involved in RTP and tackle preparation following concussion in Canadian adolescent girls’ rugby.

Methods: This qualitative study follows a constructivist grounded theory approach to co-construct knowledge between researchers and participants. Adolescent female rugby players (aged 14–19 years) with a previous rugby-related concussion, and coaches and HCPs (≥18 years) with at least one year of experience in adolescent girls’ rugby, were recruited via social media, club, and school networks. Participants took part in one Zoom interview (range 35–75 minutes). The semi-structured interview guide was informed by the Health Action Process Approach. Interviews were audio-recorded, transcribed verbatim, and uploaded to NVivo 14 for analysis using inductive grounded theory methods.

Results: Tackle preparation following concussion is highly variable and shaped by psychological, social, and structural factors. Confidence and fear of re-injury influenced players’ willingness to return to contact, while access to knowledgeable coaches, HCPs, and pitch side support shaped athletes’ progression through the RTP process. Knowledge of concussion and RTP protocols was generally low and inconsistent, contributing to variable concussion disclosure and management practices across individuals. Sociocultural and gendered factors, including the tension between the sport ethic (emphasizing toughness, winning, and rapid return to play) and the care ethic (emphasising recovery, safety, and preserving long-term health), further shaped decision-making and the quality and pacing of return to contact.

Conclusion: These findings highlight the complex interplay of psychological, social, and structural factors in the management and secondary prevention of concussion for adolescent girls’ rugby. Addressing low and inconsistent knowledge of RTP

protocols, and providing structured, context-sensitive tackle preparation guidance are critical for promoting safe and effective return-to-play in adolescent girls’ rugby. The study will inform evidence-based, gender- and context-specific best practices for concussion management and secondary injury prevention in Canadian adolescent girls’ rugby.

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The Bounce Back Study: A single session approach to treating persistent post-concussion symptoms in young people

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Abstract

Objectives: Paediatric concussion is one of the most common injuries sustained during childhood, with an estimated 33 million concussions occurring globally each year. While most children recover within one month, a significant minority will continue be symptomatic.

Improving the management of persistent post-concussion symptoms (PPCS) has become a target for research groups. Recent evidence suggests that psychoeducation, particularly when tailored to individual symptom burden, is effective in empowering families to feel better equipped to support their child after a concussion.

Neuropsychologists play a key role in many multidisciplinary teams in supporting patients with PPCS. Neuropsychologists, and neuropsychological assessment, could therefore be an appropriate vessel for delivering tailored psychoeducation to paediatric patients experiencing PPCS.

This study aimed to examine the efficacy and feasibility of a one-time neuropsychological assessment and feedback session as an intervention for youth with PPCS.

Methods: Participants were 31 children between the ages of 8-18 who were treated for a concussion at a Monash Health Emergency Department, and their parents. Participants were included in the study if they were assessed to be experiencing PPCS between 1-12 months after their injury. The final sample in this study was predominantly 65% male, with a mean age at injury of 13.2 years. Participants were enrolled on average, 58 days post-injury. Twelve participants had a history of previous concussion.

Participants were invited to a neuropsychological consultation. Additionally, parents and children completed the Melbourne Paediatric Concussion Scale at five-time points; two pre-consultations, one on the day of consultation, and at three post-intervention time points.

All analyses of participant and parent symptom trajectories were conducted in R. Linear mixed-effects models were employed to examine changes in post-concussion symptom ratings over time, separately for child self-report (PCSI) and parent report (PCSIP).

To capture potentially different symptom trajectories before and after the intervention, we specified a **piecewise (segmented) regression approach**, which included:

Pre-intervention slope: representing the rate of change from baseline (T0) to one week pre-intervention (T1).

Results and conclusions: Our models for parent and child reported symptoms revealed relatively stable symptom patterns in the pre-intervention period *(*b= -4.24, p = .55), followed by a significant negative slope post-intervention (b = -7.70, p <*.001)*, indicating accelerated symptom improvement after the intervention commenced. Importantly, these effects were observed even after controlling for age at injury, sex, concussion history, and mental health history.

The findings suggest that a standalone, neuropsychological consultation and feedback session could have a measurable impact on symptom resolution beyond the natural recovery process. The findings also support the hypothesis that targeted strategies for symptom management may be especially helpful for children who remain symptomatic after one month.

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Cognitive Outcomes Following Paediatric Mild Traumatic Brain Injury: A Systematic Review and Meta-Analysis of Studies pre-2025

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Abstract

Objective: Current knowledge of the scale of concussion incidence in paediatric populations has highlighted the need for a comprehensive understanding of post mTBI outcomes. Currently, literature proposes that cognitive symptoms can be the most enduring for some children after a mTBI and may influence subsequent emotional and behavioural problems.

Establishing a reliable understanding of the cognitive outcomes after peadiatric mTBI has been difficult to date, despite its importance, due to considerable inconsistencies in the literature. The most recent meta-analytic review in this specific area was completed in 2009, of which there has since been an expansion in our understanding of concussion aetiology, sequalae and a plethora of individual studies investigating cognitive outcomes post injury.

With the above in mind, this study aimed to (i) refine and update findings from Babikian and Asarnow's (2009) meta-analytic review, by conducting a meta-analysis of the literature (pre-2025) examining cognitive outcomes following paediatric mTBI.

Method and Participants: In this review, 63 observational studies published before 2025 were summarised in terms of participant, injury-related and methodological characteristics, and outcome related results. Of these, 49 also contributing to meta-analyses on nine cognitive-factor domains at five distinct time points post-injury. A level 3 (multivariate) random effects meta-analysis of standardised scores were conducted on each cognitive factor at the specified time since injury categories.

Additionally, quality assessment for each study was completed using the Newcastle-Ottawa Scale (NOS), recommended by the Cochrane collaboration for the assessment of risk of bias in observational studies.

Results: Meta analyses revealed that compared to healthy controls, children who sustained a mTBI performed poorer on tasks of short-term memory (<2 weeks post injury, 4 weeks – 3 months post injury, and >12 months post injury), long term storage and retrieval (< 2 weeks post-injury and 4 weeks-3 months post injury), and visual processes (4 weeks – 3 months post injury). The effect size of these significant results was negligible (all Cohen's d <0.2) All other cognitive domains and time periods post-injury were not associated with poorer performance in children who sustained a mTBI.

Findings from this review revealed that studies reporting on cognitive outcomes varied largely as a function of methodology. There appears to have been little refinement in methodologies over the last decade, with multiple possible sources of heterogeneity identified. It remains difficult to make solid conclusions about long-term cognitive outcomes post mTBI. The findings from this review, however, highlight a number of factors for studies to take into consideration in future research.

Conclusions: This review highlights a number of areas for improvement in future research. In order to obtain a more reliable picture that can translate into improved clinical care for children and adolescents with mTBI, the quality of the literature must first improve.

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Pilot neurofeedback plus cognitive training for paediatric brain tumour survivors: a randomized, sham-controlled trial

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Abstract

Background: Paediatric brain tumour survivors (PBTSs) frequently experience persistent deficits in attention, working memory (WM), processing speed, and executive functions. We tested whether individualized posterior-alpha neurofeedback (NF) can produce on-target neuromodulation and *prime* subsequent cognitive training (CT), yielding greater cognitive gains than CT alone.

Methods: In a triple-blind randomized pilot (ClinicalTrials.gov: NCT07085494), PBTSs were assigned to NF+CT (n=3) or sham-NF+CT (n=6). NF targeted individualized alpha markers derived from baseline EEG; the sham condition used prerecorded EEG signals matched in dynamics, with identical interface, schedule, and instructions. Personnel, families, and assessors were masked; allocation was software-controlled. The primary signal was the WM training effect; secondary/exploratory signals examined composite and domain-specific neurocognitive outcomes. Given the pilot nature, we emphasized effect sizes and confidence intervals, and used a preregistered exploratory threshold (one-sided $p<0.05$ / two-sided $p<0.10$) for domain findings.

Results: NF produced successful neuromodulation and larger WM training gains than sham (Cohen’s $d=1.54$; $p=0.131$), consistent with a large effect but underpowered for conventional significance. Averaging across all neurocognitive domains, NF+CT showed greater improvement than sham+CT ($\Delta=+7.19$, SD=7.06 vs $\Delta=+3.37$, SD=5.38), with a between-group effect size of $d=0.80$ (95% CI [−0.62, 2.16]). In domain-specific analyses, two domains met the exploratory threshold and favored NF+CT: **Reasoning** (two-sided $p=0.015$; $d=3.48$) and **Reaction Time** (two-sided $p=0.060$; $d=1.44$). These patterns suggest that NF may enhance the efficiency of higher-order cognition and speeded performance when paired with CT.

Interpretation: The pilot demonstrates feasibility of triple-blind delivery and on-target neuromodulation, with preliminary evidence that NF augments the cognitive impact of CT in PBTSs. Although the sample was small (n=9 total), effect sizes were consistently large across primary WM training and key domains, supporting the mechanistic hypothesis that individualized alpha modulation can “set the brain’s state” to be more receptive to training.

Limitations: As a pilot, the study was underpowered for definitive inference; confidence intervals were wide, and we could not evaluate durability or real-world transfer beyond the immediate post-training window.

Conclusions : These results motivate a fully powered, multi-arm randomized trial to confirm efficacy, test durability at 6–12 months, and probe mediating mechanisms linking NF-induced alpha modulation to improvements in WM, reasoning, and reaction time. If validated, NF-primed CT could represent a scalable, state-optimized pathway to improve cognitive outcomes in PBTSs.

Trial Registration: NCT07085494.

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Reconstructing Identity After Disruption: Caregiver Adjustment to Paediatric Traumatic Brain Injury, A Grounded Theory

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Abstract

Background: Childhood traumatic brain injury (TBI) precipitates profound disruption for families. While caregiver burden and distress are well documented, fewer studies theorise the *process* of caregiver adjustment over time with attention to systemic influences and post-traumatic growth. Caregiver adjustment has long been linked to child recovery outcomes.

Objective: To develop a grounded theory of how caregivers adjust following their child's TBI, detailing processes of coping, identity transformation, advocacy, and meaning making across time and contexts.

Methods: Using Charmaz's constructivist grounded theory, semi-structured interviews were conducted with eight caregivers (7 mothers, 1 father) of children who sustained moderate-to-severe TBI (ages at injury 7–17 years; mean time since injury ≈ 6.25 years). Interviews were analysed using initial, focused, and theoretical coding with constant comparison and memo-writing to generate a process model grounded in participants' accounts.

Results: A core process of *reconstructing stability after disruption* emerged, encompassing emotional containment, advocacy, identity transformation, and meaning making. Adjustment unfolded through three overlapping, non-linear phases: *(1) Weathering Shock and Trauma* — characterised by visceral distress, autopilot functioning, and system-induced confusion; *(2) Navigating Chaos* — marked by fractured roles, loss of imagined futures, and identity shifts amid grief and hypervigilance; and *(3) Moving Towards Acceptance and Growth* — involving meaning-making, advocacy, and pride in the child's recovery. Adjustment was dynamic and recursive, with caregivers oscillating between phases as anniversaries, transitions, and child milestones reactivated earlier emotions. Systemic insufficiency intensified distress but also catalysed advocacy and resilience.

Conclusions: Caregiver adjustment following childhood TBI is best understood as a dynamic, recursive process of reconstructing stability, rather than a linear stage progression. Interventions should prioritise early and *well-timed* psychoeducation, continuity across transitions, and ongoing psychosocial support for parents. Whole-system approaches that scaffold advocacy and recognise non-finite grief are essential. The proposed model advances theory by integrating emotional, relational, and systemic dimensions and has practical utility for service design, clinical pathways, and family-centred rehabilitation.

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Prevalence of Moderate-to-Severe Anxiety and Depression Symptoms after Concussion in Adolescents and Young Adults

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Abstract

Background: Anxiety and depression are associated with high post-concussive symptom burden, functional limitations, and poor quality-of-life. Understanding how prevalent clinically elevated levels of mental health symptoms are after concussion in adolescents and young adults is essential for early identification of those who would most benefit from specialist referral and management.

Objective: To estimate the overall prevalence of moderate-to-severe anxiety and depression symptoms after concussion in adolescents and young adults and stratified by sex, cause of injury, and preinjury conditions.

Method: This prospective observational study from the TRANSCENDENT Concussion Research Program enrolled patients aged 13-20.99 years who were diagnosed with concussion during intake assessment for routine care at one of three specialty concussion clinics between April 2024-July 2025. Participants completed standardized questionnaires and mental health measures. Primary outcomes were moderate-to-severe anxiety (Generalized Anxiety Disorder-7 [GAD-7] ≥10) and

depression (Patient Health Questionnaire-9 [PHQ-9] ≥10) symptoms. Outcomes are reported using descriptive statistics.

Results: Of 569 participants (n=318 [56%] female; median [IQR] age, 15 [14-17] years; median [IQR], 14 [8-28] days since injury), 29.6% (95%CI,26.0-33.5) had moderate-to-severe anxiety symptoms (median [IQR] score, 13 [12-16]) and 44.5% (95%CI,40.5-48.6) had moderate-to-severe depression symptoms (median [IQR] score, 14 [11-17]).

Female participants were more likely than male participants to report moderate-to-severe anxiety (n=118/318, 37.1%; 95%CI,32.0-42.5 vs n=49/251,19.5%; 95%CI,15.1-24.9) and depression (n=163/318, 51.3%; 95%CI,45.8-56.7 vs n=88/251,35.1%; 95%CI,29.4-41.1) symptoms.

Moderate-to-severe anxiety symptoms were more common following a workplace injury (n=5/9, 55.6%; 95%CI,26.7-81.1), motor vehicle collision (n=15/29, 51.7%; 95%CI,34.4-68.6), or assault (6/14, 42.9%; 95%CI,21.4-67.4) than while playing sports (n=92/391, 23.5%; 95%CI,19.6-28.0). A similar pattern was observed with moderate-to-severe depression symptoms (workplace injury: n=6/9, 66.7%; 95%CI,35.4-87.9; motor vehicle collision: n=20/29, 69%; 95%CI,50.8-82.7; assault: n=9/14, 64.3; 95%CI,38.9-83.7; playing sports: n=150/391, 38.4%; 95%CI,33.7-43.3).

Amongst those with preinjury self-reported mental health conditions, moderate-to-severe anxiety symptoms were especially common for those with previous eating disorder (n=7/9, 77.8%; 95%CI,45.3-93.7), self-harm history (n=12/17, 70.6%; 95%CI,46.9-86.7), and preinjury anxiety (n=58/119, 48.7%; 95%CI, 39.9-57.6). Moderate-to-severe depression symptoms were especially common for those with autism spectrum disorder (n=11/12, 91.7%; 95%CI,64.6-98.5), self-harm history (n-15/17, 88.2%; 95%CI,65.7-96.7), and preinjury depression (n=41/53, 77.4%; 95%cCI,64.5-86.5).

Conclusion: Approximately two weeks after concussion, nearly one-third of adolescents and young adults seeking routine care at a specialty concussion clinic had clinically elevated anxiety symptoms and nearly half had clinically elevated depression symptoms. Symptoms were most common amongst female participants, those injured in the workplace, a motor vehicle collision, or by assault, and those with preinjury conditions such as autism spectrum disorder, self-harm history, eating disorder, and previous anxiety or depression. These findings reinforce clinical recommendations to routinely screen for mental health symptoms after concussion to identify those who are commonly affected and would benefit from early referral to a mental health professional for further assessment and active treatment.

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The Overlap of Concussion and Affective Symptoms Among Adolescent Athletes

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Abstract

Background: Previous work in adolescents has explored the association between concussion and affective symptoms. Significant overlap between self-reported concussion symptoms and affective symptoms exists, as concussion symptoms are often non-specific, and affective symptoms are common across adolescent athletes. Understanding symptom patterns between concussed and uninjured adolescents may help in monitoring recovery.

Objective: We explored the relationship between concussion/concussion-like symptom severity and anxiety/depressive symptoms among adolescents with and without a concussion. We hypothesized that a stronger relationship between concussion/concussion-like symptoms and affective symptoms would be identified after concussion relative to uninjured controls.

Methods: We conducted a cross-sectional study of adolescent athletes evaluated ≤21 days of concussion (concussion group) or prior to the start of an athletic season (control group). Concussion/concussion-like symptoms were assessed in both groups using the Post-Concussion Symptom Inventory (PCSI). Anxiety and depressive symptoms were measured using the PROMIS Pediatric Global 25. We used linear regression with an interaction term between PCSI score and group status (concussion vs. control) with anxiety and depressive symptoms as outcomes in separate models, adjusting for covariates (age, sex).

Results: We enrolled and evaluated 524 adolescents: n=217 (41%) with concussion, n=307 (59%) controls. The concussion group was significantly younger (15.5±1.6 vs. 15.9±1.4 years; p=0.002), had fewer female participants (76% vs 52%, p<0.001), and reported higher PCSI scores (41.3±24.8 vs. 19.0±19.7; p<0.001) than the control group. In the adjusted model of anxiety, higher PCSI score was associated with higher anxiety scores (β= 0.29; 95% CI= 0.24, 0.34; p<0.001). The concussion group reported significantly less anxiety than the control group before (48.3±11.0 vs. 51.4±9.5; p=0.001) and after covariate adjustment (β=-6.00; 95% CI= -8.58, -3.42; p<0.001). There was a negative and significant interaction between symptom severity and group (β= –0.07; 95% CI= -0.13, -0.01; p=0.047), indicating that the increase in anxiety with greater symptom severity was attenuated in the concussion group. In the adjusted model of depressive symptoms, higher PCSI score was associated with greater depressive symptoms (β= 0.32; 95% CI= 0.26, 0.37; p<0.001). Group differences were not significant (β= –1.84; 95% CI= -4.59, 0.91; p=0.19). There

was a significant and negative interaction between symptom severity and group (β= -0.10; 95% CI= -0.17, -0.03; p=0.004), indicating the relationship between symptom severity and depressive symptoms was weaker in the concussion group compared to the control group.

Conclusion: Across both groups, concussion/concussion-like symptom severity was associated with anxiety and depressive symptoms. These associations were weaker in the concussion group, suggesting affective symptoms and concussion/concussion-like symptoms are related regardless of concussion status. Enhanced mental health screening, beyond concussion symptom inventories may assist concussion management in adolescent athletes.

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Getting Back to the Books: A Multifaceted Exploration of Factors Affecting the Implementation of Return to Learn Guidelines for Children after Concussion

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Abstract

Background: Concussion is a major public health issue, particularly among adolescents aged 15–19. In Australia, one in five children experience concussion by age 17, with 30% facing prolonged symptoms that affect mental health, schooling, and family life. Effective recovery and return to learning (RTL) require collaboration between parents, educators, and healthcare providers. However, little is known about how Australian families navigate RTL post-concussion or the barriers to implementing best-practice guidelines. This study used the Behaviour Change Wheel and COM-B model to explore experiences of concussion care among children, parents, teachers, and clinicians, identify factors influencing RTL, and inform content and implementation strategies

Methods: Children aged 10–17 in Western Australia who experienced concussion in the past two years, and their parents, were recruited via emergency departments, schools, sports clubs, and snowball sampling. Healthcare providers and teachers were recruited through professional organisations, networks, social media, and snowball sampling. Participants completed online semi-structured interviews, which were transcribed verbatim and analysed by two researchers using reflexive thematic analysis. Domains within each major theme were mapped to the COM-B model of the Behaviour Change Wheel to explore behavioural influences and inform intervention development.

Results: 38 interviews were conducted with 13 children, 13 parents and 7 healthcare professionals (including school nurses: n=4) and 5 teachers. Factors impacting the implementation of RTL guidelines for children with concussion were grouped into four key themes: 1) *Parents are the knowledge brokers for children returning to school after concussion.* Parents provided a link between advice from healthcare professionals and schools, with schools relying heavily on parents for direction and guidance on RTL. *2) A child's school experience can impact return to learning after concussion.* School environments, secure relationships with teachers, and pre-existing learning or mental health factors can influence a child's ability to engage in school after concussion as well as their confidence in accurately reporting post-concussion symptoms when at school. 3*) A systems approach is needed to effectively manage concussion recovery in schools.* Most schools lacked formal policies and dedicated resources to support return to learning, resulting in reactive management

strategies. *4) Teachers play a key role in supporting return to learning, with varying levels of concussion-related knowledge and training.* Mapping these factors onto the COM-B model provided an organised perspective on the interactions between stakeholders and key factors impacting guideline adherence.

Conclusion: Mapping stakeholder experiences to the COM-B model provided a holistic, systematic understanding of factors influencing return to learn guideline implementation. Findings underscore the need for a coordinated, evidence-based approach that prioritises each child’s individual needs to optimise recovery and successful return to learning.

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Prescribing Post Concussion Exercise via Age Predicted Heart Rate Maximum: A Comparison to Systematic Exercise Testing

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Abstract

Background: A systematic exercise test, where intensity is gradually increased until symptom provocation or patient exhaustion, is recommended for deriving efficacious exercise intensity prescriptions for concussed adolescents. In the absence of such testing, past research has suggested that clinicians recommend exercise beginning at an intensity of 50% of age-predicted heart rate max (HR_{max} [220 – age]), with successive increases in intensity as tolerated by symptoms.

Objective: To quantify differences in heart rate (HR) prescriptions when using 50% HR_{max} versus systematic exercise testing.

Methods: We conducted a cross-sectional study of adolescents evaluated ≤21 days of concussion. Participants completed a modified YMCA branching exercise test on a stationary bike, progressing through incremental intensity stages until one of two endpoints was reached: concussion symptom exacerbation (Visual Analog Scale Δ ≥3 cm) or maximum exertion (Rating of Perceived Exertion ≥17 or attainment of 100% age-predicted HR_{max}). We calculated a target HR used for the subsequent exercise prescription, as 90% of the participant's HR at cessation of the exercise test. The 50% HR_{max} exercise prescription was unrelated to exercise test performance and calculated as 0.5 times the participant's age-based HR_{max}. We used Root Mean Square Error (RMSE) and Absolute Mean Error (MAE) to quantify differences between exercise prescriptions derived from exercise testing and age-predicted HR_{max}. RMSE was also used to identify an alternative HR_{max} percentage that would more accurately estimate the target HR identified during systematic exercise testing.

Results: We enrolled 101 adolescents with concussion (age=15.9±1.5 years; 49% female; 13.2±4.4 days post-concussion). The average HR at test cessation was 171.3±17.6bpm, thus the average target HR prescription was 154.2±15.8bpm. The average 50% HR_{max} prescription was 102.3±0.9bpm, which was 52.1 bpm lower, on average, than those derived from exercise testing (MAE 52.1bpm, RMSE 54.4bpm). The 50% HR_{max} prescription was lower than the exercise test target HR for all participants. Following progression of the 50% HR_{max} method (5% HRmax increase daily), it would take 6.08 days of incrementally increasing exercise intensity to reach the exercise test target HR. An age-based HR_{max} prescription of 76% HR_{max} resulted in the lowest difference compared to exercise test prescribed target HR (MAE 15.6, RMSE 12.1); if beginning at 76% HR_{max}, the number of days of increasing/decreasing exercise to match the exercise test target HR was 2.13 days.

Conclusion: Using 50% of age-predicted HR_{max} to guide post-concussion exercise intensity recommendations may under-prescribe tolerable exercise intensity following concussion by an average of 52bpm. While this approach is conservative, it may delay engagement in higher intensity physical activity by up to 6 days. Clinicians may consider exercise prescriptions that begin at 76% HR_{max} and adjust as indicated by symptoms or consider a more intensive progression through the 50% HR_{max} method.

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The Influence of Exercise Volume and Intensity on Depressive Symptoms Following Adolescent Concussion

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Abstract

Background: Aerobic exercise can facilitate post-concussion symptom recovery and may be particularly beneficial for post-concussion mental health among adolescents. However, the relative influence of aerobic exercise volume and intensity during recovery on depressive symptoms has not yet been identified.

Objectives: We examined the influence of post-concussion aerobic exercise volume and intensity using wrist-worn actigraphy on depressive symptom ratings evaluated following concussion symptom resolution among adolescents.

Methods: We conducted a prospective cohort study of adolescents diagnosed with concussion, initially evaluated within 21 days of injury while still symptomatic (i.e., prior to recovery). Participants completed questionnaires assessing demographics and medical history, then were provided with a wrist-worn actigraphy device to wear daily until a follow-up assessment ~5 days after they reported symptom resolution. Primary actigraphy outcomes included average exercise volume (minutes/week) and intensity (average heart rate per workout). Participants reported concussion symptoms weekly to document recovery, and upon symptom resolution they returned for a follow-up visit at which they completed the PROMIS Pediatric 25 depressive symptom assessment (raw scores converted to T-scores; population normative average=50±10). Given the zero-inflated nature of the depressive symptom T-score rating at follow-up, we used negative binomial regression to evaluate the effects of exercise volume and intensity (predictors) on depressive symptoms (outcome), adjusting for age, sex, time to follow-up, and history of depressive symptoms. Negative binomial regression coefficients are represented as incidence rate ratios (IRRs), describing the relative change in expected outcome per unit increase in each predictor, providing a more interpretable measure of effect size.

Results: We enrolled 91 participants (mean age=15.8±1.5 years; 48% female; evaluated initially 13.5±4.7 days post-concussion and reassessed at follow-up 53.6±29.0 days post-concussion). Participants were monitored for an average of 27.1±20.4 days, logging 16.4±13.0 exercise sessions on average. The average exercise volume was 146.7±150.0 minutes/week, average intensity was 120.0±10.7 beats/minute, and average depressive symptom t-score was 42.5±8.5. Negative binomial regression indicated that: higher weekly exercise volume was significantly associated with lower depressive symptom ratings (IRR=0.9997 per minute/week, 95% CI: 0.9994, 0.99997, p=0.03). Female sex (IRR=1.05, 95% CI: 1.01, 1.09, p=0.02)

and a history of depression (IRR=1.13, 95% CI: 1.00, 1.27, p=0.04) were also associated with higher depressive symptoms. Age, exercise intensity, and time since concussion were not associated with depressive symptoms.

Conclusion: Greater exercise volume during concussion recovery was associated with a modest reduction in depressive symptoms ~2 months post-injury, whereas exercise intensity was not. Both female sex and prior depression history were associated with higher depressive symptoms, independent of exercise behavior. These findings indicate the benefit of consistent exercise during concussion recovery to mitigate secondary effects, such as depressive symptoms.

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Evolving Rates of Persisting Symptoms After Concussion in Youth Following Updated Return-to-Activity Guidelines: A PedCARE Substudy

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Abstract

Background: Over the past decade, clinical guidelines for concussion management have shifted from emphasizing strict rest to encouraging earlier, active rehabilitation and return to physical activity. These evolving practices may influence the prevalence of persisting symptoms after concussion (PSaC) in children and youth. Earlier research, conducted under more conservative management protocols, reported PSaC rates of 34.3% at 1 week and 13.6% at 4 weeks post-injury (Yeates et al., Unpublished). More recent work, including the present study, reflects a clinical context where activity is introduced earlier in the recovery process.

Objectives: To estimate PSaC rates in the PedCARE cohort, which was conducted after guideline updates, at weeks 1, 2, and 4 following pediatric concussion, and to compare these rates with previously rates from earlier cohorts.

Methods: This multicentre cohort study used data from the PedCARE randomized clinical trial, conducted from March 2017 to December 2019 at 3 Canadian pediatric Emergency departments. Children and youth aged 10-18, with an acute concussion (<48 hours post-injury), were randomly assigned to a stepwise return-to-PA protocol at 72-hours post-concussion even if symptomatic or to a return-to-PA once asymptomatic protocol. Participants rated symptoms using the Health and Behaviour Inventory at weeks 1, 2, and 4 post-injury. PSaC was operationalized as a reliable change z-score≥1.65 based on an orthopedic injury reference, indicating a greater-than-expected increase in postinjury symptoms relative to retrospective preinjury ratings.

Results: Participants included 384/456 children and youth with concussion [mean(SD) = 13.3 (2.1) years; 44.5% female]. Treatment groups demonstrated no differences in physical activity, thus we combined them for all subsequent analyses. Among available cases, PSaC counts and percentages were: 90/353 (25.5%) at week 1, 46/352 (13.1%) at week 2, and 25/265 (9.4%) at week 4. PSaC rates were lower than those reported by Yeates et al. (Week 1: 8.8% lower; Week 4: 4.2% lower).

Conclusion: In this post-guideline PedCARE cohort, PSaC rates were modest and declined steadily across weeks. Compared with earlier studies conducted under

more conservative management protocols, observed PSaC rates at weeks 1 and 4 suggest a decrease in the rate of symptom persistence following updated concussion care guidelines. These findings provide a contemporary benchmark for recovery trajectories in pediatric concussion and highlight the importance of clinical context when interpreting PSaC prevalence. Future work by our group will evaluate trends across sex and age subgroups.

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Comparing PROMIS Cognitive Scores to Self-Reported Symptoms in Young Adults Experiencing Homelessness With and Without a History of ABI

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Abstract

Background: As of January 2025, the number of unaccompanied youth experiencing homelessness in Columbus, Ohio and Franklin County increased by 31%, emergency shelter use among youth increased by 145%, and transitional housing placements increased by 30%. Young adults experiencing homelessness (YAEH) are a vulnerable population and more susceptible to experiencing an acquired brain injury (ABI). Additionally, young adult brains are still developing and are further vulnerable to injuries that can disrupt the later establishment of pathways for executive functioning. Those who have experienced an ABI may have long-term cognitive difficulties that are especially detrimental in young adults as they navigate independence and the need to find and access social services and supports.

Objectives: This study compares self-reported and standardized assessments of cognitive function among YAEH with and without a history of ABI

Methods: A secondary analysis was conducted using data from a project examining the intersectionality of violence and ABI in YAEH. Participants were YAEH accessing services in an urban drop-in center who completed individual interviews with a research assistant. The OSU TBI-ID identified a lifetime history of ABI and the CHATS was used as a quick self-reported survey to assess for physical, emotional, and cognitive symptoms. The Patient-Reported Outcomes Measurement Information System (PROMIS) was used to evaluate cognitive functioning. Two-sample t-tests and negative binomial regression evaluated group differences.

Results: The sample included 95 YAEH: 72 with ABI (mean age = 21.33) and 23 without ABI (mean age = 21.48). Based on the CHATS, YAEH with ABI reported significantly more cognitive deficits than YAEH without ABI: $t(93) = 2.88$, $p < .01$. The PROMIS depicted similar deficits with YAEH with ABI scoring significantly lower than YAEH without ABI: $t(93) = -3.34$, $p <.01$. There was a strong, negative correlation between PROMIS and CHATS scores: $r(93) = -.68$, $p < .001$, indicating that as CHATS symptom reporting increased, PROMIS scores decreased at levels of statistical significance.

Conclusions: Results identify significant differences in cognitive scores between YAEH with and without a history of ABI on the PROMIS and on the CHATS, a self-report symptom tool. The CHATS tool provides insight into cognitive deficits and is a more easily accessible screener to identify people who may need support. Future research should explore validating the CHATS measure to be more widely used across various populations.

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Prevalence of Autonomic Dysregulation and Symptom Provocation During Head-Up Tilt Table Testing in Youth with a Recent Concussion

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Abstract

Background: Concussion may disrupt autonomic function, with associated cardiovascular alterations that potentially contribute to concussion symptoms, including headache, phono- and photosensitivity, and anxiety. Orthostatic challenge assessments can detect post-concussion autonomic dysregulation (AD) through measurable physiological responses. Few studies have prospectively evaluated AD using passive head-up tilt testing.

Objectives: Determine the prevalence of AD (defined by tachycardia or hypotension) and symptom provocation responses to orthostatic stress during a head-up tilt table test in pediatric patients after concussion.

Methods: This AD substudy is embedded within the TRANSCENDENT Concussion Research Program, a large prospective initiative aimed at improving concussion diagnosis and care. All patients presenting at an interdisciplinary concussion clinic were prospectively approached and enrolled in the AD substudy from August 2022 to

August 2025. Eligible and consented patients aged 10-21 years who presented to the clinic within 90 days of a physician-diagnosed concussion underwent 70° tilt-table testing. Heart rate (HR), blood pressure (BP), and symptoms were recorded at rest, immediately post-tilt, and at one-minute intervals for three minutes. AD was defined as: HR increasing ^{3}40 bpm (^{3}30 bpm for ages 19+), systolic BP decreasing ^{3}20 mmHg, or diastolic BP decreasing ^{3}10 mmHg upon tilting. Symptom provocation was defined as new/worsening symptoms with tilting. Prevalence of AD and symptom provocation were estimated, with the Wilson's score method used to generate confidence intervals (95%CI).

Results: Of the 245 pediatric patients enrolled in the AD substudy, 122 patients (median age=15 [IQR:13,17] years; 54.1% female; median days post-concussion=12 [IQR:7,21]) were included in this analysis. AD occurred in 28/122 (23.0%, 95%CI=16.4-31.2%) patients, and 64/122 (52.5%, 95%CI=43.7-61.1%) reported symptom provocation after tilt. AD prevalence did not differ by sex: 15/66 (22.7%, 95%CI=14.3-34.2%) in females and 13/56 (23.2%, 95%CI=14.1-35.8%) in males, *p*=0.95. Similarly, symptom provocation prevalence did not differ by sex: 39/66 (59.1%, 95%CI=47.0-70.1%) in females and 25/56 (44.6%, 95%CI=32.4-57.6%) in males, *p*=0.11. The prevalence of positive physiological AD findings increased over time, from 12/122 (9.8%) immediately after postural change to 21/122 (17.0%) at 1-minute, 25/122 (20.0%) at 2-minute, and 28/122 (23.0%) at 3-minute, with the largest increases observed within the first minute. The prevalence of symptom provocation went from 54/122 (44.3%) at 15-sec to 56/122 (45.9%) at 1-minute, 62/122 (50.8%) at 2-minute, and 64/122 (52.5%) at 3-minute.

Conclusion: One in four pediatric concussion patients exhibited physiological AD, with increasing detection over three minutes post-tilt. Moreover, one-half reported symptom provocation following the orthostatic challenge. Our observed prevalence following head-up tilt testing was twice as high as that observed during an active standing orthostatic test in a similar cohort. Heads-up tilt testing for AD is a promising physiological biomarker; recognition and early intervention for AD may help close critical gaps in concussion care and improve outcomes for affected youth.

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Association between Exercise Intolerance and Recovery Following Sport-Related Concussion in Adolescents

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Abstract

Background: Sport-Related Concussion (SRC) is a common adolescent injury, with short- and long-term health consequences. Recovery following SRC is variable, though aerobic exercise prescription reliably shortens recovery duration. However, previous research suggests approximately 50% of adolescents are exercise intolerant following SRC. Moreover, evidence from a predominantly male, Australian cohort demonstrated adolescents who were exercise intolerant took longer to recover compared to those with exercise tolerance. The relationship between exercise intolerance and recovery following SRC has not been explicitly evaluated in female adolescents.

Objectives: The purpose of this study was two-fold: to investigate risk factors for developing exercise intolerance following SRC and to assess the relationship between exercise intolerance and recovery duration in adolescents (ages 10-19) of male and female biological sexes.

Methods: Youth participating in the pan-Canadian SHRed Concussions surveillance cohort study were recruited within 14 days of a suspected SRC. Following a physician diagnosis, participants completed a Buffalo Concussion Treadmill Test (BCTT). Pre-BCTT SCAT5 symptom severity score (SSS;/132), concussion symptom score (CSS;/10, Wong-Baker faces pain rating scale) were recorded. The BCTT was terminated when participants experienced a 3+/10 increase in concussion symptoms (exercise intolerant) or reached volitional fatigue defined by a heart rate >180bpm or a rating of perceived exertion of >18/20 (exercise tolerant). Participants were followed until medical clearance to return to sport.

Results: 281 youth (126 male, 155 female) were included in the analysis. 204 (100 Male, 104 Female) were tolerant to exercise, and 77 (26 Male, 51 Female) were exercise intolerant. Bivariate analysis suggest females were at a 59% increased risk of exercise intolerance (RR: 1.59, 95% CI: 1.06, 2.04). Mean recovery time was 21.28, 23.42, 24.39, and 31.92 days for exercise tolerant males, intolerant males, tolerant females and intolerant females, respectively. Exercise intolerance was associated with a 36% longer time to recovery following SRC in females (Time Ratio:1.36, 95% CI: 1.12, 1.66, p=0.02) with no difference for males (Time Ratio:1.13, 95% CI: 0.90, 1.42, p=0.290). Exercise tolerant males and females recovered at approximately the same rate (Time Ratio: 1.01, 95% CI: 0.86, 1.17, p=0.932).

Conclusion: Exercise testing may identify adolescents at higher risk of delayed recovery. Exercise intolerant female adolescents may benefit from targeted

treatment interventions. Future research should examine the underlying cerebrovascular and autonomic function and movement behaviors of exercise intolerant adolescents.

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Lifetime History of Concussion in Children with Attention-Deficit/Hyperactivity Disorder

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Abstract

Background: Race associated differences and disparities in concussion awareness and health care access can complicate interpretation of self-reported concussion history. While children from the general US population with attention deficit hyperactivity disorder (ADHD) have a greater lifetime history of concussion, there is a need to further explore the relationship between ADHD and lifetime concussion history in child athletes, while stratifying by race.

Objective: The purpose of this study was to investigate associations between ADHD, sex, race, and self-reported lifetime concussion history in children student-athletes between the ages of 9 and 12. Based on previous research, we hypothesized that (i) children with ADHD would have a greater lifetime history of concussion compared to children without ADHD; and (ii) the association between ADHD and lifetime history of concussion would differ in association with self-identified race.

Method: Demographic responses were documented in a sample of 12,607 children student-athletes (ages 9-12 years; 45.3% girls; 70% White; 9.6% Black, 1.8% Asian; and 10.9% ADHD) who completed pre-season testing with the Sway Medical System Balance and Cognitive Tests. Participants self-reported their sex (male, female), race (White, Black or African American, Asian, American Indian or Alaska Native, or Other), history of ADHD (yes, no), and history of concussion (yes, no). Participants who responded “I don’t know” or did not respond to race, history of ADHD or concussion questions were coded as “missing” and were excluded from analyses. Chi-square analyses documented the likelihood of having a positive concussion history stratified by sex, race, and sex-by-race subgroups, with odds ratios (ORs) and 95% confidence intervals (CIs).

Results: A significantly greater proportion of children with ADHD reported a history of concussion (19.3% versus 12.4% without ADHD; $p<.001$, OR=1.69, 95% CI 1.44-1.73). Among children with ADHD, girls (19.2% versus 10.2% without ADHD), boys (19.4% versus 14.5% without ADHD), White children (17.9% versus 13.3% without ADHD), White girls (18.9% versus 10.8% without ADHD), and White boys (20.4% versus 15.5% without ADHD) were significantly more likely to report a history of concussion.

Conclusion: Children with ADHD who were participating in sports reported a greater lifetime history of concussion compared to those without ADHD, and these findings differ by sex and race. Girls, boys, White children, White girls, and White boys with ADHD were more likely to endorse a history of concussion, compared to those without ADHD. Further research is needed to understand the risk of concussion in children with ADHD, the possible influences of socio-economic status, racial disparities in concussion knowledge and access to health care, and social determinants of health factors that may contribute to these differences.

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Post-Concussion Menstrual Dysfunction in Female Adolescents: A Longitudinal Analysis

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Abstract

Background: Menstrual dysfunction (MD), an often-overlooked aspect of female health, is characterized by delayed menarche or a disruption in regular menstruation. MD may indicate low energy availability, which negatively impacts female health and injury recovery. In past literature, ~10% of female adolescents experienced a menstrual pattern change post-concussion, but these changes weren't defined with clinical criterion. The prevalence of clinically defined MD among adolescents post-concussion has yet to be explored.

Objectives: To examine the proportion of female adolescents with concussion who report MD initially after injury compared to uninjured controls, and ~3 months later.

Methods: Female adolescents with clinician-diagnosed concussion were compared to uninjured controls. We excluded those who reported hormonal contraceptive use. Both groups completed two visits: concussion participants completed initial evaluation within 21 days of concussion, and controls were evaluated prior to the fall sports season. Follow-up occurred ~3 months later for both groups. Menstrual history was self-reported and symptom severity was assessed via Post-Concussion Symptom Inventory (PCSI). MD was classified by presence of primary amenorrhea (no menarche by age 15), secondary amenorrhea (3 consecutive months without a menstrual period after reaching menarche), and/or oligomenorrhea (≤9 menstrual periods in 12 months). Chi-Square analysis was used to compare the proportion of MD between groups at both timepoints. Multivariable logistic regression was used to test the association between group and MD presence after adjusting for age, symptom severity, and concussion history.

Results: We evaluated 25 female adolescents with concussion and 138 uninjured controls. The concussion group was younger (15.0±1.2 vs. 16.1±1.3 years; $p<0.001$), had higher PCSI scores (39.1±19.4 vs. 21.9±20.0; $p<0.001$), and more prior concussions (56% vs. 27%; $p=0.004$) than the control group. At the initial visit, there was no proportional difference in MD between groups (32% vs. 30%; $p=0.82$). However, at the follow-up visit, there was a significantly higher proportion of the concussion group with MD than the control group (44% vs. 19%; $p=0.006$). After adjusting for covariates, concussion was not associated with MD at the initial visit (odds ratio= 0.76, 95% CI= 0.26, 2.19; $p=0.61$), but was associated with a

significantly higher odds of MD at the follow-up visit (odds ratio= 3.63, 95% CI=1.19, 11.0; p=0.02).

Conclusion: MD was more prevalent among concussed female adolescents ~3 months post-concussion compared to non-injured peers. Across time, the control group had an average prevalence of MD consistent with past literature, while the concussion group had roughly double the prevalence and higher odds of MD compared to controls at follow-up. Although the cause for MD and its latency is unknown, clinicians should monitor for presence of MD post-concussion given overall female athlete health implications.

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Intersecting Effects of Insurance Type and Neighborhood Opportunity on Post-Concussion Mental Health in Adolescents

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Abstract

Background: Pediatric concussion is a leading cause of emergency visits and neurobehavioral morbidity, affecting over two million children in the U.S. annually. Mental health (MH) sequelae such as anxiety, depression, and psychological distress are increasingly recognized, yet the extent to which sociodemographic factors or insurance coverage shape these outcomes remains unclear. Understanding these determinants is essential to advancing equitable, targeted care.

Objectives: To examine the interacting effects of insurance type and neighborhood opportunity with post-concussion MH diagnoses within 12 months post-injury among youth aged 11–17, and to test whether insurance disparities differ by neighborhood context.

Methods: This retrospective cohort study used electronic health record (EHR) data from Nationwide Children's Hospital (2013–2025) for youth aged 11–17 with a physician-confirmed concussion (ICD-9: 850.0–850.9; ICD-10: S06.0). Extracted data included insurance type (Private, Medicaid, Other) and neighborhood opportunity (Ohio Child Opportunity Index [OCOI] quintiles: 0–20 to 80–100). Outcomes were: 1) *New MH diagnosis* (no prior diagnosis in preceding 12 months), and 2) Persistent MH diagnosis (present before and within 12 months post-concussion). Covariates included demographics (age, sex, race), pre-injury health history (ADHD, prior concussion, learning disability), and clinical characteristics (loss of consciousness, injury mechanism). Multivariable logistic regression models estimated adjusted odds ratios (aOR) and 95% confidence intervals (CIs), including Insurance × OCOI interactions.

Results: Among 19,667 youth (Mean(age)=14.5 years; 44.7% female), 37.1% were Medicaid-insured. Most resided in higher-opportunity neighborhoods: 34.0% and 47.9% were in the 60–80 and 80–100 OCOI quintiles, compared to 6.2% and 3.3% in the lowest two quintiles (0–20, 20–40), respectively.

After adjustment, Medicaid (government-provided public insurance) coverage was associated with 37% higher odds of new (aOR=1.37, 95% CI=1.22–1.54) and 32% higher odds of persistent (aOR=1.32, 95% CI=1.12–1.56) MH diagnoses within 12 months post-concussion, compared with private insurance coverage, for those living

in the highest OCOI quintile. A significant Insurance × OCOI interaction (*p*<.001) indicated widening disparities in the lowest-opportunity neighborhoods; among youth in the 0–20 OCOI quintile, those with Medicaid had 2.8 times higher odds of new and 6.4 times higher odds of persistent MH diagnoses than privately insured peers. Among privately insured youth, residence in low-opportunity areas (0-20 OCOI) was associated with reduced likelihood of new (aOR=0.78, 95% CI=0.61–0.99) or persistent diagnoses (aOR=0.23, 95% CI=0.11–0.49), possibly reflecting underdiagnosis or limited access to care.

Conclusion: Insurance and neighborhood opportunity were independently and jointly associated with post-concussion MH outcomes. Medicaid-insured youth in low-opportunity areas faced the greatest risk of new and persistent MH diagnoses, reflecting compounded individual and community disadvantages. Incorporating neighborhood opportunity into clinical risk assessments and enhancing follow-up for Medicaid-insured patients may improve early detection, care continuity, and equity in recovery after pediatric concussion.

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Association Between Early Cumulative Moderate-to-Vigorous Physical Activity and Brain Perfusion at 4 Weeks Following a Pediatric Concussion

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Abstract

Background: Concussion management has shifted from prolonged rest toward early, active rehabilitation strategies, as emerging evidence suggests that physical activity may promote symptom recovery in youth. However, the neurophysiological impact of moderate-to-vigorous physical activity (MVPA) remains unclear.

Objectives: To investigate the association between cumulative MVPA (cMVPA) within the first two weeks following a pediatric concussion and changes in 1) global grey and white matter perfusion, and 2) number of hypo- and hyperperfusion clusters and their summed volumes.

Methods: This substudy of the randomized controlled trial "PedCARE" included children aged 10–17.99 years who presented to the emergency department (ED) >48 hours of sustaining a concussion or orthopedic injury. Following ED discharge, concussion participants wore a hip-mounted accelerometer continuously for 13 consecutive days (24 h/day). Participants from both trial groups completed MRI scans at 72 hours (±48 hours) and 4 weeks (±5 days) post-injury, including arterial spin labelling to quantify cerebral perfusion. For each concussion participant, z-score perfusion maps were generated using the distribution-corrected z-scores method, and voxel-based analyses identified clusters of hypo- and hyperperfusion ($z \geq 2.5$ or ≤ -2.5) relative to children with orthopedic injury (OI), as well as the corresponding perfusion volumes. Accelerometer data were considered valid if ≥8 hours of wear time were recorded per day. Activity intensities were classified using established count thresholds. cMVPA was calculated across the two-week monitoring period. Missing daily MVPA were addressed using multiple imputation by chained equations, except for participants with <4 valid days of data or ≥3 consecutive missing days. Linear regression models were used to examine associations between cMVPA and six perfusion outcomes (global gray and white matter perfusion, hypo and

hyperperfusion clusters and volumes), adjusting for age, sex, and 72-hour perfusion. Fitted model estimates were pooled using Rubin's rules.

Results: The study included 72 participants with concussion [median age (IQR)=12.70 (11.71, 14.35) years, 47.1% female] and 30 with OI [median age (IQR)=12.19 (11.19, 13.58) years, 60% female]. OIs were used solely to generate z-maps. 44/72 concussion participants had valid accelerometer data and were included in the analyses [median age (IQR)=12.39 (11.56, 14.33) years, 51.2% female]. Participants accumulated a median of 5.5 hours (IQR=3.0-8.4) of cMVPA over the first two weeks after concussion, equivalent to 25.2 minutes per day (IQR=13.6-38.7). cMVPA was not significantly associated with perfusion outcomes (*ps*≥0.068).

Conclusion: In youth with concussion, cMVPA during the first two weeks post-concussion was not associated with changes in cerebral perfusion at four weeks post-injury. These findings suggest that higher physical activity levels during early recovery may not adversely affect perfusion, supporting growing evidence that early symptom-guided activity is safe following concussion. Our next step is to explore the effect of cMVPA on regional perfusion.

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Hidden Hurdles: Why Some Children Don't Recover After Concussion

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Abstract

Background: Following a concussion 30% of the paediatric population have persisting post- concussion symptoms and whilst majority of these ultimately resolve there is a group of children and adolescents who continue to experience symptoms and develop secondary diagnoses.

Objectives: This presentation aims to investigate the reasons why some individuals do not experience full symptom resolution following a concussion. It will describe the presentations these individuals have, will explore the key patterns that have been identified and discuss predicting factors.

Method: This data has been taken from a single site concussion essentials (RCT) and concussion essentials plus (pilot study). Participants were aged 8 – 18 and were subacute and chronic presentation. Multimodal intervention was provided that involved physiotherapy, psychology and psychoeducation. Analysis of participants that did not fully recover has been completed.

Results: There were 97 participants who received the concussion essentials program across both subacute and chronic studies. Within this group there were a small number of participants who continued to have a high level of symptoms, did not return to previous roles and/or required referral onto another service for management.

Conclusion: There are often patterns in the presentations of children and adolescents who fail to make a full recovery post-concussion despite multimodal evidence based treatment. This presentation will present these patterns and data on predictors of non-response to multimodal intervention. This will highlight key considerations for clinicians working in this population.

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Return to School Following TBI: The STATBI Study Academic, Health & Social Outcomes at Study Entry, 1, and 2 Years Later

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Abstract

Background: Childhood traumatic brain injury (TBI) is a leading cause of acquired disability and can result in persistent challenges that impact participation, including school.

Method: Our project, School Transition after Traumatic Brain Injury (STATBI) uses a mixed method, cohort-controlled research design to assess outcomes for students in the US who receive statewide support from BrainSTEPS in Pennsylvania compared to those in Ohio who receive variable supports. The protocol includes electronic survey administration and virtual interviews with parents and children. Measures in the STATBI protocol include standardized assessments of academic and cognitive function, health, social function, and overall participation. This presentation focuses on the specific quantitative academic, social, and health functioning measures administered at the time of study entry, one-year, and two-year post-study enrollment (PSE). RESULTS: At the time of abstract submission, data includes all completed outcome measures for 239 participants at study entry, 147 participants at the one-year PSE, and 91 participants at two-year PSE. Demographics of the sample overall are: 50.3% male, 70% White, median age at injury = 13 years old, and 63% mild injuries. 68% of the parents/caregivers report at least some college education. Academic/cognitive outcome measures include Vineland Adaptive Behavior Composite (ABC), NeuroQoL Cognitive short form, CASP, and BRIEF-2. Social/psychosocial outcome measures include: CBCL, NeuroQol Social short form, Strengths & Difficulties Questionnaire (SDQ), CASP and the FAD. Health outcome measures include: PCSI (for youth with mild injuries), Child Health Questionnaire (CHQ), and PROMIS Global Health. Descriptive statistics will be shared for the primary outcome measure in each category. Cognitive = Vineland ABC score: [Study Entry: Mdn=103, IQR=71-124; One-year PSE: Mdn= 109, IQR 77-123; Two-years PSE: Mdn=110, IQR=82.5-127]; Social: SDQ [Study Entry: Total Difficulties Score, Mdn=10, IQR= 2-23; Impact Score, Mdn=8, IQR=3-14; One-year PSE: Total Difficulties Score, Mdn=8 , IQR=1-23; Impact Score, Mdn = 7, IQR 2-13; Two-years PSE: Total Difficulties Score, Mdn=9, IQR=2-20; Impact Score, Mdn = 6.5, IQR= .35-11.6]; Health: CHQ General Health score Study Entry: Mdn= 65, IQR=27.5-96; One-year PSE: Mdn = 65; IQR = 21-92; Two-year PSE: Mdn = 95; IQR = 27-100]. Further analysis will be conducted examining data separated by injury severity and participation in formal return-to-learn program or no formal program. Additionally, significant differences

by time (study entry, one-year PSE, two-year PSE) and groups (formal RTS, no formal RTS) for each outcome measure will be presented.

Discussion: Across cognitive, social, and health domains, pooled scores continue to show group differences that fail to fall into clinically elevated ranges. However, nuanced and individualized examination of progress is essential, because students who are receiving supports through a structured return-to-school program may not qualify for specific special education services if left to rely on standardized assessments alone.

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Head Impact Kinematics in Male U17A Box Lacrosse and U16AA Ice Hockey: A Comparative Pilot Study Using Instrumented Mouthguards

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Abstract

Background: Ice hockey and box lacrosse are high-impact collision sports with elevated concussion rates among Canadian adolescent athletes. Head acceleration events (HAEs), resulting from direct or indirect collisions, are biomechanical indicators of potential concussion risk. While HAEs have been explored in adult ice hockey, limited data exists for box lacrosse and adolescent athletes. Instrumented mouthguards (iMGs) offer accurate, real-time measurement of HAEs.

Objectives: To compare HAE incidence rates and kinematics using iMGs and player-to-player contact metrics via video analysis between elite adolescent male ice hockey and box lacrosse players to inform injury prevention efforts.

Methods: A prospective cohort study was conducted during the 2024 box lacrosse and 2024–2025 ice hockey seasons involving one male U17A box lacrosse team (ages 15-16; n=19) and one male U16AA ice hockey team (ages 14-15; n=20). A subset wore iMGs during games (box lacrosse: n=9; ice hockey: n=11). Games were video-recorded and synchronized with iMG data. HAEs were verified via video review following a verified protocol. Median values with 25th-75th percentiles were compared using Wilcoxon rank sum test ($p<0.05$). Player-to-player contacts were coded by type, intensity, location, and context via video analysis for all players. Data were analyzed using Poisson regression to estimate incidence rates and incidence rate ratios with 95% confidence intervals per 60-minute game.

Results: Across six games per sport, 110 video-verified HAEs occurred in box lacrosse (22.2HAEs/game;95%CI:18.6–27.0) versus 71 in ice hockey (12.0HAEs/game;95%CI:9.6–15.0;IRR=1.55;95%CI:1.15–2.09). Peak angular acceleration was significantly higher in box lacrosse (median:1,467.5rad/sec^2;25th-75th%:803.0-2,645.0) compared to ice hockey (median:688 rad/sec^2;25th-75th%:425.0-1,063.5), while peak linear acceleration, linear velocity, and angular velocity did not differ. Head contact rates were 1.67-fold higher in box lacrosse (IR=18.0/game,95%CI:15.6–20.4) than ice hockey (IR=10.8/game,95%CI:7.8–

13.8;IRR=1.67;95%CI:1.25–2.22). Direct head contact rates were 2.66-fold higher in box lacrosse (IR=16.8/game,95%CI:14.4–19.2) than ice hockey (IR=6.0/game,95%CI:3.0–11.4;IRR=2.66;95%CI:1.49–4.73), primarily due to cross-checking (71% of contacts) in lacrosse and body-checking (79%) in hockey. Overall player-to-player contact rates were 2.74-fold higher in box lacrosse (IR=573.6/game,95%CI:525.0–626.4) than ice hockey (IR=208.2/game,95%CI:165.0–263.4;IRR=2.74;95%CI:2.16–3.48). Cross-checking was 9.44-fold higher in box lacrosse (IR=433.8/game,95%CI:410.4–458.4) than ice hockey (IR=45.6/game,95%CI:34.8–60.0;IRR=9.44;95%CI:7.24–12.30). Stick slashing rates were 10.80-fold higher in box lacrosse (IR=84.0/game,95%CI:62.4–111.6) than ice hockey (IR=7.2/game,95%CI:2.4–21.0;IRR=10.80;95%CI:3.93–29.68). Conversely, body-checking rates were 2.80-fold higher in ice hockey (IR=154.8/game,95%CI:127.2–187.8) than box lacrosse (IR=55.2/game,95%CI:45.6–67.2), indicating body-checking as a primary HAE mechanism in ice hockey.

Conclusion: Box lacrosse demonstrated higher rates of HAEs, angular acceleration, direct head contacts, and head-contact mechanisms compared to ice hockey, while ice hockey showed higher body-checking rates. These preliminary findings suggest adolescent box lacrosse may present an elevated concussion risk profile compared to adolescent ice hockey. Findings support tailored prevention strategies including rule changes, equipment design, and education.

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Non-Linear, Non-Traditional Paths to Intensive Rehabilitation following Acquired Brain Injury

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Abstract

Functional and cognitive recovery after acquired brain injury (ABI) often extends beyond an inpatient rehabilitation admission. It is therefore critical to have a system in place that supports patients and their families in the community, as well a pathway to return to a more supportive and comprehensive inpatient or outpatient intensive rehabilitation program if appropriate.

The Children's Hospital of Philadelphia (CHOP) follows patients with ABI longitudinally after inpatient rehabilitation through multi-disciplinary clinics with a physiatrist, neuropsychologist, speech language pathologist, occupational therapist, physical therapist, education coordinator, nurse, and social worker. Our AWARE clinic specializes in patients with a Disorders of Consciousness (DOC). By combining expertise from different disciplines, multidisciplinary clinics offer a more holistic approach to patient care, addressing not just the medical issues, but also the functional, emotional, and educational aspects of a patient's health. This model can ease the stress of the patient and the caregivers by consolidating the need for multiple visits to a single, comprehensive assessment. Clinic visits also allow for re-evaluation of status, progress, and goals.

This presentation will discuss a case series of patients with severe ABI that initially received inpatient rehabilitation and through longitudinal surveillance were identified to have cognitive or functional changes and readmitted to an intensive therapy program with significant improvements in cognitive and functional skills during one or more readmissions. The first patient had discharged from inpatient rehab in a DOC and subsequently returned to inpatient rehab with emergence and a later subsequent inpatient admission achieved functional goals in speaking, cognition, and assistance with transfers. The second patient admitted for a DOC rehab program and discharged emerged with global functional impairments. At subsequent follow up was readmitted to intensive outpatient therapies and was able to self-feed and walk household distances with a walker after the therapeutic readmission. Our final case is a toddler with anti-NMDA receptor encephalitis and discharged in a DOC to a residential facility. More than a year out from their diagnosis, this patient was seen in clinic, at which point their mother and staff from the facility reported improved social engagement, head and trunk control, and attempts at mobility. The patient was readmitted to inpatient rehab and was able to discharge home with improved function in feeding, communication and household ambulation.

While many inpatient rehabs accept patients only immediately following acute illness or injury, this presentation will highlight the benefits of considering non-linear or less

conventional paths towards admission or readmission to an intensive rehab program, a model which CHOP has successfully implemented in over 20 patients. At the conclusion of the presentation, we hope to facilitate open dialogue about non-linear or non-traditional admission process could be implemented in other places.

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Analyzing the Spectrum of mTBI Subgroups

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Abstract

Background: Patients with mild traumatic brain injury (mTBI) experience a variety of clinical trajectories resulting in a heterogenous population. Despite this, commonalities exist amongst patient symptoms and their evolution throughout recovery. Recent efforts to identify mTBI subtypes have described phenotypic variability, however, utilize various terminology including symptom cluster, subgroup, endotype, and endophenotype. Clinical applicability of these subtypes is challenging due to critical variations in each subtype's defining characteristics and limited inclusion of objective data.

Objective: To synthesize the commonalities and identify inconsistencies amongst current mTBI subgroup literature at various timepoints following injury utilizing a well-defined taxonomy structure.

Method: We conducted a literature review that analyzed clinical subtypes following mTBI. Studies were included if they characterized two or more subtypes based on clinical profiles at any time point (either at baseline or following mTBI) and were published prior to the first quarter of 2022. Studies were excluded if they focused on a singular subtype/symptom or if the study population was not specific to mTBI. Additional studies that did not subtype patients based on clinical phenotypes (i.e. mechanism, severity) or those that were based on commentaries, editorials, case reports, or reviews were excluded. Each study was also required to label or refer to each of their subgroups based on a predominant clinical symptom/phenotype. Following the review of the studies, each phenotype characteristic was distributed to one of five of the most frequently described subtypes (cognitive, somatosensory, vestibular-ocular, headache, and neuropsychiatric (affective/behavioral)) based on the primary article's description.

Results: Five subtypes (cognitive, somatosensory, vestibular-ocular, headache, and neuropsychiatric (affective/behavioral)) were described using 67 unique phenotype features. Each of these subgroups were described at separate timepoints post-injury, with the majority of studies describing symptom clusters in the acute and subacute recovery period. Cognitive and neuropsychiatric subgroups were the most specific, with 16 unique symptoms comprising each of these subgroups. Analysis of symptoms between each subgroup indicated significant overlap and ambiguity amongst the symptom-based subtypes of mTBI. Additionally, inconsistent terminology within symptom description and subtyping nomenclature limited the ability to compare amongst one another. Given that the majority of mTBI subgroups are currently symptom-based, the limited incorporation of objective biological data precludes categorizing many subtypes as endotypes/endophenotypes.

Conclusions: We describe the evolution of each of these symptom-based mTBI subgroups and identify ways to improve their clinical application. We suggest that improved understanding of possible biological processes that contribute to certain clinical trajectories may be identified by incorporating objective biomarkers (i.e. physiological parameters (heart rate, blood pressure), neurophysiological studies (EEG, MEG), neuroimaging (CT, MRI), serum molecules, and genetic markers) into future mTBI subtyping analysis. In doing so, advancements towards individualized symptom management, recovery, and improved care for our mTBI community is possible.

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Cracking the Code of Recovery: What Worked in Concussion Treatment

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Abstract

Background: Paediatric concussion is a common injury with 1 on 7 children by the age of 10 experiencing a concussion. Despite well published guidelines on recovery and early management, longitudinal research shows that 30 percent of children will have ongoing symptoms beyond 4 weeks and develop persistent post-concussion symptoms (pPCS).

Development of pPCS can have significant impact on children and adolescents with interruptions to school and leisure activities. Symptoms can span a variety of different domains including somatic (headache, fatigue), physical (dizziness, nausea, clumsiness), emotions (mood, emotionally labile) and cognitive (fog, memory). Given the heterogeneity of pPCS presentations amongst different children it can be complex to rehabilitate.

Guidelines and recent research recommend an individualized and multimodal approach to rehabilitation of children and adolescents with pPCS to facilitate a successful return to activity, learn and play.

Case History: The Concussion Essentials program is based at the Murdoch Children's Research Institute in Melbourne, Victoria, Australia. This presentation will highlight two different cases of pPCS who presented for assessment and management in the program. The Concussion Essentials program is a multidisciplinary team of physiotherapists and neuropsychologists who deliver individualised, tailored rehabilitation in a structured program. Weekly treatments consisted of education, physiotherapy and psychology and is determined by symptoms as well as clinician opinion. The program consists of two patient pathways a subacute pathway for assessment and management of children and youth within 3 months of concussion. As well as a chronic pathway designed for management of those who are beyond 3 months post-concussion. This series of cases will summarise the assessment and rehabilitation of 3 patients who presented across different time points for management of pPCS who recovered optimally. We will also detail the multimodal team involvement and how we worked together to maximise care of the child or youth.

Conclusion: Multimodal individualised rehabilitation delivered by physiotherapists and neuropsychologists can have a positive impact on symptoms and return to activity for children and youth with pPCS. Through this management complete resolution of symptoms is possible in both subacute phase and chronic concussion presentations.

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"Cracking the Code of Non-Recovery: When Concussion Treatment Falls Short"

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Abstract

Background: Concussion is a common injury amongst children and youth with about 20 percent of children having experienced a concussion before the age of 10. It is well recognised that 30% of the paediatric population will continue to have persisting post-concussion symptoms (pPCS) after 1 month. Recent recommendations are for management of persistent post-concussion symptoms to be managed by a multidisciplinary team delivering individualised rehabilitation.

The Concussion Essentials team is a multidisciplinary team of physiotherapists and neuropsychologists based at the Murdoch Children's Research Institute (MCRI) in Melbourne, Australia. Over the past 6 years we have been running a Randomised Controlled Trial (RCT) and a pilot study investigating the management of children and youth with pPCS across a subacute and chronic time frame.

There was significant recovery across the different studies regardless of time since injury to initial presentation. Despite the positive results there was still a small number of participants who presented with a cluster of complex physical and psychological symptoms which turned into a secondary diagnosis triggered by the concussion.

Case History: This presentation will detail two different cases where they were initially managed for pPCS but then failed to recover within the expected timeframes. These children developed a secondary diagnosis which required a different management approach after the concussion rehabilitation. This will highlight two different conditions which we have consistently seen autonomic dysregulation and functional neurological disorder.

Conclusion: Concussion rehabilitation has improved over the past 10 years and now there is well researched comprehensive care models involving different members of the multidisciplinary team. There are however a small proportion of complex presentations who do not respond as well to the treatment programs and develop a secondary disorder. Future research should be directed to this small population of non-responder to facilitate improved referral pathways and care programs.

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Educating Students with an Acquired Brain Injury – An Online Course for School Staff

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Abstract

Background: Kids Rehab and Rehab2Kids are the two specialised paediatric rehabilitation teams within the Sydney Children's Hospitals Network, providing multidisciplinary brain injury services to children across New South Wales, Australia. Collaboration between these brain injury services and their school-aged clients' educational settings is critical to improved functional and academic outcomes. Ensuring that school staff are well-informed about working with children who have sustained an acquired brain injury (ABI) is essential. For over 20 years, our team delivered a face-to-face course for teachers and support staff; the COVID-19 pandemic necessitated its transition online, which maintained high participant satisfaction and broadened reach. In 2025, we initiated the development of a fully self-paced online course to preserve the quality of education while improving accessibility and flexibility.

Objectives: The primary objective of this project was to develop a high-quality, self-paced online course that would sustain participant satisfaction. The course aimed to increase accessibility, allowing school staff to engage with the material at any time and from any location, thereby removing the constraints of scheduled in-person sessions. Additionally, the transition to an online format sought to reduce the workload on clinical educators, eliminating the need to repeat face-to-face presentations annually while maintaining the educational impact and integrity of the program.

Methods: Development was informed by feedback from previous courses, supplemented by staff surveys. A planning day clarified objectives, established a detailed project plan, and ensured alignment with educational goals. Collaboration with other hospital teams experienced in online education supported technical implementation. The course underwent a trial period during which participant feedback (n = 9) was collected and used to refine content and delivery.

Results: The *Educating Students with an Acquired Brain Injury* online course is now live. Feedback results from the trial period to date were overall positive (mean rating = 9.0 out of 10) and in keeping with that received in previous years with the face-to-face and live online formats (4-year mean = 9.1). Overall, 83% of participants reported that they would recommend the program to colleagues. The functionality of the technology platform was rated positively (mean rating = 8.4) and the inclusion of the lived experience perspective was consistently reported by participants as an

aspect they found most valuable. Pre-post course self-ratings of brain injury knowledge improved from mean = 5.4 to mean = 8.3.

Conclusion: Transitioning a long-standing face-to-face ABI education program to a self-paced online format has successfully maintained high-quality content and provided successful knowledge transfer to trial participants. This approach demonstrates the feasibility and effectiveness of online professional development in paediatric brain injury education, supporting educators in providing informed, individualized support to students with ABI and highlighting the value of long-term collaboration between healthcare and educational settings.

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Beyond the Injury: Identifying Unmet Social Needs in Paediatric Brain Injury

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Abstract

Background: The social determinants of health are the non-medical factors that influence health outcome. They are the conditions in which people are born, grow, work, live, and age, including education, housing, transportation, food security, and employment. Social determinants of health can create barriers that limit and reduce access to services, which can ultimately lead to poorer health outcomes for those who are impacted by these factors. There is documented evidence outlining the impact on health outcomes of adverse social determinants. This has been demonstrated across several paediatric conditions, including children with neurodevelopmental disorders.

Objective: The objective of this study is to understand how clinical factors such as Acquired Brain Injury (ABI) aetiology, ABI severity, presence of comorbidities and sociodemographic factors interact with unmet social needs (including education, housing, food, financial, transport, and geographic location) to help ensure that screening processes and interventions are appropriately designed and targeted.

Method: A screening tool to identify unmet social needs, was distributed to attendees at the Brain injury Clinic at Kids Rehab at The Children’s hospital at Westmead as part of a Quality Improvement (QI) project. We then undertook a retrospective chart review of the Electronic Medical Record utilising the data from the QI project to extract the demographic and diagnostic information of the screening form respondents. Descriptive statistics were calculated for the frequency and type of unmet social needs reported by families. Exploratory analysis was undertaken to investigate the relationship between reported unmet social needs and demographic/clinical characteristics.

Results: Of the 124 families attending the Brain Injury clinic during the QI project time, 83.8% of the 74 eligible families completed the screening tool and 65.6% of the respondents identified unmet social needs. The most common need identified was access to government benefits, however transport, housing and food insecurity were also identified. There was no statistically significant relationship between social disadvantage and identification of unmet social needs ($p = 0.69$). Families with a child with a severe brain injury however did report more unmet social needs than those with a mild/moderate injury ($p=0.02$).

Conclusion: Knowledge of the unmet social needs of the families who are a part of our service provides us with an opportunity to provide these families with

meaningful support, that may lead to better health outcomes. This study highlights that families with children who have more severe injury may be at greater risk of unmet social needs, but it also reminds us that families across the socioeconomic spectrum experience unmet social needs, therefore asking all families is important.

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Optimizing Rehabilitation Care for Young People with Acquired Brain Injury; Evaluation of a Dutch National Treatment Framework

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Abstract

Background: Enhancing participation is the key focus for pediatric rehabilitation of young people with Acquired Brain Injury (ABI). In the Netherlands 12 rehabilitation centers collaborated to gain consensus on measuring, guidingand treating young people with ABI in order to enhance participation possibilities. Through this project, a consensus-based treatment framework was created and published in 2023.

Objective: The aim of this study is to evaluate the use of the framework and the subsequent treatment outcomes to further enhance the treatment framework.

Methods: This prospective follow-up study (2025-2027) includes 14 pediatric rehabilitation centers. All centers have a local key-user responsible for study procedures and data capturing. Patients aged 4-25 years old, referred for outpatient rehabilitation due to (suspected) ABI are eligible to participate. An electronic database containing Patient Reported Outcome Measures (PROMs) and 37 outcome measures and 25 interventions (content of the framework) is used to gather data on treatment and outcomes.

Patients complete one short PROM targeting Quality of Life, Participation, Physical functioning and Fatigue prior to their first consultation with the rehabilitation physician.

Patients with a definitive diagnosis of Post Commotional Syndrom (PCS) or ABI start outpatient rehabilitation treatment addressing their own goals/problems and complete a second set of PROMs based on outcomes of the short PROM, including at least the Childhood-Assessment-Scale-of-Participation (CASP) as primary outcome. All patients need to complete the Canadian-Occupational-Performance-Measure (COPM) for goal setting.

Further, only those outcome measures and interventions addressing the patient’s reported goals/problems are used and completed in the database. Evaluations are performed pre- and post-treatment. Finally, satisfaction with the use of the treatment framework is investigated. Outcomes are analyzed using descriptive statistics and ANOVAs where appropriate.

Preliminary results: The electronic database was constructed in May 2025 after which inclusion started. As of October 2025, a total number of 96 patients were included. Twelve did not start treatment, 55 are still being considered for

treatment and 29 started treatment. Of those, 5 were diagnosed with PCS and 24 with ABI. Of the patients with ABI, 6 had traumatic ABI (7 mild, 1 moderate-severe) and 16 non-traumatic. None of them have completed treatment yet, therefore no further analysis can be done at this time.

Healthcare professionals were satisfied with the use and evaluation of the framework and felt that it added to the quality of the treatment. Specifically, the use of the short PROM to decide which longer PROMs to use was found to be helpful in gathering clinically useful outcomes and decreasing patient burden.

Conclusion/discussion: The use of the national consensus-based treatment framework and capturing both patient outcomes and treatment information seems promising to enhance rehabilitation-treatment. More research is needed to further evaluate the use of and satisfaction with the framework.

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"Building Bridges Together": The Implementation Process of a Rehabilitation Treatment Framework for Young Patients with Acquired Brain Injury in the Netherlands

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Abstract

Background: Enhancing participation is a key focus of pediatric rehabilitation for young people with Acquired Brain Injury (ABI). Between 2021 and 2023, 14 out of 16 Dutch rehabilitation centers collaboratively created a national consensus-based framework to optimize and harmonize care. This framework defined how to measure, guide, and treat young people with ABI, which was published in February 2023. Although national agreements were made for its'use, implementation proved challenging. All centers were committed to adopting the framework but faced practical challenges in implementation. While the development of frameworks is a recognized strategy for improving care, their effective uptake within diverse rehabilitation teams requires a systematic, theory-driven approach to behavioral change.

Objective: This study describes the implementation of the consensus rehabilitation treatment framework across the Netherlands using a phased behavioral science–based toolkit.

Methods: Fourteen rehabilitation centers with a specialized pediatric ABI team participated in this prospective implementation study. A literature search identified evidence-based implementation strategies, which were used to develop an implementation toolkit. Each center appointed a key-user responsible for guiding their team through implementation. Regular consultation meetings supported teams during the process.

Results: From the literature search, three supportive strategies for implementation were found: the Capability-Opportunity-Motivation-Behavior-Model (COM-B), the Behavioral-Change-Wheel (BCW) and the Easy-Attractive-Social-Timely (EAST)-model. Based on these supportive strategies, a six-phase toolkit grounded in behavioral theory science was developed with the aim of aligning it to the local context. Phase 0 of the toolkit provides a manual and orientation for key-users. Phase 1 analyzes existing team practices. Phase 2 defines the desired target behaviors for framework use. Phase 3 explores contextual influences, including organizational, professional, and patient-level factors. Phase 4 guides teams in selecting and executing change strategies tailored to their setting. Phase 5 emphasizes reflection and evaluation of progress. Finally, phase 6 addresses consolidation and long-term sustainability. While centers differed in pace and emphasis at the beginning of the implementation process, all teams expressed

confidence and followed all steps within the created toolkit and implemented the treatment framework.

Conclusion/discussion: Developing a national consensus framework is only the first step; effective implementation requires structural behavioral guidance. The combination of collective effort, sustained support, and a national evaluation infrastructure has advanced high-quality rehabilitation for young people with ABI in the Netherlands. The behavioral science–based toolkit offered a structured yet adaptable pathway for embedding complex frameworks across multiple centers. By integrating theoretical models with practical steps, it enabled teams to analyze context, set goals, and establish lasting change. This approach promotes both national consistency and local ownership and may be transferable to other areas of rehabilitation care and healthcare innovation.

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Effectiveness of Rehabilitation Treatment in Young Children with Disorders of Consciousness and Its Assessment Using the CRS-P and CNCS Scales

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Abstract

Background: Disorders of consciousness (DoC) following acquired brain injury (ABI) represent one of the most complex clinical conditions to assess and treat. In adults, classification is based on well-defined clinical states (coma, vegetative state/unresponsive wakefulness syndrome – VS/UWS, minimally conscious state – MCS, and emergence from MCS – eMCS). In pediatric populations, especially in young children, the applicability of these categories is problematic due to the incomplete development of communicative and functional abilities, which makes it difficult to distinguish between VS, MCS, and eMCS.

Objectives: This study aimed to evaluate the effectiveness of a multidisciplinary rehabilitation program in promoting emergence from DoC in a first cohort of children under 7 years of age.

Methods: Children admitted to the ABI Unit of a specialized neurorehabilitation center were included if they had at least one evaluation performed through both CRS-P and CNCS and were admitted within one year after the injury. Clinical data were collected following literature recommendations. All patients underwent a rehabilitation program aimed at stimulating environmental interaction through targeted sensory input (auditory, visual, tactile and olfactory) and cognitive-behavioral techniques designed to enhance appropriate responses and reducing maladaptive behaviors.

Results: Of the 35 patients (18 males, 17 females), the mean age at the event was 40.9 months (SD=25.5), the mean age at rehabilitation admission was 43.6 months (SD=26.2) and the average GCS score was 4.3 (SD=1.9). Etiologies included 11 traumatic brain injuries, 11 anoxic events, 7 encephalitis and 6 other causes. Fourteen children underwent neurosurgery, 7 had tracheostomy, 33 received enteral nutrition, 11 had symptomatic epilepsy and 8 showed paroxysmal sympathetic activity. At discharge: 1 patient died, 11 remained in VS with concordant classification across behavioral scales, 9 were in MCS from an observational clinical perspective and based on CRS-P (CNCS: 5 MCS, 3 VS, 1 eMCS) and 14 were in eMCS from an observational clinical perspective (CRS-P classified 6 as eMCS, 7 MCS, 1 VS; CNCS 13 eMCS, 1 MCS). Overall, 57.1% improved their level of consciousness (from VS to MCS or from MCS to eMCS), and 40% emerged from DoC. Emergence was much less frequent among children <18 months (22%).

Conclusion: Assessment of DoC in young children is challenging and requires age-specific tools. CRS-P and CNCS show good agreement in identifying VS but diverge in

intermediate states: CNCS appears less sensitive in detecting MCS, while CRS-P may underestimate emergence from MCS. Despite evaluation difficulties, multimodal rehabilitation seems to promote clinical improvement: in our study more than half of the patients improved their level of consciousness and emergence were exhibited by 40% of cases. Further research is needed to validate pediatric DoC scales for children under 7 years of age and to compare rehabilitation protocols that support emergence at developmental stages.

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Tired! - Participate, Recharge and Re-engage - The Creation of a Blended Rehabilitation Intervention to Reduce Fatigue in Youth With Acquired Brain Injury

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Abstract

Background: Fatigue is a common problem in adolescents (12-18 years) with acquired brain injury (ABI). For adults with Cerebrovascular Accident (CVA), a proven, effective rehabilitation intervention is available to reduce fatigue, called Cognitive&Graded-Activity-Therapy (COGRAT), which combines cognitive behavioral therapy (CBT) and graded activity training (GAT). Such an intervention was not yet available for adolescents with ABI, even though this group expressed a clear need for a program tailored to their specific needs.

Objective: The aim of this study was to adapt COGRAT to create a version suitable for adolescents (12-18 years) with ABI.

Methods: COGRAT content was analyzed and adapted to meet specific needs and wishes of the target group and healthcare professionals using co-creation sessions. Texts, content (including provision) and exercises were discussed and altered where needed. After creating the new intervention, a pilot study was conducted in four rehabilitation centers in the Netherlands (Basalt, Heliomare, Merem and Revant), after which the program was evaluated and adapted where needed.

Results: An innovative fatigue intervention called “Tired - Participate, Recharge, Re-engage!” was created. Tired! has been designed as a blended intervention, as requested by the target group, where adolescents can follow part of the program on-site in group settings and do a significant part at home in their own time. The latter is done using eHealth applications that offer guided modules (CBT) and a range of physical exercises with instructional videos. The program lasts 12 weeks with 12 physical training sessions and 3 CBT sessions on-site. Physical training on-site is 1.5 hours and online guided exercises at home are performed 5 times a week (2 days with strength exercises and cardio and 3 days with cardio only), monitored with an activity tracker. On-site CBT sessions are 1 hour and the remaining other sessions are completed at home in online weekly 45 minute modules. The Tired! first pilot study was completed and subsequently evaluated and the intervention was adjusted in co-creation where necessary. For CBT text edits were made and instructional videos were added to make the modules easier to follow. Furthermore, CBT sessions were now divided in 6 on-site and 6 online sessions for better compliance. A second pilot

study is currently taking place, that will be followed by a new evaluation and final adjustment.

Conclusion: Tired! is a blended intervention that offers an innovative approach to reduce fatigue in adolescents with ABI, combining CBT and physical training aligning with the needs of the target group. The second pilot study will provide important insights for final optimization and preliminary results on treatment outcomes. The final intervention needs to be further studied in terms of effectiveness.

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Preliminary Results of a Blended Rehabilitation Intervention to Reduce Fatigue in Youth With Acquired Brain Injury – Tired! - Participate, Recharge and Re-engage

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Abstract

Background: Fatigue is one of the most persistent problems among adolescents with acquired brain injury (ABI) while evidence-based interventions are lacking. An existing evidence-based treatment for adults to reduce fatigue, Cognitive & Graded-Activity Therapy (COGRAT), was adapted in co-creation with adolescents with ABI and healthcare professionals into an adolescent program tailored to their specific needs. This program is called Tired!, and is a blended care program addressing fatigue through cognitive behavioral therapy (CBT) and Graded Activity training (GAT) through a combination of on-site group therapy and digital-supported treatment at home.

Objective: The aim of this study was to test Tired! and investigate its feasibility and preliminary effectiveness.

Methods: This prospective pilot study was designed to investigate the feasibility and preliminary effectiveness of the 12 week Tired! program. Tired! includes 12 on-site physical training sessions, guided exercises at home, 6 on-site CBT sessions and 6 online sessions. The pilot studies were conducted in four rehabilitation centers in the Netherlands. Effectiveness is assessed using the PedsQL^{TM} Multidimensional Fatigue Scale (PedsQL^{TM}-MFS) as primary outcome to study fatigue pre- and post-intervention. In addition, the Child and Adolescent Scale of Participation (CASP) and PedsQL^{TM} Generic Core Scales (GCS)were administered to investigate participation and Quality of Life (QoL). Physical fitness was assessed with the 6-minute walking test. All outcomes will be analyzed using descriptive statistics and paired t-tests where applicable.

Preliminary Results: The first pilot study included 8 patients (12-19 years old). Five were male. Mean (SD) age was 15.9 (1.6) years. Mean PedsQL^{TM}-MFS total score increased from 38.9 (SD=22.0; range:25.0-77.8) to 49.3 (SD=28.0; range:26.4-88.9), indicating reduced fatigue. The mean CASP total score increased from 74.5 (SD=10.7; range: 58.7-87.50) to 85.2 (SD=15.0; range:64.2-96.2), suggesting improved participation. The mean PedsQL^{TM}-GCS total score increased from 54.9 (SD=23.6; range:24.1 - 79.4) to 70.5 (SD=20.2; range:48.9 - 90.0) suggesting enhanced QoL. The 6-minute walking test showed an increase in distance from 504.3 meters (SD=43.6; range: 448.1-548.0) to 577.5 meters (SD=122.3; range: 402.0 - 675.0) indicating improved physical fitness. A second pilot study including 7 patients is currently taking place. Results allowing further statistical analysis are expected early 2026.

Conclusion/discussion: Tired! is a 12-week blended care program to reduce fatigue in young people with ABI, where preliminary results suggest that this program may reduce fatigue, improve participation, QoL and physical fitness. Further research with a larger sample is needed to evaluate the feasibility and effectiveness of the intervention.

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How Do We Assess Complexity in Functioning in Children Living with Acquired Brain Injury (ABI+) and Their Families: From Scoping to Co-Creation

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Abstract

Background: Children and adolescents with acquired brain injury (ABI) constitute a highly heterogeneous population in terms of injury characteristics, functional consequences and long-term care needs. This heterogeneity translates into substantial variation in care needs, healthcare utilization and resource allocation. In the Netherlands, a new care landscape is being developed for children with severe, multifaceted problems that substantially interfere with daily functioning and high impact on the family — termed ABI+. To ensure appropriate care coordination and equitable access to services, a uniform and validated tool is needed to identify and classify children with ABI+ according to the complexity and its impact on their daily functioning.

Objective: This project aims to develop and pilot a pragmatic, co-created "complexity classification system" to support care planning and guide funding decisions for children with ABI+.

Methods: A multi-phase mixed-method approach was adopted. First, a targeted exploratory literature review identified existing instruments and scales used to measure complexity in pediatric, adult, and rehabilitation settings. Second, work visits and semi-structured interviews with Dutch healthcare professionals working in community-based pediatric ABI services were conducted to map current practices in assessing complexity. Based on these findings, a shortlist of the most promising instruments was compiled. In the next phase, this shortlist will be refined through co-creation sessions (November 2025) with healthcare professionals, researchers, and parents to jointly develop a prototype "complexity classification system" tailored to the pediatric ABI+ population. Finally, the prototype will undergo a small-scale pilot test (December 2025-February 2026) in clinical practice to explore feasibility, usability, and preliminary validity.

Preliminary Results: The literature review identified dozens of scales aimed at measuring complexity in relation to daily functioning and healthcare utilization. From these, frequently used instruments—such as the Self-Reliance Scale, About My Child, and the adult-oriented "complexity weighting system (ABI+)"—were shortlisted. Initial consultations with care providers highlighted enthusiasm for a unified tool,

while expressing concerns about its feasibility, appropriateness and implications. In our presentations we will share the results of focus groups and co-creation workshops with multidisciplinary professionals and parents aimed to refine the content and structure of the prototype.

Conclusion: This project represents one of the first efforts to operationalize and classify the complexity of daily functioning, needs and (healthcare) utilization in children with ABI and their families. A co-created complexity classification system has the potential to support transparent care coordination, interprofessional decision-making, and inform policy and funding strategies for children with ABI+.

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Neurological and Psychiatric Complications after Pediatric Acquired Brain Injury: Insights from Longitudinal EEG Monitoring

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Abstract

Background: Acquired brain injury (ABI) represents a prevalent and consequential medical condition associated with significant morbidity and mortality. ABI is increasingly, recognized as a chronic, progressive disorder with enduring neurological, psychiatric, and systemic implications. This paradigm shifts highlights the need for sustained surveillance and long-term therapeutic strategies. Although early EEG monitoring often detects clinical and subclinical seizures, longitudinal follow-up remains limited, and long-term outcomes are insufficiently characterized.

Objectives: To characterize the incidence and progression of clinical complications in children with moderate to severe ABI and to explore associations between pathological EEG patterns and neurocognitive or behavioral manifestations during rehabilitation.

Methods: We retrospectively reviewed 31 children (mean ± SD age at injury= 9±5 years) with moderate to severe ABI (Glasgow Coma Scale =7.3±4.2). Etiologies included blunt trauma (71%), tumor resection (16%), vascular injury (10%), and penetrating trauma (3%). EEG recordings were performed during wakefulness and sleep within one month of admission (initial EEG) and again after ≥300 days (1 year follow up), and interpreted by a pediatric epileptologist blinded to clinical data. EEG abnormalities (slowing, epileptiform discharges (ED), sleep features) were coded dichotomously. Clinical data included seizure history, pharmacological treatment, and functional–behavioral outcomes.

Results: We found ongoing epileptic and cognitive complications: early seizures (≤7 days post-admission) occurred in 26%, and late-onset seizures in 51% of patients. Behavioral difficulties persisted in 71% despite therapy, with 19% showing symptom worsening, requiring antipsychotic medication.

Initial and follow-up EEG features were available for 29 patients. Continuous slowing, initially present in 16 patients (55%), persisted in 7 (24%) at follow-up, while 9 patients (31%) demonstrated resolution. These changes were statistically significant. Intermittent slowing was identified in 7 patients (24%) at initial EEG and 4 patients (14%) at 1-year follow-up; 4 cases resolved and 1 new case emerged. ED increased from 5 patients (17%) at initial EEG to 13 patients (45%) at follow-up. Eleven patients (38%) developed new ED and were significantly more likely to experience late-onset

seizures (81%) and to require psychiatric treatment (63.6%), while 10% showed resolution after 1 year.

Late-onset seizures occurred most frequently in patients who had ED (70%) and pathological slowing (56%) at follow-up, compared with 20% in the normal EEG group. None of the patients who exhibited normal EEG at follow-up were prescribed psychiatric medication, compared with 44% of patients with slowing and 70% of patients with ED.

Conclusion: Children with ABI demonstrate substantial and long-term neurological and psychiatric burden, persisting beyond 300 days of rehabilitation. The development of epileptic activity during longitudinal EEG monitoring was associated with higher occurrence of late seizures and psychiatric complications. Longitudinal EEG monitoring may provide a valuable tool for clinical follow-up during rehabilitation, potentially guiding novel therapeutic strategies in pediatric ABI.

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Does Concussion Affect Balance? Insights from BESS Assessment

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Abstract

Background: It is well recognised that dizziness is a common symptom following a concussion and commonly children and adolescents report balance issues alongside this. Typically a comprehensive physiotherapy concussion assessment involves an impairment-based approach assessing the visual, vestibular, cervical and autonomic systems. A balance assessment alone does not allow for a targeted impairment therapy approach.

The Balance Error Scoring System (BESS) is a commonly used balance tool post-concussion with the modified BESS being used as a component of the SCAT and the SCOAT. As part of the Concussion Essentials randomized controlled trial conducted in Melbourne, the BESS was included among the secondary outcome measures to assess balance in children with persisting post-concussion symptoms.

Objectives: To investigate the clinical utility of the BESS as a balance assessment post-concussion. This presentation will review if balance is affected following a concussion, if balance improves with rehabilitation and if there is a correlation between vestibular function and balance following a concussion.

Methods: Data for this presentation was drawn from the Concussion Essentials randomized controlled trial conducted at the Murdoch Children's Research Institute (MCRI), Melbourne. The BESS was included as a secondary measure at baseline (1-month post-concussion) and conclusion of the trial (3 months post-concussion). Participants in the study were randomized into the usual care (UC) control group or the Concussion Essentials (CE) treatment group. The CE group received up to 8 weeks of symptom directed multidisciplinary treatment by a physiotherapist and neuropsychologist. Physiotherapy treatment included visual, vestibular, cervical and targeted exercise. The UC participants received symptom monitoring only for the 8 weeks.

Results: Data was collected on 140 participants through the Concussion Essentials RCT. Participants were randomized into the treatment group, Concussion Essentials (CE n=67) or the usual care group (UC n=73). Mean age of the participants were 13.1 years and 56.4% of them were male. BESS means for the CE group changed from 20.51 (95% CI 18.37, 22.64) to 16.58 (95% CI 14.41, 18.75). In comparison, BESS means for the UC group reduced from 22.14 (95% CI 20.07, 24.20) to 18.84 (95% CI 16.36, 21.33)

Conclusion: Balance performance measured using the BESS does not accurately reflect impairment following a concussion and should not be used as a standalone

indicator of concussion recovery. Comprehensive, impairment-level assessments extending beyond balance assessments should guide physiotherapy management.

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Comparing the Predictive Value of the Rehabilitation Complexity Scale E-Trauma (RCS E-Trauma) and Injury Severity Score (ISS) For Length of Stay (LOS) in Paediatric Head Injury Patients at a Paediatric Major Trauma Centre (PMTC).

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Abstract

Background: Paediatric head injuries are a leading cause of hospitalisation and long-term disability in children and young people (CYP), often requiring multidisciplinary care and extended inpatient stays. Predicting LOS in this cohort is important for resource planning, management of rehabilitation and providing family support. The ISS is used by PMTCs in Scotland to categorise trauma into minor, moderate or major but may not capture the complexity of rehabilitation needs. Alternatively, The RCS E-Trauma is used to assess the complexity of rehabilitation needs over time, potentially offering a better predictor of LOS as and insight into influencing factors. Comparing these tools in predicting LOS amongst this cohort remains relatively unexplored, particularly in the paediatric major trauma setting. This study aims to compare the predictive value of the RCS E-Trauma and the ISS for LOS.

Objectives: To compare the predictive value of the RCS E-Trauma and the ISS in estimating LOS in paediatric patients admitted with head injuries to a PMTC.

Methods: A retrospective study analysed data from 19 CYP (up to 16th Birthday) admitted with head injuries to a PMTC between 2024&2025. CYP were included in the study if they had a head injury that met criteria for the Scottish Trauma Audit Group ($ISS \geq 9$), had a $LOS \geq 3$ days, were over 1 year old and head injury was their main or most severe injury.

Both the RCS E-Trauma and ISS were recorded at admission. Initial statistical analysis using Spearman's rank coefficient was conducted to evaluate the correlation between each score and LOS.

Results: The ISS score for CYP included in this study ranged from 5 to 43. (median=17). The LOS ranged from 3-22 days with a median of 6.8. There was a very weak to no correlation between ISS and LOS ($r=0.11$, $p>0.5$). This contrasts with the literature, which shows ISS as a predictor for LOS.

The RCS E-Trauma score for the CYP included in this study ranged from 7-21 (median=12). The RCS E-Trauma was positively correlated with LOS ($r=0.76$, $p<0.01$). These results were statistically significant demonstrating a much stronger predictor of LOS than ISS.

Conclusion: Preliminary findings suggest the RCS E-Trauma demonstrates a stronger association with LOS than the ISS in paediatric head injury cases in a PMTC. The ISS quantifies trauma severity and predicts morbidity/mortality, with higher scores

correlating with increased surgical intervention and complications, explaining its association with prolonged LOS in prior studies. However, the RCS E-Trauma offers a precise indicator for LOS by capturing determinants like support needs and therapy intensity. Consequently, the RCS E-Trauma is more useful in providing a comprehensive, clinically relevant measure for forecasting LOS. This enables accurate resource allocation to support rehabilitation and planning for discharge and follow up.

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Test-retest reliability and minimal clinically important differences for outcome measures targeting fatigue, quality of life, participation and family impact for young patients with acquired brain injury

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Abstract

Background: Acquired brain injury (ABI) in young people can cause long-term physical, cognitive, and psychosocial daily-life impairments. Patient/parent-reported outcome measures (PROMs) are commonly used in pediatric rehabilitation to evaluate quality of life, fatigue, family-impact, and participation. While these PROMs have shown reliability in general pediatric populations, test-retest reliabilities (T-RRs) and minimal-clinically important differences (MCIDs) have not been established specifically for young people with ABI in Dutch rehabilitation.

Objective: The aim was to investigate T-RRs and the MCIDs of the patient- and parent-reported PedsQL™Generic-Core Scales-4.0 (PedsQL-GCS-4.0), PedsQL™Multidimensional-Fatigue-Scale (PedsQL-MFS), PedsQL™Family-Impact-Measure (PedsQL-FIM) and Child&Adolescent Scale of Participation (CASP) in young people (4-25 years) with ABI in rehabilitation.

Methods: In this longitudinal cohort study, patients (and parents) referred for rehabilitation completed the PedsQL™GCS-4.0, PedsQL™MFS, PedsQL™FIM (parents only), and CASP. For T-RR and MCID analyses, participants completed the PROMs at referral, two weeks later, and at 12 months. Demographic/injury-related characteristics were obtained from medical records. Descriptive statistics were calculated, with continuous variables expressed as means (SD).

T-RR was assessed using Intraclass Correlation Coefficients (ICCs) over a two-week interval. The standard error of measurement (SEM) and smallest detectable change (SDC) were calculated to confirm reliability. SEM ($SD \times \sqrt{1-r}$) reflects measurement variability; lower SEMs indicate greater precision. SDC ($1.96 \times \sqrt{2} \times SEM$) defines the smallest change beyond random variation.

The minimal clinically important differences (MCIDs) were determined using distribution-based methods ($MCID = 0.5 \times SD$ of the mean difference over one year) and compared to the SEM. Only MCIDs exceeding the SEM were considered indicative of true changes in patient-functioning beyond measurement error.

Results: Hundred-forty-five participants (patients/parents) completed PROMs at baseline, of whom 71 also completed PROMs 2 weeks later and 74 again 12 months later. Patients' mean age at baseline was 12.8 years (SD:3.55), and 64.8% were female, and most patients (74.5%) had mild-traumatic brain injury. Across PROMs, mean total scores ranged between 50.9–76.2 (patient-reported) and 51.7–84.1 (parent-reported).

T-RR was good for all PROMs (ICC>0.70, p<0.01), except for the patient-reported CASP (ICC=0.59, p<0.01). SEMs ranged from 3.62-8.75 and SDCs from 5.27-8.20 across instruments.

MCIDs ranged from 5.60-9.45. Specifically, the MCID was 6.39 for the patient-reported and 8.70 for the parent-reported PedsQL™GCS-4.0; 8.53 and 9.45 for the patient/parent-reported PedsQL™MFS, respectively; 5.60 for the parent-reported PedsQL™FIM; and 8.19 and 5.62 for the patient/parent-reported CASP. For most PROMs, MCIDs exceeded SEMs, indicating detectable changes beyond measurement error; only the patient-reported CASP showed an MCID < SEM.

Conclusion: Moderate to good T-RR was found for the PROMs used in our pediatric ABI rehabilitation cohort. Rehabilitation healthcare professionals could use the MCIDs to evaluate patients' progression over time to help determine whether treatment should be continued or altered.

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The Power of Case Management in Complex Paediatric TBI Recovery

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Abstract

Background: Severe Traumatic Brain Injury (TBI) in adolescents presents profound medical, cognitive, and psychosocial challenges that can disrupt long-term functional outcomes. While neurological recovery remains a primary focus, environmental and familial factors often complicate rehabilitation. Socioeconomic disadvantage, inconsistent caregiving, and mental health concerns within the family can fragment service access and impede recovery. Despite these challenges, the critical role of rehabilitation case managers (CMs) in addressing non-medical determinants of recovery remains under-recognised. This case study illustrates the pivotal contribution of a CM in coordinating care and mitigating psychosocial barriers following severe paediatric TBI.

Case Presentation: A 15-year-old male sustained a severe TBI with Grade 3 diffuse axonal injury following a high-speed motor vehicle collision. He required emergency neurosurgical intervention and experienced prolonged post-traumatic amnesia, resulting in significant cognitive, behavioural, and executive function impairments, consistent with frontal lobe injury.

During rehabilitation, psychosocial complexity within the family, marked by reduced parental capacity, inconsistent supervision, and disengagement from care, emerged as a major barrier to progress. Oppositional behaviours also disrupted therapy participation and continuity of care.

Early and proactive CM involvement was instrumental in stabilising the rehabilitation pathway. Acting as a central coordinator, the CM facilitated communication across health, education, and funding systems; advocated for transparent resource use; initiated an Individualised Education Plan to support school reintegration; and engaged social services to address family capacity concerns. This integrated, person-centred approach ultimately promoted more stable engagement in the patient’s ongoing care and recovery.

With sustained CM, the patient achieved meaningful gains in physical, cognitive, behavioural, and emotional domains. He reintegrated into a supported academic environment and maintained more consistent participation in therapy. The family’s engagement in the rehabilitation process was maximised as psychosocial barriers were mitigated, where possible, contributing to improved functional outcomes.

Conclusion: This case highlights the essential role of rehabilitation case managers in addressing the psychosocial determinants that influence recovery following severe paediatric TBI. By integrating health, education, and social supports, CMs enable cohesive, person-centred care that enhances engagement and long-term outcomes.

Early incorporation of case management should be considered standard practice in paediatric neurorehabilitation for children from complex psychosocial backgrounds.

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A forgotten group? The perspectives of siblings and peers of youth with ABI: a mixed methods study

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Abstract

Background: Acquired brain injury (ABI) in youth can lead to a wide range of long-term functional and psychosocial consequences. Research has predominantly focused on the perspectives of patients and their parents, while siblings & peers (S&P), who play a crucial role in providing social and emotional support, are rarely studied.

Objective: This study aims to explore the perspectives of S&P of youth (8–18 years) with ABI, in the Dutch rehabilitation setting, regarding daily functioning, quality of life (QoL), and current problems.

Methods: In this retrospective mixed-methods study. S&P voluntarily completed a digital questionnaire with eight closed and eight subsequent open-ended questions, adapted from the Child&Family-Functioning Scale, including items on daily functioning, QoL, and current problems (e.g., behavioral-, learning-, school/work-related). Quantitative data were analyzed descriptively, and qualitative data were subjected to thematic analysis.

Results: There were 68 respondents, of which 34 were siblings (50%). The median age of the youth with ABI for which S&P responded was 16.5 years (IQR 15–18), and 76% had traumatic brain injury. Twenty-eight (41%) reported diminished QoL of the affected youth with ABI. Siblings expressed more concern than peers regarding the youth with ABI's current behavior (32.4% vs. 14.7%), learning difficulties (52.9% vs. 32.4%), and independence (17.5% vs. 8.8%), whereas peers reported more concerns about school/work (29.4% vs. 17.6%). Qualitative analysis revealed five themes reflecting S&P experiences:

1. Guidance and support: S&P described varied experiences with care support. They often felt uninformed or left out when care was poorly coordinated. They also reported that proactive communication and support from healthcare professionals enhanced trust and understanding during the trajectory of their affected sibling/peer.

2. Self-management: Many S&P closely observed how the youth with ABI managed daily life, noticing shifts between dependence and autonomy. These observations shaped their own sense of responsibility and emotional involvement in recovery.

3. Perceived functioning: S&P noticed behavioral, learning and emotional problems in youth with ABI. These observations affected their daily interactions and sometimes their own school or leisure routines.

4. Participation: Respondents reported that their own social life was often disrupted by limited energy, reduced contact, or changes in group dynamics with the youth with ABI.

5. Emotional wellbeing: S&P described mixed feelings of empathy, worrying, and resilience. While supportive relationships helped them cope, uncertainty about recovery and changing social dynamics contributed to emotional strain.

Conclusion: S&P offer valuable perspectives on daily functioning, QoL, and current problems of youth with ABI. Actively including S&P in rehabilitation may strengthen social involvement and improve long-term outcomes for youth with ABI. Future studies should examine how social involvement specifically can enhance recovery and well-being in youth with ABI.

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Levelling the Playing Field: Adaptive Gaming to Enhance Participation and Social Connection in Children with Disability

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Abstract

Background

Video gaming is an integral part of childhood in Australia, with over 80% of children aged 5–18 playing regularly. Over the past two decades, gaming has evolved into a highly social activity, often involving online interaction with friends and family. It has been reported that adaptive gaming can have a positive impact on quality of life and social participation for adults with disability. However, in paediatric rehabilitation, gaming is typically used as a therapeutic tool rather than being recognised as a valued leisure occupation in its own right. For many children with disability, physical access to gaming consoles remains a significant barrier, despite the increasing availability of commercially available adaptations, adaptive controllers and switches. The extent to which children with disability use or are aware of these adaptations remains unclear.

Objectives: The objective of this study is to explore the impact of a structured adaptive gaming group on participation, access, and goal attainment for children with Acquired Brain Injury and Cerebral Palsy.

Methods: Kids Rehab at the Children’s Hospital at Westmead established an adaptive gaming group to provide children with Acquired Brain Injury and Cerebral Palsy opportunities to trial modified gaming technology with allied health support. Equipment included adapted controllers, joysticks, and switches tailored to individual access needs.
Five group programs have been conducted to date. Children completed pre- and post-assessments, including goal setting using the *Canadian Occupational Performance Measure* (COPM), self-reports on prior gaming experience and barriers to participation, and functional assessments.

Results: Participants (ages 10–17 years; both boys and girls) represented a range of functional abilities (GMFCS I–V; MACS II–V or equivalent). Gaming experience ranged from novice to highly experienced players. Reported barriers included limited parental awareness and support around adaptive gaming options.
Common goals included improving controller use, increasing knowledge of adaptive equipment, and engaging socially through gaming. Clinically significant improvements in COPM performance and satisfaction scores were achieved post-intervention.

Conclusion: Despite commercially available technology, access barriers persist. Facilitated groups like this can enhance participation, independence, and social connection for children with disability. This group intervention demonstrates that with appropriate knowledge, support and access to adaptive technology, children with disability can successfully engage in gaming as a valued leisure activity.

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The University Experience for Young People with Acquired Brain Injury

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Abstract

Background: Acquired brain injury (ABI) can result in significant and lasting changes to a young person's cognition, emotional regulation, and behaviour. These changes often present substantial challenges in accessing, engaging with, and completing education, particularly beyond the age of 16 years. While there is a well-established special educational needs and disabilities (SEND) framework for supporting children with ABI within compulsory education in the United Kingdom, there is a notable lack of tailored interventions and support for those transitioning into further and higher education settings. This age group has also been somewhat neglected in research literature, with a focus remaining on early years and primary settings.

Current literature highlights that communication difficulties following ABI can significantly affect an individual's sense of identity and belonging within peer groups. In school-aged children, behavioural challenges are also highly prevalent, often leading to disrupted learning and reduced academic attainment. For university students, the transition into tertiary education presents unique challenges; many struggle to distinguish between injury-related difficulties and broader personal or academic struggles. The complexity and variability of the university experience further compound these issues, making academic progression particularly demanding for those seeking further educational attainment after ABI.

Case history: This presentation consists of a scoping review of current literature and three case examples of young people navigating higher education following ABI, highlighting unique barriers and gaps in support systems. These cases depict specific stages of the academic journey and showcase challenges before, during, and after academic achievement:

- Case 1 – Female, 22, ABI from AVM and stroke at 17, currently applying to higher education.
- Case 2 – Female, 27, ABI from ischemic stroke during final year of university age 22. Although ABI occurred as an adult, the experience of the ABI occurring during the educational journey allows for invaluable transferable learning. Case can be removed if preferred.
- Case 3 – Female, 23, TBI from road accident at 13, now in part-time employment following completion of university degree.

Conclusion: Through these examples, we examine how the support of the university can impact the educational journey. The 'hidden disability' of ABI poses specific challenges, including masking and a lack of understanding from educators and peers.

We also explore systemic issues such as inconsistent access to reasonable adjustments and the lack of ABI-specific educational pathways in higher education.

Key learning points and recommendations for improved interdisciplinary models will be presented, including the need for transition planning and staff training. By sharing these narratives, we aim to advocate for more inclusive, proactive educational environments that recognise and support the long-term needs of young people living with ABI.

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Longitudinal Cerebellar White Matter Microstructural Trajectories Following Pediatric Concussion

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Abstract

Context: The cerebellum undergoes protracted development across childhood and adolescence, supporting motor and cognitive maturation. Functional MRI studies report cortico-cerebellar decoupling in children with concussion, evidenced by impaired connectivity. However, little is known about cerebellar structural development after pediatric concussion. In a previous study, we found no differences in the longitudinal trajectories of cerebellar gray and white matter volumes between children with and without concussion. Nonetheless, pediatric concussion has been associated with white matter microstructural alterations, typically manifested as increased fractional anisotropy (FA) and decreased mean diffusivity (MD) and radial diffusivity (RD). Therefore, DTI analyses on the cerebellum may detect subtle microstructural alterations that may not be detectable through volumetric measures.

Objective: This study aimed to characterize longitudinal cerebellar DTI trajectories in young adolescents with a history of childhood concussion, using the ABCD Study cohort.

Methods: Baseline, 2-year, and 4-year ABCD 5.1 follow-up data were used: 1) The Parent Ohio State TBI Screen-Short Modified Report to retrospectively identified 293 children with a history of concussion (i.e., head-neck injury with loss of consciousness ≤ 30 min or memory loss; baseline mean age = 9.9 years; 123 [42%] females) and 8,533 children without (baseline mean age = 9.9 years; 4,317 [50.6%] females), and 2) mean FA, MD, RD, and axial diffusivity (AD) within left and right cerebellar white matter were extracted from diffusion MRI. Scanner effects were controlled for, using longitudinal-ComBat. Mixed effects models tested group differences at baseline and in developmental slopes (ages 10–14). Sex and parental education were included as covariates.

Results: There was no group effect on the developmental trajectories of cerebellar DTI metrics. Compared to non-injured peers, children with concussion showed similar intercepts (all $p > 0.24$) and slopes (all $p > 0.27$) for all metrics in both cerebellar hemispheres, indicating that concussion did not alter cerebellar microstructure. There were significant effects of sex and parental education on both intercepts and slopes for cerebellar DTI metrics, with some metric- and hemisphere-specific differences. Boys showed higher DTI metrics values than girls at baseline, with sex-specific differences in slopes for left hemisphere FA ($p = 0.02$) and left hemisphere AD ($p < 0.001$); slopes for the other metrics and hemispheres were not significantly different. Higher parental education was associated with higher baseline FA, MD, and RD values (all $p < 0.001$) and faster slopes over time for MD, AD, and RD (all $p < 0.001$).

Conclusion: This study suggests that the microstructural development of the cerebellum between ages 10 and 14 follows similar trajectory in young adolescents with and without a history of concussion. Cerebellar development, depended on sex and parental education.

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A Case Series of Posterior Fossa Syndrome in a Clinically Referred Pediatric Brain Tumor Cohort

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Abstract

Background: Posterior Fossa Syndrome (PFS) is a debilitating condition occurring in 10-40% of cases following resection of a posterior fossa tumor. Most commonly seen in children, the syndrome presents as a regression in motor skills and communication shortly following surgery. Existing literature describes a multitude of risk factors for PFS, including tumor size, tumor molecular subgroups, and tumor type, with medulloblastoma being correlated with the highest incidence of PFS post-resection. Additional socioeconomic factors have also been correlated with outcomes following PFS diagnosis.

Case History: Our study includes a clinical case series of seven individuals ranging from eight to 19 years old diagnosed with PFS. Diagnoses included five medulloblastomas, one pilocytic astrocytoma, and one anaplastic ependymoma. All patients underwent surgical resection, six received radiation, and three received chemotherapy. Each patient underwent a neuropsychological evaluation as part of their clinical care; however, only those scores for which there were overlapping domains across a majority of patients were used in this study. An impairment index was calculated for each patient based on the number of scores that fell below the 9th percentile divided by the total number of test scores for each patient.

Of the seven patients, only two patients had impairment index scores below 50% (7% and 38%), while the remaining patients' impairments scores were greater than 50% (55% to 83% of tests administered). Available treatment and demographic-related factors were examined to identify additional factors that could be contributing to increased impairment. These included age at diagnosis, days in rehabilitation following diagnosis, hearing loss, and existing chronic health conditions, all of which did not markedly predict outcomes. Interestingly, there did not appear to be a strong relationship between maternal education and level of impairment.

Conclusion: Past studies have suggested a variety of surgical, tumor-related, and other pathobiological risk factors of long-term outcomes from PFS. Results from our clinical sample suggest that the prognosis for cognitive impairment varies for patients, and there is a need for more analysis of psychosocial and treatment factors that may contribute to outcomes.

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Engaging Clinicians and Youth in Brain Injury Research: Lessons Learned From Co-Designing a Multidomain Sport Rehabilitation Tool for Youth With Concussion

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Abstract

Background: Knowledge user engagement and co-design are increasing in pediatric brain injury research but optimal application in this field remains unknown. Challenges include: (1) involving multiple groups (e.g., youth, caregivers, clinicians) in appropriate roles for their abilities and experiences; (2) capturing the diverse needs of brain injury populations with small samples; and (3) completion of timely rigorous analyses that effectively integrate these data. We undertook a co-design study to adapt an existing return-to-play clearance assessment tool called *R2Play* for rehabilitation settings (*R2Play-Rehab*) and develop an accompanying intervention for youth with concussion.

Objectives: (1) Describe the *R2Play-Rehab* co-design process; (2) Evaluate the quality and impact of co-design implementation; and (3) Share lessons learned for co-design among clinicians and youth with brain injury experience.

Methods: We are following the Generative Co-Design Framework for Healthcare Innovation in collaboration with knowledge user partners including two clinicians (1 PT, 1 OT) and three youth with lived experience of concussion who help guide study design, conduct, and analysis. During phase 1 (pre-design), we planned co-design processes and materials with project partners. In Phase 2 (co-design), clinician participants were recruited for virtual co-design activities: (1) introduction meeting to establish shared vision; (2) two-to-four-week reflection period to consider opportunities for using *R2Play* within daily practice; and (3) design meeting to review and build upon reflections. Phase 3 (post-design) involved rapid qualitative analysis of phase 2 activities to summarize *R2Play-Rehab* intervention opportunities (approaches to use) and design requirements (system features), follow-up survey to verify analyzed findings and prioritize features, and translation of study findings to develop the *R2Play-Rehab* tool and intervention. Project partners completed the Public and Patient Engagement Evaluation Tool (PPEET) after each phase, while participants provided feedback on the co-design process in follow-up surveys.

Results: Eleven clinicians (ages 28-53) participated from diverse disciplines (4 PT, 2 DC, 1 PT/AT, 1 OT, 1 MD, 1 NP, 1 RN), with one dropout due to unexpected family circumstances. All remaining participants attended both study meetings and submitted reflections, indicating strong engagement in the co-design process. Twenty-six reflections were collected, with each participant contributing between 1-5 submissions. Consultation with clinician partners helped improve the reflection activity, while youth engagement informed design meeting discussion topics. PPEET

responses demonstrate positive perceptions of engagement quality, with partners highlighting the welcoming environment for sharing opinions, opportunities to influence change, and the impact of engagement on their knowledge of concussion and co-design.

Conclusion: Independent practice reflection followed by group discussion is a valuable approach to gather contextualized feedback from clinicians that reflects the diverse needs of brain injury populations. This work demonstrates how clinician and youth engagement can positively influence pediatric brain injury research and may be useful for other co-design initiatives within this field.

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Association of Visuo-vestibular Function with Screen Intolerance After Concussion in Adolescents and Young Adults

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Abstract

Background: Early screen time is associated with recovery time after concussion. Possible reasons may include visuo-vestibular dysfunction, cognitive activity, sleep, and/or physical activity. It is useful to understand characteristics of visuo-vestibular function in those with screen intolerance to identify risk factors for prolonged recovery after concussion and targeted treatments.

Objective: The primary objective was to estimate the prevalence of screen intolerance and abnormal visuo-vestibular function (signs and/or symptom provocation) after concussion in adolescents and adults. The secondary objective was to determine the association between abnormal visuo-vestibular findings and screen intolerance.

Method: This observational cohort study used data collected during routine care from three specialty concussion care clinics participating in the TRANSCENDENT Concussion Research Program within a learning health system. Included participants were aged 13 to 20.99 years who were diagnosed with a concussion between April 8, 2024 and September 30, 2025. Participants were asked whether screen-use triggered their post-concussive headache. The primary outcome was self-reported screen intolerance (yes vs no), defined as screen-use being a post-concussive headache trigger. Visuo-vestibular function was measured as normal vs abnormal as per the Buffalo Concussion Physical Exam. Prevalence was reported using descriptive statistics and associations calculated using a multivariable logistic model to calculate odds ratios (ORs).

Results: Of 505 participants (n=298 [59%] female; median [IQR] age, 15.0 [14.0-17.0] years; median [IQR], 14.0 [9.0-30.0] days since injury), 51.9% (95%CI, 47.5%-56.2%; n=262/505) reported screen intolerance and 67.9% (95%CI, 63.7%-71.8%; n=343/505) had abnormal visuo-vestibular findings. Screen intolerance was common in those with abnormal ocular motor tracking (smooth pursuit, n=284/504 [56.3%]; repetitive saccades, n=225/499 [45.1%]) and gaze

stabilization problems (vestibular ocular reflex, n=202/451 [44.8%]; visual motion sensitivity, n=144/340 [32.7%]) than difficulty keeping an object in focus (accommodation, n=64/327 [19.6%]; near point of convergence, n=54/329 [16.4%]). The most common combination of abnormal visuo-vestibular findings was visual motion sensitivity, vestibular ocular reflex, repetitive saccades, and smooth pursuit (n=33/505 [6.5%]). In a multivariable model, photophobia (bright lights as a headache trigger) was the only predictor for screen intolerance (OR=3.08; 95%CI,1.89-5.09; p<.001). Abnormal visuo-vestibular findings, type of screen-use, symptoms worse with mental activity, and preinjury exercise (hours per week) were not statistically significant predictors.

Conclusion: Screen intolerance approximately two weeks after concussion is common but appears to be related to photophobia rather than visuo-vestibular findings, cognitive activity, or preinjury physical activity. Clinicians should consider tailoring screen time recommendations based on the presence of photophobia. Objective quantitative measures of pupillary light reflex metrics (pupillometry) are needed to examine the pathophysiological underpinnings of screen intolerance.

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Association of Mental Health with Quality of Life 4 and 12 weeks after Concussion in Adolescents and Adults

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Abstract

Background: Concussion can negatively impact quality of life (QOL). Understanding how QOL differs based on anxiety and depression symptom severity after concussion is important to improve precision healthcare.

Objective: To compare QOL in those with minimal, mild, or moderate-to-severe anxiety and depression symptoms at 4 and 12 weeks after intake assessment for concussion in youth.

Method: This prospective cohort study enrolled youth aged 13-20.99 years between April 2024-October 2025 who presented for routine care and were diagnosed with concussion at one of three specialty concussion clinics participating in the TRANSCENDENT Concussion Research Program. The primary outcome was QOL 4 and 12 weeks after intake assessment measured using the validated 26-item World Health Organization QOL too (WHOQOL-BREF physical, psychological, social, and environmental domain scores; range 0-100; overall score measured using question

#1, “How would you rate your OQL?”; range 1-5). Higher scores represent higher QOL. Established cut-off scores for anxiety (Generalized Anxiety Disorder-7) and depression (Patient Health Questionnaire-9) symptom severity were minimal (0-4), mild (5-9), moderate-to-severe (≥10). Outcomes are presented using descriptive statistics.

Results: Of 601 participants (n=336 [55%] female; median [IQR] age, 15 [14,17] years; median [IQR], 14 [8-29] days since injury), 206 (34.3%; 95%CI,30.6-38.2) reported minimal, 216 (35.9%; 95%CI,32.2-39.9) mild, and 179 (29.9%; 95%CI,26.3-33.6) moderate-to-severe anxiety symptoms at intake assessment. 134 (22.3%; 95%CI,19.2-25.8) reported minimal, 199 (33.1%; 95%CI,29.5-37.0) mild, and 268 (44.6%; 95%CI,40.7-48.6) moderate-to-severe depression symptoms at initial assessment.

At 4 weeks, overall mean (95%CI) QOL scores were lower for those with moderate-to-severe (3.8 [3.6-4]) versus minimal (4.7 [4.6-4.8]) or mild (4.3 [4.1-4.5]) anxiety symptoms. A similar pattern was observed at 12 weeks (minimal: 4.7 [4.4-5]; mild: 4.1 [3.8-4.4]; moderate-to-severe: 3.4 [2.8-4]).

Overall mean (95%CI) QOL scores were lower at 4 weeks for those with moderate-to-severe (3.8 [3.6-4]) versus minimal (4.8 [4.6-5]) or mild (4.5 [4.3-4.7]) depression symptoms. A similar pattern was observed at 12 weeks (minimal: 4.5 [4.1-4.9]; mild: 4.2 [3.8-4.6]; moderate-to-severe: 3.7 [3.3-4.1]).

For those with moderate-to-severe anxiety symptoms, 4-week mean [95%CI] QOL scores were lowest within the psychological domain (61.9 [58-65.8]) versus physical (67.4 [63.2-71.6]), social (72.1 [68.4-75.8]), and environmental (79.3 [75.7-82.9]) domains.

Similarly, for those with moderate-to-severe depression symptoms, mean [95%CI] QOL scores were lowest within the psychological domain (64.2 [61.1-67.3]) versus physical (69 [65.4-72.6]), social (74.7 [71.5-77.9]), and environmental (81.2 [78.4-84]) domains.

QOL scores were lower within each domain for those with moderate-to-severe versus minimal or mild anxiety and depression symptoms at both 4 and 12 weeks.

Conclusion: Youth with moderate-to-severe anxiety and depression symptoms have lower QOL across all domains than those with minimal or mild symptoms, and low QOL can persist or worsen for several weeks after concussion. These findings highlight the need for early specialized mental health management after concussion.

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Tackling the Gap: Exploring How Coach Education Shapes Confidence and Perceptions of Safe Tackle Techniques in Girls' Rugby

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Abstract

Background: Tackling is the most frequent and injurious contact event in rugby. Poor technique increases the risk of injury for both tacklers and ball-carriers, and high school girls' rugby players experience disproportionately higher injury rates than boys, up to 75% higher for tackle-related injuries. To address this, World Rugby has developed educational initiatives such as *Tackle Ready* and *Contact Confident*, which aim to reduce injury rates by enhancing athletes' confidence, technique, and safety through coach education. Despite these efforts, little is known about how coaches perceive and apply safe tackle-training principles in practice. This study examined changes in coaches' attitudes and perceptions toward safe tackle techniques before and after participation in a structured tackle-training workshop.

Methods: A total of 104 high school and club rugby coaches completed a validated online survey immediately before and after attending tackle-training workshops. Pre-workshop surveys captured demographic information, prior tackle-training exposure, and baseline perceptions. Confidence in coaching safe tackle skills (5-point scale) and perceived importance of proper technique for safety and skill execution (5-point scale) were assessed. Changes from pre- to post-workshop were analyzed using linear mixed-effects regression models, adjusting for coach demographics.

Results: Before the workshop, only 28% of coaches were familiar with existing safe tackle-training programs. Following participation, significant improvements were observed in coaches' confidence to teach safe tackle techniques and in their perceived importance of proper technique for both safety and skill execution ($p < 0.05$). Coaches with formal coaching qualifications reported greater confidence in teaching both the ball-carrier ($p = 0.018$) and tackler ($p = 0.003$) roles compared to unqualified coaches. In addition, coaches with ≥ 4 years of experience demonstrated higher confidence when coaching from the ball-carrier's perspective ($p = 0.026$).

Conclusion: Participation in tackle-training workshops significantly enhanced coaches' confidence and attitudes toward safe tackling, highlighting the value of structured, evidence-informed education for injury prevention in rugby. However, while short-term knowledge and confidence gains were evident, further research is needed to understand how effectively coaches implement tackle-training principles in real-world settings, particularly in girls' rugby. Embedding and evaluating these programs within regular coaching practice represents an important next step in advancing player safety and sustainable participation in the sport.

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Sleep and Executive Function Outcomes Following Concussion in Early Childhood

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Abstract

Background: Growing evidence suggests that the quality of children's sleep plays a critical role in recovery after childhood concussion and may impact long-term outcome, including executive functioning. Concussion in early childhood has also been associated with difficulties in executive functioning. However, few studies have examined sleep and its relation to executive functioning during the acute post-injury period.

Objectives: This study examined how concussion sustained in early childhood (ages 6 months to 6 years) affects sleep during the acute recovery period and investigated the potential mediating role of sleep in the association between concussion and executive functioning.

Methods: Participants (ages 6 months to 6 years) with concussion (n=81, median age=32 months, IQR=14.0-59.0) and orthopedic injuries (OI; n=31, median age=30 months, IQR=21.5–54.5) were recruited from four pediatric emergency departments as part of the prospective longitudinal KOALA study; typically developing children (TDC; n=51, median age=36 months, IQR=18.0-59.5) were recruited in the community. Children in the concussion group were recruited within 48 hours of injury. Participants wore Philips Respironics Actiwatch-2 devices for up to five consecutive days, starting about 10 days after the injury. Actigraphy data were used to calculate the proportion of total recorded time spent in daytime and nighttime sleep. Executive functions, specifically global executive function and inhibition, were assessed with the Minnesota Executive Function Scale (MEFS; global executive function) and the Bear and Dragon task (inhibition). Group comparisons were conducted using non-parametric tests.

Results: Children with concussion did not differ significantly from the OI and TDC groups in actigraphy-derived sleep variables. Wilcoxon tests showed no significant group differences in daytime sleep (p=.625) or nighttime sleep (p=.625). Ongoing statistical modeling is examining group differences while adjusting for sex and age, considering the developmental variability in sleep-wake behaviors across the 6-

month to 6-year age range, as well as associations between sleep and executive functioning using MEFS and the Bear and Dragon task. Continued investigation is warranted to examine the association between sleep and executive functioning, as poorer sleep has been linked to greater executive difficulties in children with concussion.

Conclusion: The study's preliminary analyses failed to identify significant group differences in sleep patterns during the acute recovery period following early childhood concussion. While no group-level differences emerged, subtle trends and known variability in recovery suggest that subgroups, such as those with executive function deficits, may exhibit different sleep trajectories. Further analyses will examine the proposed "double hazard" effect, whereby sleep disturbances may exacerbate executive function difficulties following early childhood concussion. Understanding how sleep relates to executive functioning could provide valuable insight into its contribution to early cognitive outcomes after concussion in early childhood.

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Exploring Children's Experiences of Returning to Active Play Following Concussion

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Abstract

Introduction: Concussion is a prevalent health issue affecting children of all ages. Concussion has a bi-directional relationship with play; concussion can occur during play, and symptoms following concussion can impact how children re-engage in play. Play is foundational to childhood, contributing to a child's identity formation, physical health, and social, psychological and emotional development. Despite its importance, concussion literature commonly equates 'play' with organized sport, despite the many types of play experiences that are essential for child development. Active play describes children's play experiences that involve movement of any intensity, are fun, and child-led. Examples of active play may include running, hopping, climbing, or dancing, or games such as Simon Says, or hopscotch. While child-led sport (i.e., street hockey) is a form of active play, it differs from organized sport which is adult-led. To date, research has not yet explored younger children's experiences of returning to active play following concussion.

Objective: The study aims to understand the experiences of children (aged 3 to 12 years) as they return to active play following a concussion from the perspective of children, caregivers, educators, and clinicians.

Methods: Semi-structured interviews will be conducted across four participant groups: children, caregivers, educators, and clinicians. Interview guides will be informed by the Person-Environment-Occupation Model (PEO) to explore the personal (e.g., physical ability, emotional readiness), environmental (e.g., school policy, cultural norms), and occupational (e.g., gym class, recess, playgrounds) factors that may influence children's return to active play. A timeline approach will be used to help participants describe children's experiences of returning to active play in the days and weeks following concussion. Interviews will be transcribed verbatim and reviewed line by line for correctness and for de-identification. Deductive and inductive thematic analysis will be used to analyze the data; deductively using the Living Guideline for Pediatric Concussion Return to Activity/Sports Protocol, and inductively to identify new themes beyond the scope of existing guidelines.

Results: It is expected that the themes produced by this approach to data collection and analysis may include physical or emotional hesitancy and concerns regarding safety, institutional barriers and liability, challenges in identifying temporal dimensions of returning to active play, and gaps in existing return to play protocols.

Conclusion: This research will be act as an initial step in the exploration of younger children's experiences of returning to active play following concussion. Findings can contribute to changes in knowledge, practice and policy. Specifically, findings from this study will inform the creation of a return to active play protocol to better support children when returning to active play following a concussion, promoting safe participation and positive health outcomes.

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Context Matters: Lessons Learned from Co-Designing School-Based Concussion Care with Canadian Educators

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Abstract

Background: Best practices for school-based concussion management include a policy, a protocol, education, and supports to help students to safely return to school and physical activity following a concussion. Despite the availability of resources to guide school-based concussion management, many were developed without the input of educators – the individuals responsible for implementing the strategies. To ensure concussion management strategies are meaningful, practical, and relevant within the school context, co-design offers a promising approach for collaboratively tailoring resources to the Canadian school context.

Objectives: To describe key lessons learned from our co-design process with educators from two Canadian schools and to explore team members' perspectives on participating in the co-design process.

Methods: We partnered with educators from two Calgary, Canada schools to tailor school-based concussion management to each school's local context. Through this work, we developed a seven-step co-design approach to guide school-researcher partnerships. Each school formed a co-design team which included teachers and administrators. We met with each school's co-design team four times over the school year to adapt resources (e.g., policy, protocol) to reflect available resources, priorities, and school culture. We documented which resources needed to be adapted for adoption and identified barriers to implementation. Co-design team members completed the Patient and Partner Engagement Evaluation Tool to capture their perspectives and experiences of the co-design process.

Results: The seven-step co-design approach highlights the importance of addressing contextual nuances, such as existing relationships among school staff, power and privilege dynamics, and ensuring all team members have a shared knowledge base prior to collaboration. Educators valued existing concussion management resources as useful starting points but discussed that many components within the resources were impractical within their school setting. Barriers to adoption included liability concerns, student safety, and perceptions of scope of practice and overstepping boundaries. Educators described the co-design experience as "very positive" and that their school's culture fostered an environment where people felt their "views were respected". Also, educators shared that the research team helped them to interpret and apply evidence, brainstorming solutions relevant to their school's context.

Conclusion: Existing concussion management resources provide a strong foundation for school-based adoption; however, meaningful adaptation, accounting for school culture, resources, priorities, and other contextual factors is essential for implementation. Our seven-step co-design approach outlines a framework for partnering with schools to develop concussion management strategies that are contextually relevant and practical within school settings.

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Parental Emotional Suffering following Pediatric Acquired Brain Injury during Early Subacute Rehabilitation

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Abstract

Background: Pediatric acquired brain injury (ABI) represents the leading cause of long-term disability during childhood and adolescence, frequently resulting in sensory-motor, cognitive, behavioral, and emotional sequelae. Parents of children who sustain an ABI often face profound emotional challenges in coping with the sudden and unexpected event, the child's altered abilities, and the uncertainty surrounding long-term outcomes. In the first months following the injury, parents are required to revise their mental representation of their child, adjust to new caregiving roles, and confront uncertainties about the child's future level of independence. These circumstances can generate substantial emotional strain, often manifesting as anxiety symptoms. Although previous research has explored parental psychological functioning during the acute and chronic phases after ABI, little is known about emotional difficulties emerging during the subacute rehabilitation phase. Assessing parents' psychological adjustment at this specific stage is essential to provide timely, targeted, and effective support interventions.

Objective: This study investigated anxiety symptoms in parents of children who have sustained an ABI within the previous 1 to 3 months and were undergoing subacute rehabilitation. Furthermore, demographic variables related to parents and both demographic and clinical characteristics of the child were explored to identify potential factors associated with parental anxiety levels.

Methods: Eighty-four parents (49 mothers, 35 fathers) of children aged 0–20 years were assessed between 1 and 3 months post-injury (M = 1.63 months, SD = 0.48) using the reduced State Anxiety Inventory (STAI-X3). Parent-related variables included age, gender, marital status, and family socioeconomic status (SES). Child-related variables included gender, age at injury, etiology (traumatic vs. non-traumatic), injury severity, history of coma, intellectual functioning, and the presence or absence of residual impairments (motor, visual, auditory, cognitive, epileptic, or behavioral problems).

Results: Parents reported substantially higher anxiety than a clinical normative sample of adults in medical rehabilitation, a population already expected to experience elevated distress. Fathers exhibited significantly greater anxiety than mothers, with 63.3% versus 28.6% scoring above the clinical cutoff on the STAI-X3. Nevertheless, both mothers' and fathers' mean scores were significantly higher than norms ($p < 0.01$). Higher anxiety was associated with lower SES and traumatic etiology, while no significant associations emerged with other demographic or clinical variables.

Conclusions: Parents of children with ABI showed elevated anxiety during the subacute rehabilitation phase, with fathers displaying particularly high levels. This may reflect gender-related expectations, financial pressure, and a lower tendency among fathers to seek or receive emotional support. These findings highlight the importance of an early detection of psychological distress among both parents to enable the timely implementation of tailored support strategies. Promoting the active inclusion of fathers in the rehabilitation process may foster better parental adjustment, enhance family functioning, and ultimately contribute to the child's recovery.

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Association between ACRM Concussion Diagnostic Criteria Categories and Symptom Recovery in Pediatric Patients: A Multi-Cohort Prospective Study

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Abstract

Background: The 2023 American Congress of Rehabilitation Medicine (ACRM) diagnostic criteria for concussion clarify the required and sufficient features. Whether meeting criteria for *definite* versus *suspected* concussion is associated with recovery differences remains unclear

Objectives: To investigate whether the ACRM-defined concussion category (*definite* versus *suspected*) is associated with symptom burden at weeks 1, 2, 4, 8, and 12 post-injury in children and adolescents.

Methods: Data were obtained from two multicentre prospective cohorts (A-CAP: 8-17 years; 5P: 5-18 years) of children and adolescents presenting to Pediatric Emergency Research Canada sites within 48 hours of injury. In the Emergency Department, trained research assistants administered standardized assessments, including the Acute Concussion Evaluation and parent-rated evaluation of pre-injury symptoms (A-CAP: Health and Behaviour Inventory, HBI; 5P: Post-Concussion Symptom Inventory, PCSI, different versions for ages 5-7, 8-12, and 13-18). Examinations included the Balance Error Scoring System, and cognitive testing through 3 subtests from the CNS Vital Signs cognitive battery (A-CAP) and the Standardized Assessment of Concussion (5P). Children self-reported symptoms (A-CAP: HBI; 5P: PCSI) at 1, 2, 4, 8, and 12 weeks post-injury. Participants were categorized per ACRM criteria as *definite* and *suspected* and by subcategory (*clinical sign(s)*, *symptoms+exam finding(s)*, *symptoms or exam finding(s) only*). Analyses were conducted separately for the A-CAP and 5P. Symptom recovery was modelled using cumulative ordinal regression with clustered standard errors, testing Week × Subcategory × Sex and adjusting for key demographic covariates (restricted cubic splines for continuous variables). Post-model fit contrasts compared *definite and suspected* categories using weighted averages.

Results: The A-CAP cohort included 633 participants (Median [IQR] age=12.0 [10.2, 14.4] years, 40.1% female), and the 5P cohort 3,063 participants (Median [IQR] age=12.0 [9.2, 14.6] years, 39.4% female) Overall (N=3,696), 3,134 (84.8%) met ACRM criteria for *definite* [2,618 (70.8%) had *clinical sign(s)*; 516 (14.0%) had *symptoms+exam finding(s)*], 436 (11.8%) *suspected* concussion [421 (11.4%) had *symptoms only*; 15 (0.4%) had *exam findings(s)* only], and 126 (3.4%) neither. Subcategory showed significant overall effects on symptom outcomes in both cohorts ($\chi^2 \geq 28.80$, *ps*≤0.004). Post-hoc contrasts revealed greater symptoms in *definite* versus *suspected* at weeks 1 and 2 across cohort and sex (*ps*≤0.046), except in 5P 5-7-year-olds. Among females in 5P, differences persisted to weeks 4, 8, and 12 (ages 8-12: *ps*≤0.012; ages 13-18: week 4 only, *p*=0.046).

Conclusion: Children and adolescents meeting *definite* concussion criteria showed greater early symptom burden compared to meeting *suspected* concussion criteria, which largely resolved after week 2. The findings suggest ACRM certainty thresholds have the strongest prognostic value in the early post-injury period. Future analyses will explore whether meeting criteria for *definite* versus *suspected* concussion is associated with rates of persisting symptoms after concussion and quality of life.

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Injuries and Concussions in Youth Ringette: No Bodychecking, No Problem?

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Abstract

Introduction: Ringette is a female-dominated team ice sport popular in Canada. Although bodychecking is prohibited, video analysis has revealed high rates of body contact and suspected injury. Understanding injury and concussion rates in adolescent ringette is essential to improve female athlete safety and inform injury prevention strategies.

Methods: This cohort study included youth ringette players (ages 11–18) in Calgary during the 2021–22 and 2022–23 seasons, across three age divisions: under-14 (U14), under-16 (U16), and under-19 (U19). All-complaint injuries were recorded. Injury and concussion incidence rates (IRs) per 100 players per season and incidence rate ratios (IRRs) comparing rates age group were estimated using Poisson regression with team-level clustering. Injury types, mechanisms, player position, and median time-loss from sport are described.

Results: The overall injury IR was 35.88/100 players/season (95% CI: 27.45–46.91), and concussion IR was 12.94 (95% CI: 8.42–19.89). Compared to U14 (IR=27.27; 95% CI: 14.47-51.42), U16 had a similar injury rate (IR=27.85; 95% CI: 17.65–43.94; IRR=1.02, 95% CI: 0.47–2.22), while U19 had a significantly higher rate (IR=64.86; 95% CI: 44.61–94.31; IRR=2.38, 95% CI: 1.15–4.93). Head/neck (40%) and knee (23%) injuries were most common. Forwards sustained the highest proportion of concussions (59%) and non-concussion injuries (50%). Most injuries occurred during games (concussions: 91%; non-concussions: 77%). Unintentional player contact was the most frequent concussion mechanism (55%).

Conclusion: Injury and concussion rates in adolescent ringette are substantial, particularly among U19 athletes. These findings highlight the need for specific prevention strategies to reduce injury burden and enhance safety in female youth ice sport.

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Next-Level Motor Learning: A Multisite Study of Adaptive Virtual Reality Constraint-Induced Movement Therapy in Children with Hemiplegic Cerebral Palsy

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Abstract

Background: Hemiparesis, an asymmetric motor impairment resulting from stroke or brain injury, affects ~40% of children with cerebral palsy (CP)—the most common motor disability in childhood. Constraint-Induced Movement Therapy (CIMT) is one of the most effective and evidence-based interventions for upper-limb hemiparesis. It targets “learned non-use” by constraining the less-affected limb and promoting task-specific practice of the affected one. Despite strong evidence, CIMT’s intensity, monotony, and limited accessibility remain barriers in pediatrics.

Virtual Reality (VR) offers a powerful new avenue to enhance engagement and neuroplasticity through immersive, adaptive learning. In contrast to conventional therapy, VR enables real-time modulation of sensory and performance feedback, sustaining motivation while optimizing motor adaptation. “Target-manipulation boosting” rewards success by dynamically adjusting task difficulty to trigger dopamine-based reward signals, while “control-boosting”—unique to VR’s embodiment potential—alters how physical movement maps onto virtual movement, creating sensory prediction errors that recalibrate motor control. When reward and sensory prediction errors act together, they combine strong motivation with genuine motor learning.

To harness this synergy, the Rehabilitation Hospital and Sagol Brain Institute in Tel-Aviv developed an innovative VR-CIMT platform embedding adaptive, neuroscience-informed reinforcement mechanisms. BC Children’s Hospital and the University of British Columbia have joined this international multisite collaboration to evaluate its feasibility, efficacy, and clinical translation.

Objectives:
- Evaluate motor learning and functional improvement in children with hemiplegic CP using a VR-based CIMT platform.
- Examine how adaptive reinforcement schemes influence engagement, learning, and neuroplasticity.
- Develop a personalized, home-based rehabilitation model merging CIMT principles with neuroscience-driven feedback design.

Methods: This multicenter study will recruit 80 children aged 10–18 years with hemiplegic CP. Participants are randomly assigned to one of four Adaptive Difficulty and Reinforcement conditions within a custom-built VR platform. The game includes

three interactive mini-games, each targeting specific upper-limb movements as players help friendly aliens complete tasks. Each can be played with or without movement augmentation, enabling comparison of adaptive feedback effects on performance and engagement. Outcomes include the Canadian Occupational Performance Measure (COPM), different hand function assessments, Meta Quest 2 kinematics and accelerometer-based real-world activity tracking.

Results: Preliminary pilot data (n = 4) revealed greater COPM performance and satisfaction gains under augmentation:

- Performance Δ No Augmentation = 0.33 ± 1.05 vs. Δ Augmentation = 1.67 ± 2.39
- Satisfaction Δ No Augmentation = 0.17 ± 1.11 vs. Δ Augmentation = 1.25 ± 2.10

Three of four participants showed improvement, supporting feasibility, safety, and enhanced motivation.

Conclusion: This translational neurorehabilitation initiative integrates CIMT, VR, and neuroscience to overcome learned non-use through reinforcement-driven motor learning and sensory recalibration. By combining behavioral science and immersive technology, it advances a scalable model for pediatric neurorehabilitation. The Canadian site is in recruitment, and expanded multisite results will be presented at the upcoming conference.

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CONCUSS Randomised Clinical Trial of Vergence/accommodative Therapy for Concussion-Related Symptomatic Convergence Insufficiency

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Abstract

Background: Studies indicate that vision problems frequently occur after concussions and can impede return to school, work, and sports. Common issues include convergence insufficiency (affecting 45% to 49%) and accommodative dysfunction (35% to 51%). Symptoms involve reading difficulty, eye strain, blurred or double vision, problems shifting focus between near and far, light sensitivity, and discomfort in busy settings. Rigorous randomized trials and a recent Cochrane network meta-analysis show that office-based vergence/accommodative therapy effectively treats convergence insufficiency unrelated to concussion. However, there is limited high-quality evidence on this therapy's effectiveness for concussion-related vision issues. Additionally, it remains unclear whether these problems resolve naturally, as data on the time to resolution are scarce, affecting treatment and management decisions.

Objective: The CONCUSS randomized clinical trial aimed to compare the effectiveness of immediate office-based vergence/accommodative therapy with movement (OBVAM) versus delayed therapy in treating concussion-related convergence insufficiency (CONC-CI) among participants aged 11-25 with persistent post-concussive symptoms lasting 4-24 weeks post-injury. A secondary objective was to assess whether CONC-CI naturally resolves with watchful waiting.

Methods: Participants were randomly assigned to either immediate OBVAM therapy (12 sessions, twice weekly) or delayed treatment. After six weeks, outcomes were evaluated for the near point of convergence (NPC) and positive fusional vergence (PFV), then compared between groups. The Convergence Insufficiency Symptom Survey (CISS) recorded self-reported symptoms. Following the first outcome assessment, the delayed group received 16 OBVAM sessions, while the immediate group received an additional four sessions. The second outcome assessment compared both groups after each had completed 16 OBVAM sessions.

Results: In the immediate group, 46/52(88%) were classified as successful or improved at the outcome time 1 assessment based on the primary outcome measure, a composite of NPC and PFV, compared to 4/52(8%) in the delayed group. ($\chi^2(2)=67.96; P<0.001$). The mean NPC decreased (improved) 7.9cm in the immediate group and 1.8cm in the delayed group (mean difference at outcome time 1

assessment: 5.1 (95%CI: 3.9 to 6.3cm;*P*<0.001). The mean PFV increased (improved) 17.5Δ in the immediate group and 2.5Δ in the delayed group (mean difference at outcome time 1 assessment: 15.0 (95%CI:11.7 to 18.3Δ);*P*<0.001). Clinically and statistically significant improvements were observed in symptoms compared to pre-injury levels.

Conclusion: Office-based vergence and accommodative therapy significantly alleviated symptoms and signs in concussion-related symptomatic convergence insufficiency. With only 6% of the delayed group succeeding and 8% showing improvement after six weeks of watchful waiting (10 to 30 weeks post-concussion), prompt treatment should be initiated once diagnosis is confirmed.

Alvarez TL, Scheiman M, Hajebrahimi F, et al.,. CONCUSS randomised clinical trial of vergence/accommodative therapy for concussion-related symptomatic convergence insufficiency. Br J Sports Med. 2025 Oct 1:bjsports-2025-109807. doi: 10.1136/bjsports-2025-109807.

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Transforming Pediatric Brain Injury Care: A Statewide, Multidisciplinary Approach to Improving Clinical Practice and Return-to-Learn Outcomes in Arkansas

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Abstract

Background: Pediatric brain injury poses substantial challenges for families, schools, and healthcare providers. At Arkansas Children's, a multidisciplinary team has spearheaded a statewide initiative aimed at transforming clinical care, community education, and return-to-learn (RTL) strategies for children with brain injuries of varying severity. This case series examines the clinical progression, thematic analysis, and impact of this initiative, highlighting the importance of integrated partnerships with schools, state agencies, and healthcare providers. What began as a local collaboration with a single school district has since evolved into a comprehensive, statewide program.

Case History: Case reports will include both mild and severe brain injuries. Depending on the injury severity, patients may have received either inpatient concussion consultation or acute care rehabilitation consultation. Regardless of the consultation type, both approaches supported the patient's return-to-learn process through collaboration with the school and relevant community resources, helping to improve outcomes as the child and family reintegrate into their community.

Clinical services have evolved to include inpatient concussion consultations for children admitted with mild traumatic brain injury—an innovative addition to traditional outpatient care. These consultations now include same-day outreach to schools to support RTL planning and family education, addressing a critical window for intervention. These services have also evolved for the acute care rehab services, now involving the Arkansas Department of Education while the child is still admitted, working with medical team and school team to develop best plan for discharge. Additionally, a structured reference guide has been developed for school nurses and primary care providers to offer evidence-informed guidance for families not seen in the hospital's concussion clinic.

Key community engagement efforts include regular school nurse training across multiple regions of Arkansas, participation in a statewide school nurse academy, development of educational podcasts, and outreach to specialized populations such as the Air Force base and the juvenile justice system. The neuroscience service line is actively working with the Arkansas Department of Education and now other community stakeholders to build systemic solutions for information sharing, education continuity, and prevention of reinjury or re-offense among at-risk youth.

Conclusion: This program represents a model for cross-sector integration in pediatric brain injury care, blending clinical excellence with public health outreach. By prioritizing return-to-learn alongside return-to-play, the Arkansas Children’s team is redefining what holistic recovery looks like for youth with brain injuries. Ongoing work includes streamlining data-sharing protocols and formal evaluation of educational outcomes, with the goal of replicability beyond Arkansas.

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R2DRV: Longitudinal Assessment of Driving Performance After Mild Traumatic Brain Injury in Young Drivers

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Abstract

Background Mild traumatic brain injury (mTBI) and motor vehicle crashes are major causes of morbidity among young drivers. Because safe driving depends on coordinated cognitive and motor control, mTBI may temporarily impair driving ability. However, the timeline for safely resuming driving after mTBI remains poorly defined.

Objectives We compared simulated driving performance in young drivers with mTBI versus matched controls from the acute post-injury phase through recovery and tested whether safety-critical events affected performance. We hypothesized that the mTBI group would improve over time but remain below controls and safety-critical events would have a greater impact on mTBI group's performance.

Methods Licensed drivers aged 16–24 years with diagnosed mTBI and healthy controls matched on sex, athlete status, license type, and driving experience completed repeated weekly sessions in a high-fidelity simulator from ≤96 hours post-injury through one week after recovery. Each session included four 8-minute scenarios in a 2×2 design varying cognitive load and safety-critical events. This analysis focused on two scenarios without added cognitive load during weeks 1–5. Primary outcomes were average speed, speed variability, and lane position variability. Mixed-effects models accounted for repeated measures over time and group×week and group×event interactions.

Results The study includes 128 participants (64 mTBI, 64 controls; mean age 19.7 ± 1.9 years; 45.8% female; 83.5% White; 88.3% athletes; 35.9% with prior concussion). The mean Post-Concussion Symptom Score at enrollment was 26.3±16.5. Initial average speed did not differ between groups ($\beta = 0.281$, $p = 0.326$). Over time,

however, the mTBI group’s average speed declined relative to controls (group×week β = −0.243, *p* = 0.003). Safety-critical events prompted speed reductions in both groups, but the mTBI group slowed less (group×event β = 0.378, *p* = 0.025), suggesting a blunted hazard response. In the acute phase, the mTBI group showed greater speed variability than controls (β = 0.208, *p* = 0.013). There was a marginally significant trend of speed variability increasing more slowly in the mTBI group (group×week β = −0.045, *p* = 0.091). Events substantially increased speed variability across both groups (β = 0.544, *p* < .001; group×event *p* = 0.401). Lane position variability also increased over time and during events (both *p* < .001), with no group differences at baseline or across weeks.

Conclusions In the early post-injury period, young drivers with mTBI exhibit less stable speed control and reduced hazard-related slowing despite similar baseline speeds. Over subsequent weeks, they adopt slower cruising speeds and show emerging stabilization in speed variability, consistent with adaptation and recovery. Lane-keeping degrades over time and during safety-critical events for all drivers. These findings highlight the need for individualized, evidence-based return-to-driving guidelines assessing hazard response and speed steadiness during recovery from mTBI

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Delivering Virtual Group Interventions for Youth With Persistent Post-Concussion Symptoms and Their Caregivers: A Pilot Study of Move&Connect-Youth and Move&Connect-Caregivers

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Abstract

Background: Youth with persistent post-concussion symptoms (PPCS) can experience ongoing physical, cognitive, and emotional challenges and their caregivers experience increased stress. There are limited interventions that support youth with PPCS or their caregivers. Move&Connect is a virtual six-week group program with two parallel interventions: Move&Connect-Youth (M&C-Y) and Move&Connect-Caregiver (M&C-C). M&C-Y includes concussion education, active rehabilitation, and goal setting. M&C-C uses psychoeducation and practical tools to promote family communication and problem solving.

Objectives: To examine pilot studies of both M&C-Y and M&C-C with the objectives of: (1) evaluating intervention delivery, including attendance, intervention fidelity, and participant satisfaction; and (2) exploring facilitators and barriers to participant engagement.

Methods: Pilot studies of M&C-Y and M&C-C were delivered virtually using Zoom Healthcare and ran in parallel. Youth with PPCS and caregivers were recruited from a children's rehabilitation hospital in Ontario, Canada. Attendance and intervention fidelity were monitored through weekly clinician and researcher logs. Participants completed exit satisfaction surveys to gather feedback on M&C-Y and M&C-C. Semi-structured exit interviews were completed with a subset of participants to understand facilitators and barriers to engagement. Descriptive statistics were used to analyze logs and exit surveys, while deductive content analysis guided by a motivational framework was applied to the qualitative data.

Results: A total of 28 youth (M=15.3 years; SD=2.14) and 31 caregivers (M=48.9 years; SD=5.95) completed ten M&C-Y and nine M&C-C groups. Most youth identified as girls (n=20; 71%) and caregivers as women (n=25; 81%). Attendance and fidelity were high, with 71% (n=20) of youth and 68% (n=21) of caregivers attending 5 or more sessions, and clinicians adhering to the intervention protocol 96% of the time in M&C-Y and 95% in M&C-C. Satisfaction was high, with 82% (n=23) of youth and 97% (n=30) of caregivers endorsing that they would recommend the intervention to others. Youth agreed that the educational (n=23; 82%), exercise (n=20; 71%), and goal setting (n=23; 82%) components were beneficial. 97% (n=30)

of caregivers agreed that meeting other caregivers was important. Youth engagement was supported by interest in peers’ perspectives, feelings of comfort and trust, and movement and goal setting within and outside sessions. Caregiver engagement was facilitated by belief in M&C-C, emotional connection, and active group discussions. Barriers to engagement included environmental distractions, scheduling demands, and limited perceived relevance of some content.

Conclusions: The pilot studies of M&C-Y and M&C-C were delivered with high fidelity. Exit surveys combined with qualitative data revealed high levels of participant satisfaction and engagement with the interventions. These findings demonstrate important facilitators and barriers to engagement for youth with PPCS and caregivers in a virtual group-based setting.

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The Cognitive Function and Associated Microstructural Brain Changes of Children & Adolescents After Long COVID: A Longitudinal Follow-Up Study

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Abstract

Objective: This study aims to investigate changes in neurocognitive function and mental wellbeing among children and young people (CYP) during the 6 to 12 months following the onset of long COVID.

Methods: This is the follow-up study for CYP aged 7 to 25 years who participated in the COVID & the Young Brain Study that investigated the neuropsychological profiles and microstructural brain changes of CYP with long COVID. The baseline assessment was conducted between 2021- 2023 with the follow-up assessment conducted between 2022 – 2024 six to twelve months after the baseline assessment. MR-diffusion kurtosis imaging, the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV) (aged 6-16) or Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV) (aged 17 or above) and the Tower of London test were administered. Linear mixed model analysis was used to compare the longitudinal changes in the cognitive function and mental wellbeing between the baseline and follow-up assessments controlling for age, gender, socioeconomic status and follow-up time.

Results: Participants showed higher processing speed index (105.52 vs 111.26, $p<0.001$) and improved scaled score in the symbol search task (10.78 vs 12.39, $p=0.001$) within one year of the onset of long COVID. They had improved standard score in the ToL execution time (98.43 vs 107.65, $p=0.006$) and the total problem-solving time of all items (94.30 vs 100.87, $p=0.006$). Improvement on the Tower of London task correlated with changes in multiple GM DKI indices (AWF, KM, FA) spanning frontal, parietal, insular/opercular, occipital, temporal, and subcortical regions, consistent with widespread GM microstructural modulation underlying task-switching tolerance. Improvement on PSI correlated with microstructural changes (FA and DRAD) in the executive–salience network, including the right orbital middle frontal gyrus, right rolandic operculum, left insula, and left caudate.

Conclusion: CYP with long COVID showed significant improvement in neurocognitive function within one year of symptom onset with associated restoration of brain microstructure.

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Objective Measurement of Convergence Insufficiency Aids in Diagnosing mTBI in a Young Child

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Abstract

Background: Oculovisual impairments in both children and adults are well-documented following mild traumatic brain injury (mTBI), with symptoms such as blurred or double vision appearing hours to days post-injury. Since children may have difficulty articulating their symptoms, quantifying eye movements serves as an important diagnostic tool and provides a measurable means of monitoring symptom progression after mTBI.

Case History: A 6-year-old child presented to the eye clinic for an emergency visit after being punched in the left eye by another child at school two weeks prior. During the first week post-injury, the child reported light sensitivity and left-sided headache. In the second week, the child described seeing two toothbrushes and reported similar visual complaints during daily activities, suggestive of near diplopia. The parent sought emergency optometric care. The initial clinical suspicion pointed toward an ocular trauma (e.g., orbital fracture, corneal abrasion, lens dislocation, retinal tear) as these conditions can lead to photophobia and monocular diplopia. However, a thorough examination of all ocular structures revealed no abnormalities, ruling out direct ocular trauma. A binocular vision assessment revealed a significantly abnormal near point of convergence (NPC), with break/recovery distances ranging from 10 to 80 cm (normal: 3–5 cm). Given a normal comprehensive eye exam two months prior, a new diagnosis of severe convergence insufficiency was made. Due to the severity of convergence findings, the child was referred to a pediatric ophthalmologist to exclude convergence paralysis and need for neuro imaging, who confirmed the optometrist's findings. Based on clinical signs, the punch was considered to have caused a concussive (blunt force) brain injury rather than an isolated eye injury, which significantly influenced management. Initial recommendations focused on a gradual return to learning and sports. The child was removed from physical education classes, which he had been doing with double vision since the injury. At follow-up four weeks post-injury, convergence insufficiency remained severe. A regimen of oculomotor exercises was initiated, and follow-up will continue until convergence improves sufficiently to support the child’s academic and athletic activities.

Conclusion: Rapid access to optometric or neuro-optometric eye care facilitates prompt differentiation between ocular trauma and mTBI. Optometrists play a key role in objectively measuring visual dysfunction following mTBI and can monitor recovery over time through targeted oculovisual rehabilitation, ultimately supporting better functional outcomes for pediatric patients.

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R2DRV: Recovery of Cognitive Control During Simulated Driving After Mild Traumatic Brain Injury in Young Drivers

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Abstract

Background: Mild traumatic brain injury (mTBI) commonly disrupts attention, processing speed, and decision-making – functions essential for situational awareness when driving. Deficits in these domains may not be apparent on standard clinical testing but can influence real-world driving safety. Understanding how cognitive inhibitory control and attentional precision recover after mTBI is therefore critical for determining readiness to resume driving.

Objectives: We examined the recovery of cognitive control during simulated driving among young drivers with mTBI compared to matched healthy controls. We hypothesized that mTBI participants would initially show reduced accuracy but improve over time relative to controls.

Methods: Licensed drivers aged 16–24 years with clinically diagnosed mTBI and healthy controls matched on sex, athlete status, license type, and driving experience completed repeated, weekly high-fidelity driving simulator sessions from ≤96 hours post-injury through one week after recovery. Each session included four 8-minute drives in a 2×2 design varying cognitive load (present/absent) and safety-critical events (present/absent). Analyses focused on the two drives with cognitive load. While driving, participants completed the Box Identification Task, a go/no-go paradigm requiring a button press to target stimuli while inhibiting responses to distractors. Primary outcomes were average reaction time, number and proportion of correct identifications, and commission or omission errors. Mixed-effects models examined group and time effects over weeks 1–5 post-injury.

Results: The study included 128 participants (64 mTBI, 64 controls; mean age 19.7 ± 1.9 years; 45.8% female; 83.5% White; 35.9% with prior concussion; 88.3% athletes). The mean Post-Concussion Symptom Score at enrollment was 26.3 ± 16.5. Overall, the mTBI group responded faster than controls (1.2 ± 0.3 s vs. 1.3 ± 0.2 s; $p < .001$), but achieved fewer correct identifications (10.4 ± 4.8 vs. 11.3 ± 4.4; $p = 0.007$), suggesting reduced accuracy despite quicker responses. Overall, commission and omission error rates did not differ significantly between groups. In week 1, reaction times were shorter in the mTBI group (1.3 s vs. 1.4 s; $p = 0.005$), but the gap closed by week 5 ($p = 0.581$). Early accuracy deficits (10.7 ± 4.6 vs. 12.1 ± 3.5; $p = 0.029$) resolved by week 2. Mixed-effects model analyses revealed no significant group × week interactions, although reaction times and accuracy improved overall in both groups.

Conclusion: Young drivers recovering from mTBI exhibited early deficits in inhibitory control and attentional precision during simulated driving – responding quickly but less accurately – followed by normalization within five weeks. These results highlight the importance of assessing cognitive readiness, not just symptom resolution, when determining safe return to driving decisions after mTBI.

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TeachABI-Caregiver: Developing a Return to School Resource for Caregivers of Children with Acquired Brain Injury

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Abstract

Background: Acquired brain injury (ABI) is a leading cause of death and disability in children and can result in persistent cognitive, physical, and psychosocial changes that interfere with school performance. When a child sustains an ABI, caregivers are immediately confronted with new responsibilities to meet their child's needs. Yet, few resources exist to guide caregivers in supporting their children, particularly during their return to school. TeachABI is an educator-focused online module designed to build their knowledge and awareness about ABI and how to facilitate smoother return to school for students post-injury. While TeachABI has been piloted successfully with educators, caregivers could benefit from a similar resource to support their child through this process.

Objectives: To conduct a needs assessment with caregivers and clinicians to identify the supports and strategies needed to build caregivers' knowledge, skills, and confidence in supporting their child's return to school after a brain injury.

Methods: The needs assessment took a multi-pronged approach guided by Kern's Model for Curriculum Development. Problem identification was informed by a literature review and semi-structured interviews completed with ABI clinicians (n=20) and caregivers (n=12) of children with ABI in the Brain Injury Rehabilitation Team (BIRT) inpatient unit at Holland Bloorview Kids Rehabilitation Hospital in Ontario, Canada. Interview questions were developed using the Consolidated Framework for Implementation Research. Follow up questions, guided by the Theoretical Domains Framework were completed by a subset of caregivers (n=4) regarding the potential need, value, and content for a caregiver resource. Exploratory conversations were also conducted with an educator and a subgroup of the ABI clinicians (n=4) regarding the need for TeachABI-Caregiver.

Results: All caregivers expressed that access to a resource like TeachABI would be beneficial. Similarly, almost all clinicians (90%; n=18) discussed the potential benefit of using TeachABI with caregivers and families.

Throughout the needs assessment, caregivers shared ideas for what a caregiver resource could include, specifically the desire to better advocate for their child’s needs during the return to school process. Caregivers also expressed the importance of being equipped with the language and terminology related to ABI and school supports to help increase their confidence when communicating with educators. Overall, caregivers emphasized the importance of an accessible, centralized resource that strengthens their understanding of ABI and guides a smooth return to school.

Conclusion: Caregivers play a vital role in their child’s recovery and return to school transition post-ABI. However, existing resources may not equip them with the knowledge and tools they need. TeachABI-Caregiver has the potential to strengthen ABI knowledge and advocacy skills, enabling caregivers to identify supports, articulate their child’s needs, and navigate the school system with confidence. Ultimately, empowering families and fostering more inclusive classrooms.

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Youth Athletes' Experiences in Co-Designing a Concussion Education Program: Reflections and Recommendations

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Abstract

Background: Providing youth with concussion education is crucial for supporting concussion knowledge and behaviours. However, the youth voice is seldom included within the design of concussion education programs, and thus, programs may not be meeting youths' educational needs. Co-design can be a valuable methodology for actively engaging youth in the creation of education programs that are more meaningful to them. To that end, the present study established an Athlete Design Team (ADT) to co-design a peer-led concussion education program (You-CAN Sport) across five co-design meetings.

Objectives: To understand the experiences of youth in the co-design of the You-CAN Sport program and to identify strengths and areas for improvement in the co-design process to help inform future engagement initiatives.

Methods: Nine youth athletes (aged 15-17 years) participated in the ADT. A sequential mixed methods approach was used to understand youths' experiences on the ADT. Engagement was evaluated using the Public and Patient Engagement Evaluation Tool (PPEET), a survey which allowed youth to rank and describe their experiences using Likert scales and open-ended questions. Semi-structured interviews were used to further understand their experiences and to identify recommendations for future engagement activities. The data from the PPEET were analyzed using descriptive statistics. The open-ended PPEET questions and interview data were analyzed using a thematic analysis.

Results: Responses from the PPEET were positive, with no responses related to ADT experiences ranked lower than "agree" on a five-point Likert scale. The highest-rated responses by ADT members, with all nine members (100%) selecting "strongly agree", were the support provided to participate, the broad range of perspectives within the ADT, feeling heard during meetings and feeling that the engagement was a good use of their time. From the qualitative data, many ADT members noted a range of personal benefits associated with their participation, including new knowledge, feeling pride, satisfaction and enjoyment, as well as feeling a sense of

support. ADT members reported that their engagement had a positive impact on the co-designed program, noting that they brought a much-needed youth perspective and environmental expertise. Strengths of the engagement process noted by the ADT members included the meeting environment, flexibility in engagement and having the research team show changes in action. While ADT members reported enjoying the experience, they recommended several areas for improvement in the engagement process, including fostering more connections among members, including more discussions around project background and research, and offering additional engagement opportunities.

Conclusion: Insights from this study help demonstrate the impact that engagement can have on youth, and through the strengths and areas of improvement identified by ADT members, it can help guide future work seeking to engage youth in the design of education programs within and beyond the field of concussion.

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From Extreme Prematurity and Perinatal Brain Injury to Pediatric Bi-Occipital Epilepsy: A Neuropsychological Case of Developmental “Crowding”

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Abstract

Background: Extreme prematurity is associated with diffuse and enduring cognitive vulnerabilities. When compounded by perinatal cortical or cerebellar injury, developmental trajectories may become further disrupted, reflecting both structural disorganization and compensatory neuroplasticity across large-scale neural networks. These children are also at increased risk for epilepsy, adding dynamic epileptic effects to an already atypical neurodevelopmental course. This case illustrates these complexities in an extremely preterm child with perinatal occipito-temporal and cerebellar injury who later developed drug-resistant epilepsy, resulting in a globally low neuropsychological profile.

Case History: An 11-year-old right-handed girl, born at 28 weeks (1050 g) following pre-eclampsia/HELLP, had a NICU course complicated by late-onset Enterobacter sepsis, left transverse sinus thrombosis, hypoglycemia, and feeding difficulties. Early MRI revealed extensive periventricular leukomalacia, left occipito-temporal hemorrhagic–ischemic lesions, and bilateral cerebellar injury. She presents with intermittent esotropia with left amblyopia. Motor development was delayed but ultimately functional, however, coordination issues persist. The most recent MRI still demonstrates extensive abnormalities, mostly in the left posterior region. Recent fMRI has lateralized language to the right hemisphere.

At age 5, a neuropsychological evaluation revealed low-average abilities, with relative strengths in working memory and fluid reasoning and weaknesses in visuospatial, graphomotor, and language domains. At age 10, focal seizures with visual auras emerged. Recent EEG and MEG localize the seizure onset to the left occipital region. Despite dual therapy (levetiracetam + carbamazepine), seizures persisted. Parents reported declining school performance, particularly in mathematics and reading comprehension

Now reassessed at age 11, intellectual functioning is in the very-low range and relatively homogeneous, with marked visuospatial weakness, followed by low verbal comprehension and reduced efficiency in instrumental functions. Attention is sustained but effortful, and executive functions are below the age-expected level. Verbal memory is functional for simple material but less efficient for complex stories. Visual memory is weaker overall, though face recognition remains preserved. She also presents with a Specific Learning Disorder with impairment in mathematics. A recent SLP evaluation also diagnosed a Language Disorder and a Specific Learning Disorder with impairment in written language. All these weaknesses makes school very challenging for her, which has affected her self-esteem and contributed to the development of anxiety.

Conclusion: This patient’s evolution highlights effects of early brain injury on the developing brain and cognition. Overall, she has been developing at a slower pace, with a slightly more pronounced vulnerability for visuospatial skills. The early extensive injury in the left hemisphere likely prompted language to develop in the right-hemisphere, thereby competing with visuospatial networks within an overall under-efficient cortico-cerebellar system. This neuropsychological profile may reflect a crowding effect. This integrated neuropsychological interpretation refines understanding of atypical cognitive organization following extreme prematurity and informs prognosis and educational planning.

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Preliminary Findings on the Association Between Movement Behaviours and Neuroanatomical Outcomes Following Pediatric Concussion

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Abstract

Background: Early return to physical activity supports symptom recovery following a pediatric concussion. However, the relationship between movement behaviours and neuroanatomy during the acute-to-subacute phase of recovery is unknown.

Objective: To assess the individual impact of movement behaviours over the first two weeks post-injury – specifically, cumulative moderate-to-vigorous (cMVPA) and light (cLPA) physical activity, and sedentary behaviours (cSED) – on hemispheric-dependent cortical thickness (CT) and volumetric outcomes at four weeks post-concussion across literature-informed brain regions reported to be affected by pediatric concussion.

Methods: Adolescents aged 10–17.99 years with an acute concussion (<48 hours) were recruited from a pediatric emergency department. Upon discharge from the emergency department, youth wore an Actical accelerometer for 13 continuous days. Participants completed a post-acute (week 4: 28±5 days post-injury) T_1-weighted MRI scan. Actical data was categorized into 2-week cMVPA, cLPA, and cSED. Macrostructural and subcortical metrics were derived using automated segmentation in ANTs for 17 apriori regions. Linear mixed-effect random-intercept models assessed whether hemisphere moderated cumulative activity level effects on mean week-4 regional CT, with whole brain volume and age as covariates, and a subject random effect. Where hemisphere did not moderate differences, the term was dropped and added as a covariate. Activity level was tested for non-linearity via a Likelihood Ratio Test and fit with a natural cubic spline when appropriate.

Results: Forty-eight adolescents with concussion (mean age [SD]=13.1[1,88] years, 50% female) were included in the analyses. Hemisphere moderated a linear association between CT and cMVPA for the Precuneus (p=0.003), Cuneus (p=0.020), and Superior Parietal Lobule (SPL) (p=0.040), and CT and cSED for the Medial Orbital Gyrus (MOrG) (p<0.023). More cMVPA was associated with increased CT within the right Precuneus and Cuneus, and decreased CT within the left Precuneus, Cuneus, and SPL; more cSED was associated with increased CT within the left MOrG, and decreased CT within the right MOrG. A negative linear association was found between volume and cSED for the Basal Forebrain (p=0.019), with more cSED associated with decreased CT; hemisphere did not moderate these findings. Nonlinear cLPA was found to significantly improve model fit for Cuneus (p=0.016)

and Medial Frontal Cortex CT ($p<0.0001$), and hippocampal volume ($p=0.028$), suggesting a significant nonlinear effect of cLPA on CT and volume for these regions, respectively. Nonlinear cSED was also found to significantly improve model fit for the Middle Temporal Gyrus ($p<0.028$), suggesting a significant nonlinear effect of cSED on Middle Temporal Gyrus CT.

Conclusion: Several regions were found to be linearly and non-linearly associated with time spent in different movement behaviours. cMVPA displayed a unique linear hemispheric-dependent effect amongst a cluster of posterior regions. Future research is required for clinical corroboration to examine the meaningfulness of these associations with clinical outcomes.

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By Athletes, for Athletes: Co-Designing a Concussion Education Program for and with Youth Athletes

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Abstract

Background: Recent recommendations for improving the impact of concussion education initiatives emphasize the importance of co-designing initiatives alongside key end users and considering factors such as acceptability during the design process. Aligning with these recommendations, our research team established an Athlete Design Team (ADT) to facilitate the co-design of a peer-led concussion education program for youth athletes (You-CAN Sport).

Objectives: This study aims to: 1) outline the collaborative approach taken; 2) describe the recommendations provided by youth for the adaptation and co-design of the program; and 3) evaluate the initial satisfaction with and usability of the program's elements.

Methods: *Collaborative Approach:* The concept for the You-CAN Sport program grew from the sport sector wanting a sport-based version of the existing You-CAN program, which had been designed as a school-based, peer-led concussion education program. Working together with a community partner, we successfully applied for and received funding to involve youth athletes in the co-design of the program. *Co-Design:*Nine youth athletes (aged 15-17 years) participated in the ADT, engaging in five co-design meetings. The meetings were guided by the Adaptome Framework, which outlines five levels at which intervention adaptations can occur. Meeting minutes were captured and analyzed using a content analysis. *Satisfaction and Usability Testing:*A mixed-method approach assessed the program's usability and participants' satisfaction. Quantitative data was collected through a survey incorporating the System Usability Scale (SUS) and four custom items evaluating satisfaction. Qualitative data was obtained through semi-structured exit interviews. Data was analyzed using descriptive statistics and a content analysis.

Results: *Co-Design:*Key adaptations from the school-based program included more flexibility in the length and timeline for the program to match the sport setting, the inclusion of sport language and imagery in program materials, the addition of new co-designed resources for athletes, as well as an end-of-year showcase within sport

organizations. *Satisfaction and Usability Testing:*The mean SUS score was 88.9 (SD 9.0). All nine ADT members (100%) reported that the program's website was easy to use and contained the information they would need to run the program. All members suggested that they liked the program and felt it would have a positive impact on youth sports teams and that the educational resources on the web portal would meet the needs of youth.

Conclusion: Through the collaborative development of You-CAN Sport, we were able to design a peer-led concussion education program that met the needs of the sport sector and the youth athletes for whom it was created. In demonstrating our approach, we hope to encourage others to take a collaborative approach to education development and to provide a model for those looking to adapt and co-design programs for the sport sector.

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A Multidisciplinary Approach to Evaluation and Treatment of a Patient in a Disorder of Consciousness Complicated by SCI

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Abstract

Background: Over 280,000 individuals in the U.S. are estimated to be in a disorder of consciousness (DoC) per year. Guidelines for inpatient pediatric patients in a DoC emphasize modifying the environment and providing stimulation to promote arousal and responsiveness while improving motor skills and communication. In addition, guidelines for multidisciplinary teams of physical (PT) and occupational (OT) therapists, speech language pathologists (SLP), and psychologists/neuropsychologists recommend the use of co-treatments and multidisciplinary team meetings. Our team of PTs, OTs, SLPs, and neuropsychologists developed standardized protocols for services provided in our pediatric hospital based on these published guidelines. Once patients are medically appropriate, PTs, OTs, and SLPs initiate daily therapies, and neuropsychologists initiate serial neurobehavioral exams assessing level of consciousness. There are several complicating factors to consider, including the challenge of implementing a standard protocol in cases of low arousal, medical complexity, and sensorimotor deficits, among others.

Case History: The patient is an 11-year-old previously healthy male who incurred a severe traumatic brain injury (TBI) and C1/2 complete spinal cord injury (SCI) from a pedestrian versus vehicle accident. Initially, he was minimally arousable outside of medical sedation windows. Evaluation and treatment techniques within the researched guidelines and our protocol were limited due to the patient's expected sensorimotor deficits below the level of SCI. Therefore, the multidisciplinary DoC team collaborated to develop innovative strategies that would provide appropriate sensory stimulation above the level of injury to progress toward each discipline's functional goals. Strategies included utilizing sensory stimulation such as scent, taste, sound, and tactile stimulation of the face, ears, and head. As the patient's arousal gradually improved with medical management and regular treatment from the DoC team, impairments related to his SCI continued to complicate his progression of recovery related to consciousness. Neuropsychology continued to conduct examinations during co-treatments with PT, OT, and SLP to utilize therapy expertise, optimize the patient's engagement during the assessment, and allow the patient to respond within his available sensorimotor abilities. Ultimately, the patient emerged from a DoC three months post-injury and initially learned to communicate using eye gaze before progressing to limited verbal communication.

Conclusion: This case report highlights the importance of a multidisciplinary approach utilizing co-treatments, effective communication, and serial assessments when developing a plan of care for a complicated pediatric DoC. As the patient achieved success and developed more skills, our team of clinicians was able to progress their goals through cross-specialty collaboration indicating the importance of a multidisciplinary approach in the patient's overall recovery. This case example illustrates the value of a team approach in a complex case as well as for inpatient pediatric patients in a DoC more broadly.

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Identification of Clinically Relevant Subphenotypes in Pediatric Traumatic Brain Injury: the Endotype Paradigm and Progress Towards Precision Management

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Abstract

Background: Our previous work presented at the 5th annual International Pediatric Brain Injury Social meeting showed that pediatric patients with mild/moderate traumatic brain injury (TBI) and negative acute CTH findings presented at initial TBI clinic follow-up with a significantly greater symptom burden and with a different distribution of symptoms than patients with positive CTH findings. We also found that individual symptoms clustered differently during factor analysis based on CTH findings. This clustering of symptoms in sub-populations of patients is consistent with the endotype paradigm recently described in adults with moderate and severe TBI. While endotype research remains in an early phase for adult TBI and many of the comorbidity profiles are not directly translatable to children, our findings suggest that there are sub-populations within pediatric TBI that display distinct symptom profiles and experience varying burden of symptoms.

Objective: To identify subphenotypes in pediatric TBI that share a set of characteristics and symptom profiles

Method: Retrospective chart review at an academic, tertiary, free-standing pediatric hospital. Inclusion criteria were age 2-21 years, acute TBI (date of injury to clinic follow-up visit < 365 days), CT head performed during acute care treatment, and Glasgow Coma Scale score of 9 or greater (N=140). We are in the process of performing a bias-adjusted three-step latent profile analysis using R software with model selection based on fit indices.

Results: Preliminary analysis of fit indices favors at least 9 latent profiles, or sub-phenotypes, in a heterogeneous population of children with mild to moderate TBI based on post-injury symptom distribution. Each individual (N=140) will be assigned to their most probable latent profile based on calculation of posterior probabilities. The relationship between latent profiles and injury characteristics will be analyzed to characterize the clinical features of each sub-phenotype.

Conclusion: Being able to distinguish between subclasses of children with TBI who share the same broad diagnosis yet may vary in underlying pathophysiology and recovery trajectories is the next step in the process towards precision management of pediatric TBI. Individualized management algorithms for each subphenotype will lead to specific interventions targeted for distinctive symptom profiles.

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What's the Delirio? Case Studies on How Terminology Confusion After Brain Injury Impacts Rehabilitation

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Abstract

Background: Delirium, as defined by the DSM-5, is an acute disturbance in awareness, attention, and cognition due to a medical condition and can include psychomotor activity and agitation. Management of delirium focuses on prevention, using assessment scales, reducing benzodiazepine sedatives, promoting sleep hygiene, early mobility, and family engagement.

Neuroagitation in brain injury (BI) can present as disinhibition or aggression and remains minimally researched in pediatrics; however, certain practices can aide in safely managing behaviors. Misdiagnosis of behaviors can lead to frustration and prolonged courses. The following cases from our Pediatric Intensive Care Unit (PICU) highlight the commonalities, differences, and barriers to effective treatment of delirium and neuroagitation.

Case History: “R”, a 13-year-old experiencing severe aphasia after left temporal arteriovenous malformation (AVM) rupture status post hemicraniectomy and embolization, exhibited cursing and pulling lines. Physician documentation focused on term “Delirium” rather than acknowledging these as expected behaviors within BI recovery. Agitation led to over-sedation from medications including fentanyl, risperidone, dilaudid, and atarax, and hindered participation in rehabilitation care. Parents’ expectations of recovery timeline were negatively affected by completing their own research on delirium without considering BI.

“F”, a 12-year-old admitted following ruptured AVM in left thalamus, experienced low arousal and disorientation. Increased restlessness was interpreted by family and nursing as agitation, resulting in increased pharmacological use including risperidone, clonidine, gabapentin, and oxycodone. Parents also hesitant to initiate out of bed activities, recommended by rehabilitation team, due to perceived agitation. Importance of such tasks was not widely reinforced by medical providers.

“A”, 16-year-old resuscitated onto ECMO after influenza with severe respiratory distress who experienced a prolonged intubation and sedation course. Presentation included variable alertness, visual hallucinations, and agitation. Perceived agitated behaviors were treated with hydromorphone, midazolam, lorazepam, and diazepam, and patient experienced a prolonged PICU stay.

In each case, Cornell Assessment of Pediatric Delirium (CAPD) and Richmond Agitation-Sedation Scale (RASS) scores were inconsistently documented within electronic chart. When scores were tracked, CAPD was utilized more than RASS, and only initiated by physician order. Rehabilitation based strategies (redirection, routines, out of bed activities) were not widely applied outside of direct therapy.

Medical providers and nursing staff often leaned towards medication-focused treatments as a first resort when treating agitation.

Conclusion: Differentiating delirium and neuroagitation remains challenging with overlap in behaviors and use of overarching vocabulary. Misdiagnosis or delays in diagnosis can create frustration for providers and families, hinder rehabilitation care, and extend PICU stays. Initiatives to track delirium and agitation should be proactive and include non-pharmacological methods in order to optimize patient outcomes and support family involvement as well as satisfaction.

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Navigating Together: Experiences and Needs of Parents, Healthcare Professionals, and Educators Supporting the Hospital-to-School Transition of Children with Acquired Brain Injury.

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Abstract

Background: Returning to school following acquired brain injury (ABI) is an important milestone in the rehabilitation journey of children and their families. The initial transition from hospital to school represents a critical period where connections and supports can be established to facilitate positive reintroduction and long-term reintegration in school. However, challenges including the complexity of ABI, lack of ABI knowledge in schools, and poor cross-system integration mean children and families often lack adequate support during this period.

Objectives: We aimed to understand the lived experiences and needs of families, healthcare professionals, and educators supporting the hospital-to-school transition of primary-school-aged children receiving rehabilitation services post-ABI.

Methods: This qualitative study is part of a broader knowledge mobilisation project to improve hospital-to-school transition pathways for children following ABI. We conducted semi-structured interviews with 23 participants including parents (n = 7), healthcare professionals (n = 9), and primary-school educators (n = 7) to synthesise the shared and unique experiences between members of the transition. Interviewees were asked open-ended questions designed to help them contextualise, construct, and reflect on their experiences supporting hospital-to-school transition. Interview data was analysed using an interpretative phenomenological approach with stepwise thematic analysis to develop a conceptual framework of how participants made meaning of these experiences within their social and contextual setting.

Results: Participants' hospital-to-school transition experiences were shaped by how well members of the process were able to *Navigate Together*. Key themes described what this meant to participants: 1) *linking up and feeling connected* occurred when services were communicating and members formed partnerships to openly share information; 2) *finding direction and feeling prepared* described having adequate access and transfer of information across the transition, including guidance about return to school and ABI education provision and; 3) *traversing unfamiliar terrain and feeling adaptive* meant responding to the child's needs and being open to change and uncertainty inherent in the journey. When transition was well-supported participants felt on the same team, confident about the direction they were heading.

When this did not occur, participants felt they were acting alone, navigating siloed and disconnected systems.

Conclusion: Our findings provide a comprehensive and nuanced understanding of hospital-to-school transition experiences following paediatric ABI. When well-supported, the transition from hospital to school presents an opportunity to establish coordinated and sustained collaboration necessary for long-term partnerships. To achieve this, targeted transition interventions are required to support the linkages between healthcare services, educational settings, and the home.

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SMART Concussion Trial: Symptom Management vs Alternative Randomized Treatment (SMART) of Concussion Trial

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Abstract

Background: Given the heterogeneous symptom presentation following concussion in youth, trials are needed to examine whether treatments tailored to specific symptoms are more effective than non-specific multimodal treatment.

Objective: To examine if 6-week symptom-specific treatments for headache or dizziness/neck pain initiated 1-3 weeks following concussion in 13-19 year old youth are superior to a 6-week multimodal treatment program.

Methods

Design: Single-blind randomized controlled superiority trial. Participants: A consecutive sample of youth (all sexes/genders) recruited within three weeks of concussion reporting moderate-severe (3+/6 on Likert 0-6 scale) headache, dizziness and/or neck pain on the Sport Concussion Assessment Tool (SCAT) Post-Concussion Symptom Scale (PCSS).

Interventions: Participants were randomized to one of two or three treatments based on eligibility for symptom-specific treatments (3+/6 for headache-specific and/or 3+/6 for dizziness and/or neck pain-specific); all participants were eligible for multimodal treatment. Symptom-specific headache treatment was bilateral greater occipital nerve block (GONB) (0.5% Bupivacaine; 1 cc injected bilaterally). Dizziness/neck pain-specific treatment was cervicovestibular physiotherapy (CVPT). CVPT followed a standardized treatment protocol based on individual assessment. The multimodal treatment combined simple balance exercises; training in deep breathing, progressive muscle relaxation, and visual imagery; sleep hygiene education; and a cognitive-behavioral intervention and gratitude exercises to promote coping and resilience. Main Outcome Measures: 1. Change in symptom severity score (x/132) and total number of symptoms (x/22) on the SCAT from baseline to 6 weeks. 2. Time to medical clearance to return to sport.

Results: In total, 518 youth were screened, with 152 (30.4%) being eligible (87 females, 64 males, 1 other). Of those eligible, 76 declined consent and 14 withdrew prior to randomization to treatment. The remaining 62/152 (40.8%) were randomized, 30 to multimodal, 16 to GONB (3 refused the treatment but agreed to remain in the trial if provided with the multimodal treatment), and 16 to CVPT. Based on intent-to-treat analysis, all three treatments showed reductions in

symptom severity at 6 weeks relative to baseline, with no difference between arms relative to multimodal (δGONB=-1.60,95%CI:-13.30,9.90; δCVT=-4.46,95%CI:-15.46,6.54). A similar pattern was observed for total symptoms. The GONB group had a longer time to medical clearance relative to the multimodal treatment group (TR=1.52,95%CI:1.13,2.05); CVPT showed a similar pattern, albeit not statistically significant (TR=1.28,95%CI:0.95,1.72). The probability of receiving medical clearance by 30 days was 51.7% (95%CI:36.4,67.0) for the multimodal treatment, 29.8% (95%CI:10.0,49.6) for CVPT, and 18% (95%CI:4.1,32.0) for GONB.

Conclusions: Adolescents receiving multimodal treatment were medically cleared to return to sport sooner than those receiving symptom-specific treatments, although the difference was only statistically significant for comparison with GONB. Multimodal treatment was not superior to symptom-specific treatments over 6 weeks based on change in symptoms. The study was underpowered, so replication in a larger sample is needed.

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Implementing a Real-Time Analytic Data Tool to Enhance Interdisciplinary Care for Pediatric Disorders of Consciousness

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Abstract

Background: Assessment and intervention for pediatric patients with Disorders of Consciousness (DoC) are complex and multifaceted. Due to the variability in medical and neurological profiles, the inpatient rehabilitation setting is optimal for an intensive period of monitoring, intervention and transition planning. There are minimal guidelines available in relation to the frequency and timing of standardized DoC assessments in an inpatient setting, and how they contribute to clinical decision making. Integrating analytic, real-time data collection allows clinicians to visualize patient progress, identify trends, and make timely adjustments to treatment based on accessible data, supporting more responsive and individualized care.

Objective: To develop and implement an analytic data tool to track assessment and intervention within DoC care on a pediatric rehabilitation inpatient unit.

Methods: Using the Plan-Do-Study-Act (PDSA) model, an interdisciplinary DoC working group designed an analytic data tool to track and integrate assessment and intervention for children with DoC. The DoC working group reviewed the literature and this informed the selection of the following standardized assessments: Coma Recovery Scale–Revised (CRS-R), Physical and Mobility Scale (PAMS), and Cognitive and Linguistic Scale (CALS). The DoC working group identified multidisciplinary interventions and organized these tasks into a phased treatment pathway. The task list and assessments were then integrated into the analytic data tool enabling real-time data entry, automated visualization of progress, and tracking of phase-specific goals within DoC best-practice frameworks.

Design and implementation involved collaboration among physiatry, behavioral analysis, speech-language pathology, occupational therapy, physiotherapy, recreation therapy, child life, nursing, and music therapy. Education sessions were provided to clinicians involved in DoC care, with the working group meeting weekly to review tool performance and address implementation barriers.

Staff feedback surveying a larger sample size, collected through formal questionnaires, will inform updates to the analytic data tool for the next PDSA cycle. The results of the two PDSA cycles, the progression of the tool, and identified barriers to implementation will be presented at the conference.

Results: The tool was implemented in April 2025 with all pediatric DoC admissions (n=2, DOC >28 days) over a six-month period. Weekly meetings with the patients' care teams utilized data outputs to refine shared treatment priorities and tailor

interventions. The care teams involved with using the tool reported increased collaboration and involvement across disciplines.

Conclusion: An analytic data tool to track assessment and intervention within pediatric DoC was implemented on an inpatient pediatric rehabilitation unit. Initial experiences demonstrated increased interdisciplinary collaboration and involvement.

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Reading Self-Efficacy in Young Adult Females with Mild TBI Compared to Uninjured Controls: Group Differences and Functional Associations

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Abstract

Background: Reading is foundational to academic and occupational success, yet reading after mild traumatic brain injury (mTBI) remains understudied, particularly from a rehabilitative standpoint. Young adult females represent a particularly understudied demographic despite evidence of increased rehabilitation utilization following mTBI. Reading self-efficacy – meaning, confidence in reading abilities – may serve as an indicator of persistent reading or other related changes and potential therapeutic targets, particularly given its established links to academic and vocational performance. Understanding whether reading self-efficacy deficits persist in mTBI and the relationship to broader functional outcomes could inform rehabilitation priorities for this underserved population.

Methods: Data were drawn from a larger ongoing study examining reading, cognitive, and visual outcomes after TBI across the lifespan. The present analysis focused on young adult females recruited through medical records search from a large Midwestern hospital system in the United States. Healthy controls were recruited at a state fair. Participants completed self-report measures including the Survey of Reading Strategies and Self-Efficacy Skills (SOURSES), TBI Quality of Life (TBI-QOL) Cognition and Communication subscales, LaTrobe Communication Questionnaire (LCQ), and Convergence Insufficiency Symptom Survey (CISS). Independent t-tests (Welch's) were used for group comparisons; Mann-Whitney U test was used when normality assumptions were violated. Pearson correlations examined associations within the mTBI group.

Results: Young adult females (N=59; ages 18-25, M=21.8, SD=2.2) completed study measures: healthy controls (n=47) and mTBI (n=12). The mTBI group averaged 4.2 years post-onset (SD=2.4). Groups differed on all reading self-efficacy, communication, and vision measures. mTBI participants showed lower reading self-efficacy than HC across all SOURSES subscales: Processing (HC: M=26.9, mTBI: M=19.2; t=4.92, p<.001, d=1.43), Effort (t=3.06, p=.007, d=0.96), Enjoyment (Mann-Whitney U=398.5, p=.027, d=0.95), and Total (t=3.30, p=.006, d=1.23). mTBI participants also reported worse cognitive function (t=2.73, p=.015, d=0.89), greater communication problems (Mann-Whitney U=162.5, p=.025, d=-0.62), and more visual symptoms (t=-3.74, p=.002, d=-1.31). Communication satisfaction did not differ between groups (p=.116). Within the mTBI sample (n=12), all SOURSES subscales correlated with cognition (rs=.72-.80, ps≤.008). Of note, the SOURSES

Effort demonstrated the strongest correlation with vision symptoms (r=-.87, p<.001), suggesting visual difficulties particularly impact perceived effort required for reading. SOURSES Processing also correlated with communication problems (r=-.69, p=.013) and visual symptoms (r=-.67, p=.017).

Discussion: Despite the modest sample size, young adult females with chronic mTBI demonstrated large, persistent reading self-efficacy deficits compared to healthy controls (d=1.23-1.43), even years post-injury. Within the mTBI group, reading self-efficacy showed very strong associations with cognition, communication problems, and visual symptoms. These findings suggest reading self-efficacy may be a sensitive outcome measure and potentially modifiable therapeutic target. Future research should examine whether targeted reading interventions that address both cognitive processing and visual efficiency can improve functional outcomes in this understudied population.

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TeachABI Hospital Implementation Planning: Holland Bloorview Brain Injury Rehabilitation Team

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Abstract

Background: Acquired brain injury (ABI) in childhood can lead to complex and lasting challenges in various domains, including school. Although studies of school reintegration post-ABI in children and youth emphasize the importance of communication and collaboration between the hospital and school to aid in the return-to-school transition, investigations have yet to create a hospital-to-school implementation pathway specifically centered around ABI education for educators of children and youth following ABI. Holland Bloorview's Brain Injury Rehabilitation Team (BIRT) consists of interdisciplinary clinicians (medical, allied health, rehabilitation specialists) working closely with children, youth, and their families to support their transition back to home, school, and important daily activities post-ABI.

Objectives: This study aims to create an implementation pathway and implementation strategies for *TeachABI* (a short, online professional development module about ABI created for educators) within Holland Bloorview's BIRT discharge planning. Specifically, the study aims to (1) Identify how *TeachABI* can be implemented into the hospital discharge planning process from the perspectives of clinicians, educators, clients, and caregivers; (2) Create implementation strategies for *TeachABI* within hospital discharge planning for clients.

Methods: BIRT clinicians, caregivers, clients, hospital educators, and community educators completed semi-structured interviews. A directed (deductive) content analysis was completed, guided by the Consolidated Framework for Implementation Research.

Results: Through participant interviews, a pathway was created outlining the integration of *TeachABI* into the admission to discharge planning pathway. The implementation pathway highlights key implementation points for *TeachABI* across admission, ongoing assessment, intervention, and client discharge. Each group identified the school transition liaisons as key implementors for *TeachABI*, whereby it was recommended that the school transition liaisons introduce *TeachABI* to community educators and to families. Moreover, the study identified that client and

caregiver access to *TeachABI* would be beneficial, with clinicians indicating that caregiver and client completion of *TeachABI* could enhance client and caregiver advocacy within the return-to-school transition.

Conclusion: *TeachABI* is a promising tool to be integrated within the discharge planning process to support educational transitions, ensuring coordinated care, and improved outcomes for clients and families. The next phase of this study will involve trialing the implementation of *TeachABI* within Holland Bloorview's BIRT discharge planning to test the implementation pathway and strategies for *TeachABI* within the hospital to return-to-school pathway.

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Educator Reflections on TeachABI: Applying TeachABI Knowledge and Strategies in the Classroom

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Abstract

Background: Acquired brain injury (ABI) is a leading cause of death and disability in children, and sustaining an ABI can greatly impact students' functioning within the classroom. Despite the central role of educators in supporting students post-ABI, educators receive little to no formal ABI training. To address this gap in educator training and knowledge, our team created an online professional development module called *TeachABI*. *TeachABI* is a short (~45min), engaging, virtual module about ABI created for educators by teachers, clinicians, and families. *TeachABI* uses a case-based learning approach and is composed of a case study, videos of lived experiences, downloadable tip sheets, and links to additional resources. *TeachABI* aims to build capacity and confidence for educators to support students with ABI. Quantitative testing of *TeachABI* (n=50 educators) revealed an increase in ABI knowledge and confidence, maintained 2-months post-training. Given the promising quantitative findings, it is important to understand how educators might apply *TeachABI* materials within the classroom setting, and the educator experience of *TeachABI* broadly. Thus, this study aimed to understand educators' key learnings following *TeachABI* module completion.

Objectives: (1) Educators' understanding of the material presented in TeachABI; (2) Educators' intentions to apply strategies learned in TeachABI within their classroom setting, and (3) Internal and external factors that may facilitate or impede educators' ability to apply TeachABI material within their classroom.

Methods: Semi-structured interviews were conducted with 29 educators in Ontario, Canada, following their completion of the *TeachABI* module. Data were analyzed by two independent raters using directed content analysis guided by the Theoretical Domains Framework to identify key categories related to knowledge acquisition, application, and contextual influences.

Results: Educators reported increased knowledge of ABI and classroom strategies, enhanced confidence, and intentions to apply the material in practice. Educators connected new learning to prior personal and professional experiences, highlighting

the value of reflection. Internal factors (e.g., perceived competence, motivation) and external factors (e.g., classroom size, school resources, family engagement) influenced the feasibility of applying strategies. Educators also expressed a desire for continued learning and access to additional ABI-related resources.

Conclusion: *TeachABI* is a promising tool for improving educator knowledge and preparedness to support students with ABI in the classroom. However, systemic, and environmental barriers may impact educators' ability to apply knowledge and strategies learned within the classroom environment. Findings underscore the need for ongoing professional development and structural supports to facilitate inclusive education for students with ABI.

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Functional Gains Following Inpatient Rehabilitation in Pediatric Medulloblastoma: Effects of Posterior Fossa Syndrome

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Abstract

Background: Medulloblastoma tumors are the most commonly occurring malignant cerebellar neoplasm.Treatment includes surgery with subsequent chemotherapy and radiation. Posterior fossa syndrome is a rare neurobehavioral syndrome that may occur following surgery to the cerebellum. It is characterized by temporarily diminished speech, emotional lability, and motor dysfunction. A subset of these patients experience more severe presentation as evident by transient mutism following surgery. Understanding of the trajectory of posterior fossa syndrome in the acute period and patient response to rehabilitation is limited.

Objectives: To examine functional outcomes at admission and discharge from inpatient rehabilitation as measured by the Functional Independence Measure for Children (WeeFIM) in patients with medulloblastoma with and without mutism.

Methods: Retrospective record review identified patients with medulloblastoma who completed inpatient rehabilitation following tumor resection between 2002-2025. Functional outcomes were assessed by theWeeFIM Total Developmental Quotient (DQ), a composite measure of self-care, mobility, and cognition. Independent sample t-tests compared medical and demographic factors including sex, cumulative treatment exposures measured by the Neurological Predictor Scale (NPS), age at tumor resection, and length of inpatient stay by mutism history. Repeated measures ANOVA compared change in WeeFIM performance from admission to discharge as a group and by mutism history.

Results: The sample consisted of 23 patients (34.8% female, age at admission range 3.07-18.36 years). All patients had posterior fossa syndrome following surgery; 10 had a history of mutism (43.5%). Patients showed improved WeeFIM Total DQ scores from inpatient admission [M(SD)= 35.74(19.88)] to discharge [52.87(22.51)] [F(1,21)=39.65, p<.001]. Compared to those without a history of mutism, patients with a history of mutism were younger at age of tumor diagnosis (mean age=10.78 vs 7.32 years; t(21)=2.10, p=.02). The groups did not differ in terms of sex, admission NPS score, or length of inpatient stay (p>.05). While both those with and without a history of mutism showed improvements from admission to discharge, patients with mutism had significantly lower Total DQ scores at admission [(27.10(16.16) vs 42.38(20.47)] and discharge [42.90(20.78) vs 62.31(20.68)] compared to those without mutism [(F(1,21)=4.93, p=.038].There was no time by mutism interaction.

Conclusion: Patients admitted to inpatient rehabilitation after medulloblastoma resection, with and without a history of mutism, made significant functional gains during inpatient rehabilitation, suggesting that intensive rehabilitation should be considered after surgery. Despite improvement, significant functional deficits were present at discharge and those with a history of mutism had lower functional skills at both admission discharge relative to peers without mutism. Findings highlight the enduring functional deficits in patients with medulloblastoma receiving inpatient rehabilitation, especially those with transient mutism, and emphasize the need for ongoing monitoring of these patients after discharge from inpatient rehabilitation.

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From Blood to Brain: Exploring the Association Between Blood Biomarkers and Brain Connectivity Following Adolescent Sport-Related Concussion

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Abstract

Background: Sport-related concussions (SRCs) affect one in nine adolescents. SRCs result in heterogeneous symptoms which can impact long-term cognitive function. Adolescents are particularly vulnerable to SRCs due to ongoing brain development. Despite increasing prevalence, no diagnostic gold standard exists. Blood biomarkers such as Glial Fibrillary Acidic Protein (GFAP) and Neurofilament Light (NfL) have previously shown diagnostic promise as neurological biomarker targets. Resting-state functional magnetic resonance imaging measures (rs-fMRI) have demonstrated changes in the default mode network (DMN) following concussion as well. To our knowledge, no studies have attempted to unify these findings to support clinical translation.

Objectives: The primary objective was to examine the association between NfL and resting state connectivity (RSC) in the DMN post-SRC. The secondary objective was to examine the association between GFAP and RSC in the DMN. Exploratory objectives aimed to examine sex differences and effect of post-injury day (PID) on RSC.

Methods: This was a cross-sectional sub-study within the SHRed Concussions (Surveillance in High School and Community Sport to REDuce Concussions) cohort study (2019-2025). Participants included 18 female (median age 16.7; range 12-18.7) and 16 male (median age 15.5; range 13.8-17.2 years) adolescents with paired MRI and blood biomarker data. Eight females and four males had repeated MRI and blood measures. Blood was drawn within 72 hours of SRC, at one week, and biweekly until return-to-sport. rs-fMRIs were conducted as soon as possible post-SRC (0-16 days), and at 30 days post-SRC. DMN connectivity was assessed using a Pearson-correlated Schaefer 400 parcellation, evaluated whole and in anterior and posterior subdivisions. Biomarker-connectivity associations were tested across PID bins (0-3, 4-10, 11-28, or >28 days) using correlations, linear and nonlinear clustered models, including sex as a covariate.

Results: A significant second-degree polynomial relationship was identified between GFAP and posterior DMN-to-other network connectivity (p=0.022), characterized by

an inverted U-shape where connectivity increases with GFAP concentrations until 80pg/mL, and declines thereafter (β=+0.0008, p=0.001 for GFAP <80pg/mL; β= –0.0005, p=0.013 for GFAP >80pg/mL). While this relationship was not moderated by sex, there was a main effect of sex where females exhibit significantly lower posterior DMN-to-other network connectivity (β= –0.021, p=0.011). Exploratory analyses by PID revealed no significant trends between DMN connectivity and blood biomarkers.

Conclusion: GFAP demonstrated a second-degree polynomial relationship with posterior DMN-to-other network connectivity, suggesting that astrocyte reactivity may have a nonlinear association with DMN integration. Females also exhibited lower posterior DMN-to-other network connectivity. This finding is partially consistent with previous studies reporting sex-related alterations in the posterior DMN, with females often showing greater DMN disruption following injury. Limited sample size raises the possibility of type II error. Larger studies are needed to investigate sex differences in network alterations and further evaluate the GFAP-DMN relationship post-SRC.

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Plasma Biomarkers of Inflammation after Concussion Symptom Resolution: Associations with Subsequent Injury Risk

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Abstract

Background: Adolescent athletes have a higher risk of subsequent injury following a sport-related concussion which persists beyond concussion symptom resolution, a commonly accepted indicator of clinical recovery. Plasma biomarkers, including inflammatory cytokines IL-1β, IL-6, IL-10, and TNF-α, are acutely elevated post-concussion and are associated with symptom severity and recovery.

Objective: Our objective was to explore the relationship between cytokine plasma biomarker levels (IL-1β, IL-6, IL-10, TNF-α) after concussion symptom resolution with subsequent injury risk upon return to sports.

Methods: We conducted a prospective cohort study of adolescents enrolled <21 days post-concussion. Participants completed demographics, injury and medical history, and weekly questionnaires where they self-reported concussion symptom resolution. Following symptom resolution, participants underwent venipuncture and plasma samples were assayed for cytokine variables of interest using Simoa® Cytokine 4-Plex Assay. For six months following symptom resolution, participants completed monthly questionnaires reporting whether any new sport-related injuries had occurred (yes/no) and the number of hours they participated in games/practice during the previous month. To compare groups (subsequent injury/no subsequent injury) on key demographic and characteristic variables, we used T-tests and chi square/Fisher’s exact tests. T-tests and Cohen’s d effect sizes were used to univariably compare cytokine levels between groups.

Results: A total of 36 participants (15.5±1.5 years old, 32.7±21.3 days to symptom resolution) underwent venipuncture following their concussion symptom resolution and completed at least 6 months of subsequent injury monitoring. Of these, N=9 (25%) reported sustaining a subsequent sport-related injury (n=4 ankle sprain or fracture; n=3 concussion; n=1 clavicle fracture; n=1 lumbar strain). There were no significant between group differences in sport exposure hours (25.6±9.8 vs. 24.5±16.9 hours/month; p=0.86), age (16.0±1.9 vs. 15.3±1.4 years; p=0.28), sex (67% vs. 56% female; p=0.56), or symptom resolution time (28.7±11.3 vs. 34.1±23.8 days post-concussion; p=0.52). Higher levels of IL-10 (4.9±2.5 vs. 3.7±1.4 pg/mL; p=0.08; d=0.68) and TNF-α (6.0±2.4 vs. 4.9±1.5 pg/mL; p=0.12; d=0.61) were identified among those who sustained a subsequent injury compared to those who did not, with moderate effect sizes. There were no significant between group differences in levels of IL-1β (p=0.36; d=0.38) and IL-6 (p=0.79; d=0.11).

Conclusion: We observed that IL-10 and TNF-α concentrations were higher in those who sustained a subsequent injury following concussion symptom resolution. These biomarkers may reflect persistent inflammation and potentially incomplete physiological recovery after concussion. Identification of cytokine plasma biomarkers that remain elevated after concussion symptom resolution may provide insight into an athlete's risk of future injury and assist in the development of personalized treatment strategies aimed at reducing this risk.

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Chiropractic Sacro Occipital Technique and Cranial Care and Conjoint Therapy for Care of Refractory Brain Trauma in a 14 Year Old Male

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Abstract

Background: A 14-year-old Caucasian male presented to this clinic on March 11, 2025. He suffered a concussion on February 1, 2025 after jumping up and hitting his right temporoparietal region on a doorframe. He saw a neurologist who prescribed Naproxen and told it would take some before he would be feeling better. No other treatment or advice was offered. He was also currently undergoing orthodontic treatment since August 2025. Since his concussion his disabilities were so profound he was unable to attend school, and was unclear when he could ever return.

Case History: Initial presenting symptoms included a constant frontal temporal headache (worse on the right), with chronic fatigue, and multiple neurological symptoms consistent with a post-concussion syndrome, such as difficulty interpreting speech, recognizing symbols or shapes, sensitivity to sounds and bright lights, memory lapses, and nausea.

Physical examination found positive Romberg’s sign, alternate hand clapping, light and contrast sensitivity, and vagus palate test. He had convergence insufficiency, hyperacusis to tuning fork test, and bilateral nystagmus. Also noted were positive signs of TMJ distress with palpatory pain at right sphenoid greater wing and adjacent regions, hypertonic muscles of mastication, and decreased TMJ translation bilaterally. Initial working diagnosis was post concussion syndrome aggravated by clenching and mal-occlusion.

Treatment included sacro occipital technique (SOT) chiropractic care to reduce pelvic torsion and improve CSF ascending circulation, cranial manipulative care to the right temporal bone and related regions, with care specifically to the TMJ regions. Red light therapy (LightMD) was utilized along with nutritional supplementation (short chain fatty acids, fat-soluble turmeric, EPA/DHA oils, and glutathione) to help reduce inflammation and improve circulation.

Outcome: Within the first 3-weeks of care (six office visits) he immediately noted a temporal relationship between the care rendered and a decrease in headaches and increase in his ability to function. He was seen 1-2 times per week through mid-May 2025 when he noted a complete reduction of his headaches with no neurological abnormalities except for some vision related issues. By the end of May 2025 he was referred to a functional optometrist for vision therapy and completed a course of therapy in two-months at which time he was completely symptom free and ready to return to school.

Conclusion: With pediatric brain trauma sometimes watching-and-waiting is a reasonable option, however for children in their formative years having inability to go to school and have social interactions due to chronic post-concussion syndromes may warrant innovative therapeutic applications. Conservative low-risk care that yields positive outcomes such as what was used in this case suggest that SOT chiropractic and cranial incorporating nutritional supplementation, red-light therapy, and functional optometry vision therapy, may offer valuable options for a subset pediatric patients suffering from brain trauma.

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Investigating Sex-Related Differences in Perinatal Stroke through MRI-Based Analysis

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Abstract

Background: Perinatal arterial ischemic stroke (PAIS), with a birth prevalence of 1 out of 1100 live births, is the most common cause of hemiparetic cerebral palsy and causes lifelong disability. Timely diagnosis is challenging; newborns lack sudden deficits that herald stroke in older people, thus there are no acute therapies. In one-third of children, their stroke is silent until movement challenges are appreciated in childhood. Our group recently found that male infants are twice as likely to be diagnosed acutely compared to females.

Objectives: This study aims to use MRI to investigate why some newborn strokes are silent, particularly in females, by comparing stroke volume by diagnosis timing (acute vs silent), stratifying by sex, and comparing stroke location by timing of diagnosis.

Methods: Retrospective cross-sectional study using a unique population-based database of arterial ischemic perinatal stroke. Cases are classified as acute (115; 68% male) or silent (46; 48% male) based on timing of presentation. Size of stroke (as measured by volume) on MRI will be measured using a novel semiautomated pipeline, adapting a validated method by our group. Linear regression will compare volume by diagnosis timing, stratifying by sex. With our sample of 161 cases, we have 80% power to detect a 15% difference in volume. Location of stroke will be classified according to standard categories and compared by timing of diagnosis with chi-square tests. Volume will be normalized to the size of the child's cranial vault. Pre-existing MRI scans in the APSP registry will be evaluated for stroke volume and location.

Results: A preliminary analysis was run on a subsample (n = 17, 71% male). Mean stroke volume did not differ by sex (two-sample t-test, $p = 0.5650$). Females were scanned at a later age than males (two-sample t-test, $p = 0.0087$). After adjusting for age, sex was not associated with stroke volume ($p = 0.416$), whereas higher age at scan was associated with smaller volume ($p = 0.044$). Preliminary volumes were not normalized to the size of the child's cranial vault.

Conclusion: These preliminary analyses are not statistically significant and are presented as a non-inferential sample; assumptions should not be drawn. This project will improve understanding of the pathophysiology that drives differential recognition of perinatal stroke by linking sex differences in imaging characteristics

with clinical outcomes. Identifying sex differences will support earlier diagnosis, guide clinical protocols, and inform public health decision-making, enabling more equitable care. Full-cohort APSP analyses will evaluate sex-related differences in stroke volume and location (normalized to the size of the child’s cranial vault) and will model age at diagnosis and regional involvement to test drivers of early recognition.

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Functional outcome of patients underwent hemispherotomy before 1 year old; retrospective study

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Abstract

Introduction: Hemispherotomy is a definitive surgical procedure for achieving seizure freedom in patients with drug-resistant epilepsy caused by unilateral cerebral lesions. However, postoperative hemiparesis and visual field defects are common. Although several studies have reported functional outcomes after hemispherotomy, few have focused on patients operated on before one year of age. This study retrospectively investigated postoperative motor development in such patients treated at our institution.

Method: We included patients who underwent hemispherotomy at ≤1 year of age between April 2016 and March 2025 and received at least one postoperative physical assessment. Clinical data, including sex, age at seizure onset, age at surgery, and etiology, were extracted from medical records. Postoperative hemiparesis, activities of daily living (ADL), and language function were evaluated longitudinally at preoperative, 3-month, 6-month, and annual follow-ups up to 5 years after surgery. Correlations were analyzed between age at surgery and the ages at acquisition of head control, independent sitting, and standing.

Results: Seventeen patients (10 right, 7 left hemispherotomies) were included. Mean age at surgery was 4.2 ± 2.5 months. The etiologies were hemimegalencephaly (n = 13), cortical malformation (n = 3), and Sturge–Weber syndrome (n = 1). The mean follow-up period was 3.5 ± 1.0 years. At final follow-up, seizure outcomes were Engel class Ia in 12 patients (71%), class II in 3 (18%), and class III in 2 (12%). All patients developed postoperative hemiparesis and visual field defects. Four patients achieved head control preoperatively, and all achieved it within 3–12 months postoperatively; those without head control preoperatively acquired it at 7.6 ± 2.7 months of age. Independent sitting was achieved in 14 patients (15.6 ± 5.9 months of ages), standing in 12 (36.7 ± 12.5 months of ages), and walking in 8 (41.9 ± 13.1 months of ages). Among those who walked, four required orthoses (four short leg braces). Age at surgery significantly correlated with age at head control ($r = 0.574$, $p = 0.04$) but not with sitting ($r = 0.169$, $p = 0.56$) or standing ($r = 0.343$, $p = 0.27$).

Discussion: All patients finally achieved major motor milestones, though the timing varied widely. Younger surgical age was associated with earlier acquisition of head control, suggesting that early surgery may facilitate motor development through enhanced hemispheric plasticity. In contrast, higher-level motor functions such as sitting and standing appeared influenced by multiple factors, including postoperative physical therapy, seizure control, and muscle tone abnormalities.

Conclusion: Early hemispherotomy before one year of age may promote earlier acquisition of basic motor milestones. However, the development of advanced motor skills likely depends on multifactorial influences. Larger, multi-institutional studies with detailed functional assessments are warranted to further clarify postoperative developmental outcomes.

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Do Multifaceted Pre-Season Measures Differ in Youth Schoolboy Rugby Union Players With and Without a History of Concussion?

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Abstract

Background: Concussion is a common injury in youth rugby, and prior history may influence preseason physical and physiological characteristics. Understanding baseline differences between players with and without a history of concussion can help to interpret post-injury outcomes and guide targeted prevention strategies.

Objectives: To compare preseason symptom severity, neck strength, exercise tolerance, and vestibulo-ocular reflex (VOR) function in schoolboy rugby players with and without a self-reported history of concussion.

Methods: One hundred and thirty-five male schoolboy rugby players (mean age 17.0 ± 1.0 years) completed a preseason assessment at a sports medicine clinic. Players reported concussion history and completed the Post-Concussion Symptom Scale (PCSS; score range 0–132), composite isometric neck strength testing (normalised to bodyweight; N/kg), the modified Buffalo Concussion Treadmill Test (mBCTT; maximal heart rate [bpm], rate of perceived exertion [0–10], and time to cessation [s]), and horizontal VOR gain testing using video-oculography. Between-group comparisons were performed using non-parametric tests.

Results: Sixty-five participants (48%) reported a history of concussion. There were no significant between-group differences in PCSS scores, neck strength, VOR gain, or mBCTT time to cessation. Players with a history of concussion demonstrated a slightly lower maximal heart rate (median = 193 bpm, IQR = 186–199) compared with those without a history of concussion (median = 196 bpm, IQR = 191–201; $p = 0.025$), although the effect size was small.

Conclusion: Among adolescent rugby players, a self-reported history of concussion was not associated with meaningful preseason differences in symptom severity, neck strength, exertional tolerance, or VOR function. The modest reduction in maximal heart rate observed in players with previous concussion may not be clinically significant but warrants further investigation. These findings support the value of multimodal preseason testing to establish individual pre-injury profiles in youth rugby athletes.

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Pediatric Brain Injury Clinical Roadmap

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Abstract

Effective cognitive rehabilitation for children with acquired brain injury requires a nuanced understanding of recovery that accounts for evolving cognitive and behavioral capacities across the neurorehabilitation continuum. To address this need, I am presenting a structured, evidence-informed roadmap that delineates four distinct stages of cognitive recovery: (1) disorders of consciousness, (2) confusional stage (post traumatic amnesia), 3) self-regulation foundation, and (4) acute cognitive impairment. This knowledge translation roadmap based on the synthesis of current research is designed to support clinicians in the application of stage-appropriate cognitive rehabilitation approaches and strategies.

A novel contribution of this framework is the introduction of the *self-regulation foundation* stage, which titles the important foundational aspects of cognitive and behavioral dysregulation that follows confusional states but precedes a more metacognitive based approach to cognitive rehabilitation requiring online awareness. The self-regulation foundation stage is characterized by impairments in attention, emotional regulation, initiation, and behavioral control, which significantly impact readiness for higher-order cognitive interventions due to the inability to adjust behaviors once general awareness is achieved, a key ingredient of online awareness.

My presentation recaps the well-defined treatment approaches that exist in the stages of disorders of consciousness, confusional stage, and acute cognitive impairment. Additionally, it highlights the research that supports the need to adjust the clinical approach to those who present with self-regulation deficits , including the early research on EEG based biomarkers thought to detect error awareness (ERN) and subsequent behavior adjustment (Pe) and how these biomarkers differ in patients post brain injury versus healthy controls. The presentation includes case studies of pediatrics post brain injury who present with impairments in attention, initiation, and/or inhibition with stable memory who obtain improved functional outcomes using principles of the proposed self-regulation foundation stage, including immediate, error-based feedback as opposed to the errorless approach of confusional stage and the error-based, delayed feedback highlighted in the research presented.

The roadmap integrates interdisciplinary assessment tools to determine a child’s current stage of recovery and tools to monitor progression between stages. Recognizing that each stage demands tailored rehabilitation approaches, the framework provides guidance on appropriate approaches for each, including levels of error allowance, cueing types, and timing of feedback to optimize skill acquisition based on cognitive profiles.

This knowledge translation effort bridges current research and clinical practice, providing a pragmatic tool to enhance individualized care and improve outcomes for children post brain injury across all stages of recovery.

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Seeing the Impact: A Video-Based Epidemiological Study of Head Events in Canadian Female Youth Flag Football

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Abstract

Background: Youth flag football participation is increasing, with the sport set to debut at the 2028 Olympic Games. Although often promoted as safer than tackle football, research on head impacts in youth female players is limited. Head acceleration events (HAEs), including direct head impacts and indirect impacts with observable head movement, can be used as a potential proxy for head injury risk and to quantify the cumulative mechanical strain experienced by the brain over time. Understanding the incidence and mechanisms of HAEs and suspected head injuries is essential to inform prevention strategies.

Objectives: To describe the incidence and mechanisms of HAEs and suspected concussions in under-14 female athletes at elite-level flag football.

Methods: Data were collected from the 2025 Canadian Elite Flag Nationals, including 58 female U14 players across five provincial teams. Fifteen 40-minute games (nine round-robin, six playoff) were played using standard 5v5 rules on a 60×25 m field. Game video was captured by the research team and supplemented with streamed footage (sideline and endzone views). Two reviewers extracted game-level data including player, team, position, play type, and outcome (e.g. completion, flag pull, touchdown). HAEs were defined as direct head impact or indirect contact causing observable head motion. A suspected concussion was defined as any HAE resulting in observable signs (e.g. grabbing head/face or removal from play). Player-hour exposure was calculated as the number of athletes on the field per team multiplied by the total match duration (hours) across all games. Exposure was expressed at the individual level (per athlete-match and per 1000 player-hours). Incidence rates were calculated using Poisson regression with 95% confidence intervals (CI) estimated using robust standard errors clustered by team.

Results: Across 15 games, 66 HAEs, 55 direct HAEs and 10 suspected concussions occurred among 58 players. Players experienced 0.21 HAEs per match (95% CI: 0.14–0.32), 0.18 direct HAEs (95% CI: 0.11–0.29) and 0.03 suspected concussions (95% CI: 0.02–0.06). Corresponding rates per 1000 player-hours were 316 HAEs (95% CI: 210–475), 264 direct HAEs (95% CI: 158–439), and 48 suspected concussions (95% CI: 25–92). Most HAEs occurred during flag pulls (55%), or catching (29%); suspected concussions similarly involved flag pulls (50%) or catching (33%).

Conclusion: Players experienced approximately one HAE every 3 hours (~5 matches), one direct HAE every 4 hours (~6 matches), and one suspected concussion every 20 hours (~30 matches). Over half of all events involved a flag pull, highlighting an

opportunity for coaching interventions on safe flag-related techniques. Reporting direct HAEs and suspected concussions provides an important starting point for monitoring head impact risk in youth female flag football, informing future evidence-based injury prevention strategies in this growing sport.

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Caregiver Experience and Engagement from an Online Preterm Parenting Program: The I-InTERACT RCT

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Abstract

Background: Children born very preterm, or VPT (<32 weeks' gestation), are at increased risk for neurodevelopmental impairments and behavior challenges due to early brain injury and disrupted brain development. Although early intervention programs provide critical support from birth to age three, there remains a significant gap in services for children over three and their families, leaving many with ongoing, unmet developmental and behavioral needs. To address this gap, the online parenting program I-InTERACT-Preterm was created to support parents of children born VPT. The pilot trial showed high attrition and feedback emphasizing difficulty completing the program and the need to improve accessibility. Thus, a microlearning version was developed to offer bite-size segments with specific learning objectives. Microlearning delivers content in short segments designed to enhance engagement and focus on learning objectives.

Objectives: We aimed to examine whether sessions in the I-InTERACT Microlearning program met the 5–7-minute microlearning benchmark, compare completion rates between the standard and microlearning versions, and evaluate total program completion times to assess participant engagement across formats.

Methods: We developed microlearning sessions to be completed within approximately 5–7 minutes, each addressing a specific learning objective. The standard program contains seven full-length sessions while the microlearning version contains 24 short modules. Session completion times were extracted for each participant enrolled in the ongoing three-arm RCT comparing I-InTERACT, I-InTERACT Microlearning, and Internet Resources (control). We conducted descriptive analyses and an independent samples t-test to compare completion times between I-InTERACT and I-InTERACT Microlearning.

Results: Forty-eight families of VPT children ages 3-8 were enrolled (enrollment goal = 140). Families were randomized into I-InTERACT (n=16), I-InTERACT Microlearning (n=18), and Resources (n=14). Seven families were lost to follow up, and two families withdrew from each of the microlearning and standard program groups before post-treatment testing (three months post-baseline). Of the 24 Microlearning sessions, 17 had average completion times under seven minutes (range: 2–6.33 minutes). Among families that did not withdraw, 43% of those assigned to I-InTERACT completed five or more online sessions, compared to 56% of families assigned to I-InTERACT Microlearning. There was no significant difference (*p* = .27) in total completion times

between users of I-InTERACT (M = 183 minutes) and Microlearning (M = 159.44 minutes).

Conclusion: Preliminary findings suggest that the I-InTERACT Microlearning program met its 5–7-minute benchmark for most sessions and demonstrated shorter total completion times than I-InTERACT. Families in the Microlearning condition also showed higher rates of session completion, indicating that shorter, focused content may enhance engagement and accessibility for parents of children born VPT. These results suggest that microlearning may represent a potentially scalable and user-friendly approach to delivering parenting interventions beyond early childhood. Efficacy and satisfaction data will be examined once full recruitment is complete.

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Injury- and Non-Injury Factors Affecting Performance of 11-18 Year Olds on TBI-Related Neurocognitive and Symptom-Based Functional Assessments

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Abstract

Background: Injury stratification and prognostication remain significant challenges in paediatric traumatic brain injury (TBI). However, the emerging Clinical-, Biomarker-, Imaging-, and Modifiers (CBI-M) framework has highlighted the need to consider the contribution of various modifiers on injury presentation and outcome, such as patient factors (e.g., age, premorbid conditions) and injury mechanism.

While injury mechanisms are often summarised in the literature (e.g., fall from height), more detailed reports about the injury event (e.g., impact location) and their influence on functional assessments are scarce.

To this end, we performed a preliminary, exploratory analysis in 11-18-year-olds with and without a history of sports-related head injury, as part of an ongoing study. Our analysis focused on previously unexplored variables relating to the injury event, in addition to selected lifestyle factors (e.g., regular exposure to head impacts/tackling/falling).

Objective: To evaluate the influence of injury- and non-injury factors on four TBI-related neurocognitive and symptom-based functional assessments.

Method: Participant groups included acute patients (sports-related injury <14 days; n=17), old injury patients (sports-related injury >6 months; n=8), and healthy controls (no prior head injury; n=8).

In the full cohort (n=33, 12 females), the following variables were evaluated: *age at enrolment, sex, pubertal development score, sleep disturbance score, duration of weekly vigorous exercise, exposure to regular head impacts or tackling/falling.*

In the patients only (n=25, 7 females), we investigated: *history of >1 head injury, age at injury, >1 impact during injury event, lateral head impact, impacting object moving, premorbid neurodevelopmental or neuropsychological conditions, loss of consciousness, and post-traumatic amnesia.*

Each variable was entered into a separate ordinal regression model for each of the following assessments: Post-Concussion Symptom Scale (PCSS), Neuro-QoL Cognitive Dysfunction Short Form, Trail Making Test (TMT)-A and TMT-B.

The models were adjusted for injury status in each analysis (patient/control in full cohort, acute/old injury in patient-only analysis). Odds ratios (OR) with 95%

confidence intervals (CI) were calculated. Multiple-comparisons correction was applied for each outcome using a 5% false discovery rate.

Results: The median (inter-quartile range) age was 14 (12-16) years for both cohorts.

Full cohort: Whilst several trends emerged, no significant associations remained after multiple comparisons correction.

Patients Only: A significant association was observed between a lower TMT-B Standard Score and post-traumatic amnesia (OR: 0.06 [CI: 0.01 – 0.38], p=0.021). No other associations survived multiple comparisons correction.

Conclusion: No significant correlations emerged between the non-injury variables and performance on any of the four functional assessments. In the patient-only cohort, post-traumatic amnesia appeared to negatively influence TMT-B performance. However, no other injury-related variables reached statistical significance. Nevertheless, to maximise the benefits of the CBI-M framework, variables relating to the injury event and other patient factors warrant further investigation in larger paediatric TBI studies.

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Examining the Impact of Implementation Fidelity on Head Acceleration Outcomes in Youth Tackle Football

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Abstract

Background: COmmunities Aligned to reduce Concussion and Head impact exposure (COACH) is an intervention to improve knowledge, skills, and attitudes of coaches to promote effective and safe youth football practices. Fidelity is the extent to which an intervention is delivered as intended, a crucial implementation outcome when evaluating intervention effectiveness and its potential to reduce head acceleration event (HAE) outcomes.

Objective: Evaluate the relationship between implementation fidelity of COACH and HAEs outcomes among youth tackle football players.

Methods: Athletes participating in a local youth football league participated in this study from two teams (12U, n=14; 13U, n=21) in 2023 and two teams (11U, n=15, 12U, n=16) in 2024. Coaches were trained following COACH guidelines, received a resource booklet for contact aligned with National Federation of State High School (NFHS), guided practice plans, attended a pre-season clinic, and were paired with a local head coach mentor during the season. Athletes on COACH teams wore instrumented mouthguards recording HAEs frequency and magnitude. Weekly HAEs per athlete exposure (AE) were calculated by dividing total HAEs by session attendance. Trained staff attended all practices and games to collect biomechanical data and video. Implementation fidelity was monitored daily using a 0–2 scale (adequate = 2, partial = 1, none = 0) across five essential elements (practice plan submission and adherence, use of alternative contact levels, and limits on live contact per session and week). Fidelity scores were calculated as the weekly implementation percentage (sum achieved divided by maximum possible) and compared across teams and season weeks in relation to HAEs per AE.

Results: A total of 5437 HAEs were collected across 146 practice sessions. The 2023 12U team maintained 75–100% fidelity across all essential elements for the first 5 weeks, with 1-2 HAEs per AE per practice. Midseason shift in coaching staff reduced fidelity 0–33% for limiting live contact and 33–50% for alternative contact, resulting in a 2.2–9.0× increase in HAEs per AE per practice. The 2023 13U team maintained 50-100% fidelity throughout the season across all essential elements, with 1-2 HAEs per AE per practice across 12 of 15 practices. The 2024 11U team started with 0-50% fidelity to limit live contact time, peaking at 22 HAEs per AE per practice; after organizational leadership redirected the coaches to COACH objectives, fidelity

improved to 75-100% and HAEs dropped 3–4x. The 2024 12U maintained 75-100% fidelity throughout the season, with consistently 0-1 HAEs per AE per practice.

Conclusion: Results suggest the COACH program was effective in reducing HAEs when coaches implemented it with good to excellent fidelity. This pilot experience provided valuable insights into how coaches interact with and implement the COACH program, informing future adaptations for large scale implementation.

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Rethinking Rehabilitation – Empowering Families and Community Professionals to Support Rehabilitation at Home

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Abstract

Background: Multifactorial changes in the incidence, diagnosis, acute treatment and insurance policies for pediatric Traumatic Brain Injury (TBI) and other Acquired Brain Injury (ABI) have shortened hospital stays and resulted in patients returning home earlier in the recovery process. More rehabilitation is occurring in home communities, often without easy access to medical and rehabilitation specialists. The full impact of pediatric brain injury, which unfolds over months and years, happens at home- not in hospitals or medical clinics. Excellent resources about pediatric TBI exist; however, most resources provide generalized educational materials or are geared toward rehabilitation professionals that have specific credentials. This leaves community professionals (e.g. teachers and social workers) searching for trustworthy information and practical guidance. A common result is that parents and families who are still trying to understand their child's injury and cope must also educate the people who will work with their child.   Easily accessible support tools that empower community providers who do not have specific brain injury expertise are needed to fill these gaps in care.

Objectives: We will present two innovative approaches that provide rehabilitation supports in home communities, CareCircle and HOMES. CareCircle is a newly released app that provides a platform for families to share tailored, individualized resources with their community. HOMES is a collection of free, sharable, bite-sized educational and interventional tools developed to support community professionals who may not have prior knowledge with ABI.

Methods: We will describe how focus groups / interviews (n=22) and surveys (n=43) were used to identify insights about caregivers' lived experience and used to inform CareCircle development. HOMES also used survey data collected from a multidisciplinary network of consultants (n=150) to identify perceived gaps in education and intervention materials for pediatric TBI. Focus groups and interviews also were conducted with HOMES consultants to understand how community professionals search for existing on-line information about ABI (n=6)).

Results: Outcomes from the data collected demonstrate that Care Circle and HOMES both offer features uniquely suited to pediatric brain injury recovery and rehabilitation. Themes from caregiver focus groups, surveys, and interviews across both projects indicate that it is important to have an individualized understanding of care needs specific to the patient. HOMES data also indicated that the largest perceived gaps in care are identifying safe ways to manage challenging behavior after ABI, and accessing strategies that promote positive adjustment following newly acquired disability.

Conclusion: CareCircle and HOMES materials both offer novel ways to help bring support to families completing rehabilitation at home that address gaps in current services.

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A protocol for testing ‘Brain 101’ for supporting students with concussion in UK classrooms

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Abstract

Background: Children and young people (CYP) with concussion may experience a range of physical, cognitive, emotional, and social challenges, including headaches, dizziness, fatigue, difficulty concentrating, and emotional instability. These symptoms can impact academic outcomes, with cognitive demands such as reading, writing, and concentration proving especially challenging. The school environment plays an important role in supporting CYP following concussion. However, teachers report lacking sufficient training on the effects of concussion, which impacts their ability to support pupils in the classroom. Extant literature demonstrates that peer knowledge of concussion enhances social support for CYP with concussion, improving quality of life, reducing isolation, and decreasing emotional and behavioural symptoms. The provision of concussion education for teachers and pupils is crucial to support pupils returning to school post-concussion. It increases the likelihood of reporting, which is associated with improved outcomes long term. ‘Brain 101’ is a US-based concussion education resource designed to improve concussion knowledge for CYP and educators. This project will test what adaptions are needed for Brain 101 to be used in the UK.

Objectives:
1. To explore the school experiences of young people who have sustained a concussion; 2. To investigate the ‘Brain 101’ intervention to improve concussion knowledge and understanding of school children and teachers; 3. To determine what changes or adaptations may be needed to ‘Brain 101’ for use in a UK population.

Methods: A pilot Randomised Controlled Trial (RCT) will be conducted across eight mixed-gender mainstream schools in Northern Ireland (four primary and four post-primary), involving approximately 250 pupils and 20 teachers. Schools will be randomly assigned to either an experimental (N=6) or control (N=2) condition using a 3:1 allocation ratio. A larger experimental group will enable more comprehensive data collection on Brain 101’s effectiveness. Randomisation will be conducted by an independent third-party using block randomisation stratified by school type (primary vs. post-primary), ensuring balanced allocation.

Qualitative interviews will be conducted with CYP who have experienced concussion to gain an understanding of their experiences and their perspectives on the ‘Brain 101’ resource – providing insights into the resource and acceptability testing.

Results: Expected outcomes: It is anticipated that ‘Brain 101’ will enhance concussion knowledge, confidence, self-efficacy, and behavioural intentions. It is

expected that the insights provided in qualitative interviews will further shape the resource.

Conclusion: The two-stage approach is strategically sequenced. The Pilot RCT will provide testing for an existing evidence-based intervention, to determine if it translates effectively into a UK context, and the qualitative interviews will provide in-depth, representative insights into how concussion is experienced and provide acceptability testing. Together, this research will address key knowledge gaps in concussion management among educators and peers and lay the groundwork for a scalable, school-based support system in the UK.

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Athlete Impulsivity Affects On-Field Behavior and Head Impact Magnitude Variability in Youth Football

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Abstract

Background: Youth football has one of the highest rates of concussions and non-concussive head acceleration events (HAEs), which are events that do not result in acute signs or symptoms of concussion. Youth brain development continues into adolescence, specifically regions of the brain responsible for impulse control. As a result, children often exhibit reduced brain development maturity in these areas which manifest as the tendency to act with minimal forethought (i.e., impulsivity), often leading to risky decision making. Impulsivity may not only result from exposure to repetitive head impacts but also contribute to their occurrence and severity.

Objective: To better explore the relationship between impulsivity and on-field behaviors in youth tackle football and evaluate the relationship between measures of impulsivity and head kinematics metrics over a single season.

Methods: Athletes (n=77) were instrumented with custom mouthpieces measuring HAEs for their entire season. They completed pre- and post-season cognitive assessments, including NIH Toolbox, ImPACT, and Conner's Continuous Performance Task (CPT3). Highly impulsive and non-impulsive athletes were identified using CPT3 t-scores (directly measuring impulsivity) and ImPACT Impulse Composite scores (indirectly measuring impulsivity from X's&O's and Color Match subtasks) based on scores 1.5 standard deviations above (highly impulsive) or below (less impulsive) the sample mean. Impulse Composite scores on ImPACT had to match those of the CPT3 score report to be included for film review. We conducted individual interviews with high school coaches (n=4) and certified athletic trainers (n=4) to identify observable characteristics of impulsive behaviors. Interviews were recorded and thematically analyzed to identify common characteristics. Game footage was reviewed to identify and tally impulsive behaviors in competition settings. Descriptive statistics of behavioral incident rates and HAE magnitudes were calculated to compare impulsive athletes to non-impulsive athletes.

Results: Seven athletes were identified as "highly impulsive" (n=3) or "non-impulsive" (n=4) based on combined ImPACT and CPT3 scores. Individual interviews with coaches and athletic trainers revealed common impulsive behaviors including personal fouls, arguing, aggressive contact, exaggerated body language, and trash talking. Impulsive athletes had an average of 6 behavioral incidences per game and averaged 49 incidences over the entire season, compared to non-impulsive athletes who averaged less than one per game and averaged 6 incidences over the season. The highest frequency behaviors exhibited by impulsive athletes included aggressive

contact and taunting or trash-talking opponents. Head kinematics were similar between groups, though impulsive athletes exhibited greater variability.

Conclusion:_Impulsivity can influence on-field behavior which in-turn may influence HAE exposure. Understanding the relationship between impulsivity scores and behavior manifestation can inform targeted interventions to improve safety in youth football. Future work will examine behavioral characteristics and their effect on HAEs among impulsivity subtypes (e.g. UPPS-P scale).

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Evaluating Recumbent Cycling as a Platform to Measure Motor Recovery in Pediatric Traumatic Brain Injury

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Abstract

Background: Monitoring recovery following pediatric traumatic brain injury (TBI) is essential for care planning. However, this has been challenging as existing measures of motor function are often unsuitable for use throughout recovery, particularly when individuals are non-ambulatory. Electromyography-based measures of motor control have shown promise for monitoring function and predicting outcomes in *ambulatory* children with CP and TBI. However, to be practical for broad use in TBI care, these measures must be extended to capture motor control across the recovery spectrum. Recumbent cycling may be a valuable tool to reliably assess dynamic motor control throughout recovery but has been minimally explored in this context.

Objectives: This study aimed to evaluate whether dynamic motor control during recumbent cycling parallels walking to guide development of novel assessment tools in pediatric TBI.

Methods: Bilateral, lower-limb electromyography data (rectus femoris, vastus lateralis, medial gastrocnemius, medial hamstring, tibialis anterior, soleus) were collected from six uninjured controls (13.1 [IQR: 9.9, 15.0] years) and five individuals in chronic recovery from moderate-to-severe TBI (cTBI; 15.5 [13.2, 17.5] years; 4.5 [3.4, 5.8] years from injury) during walking and recumbent cycling trials. Participants completed three overground walking trials at self-selected speed and one-minute cycling trials at multiple power and cadence levels. Cadence values were set at fixed proportions of participants' walking cadence and reinforced via biofeedback. Power values were set based on the level at which each participant could maintain their walking cadence for the trial duration. Electromyography data for the more-affected (cTBI) or a random limb (controls) were high-pass filtered (40 Hz), rectified, low-pass filtered (10 Hz), and normalized. Non-negative matrix factorization was used to derive the total variance accounted for by one synergy ($tVAF_1$), a measure of dynamic motor control where higher values indicate less complex control. $tVAF_1$ values were compared between cycling and walking using Pearson's correlation coefficients and across power and cadence levels.

Results: Small inter-cohort differences in $tVAF_1$ were observed during walking, as the cTBI cohort had less complex control (0.70 [0.67, 0.71]) than controls (0.66 [0.65 0.67]). Motor control complexity during walking and cadence-matched cycling was also moderately correlated across cohorts (r = 0.61), suggesting individuals used similar control strategies during both activities. Interestingly, $tVAF_1$ increased with

increasing power levels in cTBI ($\Delta tVAF_1$ = 0.06 [0.01, 0.11] between high and low power) and controls ($\Delta tVAF_1$ = 0.05 [-0.05, 0.06], but was less affected by changing cadence (cTBI: - 0.04 [-0.05, 0.01]; controls: 0.002 [-0.01, 0.03]).

Conclusion: Findings suggest dynamic motor control during recumbent cycling is similar to walking, supporting its potential as a platform to track motor recovery in pediatric TBI. Ongoing work will expand the sample size and extend the protocol into individuals in sub-acute recovery to better understand the utility of this measure.

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From education to everyday change: a qualitative study of Move&Connect-Caregivers' impact on caregivers of youth with persisting post-concussion symptoms

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Abstract

Background: Persisting post-concussion symptoms (PPCS) impact not only the youth with a concussion but also the family system. Caregivers are central to youth recovery yet frequently report increased stress, feelings of uncertainty, and unmet support and educational needs. Despite this, there are limited interventions designed to target caregivers' well-being after pediatric concussion. *Move&Connect-Caregivers (M&C-C)*, a six-week virtual group-based intervention for caregivers of youth with PPCS, was developed to address this gap. The intervention provides education, skill-building, and social support, with previous research establishing the intervention's development and feasibility. To build on this, the current study explores the impact of *M&C-C* on caregivers of youth with PPCS.

Objective: To understand how participation in *M&C-C* influences caregivers' daily life and the broader family's experience with PPCS recovery.

Methods: A qualitative descriptive study using semi-structured interviews with 19 caregivers was conducted Interviews were completed virtually via Zoom Healthcare after caregivers' participation in *M&C-C*. Interview data was analyzed using reflexive thematic analysis, and credibility was supported through reflexive memoing and an audit trail.

Results: Caregivers were 44 to 57 years-old (M=49.9, SD=3.8) with most (n=16, 84%) identifying as women and mothers. Ethnic identities included White (n=14, 74%), Chinese (n=1, 5%), Black (n=1, 5%), Arab (n=1, 5%), and multi-ethnic backgrounds (n=2, 11%). Additionally, nine youth with PPCS provided their perspective on caregiver participation. Youth were 15 to 18 years old (M=16.4, SD=0.88) and identified as girls (n=6), boys (n=2), or gender fluid (n=1).

Four themes with corresponding subthemes were generated and sequenced to illustrate *M&C-C*'s impact on caregivers' daily routines and overall family experience with recovery. The journey begins with the first theme of the education and peer connection caregivers experienced within the group; this set the stage for further growth to occur. The second and third themes represent the progression in their journey in parallel. That is, caregivers report increased gentleness toward oneself with growing emotional awareness, patience, and relief, alongside a shift in injury perception characterized by forward and strength-based thinking. As the journey moved from understanding to application of skills, the fourth theme describes how

caregivers demonstrated behaviour change in everyday contexts, including parenting, parent and child communication, and psychological skill building that improved family dynamics. Aligned with caregiver themes, youth observed at-home changes; they described that their parent was more patient, provided greater autonomy, and used new supportive approaches.

Conclusion: This study shows that caregiver focused interventions can enhance caregiver well-being and family functioning by building knowledge, confidence, and practical skills that carry into daily life. *M&C-C* has the potential to reduce stress and strengthen advocacy skills, supporting better outcomes for families of youth with concussion.

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Survivors Journey: Development, Case Illustration, and Usability of a Digital Intervention for AYA Brain Tumor Survivors

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Abstract

Background: Adolescent and young adult (AYA) survivors of pediatric brain tumors often face persistent challenges related to neurocognitive late effects and overall quality-of-life. Despite these needs, few digital interventions are tailored to their lived experiences. Adapted from the Teen Online Problem Solving (TOPS) intervention, which is standard of care for traumatic brain injury, Survivor’s Journey (SJ) was developed to address this gap through participatory design with AYA survivors and their caregivers.

Objective: This project aimed to develop a digital, family-based problem-solving intervention that reflects the priorities of AYA brain tumor survivors, illustrates its application through a case example, and evaluates preliminary usability and acceptability.

Methods: SJ was created using participatory design with the Childhood Brain Tumor Foundation and an advisory board comprising six brain tumor survivors and three caregivers. Through virtual sessions, AYAs contributed to content creation, including video segments on personal experiences, coping strategies, and school-related challenges. Two usability studies were conducted with three AYAs and three graduate students using structured tasks and a 20-item standardized survey assessing technological, pedagogical, and sociocultural usability. On this survey, scores range from 1 (Strongly Disagree) to 5 (Strongly Agree). A case example of a 21-year-old survivor illustrates pilot session content, goal setting through the SJ problem-solving tool and the Goal Attainment Scale (GAS), and engagement.

Results: Participants found the content relevant and empowering. Early input led to streamlining SJ from ten to eight sessions, with optional supplemental modules addressing the heterogeneity of psychosocial and physical sequelae (e.g., pain management, seizures, initiation). The advisory board emphasized survivor-relevant topics such as sleep, fatigue, emotional regulation, and self-advocacy, and highlighted the importance of caregiver involvement to support skill generalization. Content was tailored by developmental stage (e.g., school vs. work examples) and reading level. Additional interactive exercises (e.g., quizzes on common thinking traps) were developed to increase engagement. Usability testing revealed

navigational and interface challenges (e.g., skipping lessons, task completion uncertainty), prompting quick fixes (e.g., relabeling buttons, clarifying instructions) and deeper redesigns (e.g., lesson locking, enhanced progress indicators). Survey results showed strong pedagogical usability, with high ratings for engagement, learning support, and goal alignment ($M \geq 4.33$). Technological usability was generally positive but showed lower scores for accessibility (Q18, $M = 3.30$). Sociocultural usability was mixed, with strong agreement on bias avoidance (Q19, $M = 4.60$) but lower ratings for inclusivity and social interaction ($M \leq 4.00$). The case participant demonstrated proficiency in four of five goals on the GAS.

Conclusions: Early usability and case illustration demonstrate the value of participatory design with community partners for digital interventions. Ongoing refinements will continue to be guided by survivor feedback, with future plans for broader implementation and evaluation.

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Cognitive-Motor Integration in Varsity Athletes: Associations with Sex, Concussion History, and Sport Contact Level

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Abstract

Background: Cognitive-motor integration (CMI) tasks assess the ability to coordinate perceptual input with motor output. CMI reflects essential brain functions such as attention, decision-making, movement precision, and movement efficiency. Understanding baseline CMI differences across sex, prior concussion, and sport contact exposure can inform the interpretation of these tasks following concussion.

Objectives: To examine whether sex, sport contact exposure, and concussion history are associated with baseline CMI performance in Canadian varsity athletes.

Methods: Prior to the start of their competitive season, varsity athletes completed a tablet-based CMI task (BrDi™) with four conditions: direct, reverse, plane difference, and reverse plane difference. Outcome measures included reaction time (RT; time from target appearance to movement initiation, reflecting perceptual-motor processing and decision-making), variable error (VE; movement endpoint variability, reflecting movement precision), movement time (MT; total time to complete the movement, reflecting motor planning and execution precision), and normalized path length (NPL; a movement efficiency measure, reflecting how directly and smoothly athletes move to the target). Sports were categorized as Non-Contact (Men's and Women's Volleyball), Contact (Men's and Women's Basketball and Soccer; Women's Hockey), or Collision (Men's and Women's Wrestling and Rugby; Men's Hockey). Linear mixed-effects models were fit for each outcome with sex, sport contact category, and concussion history as fixed effects, controlling for condition, and athlete as a random effect. Post-hoc pairwise comparisons examined differences between sport categories within each sex. Effect sizes (Cohen's d) and mean differences with 95% confidence intervals were reported.

Results: A total of 254 athletes (111 females; mean age 20.0±2.0 years) completed the CMI task. Athletes with a history of concussion exhibited slower RTs compared to those without (RT: 0.246±0.007s vs 0.235±0.007s; mean difference = 0.011s; 95% CI [0.001,0.034]; *d*=0.21; *p*=0.041). Males exhibited faster and more precise movements than females, completing the movement faster (MT: 1.23±0.02s vs 1.34±0.02s; mean difference = 0.13s, 95% CI [0.07,0.19]; *d*=0.84; *p*<0.001) with slightly more efficient movement trajectories (NPL: 124.83±1.54 vs 130.21±1.64; mean difference = -5.38, 95% CI [-9.82,-0.94]; *d*=0.24; p=0.018). No significant differences were observed for VE, nor were sport contact category or sex × sport interactions significant for any outcome (p>0.05), and post-hoc comparisons revealed no significant pairwise differences between non-contact, contact, or collision sports.

Conclusion: Baseline CMI performance differs by sex and was influenced by prior concussion, but not by sport contact category. Males demonstrated faster and more precise movements, with a large effect size for movement time, indicating potential relevance for athletic performance. Athletes with a history of concussion exhibited slower reaction times and slightly less efficient movement trajectories, but small effect sizes indicate limited practical impact, indicating sex and prior concussion are associated with preseason CMI performance, whereas sport contact exposure is not.

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Before the Whistle: Using Video-Analysis to Evaluate Utilization Fidelity of Neuromuscular Training Warmups with Adolescent Ringette Players

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Abstract

Background: Ringette has one of the highest reported sport injury rates for adolescent girls, yet there is limited literature regarding ringette-specific injury prevention. The goal of neuromuscular training (NMT) warmups is to reduce injury rates and includes five components: aerobic, agility, strength, balance, and head on neck control. This study aimed to evaluate the utilization fidelity of a ringette-specific NMT warmup [i.e., total time spent in warmup, time spent in each component].

Methods: A quasi-experimental sub-study (SHRed Concussions) including adolescent ringette athletes (ages U14-U19; levels C-AA) during the 2024-25 season (Alberta). Through transdisciplinary collaborations, teams implemented a ringette-specific NMT warmup following a preseason coach workshop. Each month, one game and one practice were filmed then analyzed using Dartfish software.

Results: Seventy-four warmups (40 games, 34 practices) were analyzed across 13 teams. The mean warmup duration was 473.3 seconds. The median time [seconds(s);min-max] spent in each component for off-ice warmups was: aerobic 72.7s (21.6-195.7), agility 47.2s (0-183.3), strength 43.7s (0-165.9), balance 0s (0-50.4), head/neck 0s (0-75.6), and non-NMT 197.2 (0-457.1). For on-ice warmups, the median time spent was: aerobic 35.5s (0-164.5), agility 0s (0-210.5), strength 0s (0-79.5), balance 0s (0-20.7), head/neck 0s (0-59.7), non-NMT 8.9s (0-435.0). The median number of NMT components used per warmup was 3/5 for off-ice and 1/5 for on-ice.

Conclusion: Teams adopted the NMT warmup; however, overall adherence was low, with better implementation off-ice and poor adherence on-ice. Findings highlight the need for transdisciplinary strategies with sport and athlete partners to optimize implementation in adolescent ringette players.

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Examining Foot Control as a Marker of Early Post-Injury Driving Impairment in Adolescents with Mild TBI

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Abstract

Background: Mild traumatic brain injury (mTBI) and motor vehicle crashes are two significant public health issues disproportionately affecting young drivers. mTBI can disrupt neurocognitive and motor processes critical for safe driving. However, little is known about how these impairments manifest in specific control behaviors—such as foot movement—during the early post-injury period.

Objectives: This study compared foot control behaviors in young drivers with mTBI within 10 days of injury to those of matched healthy controls, and examined associations between these behaviors and simulated driving performance. We hypothesized that adolescents with mTBI would exhibit altered foot control behavior patterns—characterized by fewer adaptive movements and delayed responses towards roadway hazards—and that these alterations would be associated with poorer simulated driving performance.

Methods: Thirteen young drivers with mTBI (M = 19.66 years, SD = 2.04) were matched with 13 healthy controls (M = 19.00 years, SD = 2.20) on sex, age, athlete status, and driving experience. Each participant completed two simulated drives featuring a "cut-off" event, where a lead vehicle approached, passed, and abruptly braked – once with and once without a concurrent cognitive load. Events were divided into three temporal windows: (1) approach, (2) passing, and (3) cut-off/brake. Video-recorded foot movements were coded into nine behavior categories (e.g., pedal press/release, wag, hover over brake/accelerator, pedal tap). Simulator-derived performance metrics (e.g., reaction time, velocity, headway distance) were analyzed by temporal window.

Results: During the passing window, controls exhibited significantly more total foot behaviors than the mTBI group (p = .044). Controls also showed slower starting velocities (p = .025), greater headway distance at brake reaction (p = .048), and greater minimum headway distance (p = .024). Across all participants, more total

foot behaviors before the cut-off were correlated with greater headway distance at brake press (p = .021) and minimum headway distance (p = .007), but with lower velocity at cut-off (p = .005) and faster throttle release (p = .028).

Conclusions: Adolescents with mTBI showed early post-injury alterations in foot control and less adaptive responses to roadway hazards, suggesting disruptions in motor coordination. Findings suggest that even within 10 days post-injury, motor control disruptions may pose elevated crash risk. Fine-grained assessment of motor behaviors such as foot control may enhance post-injury driving readiness evaluations and inform return-to-drive guidelines.

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Characteristics of Feasibility and Pilot Studies of Non-pharmacological Interventions for Individuals with Traumatic Brain Injury or their Families: A Scoping Review

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Abstract

Background: Pilot and feasibility studies are important in the development of meaningful and effective interventions for individuals with traumatic brain injuries (TBI). They are often used to refine intervention design and prepare for larger studies. However, terminology and methods for pilot and feasibility studies are applied inconsistently and reporting practices lack standardization. This variability creates challenges for conducting and evaluating important early phase research. This scoping review provides an overview on existing TBI intervention studies and synthesizes the reporting of feasibility and pilot intervention research.

Objectives: To survey evaluation metrics used in pilot and feasibility studies of non-pharmacological interventions for people with TBI and their families. Aims were to (1) describe the reporting of intervention studies; and (2) provide guidance on key considerations for conducting feasibility and pilot research in TBI.

Methods: The review followed Arksey and O'Malley's framework with extensions from Levac et al. and adhered to PRISMA-ScR checklist. Four databases: (1) Ovid MEDLINE, (2) EMBASE, (3) CINAHL, and (4) PsycInfo were searched. Included studies were peer-reviewed evaluations of non-pharmacological interventions for people with TBI and/or their family members that were described as pilot and/or feasibility work. Data were extracted on study characteristics, intervention characteristics, and pilot/feasibility design metrics.

Results: After screening titles and abstracts of 9,342 articles, 539 studies were eligible for full-text review, with 155 meeting inclusion criteria. Publication dates ranged from 2003 to 2024. Most studies used quantitative methods (n=105; 67.7%), followed by mixed/multi (n=48; 30.9%), and qualitative (n=2; 1.3%) approaches. Common designs included randomized controlled trials (n=35; 22.6%), pre–post designs (n=20; 12.9%), and case-studies (n=18; 11.6%); several didn't provide detail to classify design (n=19; 12%). Intervention focus varied, with psychology (n=31, 20%), cognitive (n=30, 19.3%), and exercise rehabilitation (n=23, 14.8%) being the most common. Fifty-four studies were described as feasibility studies (34.8%), thirty-two as pilot (20.6%), and sixty-nine used both labels (feasibility and pilot; 44.5%). Among studies using feasibility or combined labels (n=123), only 18.6% provided a definition of feasibility (n=23), and 10.5% operationalized feasibility metrics by referencing frameworks/guidelines (n=11) or prior literature (n=2); the remainder did not have an operational approach (n = 110; 89.4%). Despite this, most

feasibility/combined studies reported quantitative metrics (n=113; 91.8%), and efficacy/outcome data (n=92; 74.7%). Pilot-only studies (n=32) rarely provided a definition of “pilot” (n=1; 3.2%) and primarily evaluated outcomes with hypothesis-testing (n=31; 96.8%), occasionally drawing feasibility inferences (n=5; 15.6%).

Conclusion: Mapping pilot and feasibility studies of TBI interventions highlights inconsistent definitions and limited operationalization following best practice recommendations. Findings emphasize the need for clear terminology, evidence-based consensus frameworks, and routine reporting of metrics to strengthen early-phase research studies.

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Changes in Multifaceted Measures Following Sports-Related Concussion in Schoolboy Rugby Players: A Case Series

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Abstract

Background: Concussion is a common injury in adolescent contact sport, yet recovery trajectories across multiple physiological domains are not well understood. Evaluating changes in symptoms, neck strength, exercise tolerance, and vestibulo-ocular reflex (VOR) function throughout recovery may help inform safe return-to-play (RTP) decisions.

Objectives: To evaluate changes in symptoms, neck strength, exercise tolerance, and VOR function in schoolboy rugby players following sports-related concussion (SRC) and during recovery.

Methods: Male schoolboy rugby players (aged 15–19 years) completed preseason baseline assessments including the Post-Concussion Symptom Scale (PCSS; 0–132), isometric neck strength (normalised to bodyweight, N/kg), modified Buffalo Concussion Treadmill Test (mBCTT; maximal heart rate [bpm], rate of perceived exertion [0–10], and time to cessation [s]), and horizontal VOR gain using video-oculography. Players diagnosed with SRC were reassessed weekly until medical clearance. Between-time comparisons were performed using non-parametric analyses.

Results: Sixteen players sustained SRC (median age 17.0 years, IQR 16.0–18.0). The median time to first post-injury assessment was 4 days (IQR 3.0–5.75), and median time to medical clearance was 20 days (range 10–29). At clearance, 69% of players had at least one unresolved measure: symptoms (38%), neck strength (42%), mBCTT performance (27%), or VOR gain (42%). Symptom severity increased acutely after injury (+10 points, IQR 6.0–33.0) but returned to baseline by clearance. Neck strength decreased initially (–1.22 N/kg, $p = 0.003$) but normalised by clearance. mBCTT time to cessation decreased early (–180 s, $p = 0.011$) but exceeded baseline by clearance (+49 s, $p = 0.008$). VOR gain declined slightly post-injury ($p = 0.04$). Match concussion incidence was 9.03 per 1000 match hours.

Conclusion: Despite clinical recovery, 69% of players exhibited at least one unresolved physiological or performance measure at the time of medical clearance. These persistent deficits highlight the need for multimodal assessment during

concussion recovery and support the inclusion of neck strength, exertional tolerance, and VOR testing to guide RTP decisions in youth athletes.

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Development of the Melbourne Paediatric Concussion Scale (MPCS) through expert workgroup consensus

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Abstract

Background: Following a concussion, post-concussion symptoms (PCS) are expected to resolve within four-weeks of injury. However, persisting PCS (pPCS) have been reported in around 30% of children and adolescents. Symptom scales are pivotal to concussion assessment and management, with symptom measurement among the most utilised approaches for evaluating outcome and recovery post-concussion. To better support clinicians, symptom scales ideally need to be able to assist diagnosis, monitor recovery, identify those at risk of pPCS, and guide treatment. Many of the commonly utilised symptom scales for paediatric concussion were not designed to address all these clinical functions.

Objectives: To develop a revised version of an existing symptom scale through expert workgroup consensus, that could be used to support clinician decision making about treatment and improve how symptom recovery is monitored over time.

Method: The Post-Concussion Symptom Inventory (PCSI) was revised through a consensus process involving clinician researchers with expertise in paediatric concussion. The clinician group included clinicians across rehabilitation, emergency medicine, physiotherapy, and psychology disciplines. The primary revisions, consisting of additional items, were discussed among clinicians until unanimous agreement. Items in the final symptom list were subsequently classified into symptom domains.

Results: The Melbourne Paediatric Concussion Scale (MPCS) is a modified version of the PCSI, that was developed to improve the subacute management of paediatric concussion. Specifically, the adaptations aimed to support clinician decision making about appropriate treatment, and improve the way that recovery was monitored over time. With the input of clinicians from several clinical disciplines, the PCSI was modified to include ten additional items, each reflecting a specific symptom or clinical problem intended to inform decisions about treatment. MPCS items were classified into nine symptom domains: neurological, cognitive, mood, behaviour, autonomic, sleep, cervical, vestibular, and hormonal.

Conclusions: The MPCS was developed by an expert team of clinician researchers with expertise in paediatric concussion, with the aim of improving the subacute management of paediatric concussion. The revised measure, with additional items and domain classifications, provides clinically important information above that of the PCSI.

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Exploring the Effects of Cannabidiol on Blood Pressure Regulation in a 9-Year-Old Boy with 38% of his Brain Surgically Remove at Birth: Case Study

J. Patrick Neary[1], Annabelle Manalo-Morgan[2], Ovesh Purahoo[1], James White[1], Amir Rajaei[1], Jyotpal Singh[3], Payam Dehghani[3]

[1]University of Regina, Regina, Canada. [2]Vanderbilt University, Nashville, United States. [3]Saskatchewan Health Authority, Regina, Canada

Abstract

Background: Participant MM is a 9-year-old boy who had 38% of his brain (left occipital lobe, left parietal lobe and parts of his left temporal lobe) surgically removed at 5-weeks of age due to epileptic seizures as an infant. Seizure medications (Oxcarbazepine, Lorazepam, Phenobarbital, Levetiracetam, and Vimpat) were prescribed and used therapeutically until age 6-months. Thereafter, he was administered 100% cannabidiol (CBD) at a dose of 50 mg/day using a gastrointestinal feeding tube. His prescribed seizure medications were reduced and only given intermittently during a seizure event. Participant MM has functioned as an active health child reaching cognitive, physical and emotional milestones.

Case History: Participant MM was assessed in the Exercise Physiology Laboratory on two separate occasions back-to-back on Day 1 and Day 2 at the same time of the day. Day 1 was without his normal medications (CBD and Oxcarbazepine), on Day 2 he was administered oral 100 mg CBD with his morning breakfast approximately 60 minutes prior to assessment. Briefly, he completed a modified Neary Protocol by doing a 30-minute seated resting period. On Day 1, when MM did not take his medication and presented to the laboratory, he appeared more anxious and "fidgety." On Day 2, following his normal CBD medication prescription, MM presented as much "calmer." On both visits to the laboratory, non-invasive blood pressure (BP) was continuously recorded for 30 minutes in a seated position using finger photoplethysmography (Finapres NOVA). Wavelet transformation was applied to the collected BP signal, allowing separation into cardiac interval (0.6-2Hz), respiratory interval (0.145-0.6 Hz), and smooth muscle cell (myogenic) interval (0.052-0.145 Hz).

Conclusions: Decreased median WT amplitude was observed in the cardiac interval (0.6-2Hz) on Day 2 (median = 0.011, IQR = 0.30) compared to Day 1 (median = 0.15, IQR = 0.26). Conversely, median WT amplitude was increased in the smooth muscle cell (myogenic) interval (0.052-0.145Hz) on Day 2 (median = 0.056, IQR = 0.072) compared to Day 1 (median = 0.040, IQR = 0.049). The present findings showed a modulatory effect of CBD on resting blood pressure oscillations in participant MM, by decreasing cardiac influences and increasing myogenic-related influences likely associated with intrinsic vasomotion of vascular smooth muscle cells and thus can be interpreted as indicative of altered cardiovascular regulation. This pattern suggests a shift from central cardiac-driven haemodynamics toward enhanced local vascular autoregulation as a compensatory mechanism to maintain microcirculatory

perfusion and tissue oxygenation when CBD is administered. It is likely that the endocannabinoid system was stimulated by the cannabinoid administration and warrants further investigation.

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Differences in Wavelet Transformation of Resting Cerebral Blood Flow Velocity following Cannabidiol Administration in a 9-year-Old Boy Missing 38% of his Brain: Case Study

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[1]University of Regina, Regina, Canada. [2]Vanderbilt University, Nashville, United States. [3]Saskatchewan Health Authority, Regina, Canada

Abstract

Background: Participant MM is a 9-year-old boy who had 38% of his brain (left occipital lobe, left parietal lobe and parts of his left temporal lobe) surgically removed at 5-weeks of age due to epileptic seizures as an infant. Seizure medications (Oxcarbazepine, Lorazepam, Phenobarbital, Levetiracetam, and Vimpat) were prescribed and used therapeutically until age 6-months. Thereafter, he was administered 100% cannabidiol (CBD) at a dose of 50 mg/day using a gastrointestinal feeding tube. His prescribed seizure medications were reduced and only given intermittently in the event of a seizure. MM has functioned as an active health child reaching cognitive, physical and emotional milestones.

Case History: Participant MM was assessed in the Exercise Physiology Laboratory on two separate occasions back-to-back on Day 1 and Day 2 at the same time of the day. Day 1 was without his normal medications (CBD and Oxcarbazepine), and on Day 2 he was administered oral 100 mg CBD with breakfast, approximately 60 minutes before assessment. On day 2, following his normal CBD medication, MM presented as much "calmer." Briefly, he completed a modified Neary Protocol by doing a 30-minute seated resting protocol. On both visits to the laboratory, a 5-minute assessment of the right middle cerebral artery (MCA) blood flow velocity was completed using transcranial Doppler ultrasonography (TCD). The 5-minute recording was preceded by 25 minutes of seated rest with the TCD operational for the 30-minutes. Wavelet transformation was applied to the collected MCA signal allowing separation into cardiac (0.6-2Hz), respiratory (0.145-0.6 Hz), and smooth muscle cell (myogenic) interval (0.052-0.145 Hz).

Conclusions: Decreased median WT amplitude was observed in the cardiac interval (0.6-2Hz) on Day 2 (median = 0.12, IQR = 0.32) compared to Day 1 (median = 0.15, IQR = 0.28). Furthermore, a decreased median amplitude in the smooth muscle cell range (0.052-0.145Hz) was observed on Day 2 (median = 0.033, IQR = 0.039) compared to Day 1 (median = 0.061, IQR = 0.070). The observed reductions in median wavelet transform (WT) amplitude in the cardiac frequency band (0.6–2 Hz) and smooth muscle cell frequency band (0.052–0.145 Hz) on Day 2 (post-CBD administration) compared to Day 1 (pre-CBD administration) suggests a dampening of cerebral blood flow (CBF) oscillations. These frequency bands in TCD analysis reflect sympathetic cardiac-driven pulsatility and myogenic vascular tone, respectively. A decrease in amplitudes indicates reduced vascular pulsatility and

tone, potentially due to a shift toward vasoconstriction or stabilization of cerebral autoregulation, rather than vasodilation. This is particularly relevant in a paediatric context, where baseline vascular reactivity may differ from adults due to immature autoregulatory mechanisms. The results suggest that CBD modulates the cardiac and smooth muscle cell (myogenic) contribution to cerebral blood flow in participant MM.

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Effects of Cannabidiol on Cardiovascular Autonomic Function of a 9-Year-Old Boy with 38% of his Brain Surgically Remove at Birth: Case Study

James White[1], Ovesh Purahoo[1], Amir Rajaei[1], Annabelle Manalo-Morgan[2], Jyotpal Singh[3], Payam Dehghani[3], J. Patrick Neary[1]

[1]University of Regina, Regina, Canada. [2]Vanderbilt University, Nashville, United States. [3]Saskatchewan Health Authority, Regina, Canada

Abstract

Background: Participant MM is a 9-year-old boy who had 38% of his brain (left occipital lobe, left parietal lobe and parts of his left temporal lobe) surgically removed at 5-weeks of age due to epileptic seizures as an infant. Seizure medications (Oxcarbazepine, Lorazepam, Phenobarbital, Levetiracetam, and Vimpat) were prescribed and used therapeutically until age 6-months. Thereafter, he was administered 100% cannabidiol (CBD) at a dose of 50 mg/day using a gastrointestinal feeding tube. His prescribed seizure medications were reduced and only given intermittently during a seizure event. MM has functioned as an active health child reaching cognitive, physical and emotional milestones.

Case History: Participant MM was assessed in the Exercise Physiology Laboratory on two separate occasions back-to-back on Day 1 and Day 2 at the same time of the day. Day 1 was without his normal medications (CBD and Oxcarbazepine), and on Day 2 he was administered oral 100 mg CBD with his morning breakfast, approximately 60 minutes before assessment. On both visits to the laboratory, resting heart rate and blood pressure were collected over 30 minutes in a seated position using a 3-lead electrocardiograph (ECG) and finger photoplethysmography (Finapres NOVA), respectively. The final 5-minute recording was used for analysis of the data, using Kubios HRV and Ensemble R software to examine differences in heart rate variability (HRV), blood pressure variability (BPV), and blood pressure sensitivity (i.e., baroreflex sensitivity, BRS), respectively.

Conclusions: During Day 2, MM presented with a higher average heart rate (80.7 vs 71.5 bpm), lower R-R interval (743.3 vs 839.2 ms), increased low frequency (LF)/high frequency (HF) ratio (1.4 vs 0.4), decreased BRS (24.1 vs 30.0 ms/mmHg) and BPV (159.4 vs 211.1 mmHg^2) on Day 2 compared to Day 1. Taken together, these results suggest a decreased BRS after CBD administration and may reflect a temporary attenuation of the autonomic reflex mechanism that regulates heart rate in response to blood pressure changes. Chronic CBD treatment has been shown to improve BRS overall by reducing sympathetic nerve activity and enhancing vascular function. Decreased BPV (211.1 to 159.4 mmHg^2) on Day 2 in participant MM indicates greater stability in blood pressure. In the context of CBD administration, this reduction suggests improved autonomic balance and cardiovascular regulation. Acute and chronic CBD dosing has demonstrated antihypertensive properties in human studies, potentially through mechanisms like reduced sympathetic dominance and normalized spectral blood pressure components (e.g., low-frequency power and

LF/HF ratio). Overall, these changes after acute CBD intake may contribute to the therapeutic potential in managing and improving autonomic function resulting from CBD administration in MM.

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How Well Are They Doing It? a Secondary Evaluation of the Dose-Response Relationship Between a Rugby-Specific Neuromuscular Training Warm-Up and the Hazard of Concussion in Canadian High School Girls’ Rugby

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Abstract

Background: The highest concussion rate (CR) previously reported in rugby union was in Canadian girls’ high school rugby (37.5 concussions/1000 game-hours). A rugby-specific neuromuscular training (NMT) warm-up (aerobic, agility, balance, strength, head-on-neck exercise components) reduced game-CRs 59% when used ≥3 times per week in English schoolboy rugby. A similar NMT program implemented among Canadian high school girls showed no significant reduction in CRs in intent-to-treat (Incidence Rate Ratio [IRR]=0.76, 95% CI: 0.50–1.15) or per-protocol (IRR=0.75, 95% CI: 0.47–1.19) analysis. Coach-reported weekly utilization (median=3.3; range: 0-4) suggested strong engagement where 10/17 teams reported NMT use ≥3x/week. A more objective assessment of adherence may better reflect the association between use and concussion risk.

Objectives: To examine the dose-response relationship between adherence, using video-assessed program fidelity to a rugby-specific NMT warm-up, and CR in Canadian high school girls’ rugby (age 14-18).

Methods: This is a secondary analysis of a quasi-experimental study that compared CRs across two Calgary, Canada high school girls’ rugby cohorts (control seasons 2018, 2019; intervention seasons 2022, 2023). Prior to the 2022 and 2023 seasons, coaches attended workshops introducing the rugby-specific NMT warm-up. Research personnel filmed one game and one practice warm-up per team to validate program use. This analysis included only intervention teams. The primary outcome was therapist-validated suspected game-concussion. Adherence was assessed by video-assessed program fidelity (None, Low, Medium, High) based on two criteria (completing ≥80% of exercises in program; ≥50% of exercises in each component completed). Cox proportional hazards models estimated hazard ratios (HRs; 95% CIs) to compare teams across levels of adherence, adjusted for age, concussion history, and team playing division, clustered by team.

Results: In total, 468 players (N=17 teams) participated across two intervention years (3,817.5 game-hours). Median time to game-concussion was 3 game-hours (Interquartile-range: 1.5–5.5). Video-based fidelity differed between game and practice settings. Four teams had high practice NMT program fidelity, and one had high game fidelity. Relative to those with no practice NMT program fidelity, those with low (HR=1.064; 95% CI: 0.580-1.951) and medium (HR=0.749; 95% CI: 0.495-1.132) practice fidelity showed no association with concussion; however, those with high practice fidelity had a 40% lower hazard for game-concussion (HR=0.598; 95% CI: 0.359–0.995). Similarly, those with high game program fidelity had a 38% lower hazard of game-concussion (HR=0.622; 95% CI: 0.473–0.810) compared to those with no game fidelity. For every year increase in age, the hazard of game-concussion was 24% lower (HR=0.762; 95% CI: 0.589–0.986).

Conclusion: Higher adherence to a rugby-specific NMT warm-up was associated with a lower hazard of game-concussion. A potential dose-response between practice program completion and concussion exists. Future concussion prevention research should focus on supporting NMT warm-up adherence and ensure optimal fidelity.

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Brain Criticality Under Sedation Amplifies EEG Predictive Biomarkers of Recovery Across the Lifespan in Severe Brain Injury

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Abstract

Introduction: The critical brain hypothesis suggests that optimal brain function emerges at the edge of order and chaos—a state balancing stability and flexibility that supports adaptability. Electroencephalography (EEG) can assess levels of consciousness anesthesia in adults using features that quantify neural criticality, such as Permutation Entropy, Lempel–Ziv Complexity, Higuchi Fractal Dimension, detrended fluctuation analysis (DFA), and spectral slope. This study explores the comparative prognostic value of criticality-related EEG features recorded during drug-free and sedation states in severely brain injured children. To test the generalizability of our pediatric model, we also evaluated lifespan models by combining data from pediatric and adult patients with severe brain injury. We hypothesized that EEG features recorded under steady-state sedation would better predict functional outcomes than drug-free baseline recordings, reflecting anesthesia's ability to reveal latent neural dynamics associated with recovery potential.

Methods: EEG was collected at the bedside from children (n = 32, 5–16 y) and adults (n = 50, 19–88 y) admitted to the intensive care unit with severe brain injury. EEG was recorded while participants were exposed to GABAergic sedation (propofol or midazolam) and during drug-free periods. Data were preprocessed using MNE-Python and Autoreject, segmented into 10-s artifact-cleaned epochs, and analyzed using NeuroKit, FOOOF, and SciPy to extract features. The patients' functional outcome was measured around three months after discharge from the ICU using the Glasgow Outcome Scale-Extended (GOS-E) and binarized into good (GOS-E ≥ 4) and poor recovery groups. Mann–Whitney U tests with false-discovery-rate correction were used to compare features across recovery groups; cross-validated machine-learning models were applied to combined pediatric and adult datasets to assess predictive accuracy across baseline and sedation states.

Results: In the pediatric cohort, sedation enhanced the discriminative power of criticality-related EEG features. Under baseline conditions, four features (Sample Entropy, Lempel-Ziv Complexity, DFA, FOOOF Slope) significantly differentiated recovery groups. During sedation, these remained significant and three additional features (Permutation Entropy, Lyapunov Exponent, Higuchi Fractal Dimension) emerged, yielding 7/9 significant features. In lifespan-trained machine-learning models integrating pediatric and adult data, classifiers trained on sedation features achieved higher predictive accuracy (AUC = 0.82 ± 0.04) than those trained on baseline features alone (AUC = 0.70 ± 0.06), confirming that sedation amplifies recovery-relevant EEG signatures across age groups.

Conclusions: EEG markers of neural criticality measured under GABAergic sedation outperform drug-free baseline in predicting recovery after severe brain injury, both in pediatric and adult patients. Sedation appears to unmask latent critical dynamics linked to residual consciousness capacity. These findings support the use of sedation-state EEG paradigms as a powerful prognostic tool across the lifespan and advance the understanding of critical brain dynamics underlying recovery potential after severe brain injury.

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Does Neighborhood Noise and Light Pollution Influence Pediatric and Adolescent Concussion Recovery?

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Abstract

Background: Up to 67% of youth report sleep changes after concussion, which is associated with increased risk of prolonged recovery beyond the typical 28 days. Clinical assessments for sleep often focus on biological or behavioral factors, overlooking the potential impact of environmental exposures. Given that urban light and noise pollution are disruptors of healthy sleep, examining their association with clinical outcomes may reveal insights into how environmental context influences recovery after concussion.

Objectives: The aim of this study was to investigate whether neighborhood level noise and light pollution influence concussion recovery. Specifically, we hypothesized patients living in highly noise and light polluted areas would show greater prevalence of prolonged recovery compared to those in low noise and light pollution areas.

Methods: We analyzed data from a cohort of pediatric patients (n=3,328) aged 5–18 years, collected between January 2020 and July 2025. Patient demographic characteristics and clinical outcomes were used to determine recovery duration. Environmental exposure data were obtained from NASA's Artificial Light at Night (ALAN) satellite dataset, which measures average nighttime radiance ($W \cdot sr^{-1} \cdot m^{-2}$), and from the U.S. Department of Transportation's National Transportation Noise Map estimating the proportion of residents exposed to noise levels exceeding 50 dB from road, air, and rail sources. Patient addresses were geocoded to corresponding census tracts for spatial linkage with environmental data. Spatial analysis was performed using Local Indicators of Spatial Association (LISA) to identify geographic clusters where light and noise exposure were significantly high or low. A univariate regression model was used to examine independent factors associated with sleep disturbance. Significant variables from the univariate model were included in the multivariate model to assess individual effects of sex, concussion history, light, noise, and sleep disturbance on prolonged recovery. Prolonged recovery was defined as remaining in care >28 days.

Results: A total of 2,323 patients were included in analyses (average age=13.56 years; 50% female). 64% of patients reported a change to their sleep since injury. In a univariate analysis, age (OR 1.09, 95% CI 1.06–1.12) and sex (OR 1.43, 95% CI 1.24–1.64) were significantly associated with sleep disturbance, while light and noise pollution were not significant factors. After adjusting for characteristics significantly associated with prolonged recovery in the univariate analysis, female patients had

increased odds of prolonged recovery (OR 1.79, 95% CI 1.56–2.06), as did those who reported sleep disturbance (OR 2.52, 95% CI 2.18–2.92).

Conclusion: This study examined integrating environmental health and clinical recovery data to better support pediatric concussion patients but found no association for noise and light pollution with recovery. Although only female sex and sleep disturbance were associated with prolonged recovery, we encourage future research to explore other types of environmental context in concussion management.

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Associations Between Cumulative DAMAGE and Neurocognitive Outcomes in Youth Football Athletes

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Abstract

Background: Repetitive head impacts are an ongoing public health concern, yet the relationship between head impact exposure (HIE) and adverse cognitive outcomes in football remains unclear. This uncertainty is particularly concerning for young athletes who are still undergoing critical brain development in areas such as the prefrontal cortex, which is responsible for executive functions like working memory and inhibitory control. While head kinematic measures offer insight into impact characteristics, they cannot directly quantify tissue-level brain deformation or predict potential cognitive impairments. Finite element (FE) models address this limitation by providing robust estimations of brain strain, but their complexity and computational demand render them challenging for real-time use. DAMAGE (Diffuse Axonal Multi-Axis General Evaluation) is a metric that uses fundamental principles of motion, informed by kinematic time history data, to rapidly estimate maximum brain strain, thus providing a more efficient alternative to FE modeling.

Objective: To evaluate the relationship between cumulative DAMAGE and pre- to post-season changes in cognitive performance and explore the effect of cumulative exposure on relationships.

Methods: Youth football athletes (n= 46) were instrumented with custom mouthpieces measuring head acceleration events (HAEs) across two football seasons. A total of 6,360 visually-verified HAEs were collected. DAMAGE was calculated to estimate brain strain and summed to calculate cumulative DAMAGE. Additionally, athletes completed neurocognitive testing at pre-season and post-season timepoints, including the ImPACT, NIH Toolbox, and the modified Behavior Rating Inventory of Executive Functioning (mBRIEF). A generalized linear model was used to examine the relationship between cumulative DAMAGE values and post-season cognitive test scores, controlling for pre-season performance. No additional covariates were included in the model.

Results: Greater cumulative DAMAGE was significantly associated with slower post-season reaction time ($p < 0.0001$). Likewise, higher cumulative DAMAGE for all HAEs was significantly associated with poorer post-season executive functioning ($p < 0.0001$). Increased cumulative DAMAGE was also associated with reduced working memory performance ($p < 0.0001$).

Conclusions: Results suggest that overall cumulative DAMAGE across a football season is a meaningful predictor of cognitive change. Greater cumulative exposure was associated with slower reaction time, poorer executive functioning, and reduced

working memory (ImPACT, BRIEF, NIH Toolbox), indicating that total exposure may contribute to declines in these domains Future work will explore how specific factors, such as playing position, age, and time played, may influence patterns of cumulative brain strain and, in turn, cognitive outcomes. Specifically examining differences across playing positions may help clarify whether certain roles are associated with disproportionately higher strain and greater risk for cognitive decline.

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From the Trauma to the Trajectory: Increased Prevalence of Autism Spectrum Disorder following Abusive Head Trauma

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Abstract

Background: Abusive head trauma (AHT) is the most common cause of head trauma in infants and young children and is associated with significant neurodevelopmental sequelae. An injury occurring in an immature brain has the potential to diffusely affect ongoing neural network development. As autism spectrum disorder (ASD) is associated with widespread disruptions of network connectivity, infants and children with abusive head trauma could have increased risk for autism spectrum disorder. However, the prevalence and risk factors for ASD following AHT remain unknown.

Objectives: To determine the prevalence and timing of autism spectrum disorder in a cohort of children with abusive head trauma followed by a multidisciplinary child head injury program.

Methods: Retrospective single-center observational study of 125 children who sustained abusive head trauma before 48 months of age. Patient characteristics were reported as frequencies and proportions for categorical variables and as median, interquartile range (IQR) for continuous variables. Differences between groups were determined by Fisher's exact test for categorical variables and Kruskal-Wallis test for continuous variables. Analyses were performed on Stata version 18.5 (StataCorp LLC, College Station, TX, USA) and SPSS version 29(IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp). A p-value of <0.05 was considered statistically significant.

Results: Autism Spectrum Disorder was present in 13.6% of children with AHT, with a median age at diagnosis of 28 months (IQR 22, 37). Twenty-one (16.8%) of additional children within this cohort had clinical concern for autism at some point during their clinical follow-up but were ultimately not diagnosed with ASD. Of the total group of children with clinical concern for ASD, the children ultimately receiving a formal diagnosis of autism presented with behavioral and communication concerns at a younger age than those with clinical concern not diagnosed with ASD (17 months, 13-21 vs 21 months, 16-48). Interestingly, sex, age at AHT, and other sociodemographic variables were not associated with ASD. However, increased injury severity score, reflecting more severe clinical presentation, was significantly associated with a diagnosis of ASD following AHT. Additionally, children with continued follow-up within our institute were significantly more likely to be diagnosed with ASD.

Conclusion: Autism spectrum disorder is notably more prevalent in infants and children with abusive head trauma (13.6%) compared to the general population

(3.2%). Independent of sociodemographic susceptibility, significant brain injury at a young age may disrupt neurodevelopmental processes and connectivity, increasing the risk for autism spectrum disorder. These findings support long-term neurodevelopmental follow-up after abusive head trauma.

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The Feasibility of Fit ABCS: A Web-based Resource that Guides Community Fitness Instructors in the Delivery of a Group Exercise Program for Pediatric Brain Tumor Survivors

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Abstract

Background: Our team developed a group exercise program for pediatric brain tumor survivors (PBTS) with the primary goal of improving cognition. Following a successful pilot study where hospital staff with neuro-oncology expertise delivered the program in the community, we developed a web resource (Fitness to Aid the Brain and Cognitive Skills [Fit ABCS]) that guides community fitness instructors in the delivery of the program. Fit ABCS content was informed by a scoping review and input from health/fitness professionals.

Objectives: Evaluate the feasibility of a community-led group exercise program for PBTS using Fit ABCS.

Methods: The 12-week exercise program (3 sessions per week, 90-minute sessions) involved PBTS (6-17 years old) who were recruited through the Neuro-Oncology Program at the Hospital for Sick Children (Toronto, Canada). Participants completed assessments (cognitive, physical, cardiovascular fitness, neuroimaging, health-related quality of life questionnaires) at baseline, post-intervention, and three-month follow-up. Community fitness instructors were not required to have previous experience with PBTS. They received training about the program and PBTS via Fit ABCS and then used Fit ABCS to plan exercise sessions, document attendance, and report session challenges/successes. Each instructor also completed a one-time Instructor Feedback Questionnaire at the conclusion of an exercise cohort/group. Primary feasibility indicators (participant recruitment, attendance, adherence; instructor adherence [2], acceptability [2]) were evaluated with Bayesian statistics.

Results: Ten fitness instructors (none with PBTS experience) facilitated 5 program cohorts involving a total of 16 PBTS. Posterior means for participant recruitment (14%), adherence (33%), and attendance (78%) fell below *a priori* targets (20%, 80%, 80%, respectively). Posterior means for instructor adherence (95%, 97%) and acceptability ratings (81%, 82%) surpassed *a priori* targets (80%). Posterior probabilities fell below our 80% target for all indicators except instructor adherence. Thirteen of the 16 PBTS attended greater than 80% of the exercise sessions. Fifteen, 12, and 11 youth completed the baseline, post-intervention, and 3-month follow-up assessments, respectively. Fatigue and/or time constraints limited completion of the entire cognitive assessment, which affected adherence rate. 100% of instructors indicated that the Fit ABCS Instructor Training Module contained all the necessary information for leading the exercise program, but they suggested expanding video examples of PBTS' cognitive and physical challenges to include clips from actual

program sessions. 80% of instructors felt the Fit ABCS Activities Library had all the necessary information and suggested an option to add/modify exercises.

Conclusions: Based on feasibility outcomes and study team observations, we developed recommendations to increase the success of future exercise trials for PBTS: provide consistent, comprehensive instructor training, document and reflect on exercise sessions, conduct multi-site research involving more diagnostic groups (i.e., different types of acquired brain injury or cancer), minimize participant burden, and obtain program-specific feedback from instructors and participants.

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When Recovery Isn’t Reassurance: Parental Stress After Neurocritical Illness is Independent of their Child’s Motor Status

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Abstract

Background: Children admitted to the pediatric intensive care unit (PICU) with neurocritical illness often experience residual motor deficits following hospital discharge. Studies have shown that parents of children with physical disabilities have higher levels of stress than parents of children without physical disabilities. Although parental stress has been evaluated in relation to chronic physical disability, the relationship between parental stress and new-onset motor impairment in children recovering from neurocritical illness has not been well-described.

Objective: The aim of this study is to determine whether parental stress correlates with the presence of residual motor deficits in children discharged from the PICU following neurocritical illness.

Methods: A single-center observational study of children with neurocritical illness followed by a multidisciplinary post-intensive care clinic. Neurodevelopmental sequelae, including motor deficits, were characterized in clinic notes as well as the “motor” value of the Functional Status Scale. Parental stress was measured at the first clinic visit using the Impact of Event Scale- Revised (IOE-R), a widely used tool for assessing post-traumatic stress in adults. Patient characteristics were reported as frequencies and proportions for categorical variables and as median and interquartile range (IQR) for continuous variables. Differences between groups were determined by Fisher’s exact test for categorical variables and Kruskal-Wallis test for continuous variables. Analyses were performed on Stata version 18.5 (StataCorp LLC, College Station, TX, USA) and SPSS version 29(IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp). A p-value of <0.05 was considered statistically significant.

Results: Our cohort included 115 children admitted to the PICU for a variety of neurological diagnoses, with infectious/inflammatory (28%), vascular (22%), status epilepticus (16%) and TBI (15%) being the most common categories. The average age at admission was 5 years (IQR 0.1 - 10.1 years). The length of PICU admission was 9 days (IQR 4, 24) and overall hospital stay averaged 27 days (IQR 10, 53). Children were first seen in clinic 36 days (IQR 17, 52) following hospital discharge, with 55% of the cohort experiencing new motor deficits. Parental stress was reported in 96% of the cohort, with 56% of parents endorsing moderate to severe stress (> 23 on the IOE-R); however, there was no significant association between the presence or severity of parental stress and the presence of new motor deficits in children.

Conclusion: Post-PICU parental stress is a significant concern, reported by 96% of parents in our cohort. While parents of children with physical disabilities are reported to experience more stress, the traumatic stress in parents following a child's critical illness appears to be independent of new motor deficits. This data emphasizes the importance of measuring parental stress for all parents of children followed in a post-intensive care clinic.

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Physician follow-up informs more conservative return-to-play but lower risk of recurrent sport-related concussion

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Abstract

Background: Current international consensus statements recommend medical follow-up by a physician or qualified health care provider following a sport-related concussion (SRC). However, adolescent athletes often continue to navigate return-to-play (RTP) independently, which may have implications on time-to-RTP and recurrent-SRC.

Objective: To evaluate time-to-RTP following a SRC with and without physician-diagnosis and the odds of a same-season recurrent-SRC in in adolescent (10-19 years) participating in American football, ice-hockey, ringette and rugby.

Methods: This is a sub-study within the larger "SHRed Concussions" cohort. Adolescents participating on teams were recruited at the beginning of their seasons. Individual participation for practices and games was collected throughout the season. If a suspected-concussion occurred, injury report forms were completed and then validated by a study clinician (e.g., Athletic therapist, physiotherapist). Participants with a suspected-SRC were offered an assessment with a study physician. Cox-proportional hazard ratios (HR) were used to evaluate time-to-RTP (days) by physician-diagnosis (yes/no). Sex (male/female), sport (football, ice-hockey, ringette, rugby), and self-reported concussion severity (5-point Likert scale; 1=Unable to perform activities-of-daily-living; 5=Able to participate as if there was no injury) were included, clustering on individual to account for multiple concussions. Firth logistic regression was used to estimate the odds of same-season recurrent-SRC by physician-diagnosis of their index-SRC (yes/no), sex and sport.

Results: Between 2021/22–2023/24, 1022 concussions in 837 adolescents participating on football, ice-hockey, ringette or rugby teams were reported. Concussions occurring in a different sport or outside the season were excluded (n=149). Of the 843 in-season suspected-SRC, 674 (77.21%) adolescents sought physician-diagnosis, whereas 153 (17.53%) had no physician assessment. It was determined that 49 suspected-SRC (7.27%) did not meet diagnosis criteria after a physician assessment and were excluded. Therefore, 824 SRC in 708 adolescents were included, with 49 adolescents (6.92%) sustaining a same-season recurrent-SRC.

Physician-diagnosis (HR=0.03, 95%CI;0.01-0.05), female sex (HR=0.73, 95%CI;0.60-0.87), and greater self-reported concussion severity (HR=0.86, 95%CI;0.80-0.94) were associated with longer time-to-RTP. Relative to ice-hockey, football (HR=0.54, 95%CI;0.32-0.93) and rugby (HR=0.55, 95%CI;0.33-0.92) SRC took longer to RTP where as no difference in time-to-RTP was found for ringette SRC (HR=1.10, 95%CI:0.57-2.14). Athletes with a physician-diagnosed-SRC had a 55% lower-odds of a same-season recurrent-SRC compared to athletes with no physician assessment (OR=0.45, 95%CI;0.23-0.86). No association was found with sex or sport.

Conclusion: Physician-diagnosis, being female, playing rugby or football, and reporting a greater concussion severity at time-of-injury were associated with longer time-to-RTP for adolescent athletes. Furthermore, in those with a physician-diagnosed concussion, the odds of sustaining a same-season recurrent-SRC was 55% lower. Interpretation is limited as the analysis does not consider athlete exposure time for the risk of a recurrent-SRC. Future research evaluating recurrent concussion rates by physician-diagnosis will help to inform prevention strategies targeting concussion management policies and laws.

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Integrating Lived Experience to Advance Pediatric Concussion Care Guidelines Through the TRANSCENDENT Community Advisory Committee

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Abstract

Background: High-quality pediatric concussion guideline recommendations depend on strong evidence and input from experts and from people with lived experience of concussion. The TRANSCENDENT Concussion Research Program, funded by the Ontario Brain Institute, established a Community Advisory Committee to ensure that lived experience informs concussion research, pediatric clinical guideline updates, and knowledge translation. The committee works alongside researchers and guideline developers to ensure that priorities reflect the real-world needs of patients and families, and that evidence is communicated in ways that are clear, accessible, and useful to those most affected.

Objectives: To establish and sustain a Community Advisory Committee that ensures lived experience informs both research activities and the Living Guideline for Pediatric Concussion. The goals were to (1) recruit and engage individuals representing a range of concussion experiences and ages, including youth, (2) integrate their perspectives into ongoing research projects, living guideline updates, and pediatric concussion implementation projects, and (3) collaborate with provincial and national partners to align concussion protocols and reach families, educators, and community members who support young people with concussion.

Methods: The committee was developed using guidance from the Ontario Brain Institute, the Children’s Hospital of Eastern Ontario Research Institute, and the Ontario Strategy for Patient-Oriented Research. An environmental scan identified best practices for community engagement in research. Recruitment focused on individuals with diverse experiences with concussion, including youth, parents, caregivers, teachers, and coaches. Twelve community members were recruited to form the inaugural committee, reflecting diversity in age, gender, background, and concussion experience. The committee meets quarterly through facilitated virtual sessions. Each meeting includes structured discussion, written feedback, and summary reports to maintain transparency and engagement. A Memorandum of Understanding outlines member roles, expectations, and compensation.

Results: Since its creation, the committee has informed more than fifteen collaborative projects, including the Living Guideline for Pediatric Concussion updates and development of guideline supplements on early childhood and concussion related to interpersonal violence. Members have reviewed clinical

recommendations, informed the design and wording of educational resources for healthcare providers, teachers, coaches, and families, supported public concussion education events, and co-authored a peer reviewed publication.

Conclusion: The TRANSCENDENT Community Advisory Committee demonstrates how integrating lived experience enhances the quality and reach of the Living Guideline for Pediatric Concussion. Involving youth, caregivers, educators, and community leaders ensures that guideline updates and resources meet the real-world needs of children and families. This model strengthens evidence translation, promotes consistent concussion care, and provides a framework for meaningful community engagement in pediatric brain injury research.

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Resting-State and Stimulus-Based Functional Magnetic Resonance Imaging in Children with an Acute Disorder of Consciousness Following an Acquired Brain Injury: An Exploratory Study

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Abstract

Background: Following moderate-to-severe acquired brain injury (ABI), patients may experience an acute disorder of consciousness (DoC), which is characterized by impairments in awareness and arousal. When caring for behaviourally unresponsive, brain-injured children, clinicians face two major challenges: accurately assessing the patient's current level of neurological function and predicting their long-term outcomes. These evaluations are critical because they guide decisions related to treatment, rehabilitation, and life-sustaining therapies, all of which directly impact patient outcomes. Current tools are limited by low specificity and variable sensitivity, so there is an urgent need for an objective assessment that can support accurate assessments and predictions. Functional magnetic resonance imaging (fMRI) is emerging as a potential tool for this purpose. Recent fMRI studies suggest that after ABI, the preservation or recovery of 'normal' resting-state functional connectivity (RSFC) patterns and cognitive functions is associated with improved recovery. However, studies have primarily focused on adults or children with chronic DoC, thus leaving a gap in our understanding of how fMRI can be applied in the context of acute pediatric DoC.

Objective: Therefore, the objectives of this study were to (i) characterize the resting-state functional connectivity (RSFC) patterns and (ii) evaluate the auditory functioning and command-following abilities of unresponsive, brain-injured children using both resting-state and task-based fMRI.

Methods: After informed consent, four children (7-12 years old) admitted to the Pediatric Critical Care Unit with an acute DoC (GCS ≤ 11) after moderate-to-severe ABI underwent 3T fMRI scans within the first four days of admission. Immediately after the clinical scan, patients completed a resting-state fMRI scan followed by task-based scans involving auditory processing and command-following paradigms. After pre-processing, functional network connectivity analysis was performed on the resting-state data to measure the connectivity within and between resting-state networks. Resting-state scans from seven age- and sex-matched typically developing children were used for comparison. Meanwhile, single-subject fixed-effects analysis was performed on the task-based data, according to the general linear model.

Results: Compared to controls, patients demonstrated *decreased RSFC* within the default mode, salience, and dorsal attention networks and *increased RSFC* between the following network pairs: visual-salience, visual-frontoparietal, dorsal attention-

frontoparietal, dorsal attention-default mode, and salience-default mode. Furthermore, while all patients demonstrated activation in regions associated with sound perception, speech processing, and language comprehension, only two had evidence of covert command-following.

Conclusion: These early findings support existing research that has shown acute ABI to be associated with marked alterations in the RSFC, particularly in regions implicated in consciousness and cognitive control. We also contribute fMRI evidence of covert cortical processing and covert consciousness during acute pediatric DoC, which has only been shown once before. By describing how fMRI can be applied in this patient population, this work has the potential to shape clinical practice.

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Codes, Clinics, and Caregivers: Parental Stress That Defies the Alarm

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Abstract

Background: Children admitted to the pediatric intensive care unit (PICU) with neurocritical illness experience “code” events for respiratory / cardiac decompensation or clinical declines such as status epilepticus / unresponsiveness. While many PICUs have a provider specifically assigned to support parents during a code, the overall experience of the event is inherently stressful.

Objective: The aim of this study is to evaluate the relationship between the presence / type of code event in children with neurocritical illness and parental stress reported in a post-intensive care clinic.

Methods: A single-center observational study of children with neurocritical illness followed by a multidisciplinary post-intensive care clinic. Code events documented in the medical record were classified by etiology of cardiac/respiratory or neurological (altered mental status or seizure activity) as well as multiple code events for children experiencing more than 2 unrelated code events. Parental trauma was measured at the first clinic visit using the Impact of Event Scale- Revised (IOE-R), a widely used tool to assess post-traumatic stress in adults. Patient characteristics were reported as frequencies and proportions for categorical variables and as median and interquartile range (IQR) for continuous variables. Differences between groups were determined by Fisher’s exact test for categorical variables and Kruskal-Wallis test for continuous variables. Analyses were performed on Stata version 18.5 (StataCorp LLC, College Station, TX, USA) and SPSS version 29(IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp). A p-value of <0.05 was considered statistically significant.

Results: Our cohort included 115 children admitted to the PICU for a variety of neurological diagnoses, and the average age at admission was 5 years (IQR 0.1 - 10.1 years). The length of PICU admission was 9 days (IQR 4, 24), and 29 children experienced codes during this time (13 neurological, 10 respiratory, and 6 multiple). The presence of a code event was significantly associated with longer PICU and hospital admissions, especially children with multiple code events. Children were first seen in clinic 36 days (IQR 17, 52) following hospital discharge, and parental stress was reported in 96%, with more than half of parents endorsing moderate to severe stress; however, the presence or type of code event was not associated with the presence or severity of parental stress reported in the follow-up clinic.

Conclusion: In children with neurocritical illness, code events are associated with longer PICU and overall hospital admission. While post-PICU parental stress is a

significant concern, this traumatic stress seems to be independent of code events experienced in the PICU. These findings emphasize that parental stress is not only related to life-threatening events during their child’s critical illness and the importance of measuring parental stress for all parents of children followed in a post-intensive care clinic.

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Trends in Concussion Among Migrant Youth in British Columbia

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Abstract

Background: Each year, 600,000 concussions are sustained in Canada, with approximately 50% occurring in the pediatric population. Concerns are mounting about the impacts on physical, mental and social health in youth. Despite the large number of injuries and numerous health concerns, certain groups have not been identified in concussion research yet experience traumatic brain injuries (TBI). For example, a population study in Germany identified 28% of refugee minors sustained a head injury. These findings demonstrate that TBIs, such as concussions, occur among migrant youth, and it is important to investigate concussions in this population and the mechanisms of injury

Objectives: The primary aim of this study is to explore the trends over 10 years of concussion among migrant youth, and mechanisms that contribute to injury in British Columbia (BC), Canada.

Methods: We conducted a secondary analysis of the British Columbia Adolescent Health Survey (BCAHS) for the years 2013, 2018, and 2023. The BCAHS is a province-wide clustered, stratified, random survey administered in public schools, grades 7-12, across BC. The BCAHS questions include immigration status and if a head injury/concussion had been sustained in the past 12 months. Analyses grouped the sample by migrant status (Canada-born and migrant) and sex (male and female). Analyses were performed using SPSS Complex Samples to account for cluster, strata, and data weighting. For descriptive statistics, we used Rao-Scott chi-square crosstabulations. We used age-adjusted logistic regressions for trend analyses, as described by Homma et al. (2016).

Results: The total unweighted sample included 18,633 migrant youth from three waves of the BC AHS (2013, 2018, 2023). The weighted prevalence of concussion among migrant youth was 16.3%, 13.0%, and 9.8%. Between 2013 and 2023, reports of concussion in the past year among migrant youth decreased by nearly half. Among male migrant youth, sustaining a concussion was more common in the past and has decreased over time. Similarly, among female migrant youth, sustaining a concussion has also decreased over time. Decreases may be due in part to declines in sports involvement over time, as organized sports were the most common mechanism of concussive injuries for migrant youth across all three survey years (56.4%, 46.7%, 34.5%). Recreational sports (informal play) also consistently ranked among the top three injury causes for migrant groups in 2018 (21.9%) and in 2023 (17.0%).

Conclusion: Concussions represent a significant health concern for youth, with organized sports being a leading cause of injury, particularly among migrant populations. Over the past decade, concussion prevalence among migrant youth in BC has decreased substantially, yet ongoing investigation into the mechanisms of injury and risk factors for concussion remains critical for tailored prevention and management strategies aimed at reducing the burden of concussion in this group.

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Evolving Evidence: Updates to the Living Guideline for Pediatric Concussion

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Abstract

Background: The pace and quality of concussion research continue to accelerate, requiring mechanisms that keep clinical care and prevention of concussion recommendations aligned with latest evidence. Traditional concussion guidelines quickly become outdated, creating inconsistency across healthcare, school, and sport settings. The Living Guideline for Pediatric Concussion (pedsconcussion.com) uses a continuous, consensus-based model to ensure recommendations remain current and clinically relevant. This process integrates ongoing evidence review, expert consensus, patient engagement, and implementation planning to translate research into practice and support consistent concussion care across North America and beyond.

Objectives: To update and expand the Living Guideline for Pediatric Concussion using a scoping review living guideline methodology and an integrated knowledge translation (iKT) framework. Specific aims were to: (1) synthesize and appraise new research to refine existing recommendations; (2) introduce new modules addressing Early Childhood, Interpersonal Violence (IPV), and Prevention of Concussion; (3) maintain a living evidence map as an open repository to enhance transparency and usability; and (4) strengthen alignment between guideline recommendations, provincial and national concussion protocols, and international consensus statements.

Methods: A multidisciplinary panel of 48 experts from North America reviewed new evidence. Evidence mapping was used to categorize studies by topic, population, and study design, creating a dynamic, searchable evidence repository. Draft recommendations and module updates were developed through iterative discussion, review of international consensus statements, and refined through structured Delphi-style voting, requiring at least 80% participation and 75% agreement for adoption. iKT strategies were embedded throughout, including collaboration with sport, health, and education partners to promote awareness, alignment, and uptake of best practices.

Results: The updated Living Guideline incorporates the synthesis and appraisal of recent evidence alongside the expansion of guideline modules. Recommendations continue to support early return to school and activity, individualized subthreshold aerobic exercise, risk factor assessment, early referrals for pediatric patients at risk of persistent symptoms, early identification of mental health challenges, and a role for targeted rehabilitation to address symptoms. Three new modules were introduced: Early Childhood; Interpersonal Violence (IPV); and Prevention of Sport-

Related Concussion. The living evidence map serves as an open, dynamic repository, supporting transparency, future reviews, and identification of research gaps. Collaboration with national and provincial partners strengthened alignment between the Living Guideline, provincial and national concussion protocols, promoting consistent adoption across healthcare, educational, and sport settings in Canada.

Conclusion: The 2025 Living Guideline for Pediatric Concussion Care demonstrates the impact of a living, evidence-driven approach in a rapidly evolving field. Through continuous updates, iKT, and broad collaboration, the guideline delivers current, equitable, and actionable recommendations for clinicians, educators, community members, and policy makers. The targeted supplements extend the reach of concussion recommendations to previously underrepresented populations and ensure that research discoveries continue to inform real-world practice.

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Inflammatory Cytokines and Symptom Severity Following Sport-Related Concussion in Adolescents: Differential Associations by Injury Status and Sex

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Abstract

Background: Sport-related concussions (SRC) are common among adolescents and characterized by variable symptoms and recovery times. Females experience higher incidence rates, greater symptom burden, and increased risk of persistent post-concussive symptoms (PPCS), yet remain under-represented in SRC research. Blood-based biomarkers, particularly pro-inflammatory cytokines (i.e., interleukin (IL)-6, IL-8, and IL-1β), may offer insight into biological disparities and symptom prediction following concussion. Further research is needed to clarify sex-specific inflammatory responses and inform targeted clinical management.

Objectives: The primary objective of this study was to investigate differences in blood plasma concentrations of IL-6, IL-8, and IL-1β between baseline (uninjured) and post-SRC (≤10 days) in adolescents. The secondary objective was to investigate whether the associations between cytokine concentrations and symptom severity (SS), by injury status, was moderated by sex.

Methods: This prospective cohort study included participants aged 10-18 from the SHRed Concussions (Surveillance in High School and Community Sport to Reduce Concussions and their Consequences) study from 2019 to 2025. Exclusion criteria were systemic conditions (e.g., cancer) or recent/concurrent inflammatory processes (e.g., fracture <12 months). SS was measured using the 22-item post-concussion symptom severity scale embedded in the SCAT5 (maximum score = 132). Mixed-effects linear regression models examined associations between cytokine concentrations (pg/mL; natural log-transformed, ln) and symptom severity (square root-transformed).

Results: This analysis included 584 baseline (males: n=374; females: n=168) and 116 post-injury blood samples (males: n=62; females: n=54) collected within 10 days following SRC. A sex-moderated effect was observed in IL-8 (p<0.001), with males demonstrating a lower post-injury concentration relative to baseline (ß = -1.57, 95% CI: -2.11 to -1.03, p<0.001), whereas females showed no difference (β=0.71, 95% CI: -0.04 to 1.47, p=0.341).

Similarly, the concentration of IL-6 was significantly lower in males post-injury relative to baseline (β_{males} = -0.15, 95% CI: -0.28 to -0.01, p=0.039) but not in females ($\beta_{females}$ = -0.04, 95% CI: -0.25 to 0.16, p=0.676). A similar pattern was also observed

for IL-1ß (β_{males} = -0.02, 95% CI: -0.03, -0.01, p=0.003; β_{females} = 0.00, 95% CI: -0.01, 0.01, p=0.889).

None of the associations between inflammatory markers and symptom severity, by injury status, were moderated by sex. However, sex was retained as a main effect showing females had higher symptom severity in all three models (all p<0.001). A unit increase of ln IL-6 resulted in a significant increase in symptom severity in baseline samples only (β_{baseline} = 1.32, 95% CI: 0.31 to 2.33, p=0.011) but a non-significant decline post-injury ($\beta_{\text{post-injury}}$ = -1.36, 95% CI: -4.15, 1.43, p=0.339), with these slopes being significantly different (p=0.035).

Conclusion: Males consistently exhibited significantly lower post-injury cytokine concentrations relative to baseline, while females showed no such difference, suggesting sex-dependent inflammatory regulation following SRC.

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Physiotherapy Management within a Multimodal Rehabilitation Program for Paediatrics with Persisting Post Concussion Symptoms.

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Abstract

Background: Paediatric concussion is a common injury in Australia with 1 in 7 children and adolescents experiencing a concussion in their lifetime. Despite well published guidelines on recovery and early management, longitudinal research shows that 30 percent of children will have ongoing symptoms beyond 4 weeks and develop persistent post-concussion symptoms (pPCS). Physical symptoms of pPCS include headache, nausea, dizziness, fatigue poor co-ordination and reduced balance and can be attributed to a number of different physical systems such as the visual, vestibular, cervical or autonomic systems.

Objectives: This study aims to investigate the physical symptom profile that children and youth with pPCS present with. It also investigates the impact that targeted physical rehabilitation can have on symptoms and secondary measures across the physical systems.

Design: This was a single site, assessor-blinded RCT. Symptomatic participants aged 8 – 18 were recruited and baseline secondary measures were administered at 3 weeks post-injury. Participants were then randomized into the usual care (UC) control group or the Concussion Essentials (CE) treatment group. The CE group received up to 8 weeks of symptom directed multidisciplinary treatment by a physiotherapist and neuropsychologist including visual, vestibular, cervical and targeted exercise. The UC participants received symptom monitoring only for the 8 weeks. Primary outcome was the Paediatric Concussion Symptom Inventory (PCSI).

Results: Complete data was collected on 140 participants who were randomized into CE (n=67) or UC (n=73). Mean age was 13.1 years and 56.4% of them were male. MPCS means for the CE group reduced from 36.75 (95% CI 31.03-42.47) to 8.55 (6.66-11.04, p<0.001). In comparison, MPCS means for the UC group reduced from 33.53 (95% CI 28.34-38.72) to 21.89 (95% CI 15.68 – 28.10, p=0.410). Proportions with symptom resolution were: UC: 37% (27/73) , CE: 61.2% (41/67) (adjusted risk difference = 24.3%, 95% CI – 40.3-8.4%).

Conclusion: Individualised targeted physiotherapy treatment as part of a multi-disciplinary rehabilitation program is effective in reducing symptoms in children with pPCS.

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Radiographic Spine Findings as Independent Risk Factors of Motoric Outcomes in Abusive Head Trauma

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Abstract

Background: Abusive head trauma (AHT) is the leading cause of traumatic brain injury in infants and young children, resulting in significant neurodevelopmental sequelae. Associated spine injury has been increasingly recognized in infants with AHT, most commonly spinal subdural hemorrhage (SDH) and ligamentous injury (LI); however, direct spinal cord injuries such as cord contusion or infarct are rare. Complete spine imaging has become standard of care in children when there is clinical concern for AHT although the clinical relevance and developmental impact of spinal involvement in AHT remains unknown.

Objective: This study investigates the motor outcomes in children with AHT with and without associated spine injury.

Methods: A single-center observational study of infants and children with AHT followed in a multidisciplinary child head injury clinic. The diagnosis of abusive head trauma was confirmed by a team of experts in child abuse. Neuroimaging was reviewed by two pediatric neuroradiologists. Spinal cord imaging reported location of SDH as well as presence of LI. Motor Quotients were derived from Gessell Developmental Schedule and Bayley Scale of Infant and Toddler Development. Patient characteristics were reported as frequencies and proportions for categorical variables and as median and interquartile range (IQR) for continuous variables. Differences between groups were determined by Welch’s t-test.

Results: Between March 2018 and August 2024, 257 children were admitted with expert-confirmed abusive head trauma. Of those, 170 survivors have clinical and radiographic data including spine imaging (CT or MRI). Motor quotients are available for 123 children with AHT. In this cohort, cervical spine subdural hemorrhage ($p=0.001$), ligamentous injury ($p=0.02$), and ligamentous injury plus non-cervical hemorrhage ($p=0.023$) are independent risk factors for lower developmental motor quotients. Children with possible / probable spinal SDH redistribution, however, did not have significantly different motor outcomes from patients with AHT and normal spine imaging.

Conclusions: In children surviving abusive head trauma, cervical subdural hemorrhage and ligamentous injury are at higher risk for severe motor impairment and may benefit from more intensive motor screening and rehabilitation. Spine neuroimaging can serve as a valuable clinical adjunct for prognostication in infants and children with abusive head trauma.

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Empirical Evaluation of Coma Recovery Scale-Revised Rating Scale Categories in Pediatric Rehabilitation: Developmental Differences in Measurement Structure

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Abstract

Background: Accurate assessment of consciousness in children after severe brain injury is critical for diagnosis and rehabilitation planning. The Coma Recovery Scale-Revised (CRS-R) is the most widely used behavioral tool for identifying states of consciousness, yet its measurement structure has not been empirically tested across developmental stages.

Objective: To evaluate the psychometric properties of the CRS-R in children with disorders of consciousness (DoC) and examine whether the hierarchy of behaviors differs between school-age children and adolescents.

Method: A Rasch analysis was conducted using 1,370 CRS-R assessments from 98 children (ages 5-18 years) with traumatic or non-traumatic brain injury across four pediatric rehabilitation hospitals. Analyses used the partial credit model (Winsteps 5.6.2.0). Reproducibility, structural validity, and measurement accuracy were tested using calibration and validation subsamples. Developmental differences were examined by comparing rating scale category measures and thresholds between school-age (5-12 years) and adolescent (13-18 years) groups.

Results: The CRS-R demonstrated excellent reproducibility (r = .99 for person measures) and high reliability (Wright's PSR = .93; strata = 3.8). Most items fit the Rasch model, supporting a unidimensional measure of neurobehavioral function. The general hierarchy was consistent across ages but showed notable developmental divergence.

School-age children displayed lower mean measures for basic arousal and visual behaviors (e.g., *Eye Opening without Stimulation* = 48.2 vs 55.1 units), suggesting these behaviors occur at lower ability levels earlier in development. In contrast, higher-level communicative behaviors were markedly more difficult for school-age children, particularly *Functional Communication* (91.2 vs 74.0 units), which exhibited

the largest developmental gap. Similarly, *Functional Object Use* (79.9 vs 73.9 units) and *Consistent Movement to Command* (74.4 vs 68.5 units) were somewhat harder for younger children. These patterns indicate that while many behaviors align across ages, language-mediated and intentional communication behaviors may be more developmentally constrained in younger children with DoC.

Conclusion: The CRS-R demonstrated strong psychometric performance across pediatric age groups but showed meaningful developmental variation in higher-order communicative items. Younger children exhibited relatively easier basic arousal and visual behaviors yet greater difficulty achieving functional communication. These results underscore the need for age-sensitive calibrations and clinical interpretation guidelines to improve diagnostic precision and developmental validity of consciousness assessment in pediatric rehabilitation.

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Symptom Severity and Vestibular/Ocular Motor Screen Symptoms 5–15 Years After Adolescent Sport Injury: Comparing Concussion, Musculoskeletal Injury, and No Injury Cohorts

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Abstract

Background: Sport-related concussions (SRC) are traumatic brain injuries that may lead to long-term, persistent symptoms and impairments. The potential long-term impact of SRC on the adolescent brain remains poorly understood. Including musculoskeletal-injured and uninjured control cohorts in concussion research allows for clearer differentiation of concussion-specific effects from those related to musculoskeletal injuries or normal development variation.

Objectives: This study aimed to compare symptom severity and symptom provocation during administration of the Vestibular/Ocular Motor Screening and optokinetic nystagmus (VOMSokn) across three groups of young adults: those with a 5–15-year history of adolescent sport-related concussion (SRC), those with a history of adolescent sport-related musculoskeletal injury (MSK), or no injury (UI).

Methods: This historical cohort study recruited individuals (ages 18-33) who played adolescent sport 5-15 years prior. Participants were assigned an exposure cohort, based on diagnosis of time-loss (>7-days) SRC or MSK injury, or UI. Symptom severity score (SSS) was measured using the Post-Concussion Symptom Scale (PCSS) (SSS /132; 0-6 Likert scale for each of 22 post-concussion symptoms). Symptom reporting on the VOMSokn (score /320; 0-10 Likert scale for headache, dizziness, nausea and fogginess symptoms) was also assessed. Differences in SSS and VOMSokn between cohorts were assessed using generalized linear models adjusted for sex (male, female), age (years), and time-since injury (years). For the SRC cohort, a generalized linear model with gamma distribution and log link was used to examine the association between number of prior concussions and symptom severity, adjusting for the same covariates.

Results: A total of 288 participants (100 SRC, 100 MSK, 88 UI) consented to participate. Compared to the MSK cohort, the SRC cohort reported higher SSS (females: mean difference = 7.72, 95% CI: 2.54, 12.89, p=0.003; males: 4.70, 95% CI: 1.19, 8.20, p=0.009). Females in the SRC cohort reported higher SSS than UI females (mean difference = 9.96, 95% CI: 5.05, 14.86, $p<0.001$). Within the SRC cohort, each additional concussion reported was associated with a 12.3% increase in SSS (95% CI: 4.0%, 21.1%, p=0.003). SRC participants reported more symptoms on the VOMSokn compared to MSK and UI cohorts. SRC females had a 12.86-point higher mean VOMSokn symptom score than MSK females (95% CI: 2.03, 23.68, p=0.020), while

SRC males had a 9.14-point higher score compared to MSK males (95% CI: 2.17, 16.12, p=0.010).

Conclusion: These findings indicate a history of adolescent SRC may be associated with increased symptom severity and symptoms on the VOMSokn 5–15 years post-injury. These results highlight the need for understanding preinjury characteristics on postinjury symptom reporting, and the development of targeted symptom management strategies post-SRC. Future research should focus on establishing the clinical significance of these symptoms and association with potential impairments and disability to better guide long-term care.

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Grief-Informed Intervention for Parents of Children in the Pediatric Intensive Care Unit: A Randomized Clinical Trial

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Abstract

Background: Admission of a child to the pediatric intensive care unit (PICU) is a traumatic experience and impacts family mental health. Stressors include uncertainty of the child's outcome, changes in family relationship, feelings of helplessness which are responses to grief. However, the impact of a grief-informed intervention, compared to traditional stress reduction techniques, on parent and sibling behavior is unknown.

Objectives: To assess the feasibility of implantation of a parent support program in the PICU and to compare two parent support interventions, the grief-informed Healing Circles program adapted for parents in the PICU and traditional mediation and stress reduction techniques.

Methods: 100 parents with a child admitted to the PICU within the previous week were randomly assigned to receive 8 one-hour sessions on grief, using the curriculum Healing Circles or 8 one-hour sessions using standard stress reduction techniques. Parents completed measures to assess grief levels with the Parent Experiences of Child Illness (PECI) and associated parent functioning with the Adult Behavior Checklist (ABCL) every 3 months for 1 year. Additionally, one sibling of the child in the PICU was randomly chosen to assess sibling functioning with the Child Behavior Checklist (CBCL). Outcomes were analyzed using nonparametric measures and partial least squares (PLS) models were conducted. Relationships were analyzed solely within the intervention group (IG) due to attrition and small sample size.

Results: Parents attending grief-informed sessions had significantly higher dose efficacy, $p = .021$. Attending 8 Healing Circles sessions was associated with significantly less guilt and worry (($\beta = 0.631$, $p < .001$), less uncertainty ($\beta = 0.541$, $p < .001$), and more emotional resources ($\beta = 0.347$, $p = .032$). Positive path coefficients from dose to adult internalizing change scores ($\beta = 0.262$, $p = .063$), and from adult internalizing change scores to sibling internalizing change scores ($\beta = 1.016$, $p = .098$) were marginally significant.

Conclusion: Parents of children with critical illness experience trauma and grief. Offering a grief-informed intervention during the hospitalization of a critically ill child may improve parental and sibling mental health.