



# Psychological Factors Associated with Delayed Symptom Resolution in Children with Concussion

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**Objective** To characterize the psychological factors associated with persistent symptoms after pediatric concussion.

**Study design** Longitudinal cohort study of 179 children with concussion 8-18 years old evaluated in a pediatric emergency department. Participants were followed for 1 month for delayed symptom resolution, defined as  $\geq 3$  symptoms that were new/worse than preinjury symptoms measured by the use of graded symptom inventory. Pre-injury psychological traits were measured by parental report on subscales of the Personality Inventory for Children-2 (maladjustment, cognitive abilities, somatization). Child report of postinjury anxiety and injury perception were measured with the State-Trait Anxiety Inventory for Children and Children's Illness Perception Questionnaire. Psychological instrument scores were compared between those with and without delayed symptom resolution via a Kruskal-Wallis test. Associations between psychological traits and delayed symptom resolution were investigated by the use of logistic regression.

**Results** Delayed symptom resolution occurred in 21% of participants. Score distributions were significantly worse on the State-Trait Anxiety Inventory for Children (38 [IQR 33-40] vs 35 [IQR 31-39];  $P = .04$ ) and somatization subscale (1 [IQR 0-3] vs 1 [IQR 0-1];  $P = .01$ ) among children with delayed symptom resolution compared with children with early symptom resolution. Somatization was associated with delayed symptom resolution (aOR 1.35, 95% CI 1.08-1.69). The proportion of children with abnormal somatization scores was significantly greater in the delayed symptom resolution group (34.2%) than the early symptom resolution group (12.8%;  $P < .01$ ). Other psychological measures were not different between groups.

**Conclusion** Somatization is associated with delayed symptom resolution in this cohort of children with concussion. Postconcussive symptoms lasting at least 1 month may warrant referral to a neuropsychologist familiar with postconcussion care. (*J Pediatr* 2016;174:27-32).

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Although postconcussive symptoms for most children resolve in 1-2 weeks, 15%-30% of children who sustain a concussion experience symptoms that last at least 3 months.<sup>1,2</sup> Postconcussive symptoms garner considerable attention in the clinical management of pediatric concussions. Widely accepted guidelines recommend that the return-to-play process should not begin until the athlete is asymptomatic.<sup>3</sup> Experts also recommend that accommodations be made for persistent symptoms as children return to the classroom.<sup>4-6</sup> Underlying these recommendations is the assumption that ongoing symptoms represent an incomplete resolution of the pathophysiologic changes that occur after a concussion.<sup>7,8</sup>

Although injury factors such as the severity of injury likely contribute to the persistence of symptoms,<sup>9</sup> noninjury psychological components clearly influence symptomatology after concussion.<sup>10</sup> For example, pre-existing anxiety and depression are risk factors for the development of persistent postconcussive symptoms.<sup>11-14</sup> Even among patients who do not sustain head injuries, individuals may report symptoms consistent with postconcussive syndrome.<sup>15-17</sup> In addition, poorer patient perceptions of the impact of concussion

CIPQ	Children's Illness Perception Questionnaire
COG1	Cognitive Impairment-Inadequate Abilities
CT	Computed tomography
DIS-S	Psychological Discomfort Short subscale
ED	Emergency department
GCS	Glasgow Coma Scale
PIC-2	Personality Inventory for Children, Second Edition
SOM	Somatic Concern Short subscale
STAIC	State-Trait Anxiety Inventory for Children

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have been shown to be associated with persistent symptoms.<sup>18,19</sup> Although increasing evidence suggests a significant role for noninjury psychologic factors in adults experiencing delayed symptom resolution, this phenomenon remains relatively unexplored in children.

For practicing pediatric providers, knowing whether psychological factors contribute to delayed symptom resolution in children with concussion, similar to patterns seen in adults, is important for management. If psychological factors contribute significantly to delayed symptom resolution, referral to specialists who can address these factors may be indicated. Our objective was to characterize better the psychological factors associated with persistent symptoms in children after a concussion. To achieve this objective, we explored the contributions of specific psychological characteristics to the development of delayed symptom resolution among children who presented to an emergency department (ED) with an acute concussion. We hypothesized that preinjury difficulties with psychological adjustment and postinjury anxiety and negative injury perception are associated with delayed symptom resolution in children.

## Methods

We conducted a prospective cohort study from October 1, 2010, to March 31, 2013, at a tertiary care pediatric trauma center ED. We enrolled a convenience sample of children ages 8-18 years who sustained concussions <6 hours before they arrived to the ED. Participants were considered to have a concussion if they had a Glasgow Coma Scale (GCS) score of 13 or 14 (assigned by a faculty physician or resident) or at least 2 of the following signs/symptoms occurring after a direct blow to or rapid acceleration/deceleration of the head: bystander-witnessed loss of consciousness; post-traumatic amnesia; disorientation to person, place, or time; subjective feelings of slowed thinking; perseveration; vomiting/nausea; headache; diplopia/blurred vision; dizziness; or somnolence. Children were excluded for the following: open head injuries; intoxication with alcohol or controlled substances, receipt of narcotics, injuries resulting from child abuse, multisystem injuries, or underlying central nervous system abnormalities such as malignancy, structural abnormalities, previous surgery or instrumentation, developmental delays, or seizure disorders. Participants were enrolled in the ED from 7:00 a.m. to 11:00 p.m. by trained research assistants. A research assistant then telephoned participating families 3 and 30 days after the ED visit to complete data collection by the use of scripted interviews. Participants not contacted after 3 attempts were considered lost to follow-up. The study was approved by the Colorado Multiple Institutional Review Board.

Demographic information, injury characteristics, and mechanism of injury were collected by research assistants at the ED enrollment visit. Baseline symptom inventory scores were obtained by use of the Concussion Symptom Inventory.<sup>20</sup> The Concussion Symptom Inventory was modified

to include 2 additional symptoms (sadness and irritability), and the wording was adjusted for the age of our population. The possible score range was 0-28. Delayed symptom resolution, our primary outcome, was defined as the presence of 3 or more symptoms 30 days after injury that were absent or less severe in the week before injury. This definition was derived from findings of new postconcussive symptoms in a similar cohort.<sup>21</sup> In addition, the *International Statistical Classification of Diseases and Related Health Problems, 10th revision*, definition requires at least 3 postconcussive symptoms to meet criteria consistent with persistent postconcussive syndrome.<sup>22</sup> Children who did not meet the criteria for this outcome were considered to have early symptom resolution.

Psychological characteristics were assessed by the use of 3 different instruments. The Personality Inventory for Children, Second Edition (PIC-2) is a parent-report instrument that assesses behavioral and emotional adjustment in children and correlates well with other measures of child behavior.<sup>23</sup> PIC-2 subscale responses were collected from parents at the time of injury and reflect preinjury psychological traits of the child. For this study we used 3 validated subscales. The Cognitive Impairment–Inadequate Abilities (COG1) subscale quantifies cognitive competence and correlates with cognitive and academic achievement. The Psychological Discomfort Short subscale (DIS-S) assesses general maladaptive psychological tendencies and correlates with measures of depression and anxiety. The Somatic Concern Short subscale (SOM) measures the tendency to internalize problems and express them through physical symptoms. Raw scores on the DIS-S, SOM, and COG1 subscales  $\geq 5$ , 3, and 5 correspond to a T-score  $\geq 60$ , respectively, in both boys and girls; T-scores  $\geq 60$  indicate abnormally high levels of dysfunction in each domain relative to the general population. Raw scores were used for statistical analysis.

The second instrument used was the State-Trait Anxiety Inventory for Children (STAIC).<sup>24</sup> We used only the child's response to the state portion (anxiety as a response to a specific event) of the STAIC because we were primarily concerned with the relationship between acute postinjury anxiety in response to a concussion and delayed symptom resolution. The instrument includes 20 items with a score range of 20-60, where greater scores indicate greater anxiety. Response to this item was recorded during the ED visit.

The Children's Illness Perception Questionnaire (CIPQ) measures 5 specific attributes of how a child conceptualizes illness: identity, consequences, causes, timeline, and curability.<sup>25</sup> We modified the CIPQ for concussion as the condition of interest.<sup>18</sup> Possible scores range from 0 to 18, with greater scores indicating increasingly negative perception of the concussion. There are no normative data for the CIPQ. We administered the CIPQ during a 3-day follow-up call to allow time for the participants to develop a perception of the impact of their concussion. **Table I** summarizes each of the instruments used and timing of collection.

All analyses were completed with SAS Software, v9.4 (SAS Institute, Inc, Cary, North Carolina). Bivariate statistics

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