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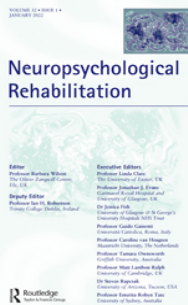
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# Global and domain-specific self-esteem after pediatric traumatic brain injury: Contribution of injury characteristics and parent mental health

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## ABSTRACT

This prospective, longitudinal case-control study examined global and domain-specific aspects of self-esteem 6-months following pediatric traumatic brain injury (TBI) and evaluated the contribution of injury-related factors and parent mental health to child self-esteem. Participants included 103 children with mild-severe TBI representing consecutive admissions to the emergency department of the Royal Children's Hospital, Melbourne, Australia. Forty-three age-and-sex matched typically developing controls were recruited for comparison. Information regarding injury characteristics including age at injury and clinical indicators of TBI severity were collected for participants at recruitment, with research magnetic resonance imaging conducted 2–8 weeks later. At 6 months post-injury, children rated their global and domain-specific self-esteem (Harter Self-Perception Profile for Children), and ratings of parent mental health were collected (General Health Questionnaire). Self-esteem for behavioural and academic domains was significantly poorer for children with TBI relative to TD children. In the TBI group, higher child-rated scores of global and domain-specific aspects of self-esteem were associated with more severe TBI, presence of frontal neuropathology, younger age at injury, and lower parental symptoms of anxiety/insomnia. Given the psychological status of parents represents a potentially modifiable risk factor, it may form the target of clinical interventions designed to bolster child self-esteem following pediatric TBI.

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## Introduction

Self-esteem is defined as an individual's judgement of self-worth (Leary & Baumeister, 2000) and is consistently shown to be a key determinant of social and emotional well-being in children and adolescents (Orth & Robins, 2014; Roberts & Monroe, 1992). Despite this, little is known about the effect of childhood traumatic brain injury (TBI) on self-esteem, particularly how children with TBI perceive their own performance across various functional life domains. Moreover, few studies have examined the contribution of injury and non-injury related factors (e.g., parent mental health) to self-concept in children with TBI.

## Defining self-esteem: Theories and evidence from typical development

Some theorists have suggested that children perceive their self-worth as multi-dimensional, comprising both global and domain-specific aspects which are separate but closely related (Harter, 1999, 2012; Marsh, 1992). In other words, children can evaluate the self as a totality, but can also perceive their self-worth with reference to functional aspects of their life, including social, scholastic, athletic, behavioral, and physical dimensions. The relationship between global and domain-specific aspects of self-esteem is explained by a bottom-up model, which proposes that children's perceptions of their domain-specific abilities contribute to global perceptions of self-worth (James, 1890; Marsh, 1992). Complementing the bottom-up model, the interpersonal model (Cooley, 1902; Leary & Baumeister, 2000; Mead, 1934) suggests that social evaluations heavily influence a child's perception of self-worth. Specifically, children use their interpretation of others' perceptions to form internal representations of their own abilities and overall self-worth.

Development of self-esteem is characterized by several age-related processes. Younger children, between two and four years, struggle to distinguish between their current or actual self, and their desired self (Harter, 2006). For this reason, they are more likely to rate their competencies favorably, consistent with their tendency to describe their ideal self. As children transition to middle childhood, their ability to conceptualize themselves as unique individuals begins to emerge (Harter, 2012). While this process results in increasingly realistic self-appraisals, it can also lead to reductions in positivity of child self-perceptions. From approximately 8 years of age, there is an increasing propensity for social comparison to shape the child's understanding of how their personal attributes and capabilities might be similar or different from others. This coincides with the development of perspective taking, which undergoes rapid maturation across middle to late childhood (Eisenberg et al., 2005; Van der Graaff et al., 2014). During this transitional period, a child's sense of self is strongly influenced by others' perceptions (e.g., parents, teachers, and

classmates), which partially accounts for declining, but potentially more accurate self-views.

While there exists substantial literature on development of self-esteem across childhood and adolescence, research examining the impact of early life brain injuries (e.g., TBI) on self-concept is sparse. Preliminary studies have documented poorer ratings of global self-esteem among children and adolescents with TBI compared to healthy controls (Andrews et al., 1998; Hawley, 2012); however, a more recent study found significantly reduced self-concept in only a small proportion of children with an acquired brain injury (ABI) (Hendry et al., 2020). Even less is known about child self-esteem across specific domains after pediatric TBI. Pastore and colleagues compared the psychosocial profile of 26 adolescents with traumatic or vascular brain lesions with 18 typically developing controls and found that self-esteem for physical condition and attractiveness was significantly lower amongst adolescents with brain lesions (Pastore et al., 2015). More recently, Meadows et al. (2017) examined whether rejection sensitivity moderated the effects of mild complicated-severe TBI on child ratings of self-esteem. In this study, the TBI group ( $n = 51$ ) did not differ from the orthopedic injury control group ( $n = 49$ ) on a range of self-report measures, including global self-worth as well as social, athletic, and physical self-esteem. Of note, at high levels of rejection sensitivity, children with mild-complicated/moderate TBI perceived their social competence to be significantly poorer than orthopedic controls (Meadows et al., 2017).

Consistent with previous research reporting an association between childhood chronic illness, stressful life events and reduced self-esteem (Luciano & Orth, 2017; Orth & Luciano, 2015; Pinquart, 2013; Tetzner et al., 2016), preliminary evidence suggests that pediatric TBI also exerts a negative influence on global and domain-specific aspects of self-esteem. Nevertheless, similar to other outcomes post-childhood TBI, it is likely that substantial individual variation also exists for self-esteem outcomes. This suggestion is in keeping with the Heuristic Model of Social Competence (HMSC; Yeates et al., 2007) which posits that post-injury psychosocial outcomes (e.g., self-concept) reflects a complex interplay of injury-and non-injury-related variables. More specifically, the model proposes that injury-related factors interact dynamically with environmental variables to exert influence on social competence (social, emotional, and behavioral outcomes). Factors associated with brain insult, such as injury severity, age at injury, and location of cerebral lesions, are proposed to elevate risk for social maladjustment, including poorer self-perceptions or self-esteem, after childhood TBI, with environmental factors (e.g., socioeconomic status, family function, and parent well-being) conceptualized as resilience factors that can ameliorate the neurological effects of pediatric TBI.

In line with the HMSC model, previous studies of childhood TBI have linked poorer post-injury cognitive and psychosocial outcomes to a range of injury-related and developmental risk factors, including more severe TBI, younger

age at cerebral insult, and increased lesion burden assessed on MRI (Catroppa et al., 2008; Karver et al., 2012; Keenan et al., 2018, 2019; Ryan et al., 2015; Wilde et al., 2012). Other studies have revealed mixed findings on the role of injury-related factors (Crowe et al., 2012; Rosema et al., 2012) and highlighted the role of the family environment in post-injury psychosocial outcomes. For instance, better post-injury social and behavioral adjustment have been linked to greater availability of home resources (e.g., learning materials) and more effective parenting (Durber et al., 2017; Schorr et al., 2020; Wade et al., 2016; Yeates et al., 2010). To date, however, few studies have examined the respective contribution of injury and environmental factors to self-esteem in children with TBI. One notable exception is Hawley's (2012) study which examined 96 children with mild-severe TBI and identified large and significant associations between caregiver stress and child self-esteem, such that parents experiencing higher levels of stress were more likely to have children who reported poorer ratings of self-worth.

With increasing recognition that parent mental health symptoms may influence child perceptions of self-worth in TD children (Goodman et al., 1994; Krauss et al., 2020; Miller et al., 1999; Orth et al., 2014; Siskowski, 2006) coupled with accumulating evidence supporting the heightened susceptibility of family environmental factors for social and behavioral adjustment after childhood brain insult, it stands to reason that enhanced caregiver psychological function might ameliorate the risk of maladaptive perceptions of self-worth after pediatric TBI (Anderson et al., 2006; Beauchamp et al., 2021; Holland & Schmidt, 2015; McNally et al., 2013; Micklewright et al., 2012; Ryan et al., 2017; Schorr et al., 2020; Wade et al., 2016; Yeates et al., 2004). In other words, parents with intact mental health are likely better placed to support and provide care for their children as they learn to cope with the day-to-day limitations associated with TBI (Beauchamp et al., 2021; Yeates et al., 2007), with secondary benefits for children's self-esteem. This hypothesis is broadly consistent with the sociometer theory of self-esteem (Leary & Baumeister, 2000) which postulates that children who feel accepted and supported by interpersonal relations, including parental relations, perceive higher self-worth. Further, as caregiver psychological function is potentially modifiable, parents represent a promising target for early interventions designed to buffer against the emergence and/or persistence of maladaptive self-appraisals in children with TBI.

The present study represents a sub-study of the larger study "*Social Competence following Child TBI*" which evaluated children's social trajectories in the two years following a TBI (Anderson et al., 2017). The current study aimed to (1) explore the impact of pediatric TBI on global and domain-specific aspects of children's self-esteem (i.e., social competence, scholastic competence, athletic competence, behavioural conduct, physical appearance, and global self-worth) at 6 months post-injury; and (2) examine the respective contribution

of (i) injury-related factors (i.e., TBI severity, age at injury, and presence of frontal, extra-frontal and subcortical neuropathology) and parent mental health (i.e., anxiety/insomnia and depressive symptoms) to child-rated self-esteem. Consistent with preliminary research (Andrews et al., 1998; Hawley, 2012; Pastore et al., 2015), we predicted that global and domain-specific aspects of self-esteem would be poorer for children with TBI relative to TD controls at 6 months post-injury. In keeping with the HMSC model (Yeates et al., 2007), we also hypothesized that for children with TBI (i) age at injury, (ii) TBI severity, (iii) presence of frontal, extra-frontal, and subcortical neuropathology, and (iv) parental mental health at 6 months post-injury would be associated with child-rated self-esteem.

## Methods

### Design

The “*Social Competence following Child TBI*” study was a single site, prospective, longitudinal, case–control observational study, with participants recruited consecutively from the emergency department of the Royal Children’s Hospital and subsequently assessed acutely and at 6-, 12- and 24-months post-injury (Anderson et al., 2013). The present study uses data from acute and 6 month time-points.

### Participants

The current study sample comprised 146 children, 103 survivors of mild-severe TBI, and 43 typically developing (TD) children matched on age and sex. Children with TBI were recruited at the time of injury and represented consecutive admissions to The Royal Children’s Hospital (RCH), Melbourne, between 2007 and 2010. TD controls were ascertained over the same time period and recruited from local community schools to ensure a range of socio-economic backgrounds.

Inclusion criteria for the TBI group were (i) age between 5 and 15 years at time of injury; (ii) documented evidence of TBI, including a period of altered consciousness or at least two post-concussive symptoms; (iii) medical information sufficiently detailed to determine injury severity, including Glasgow Coma Scale (GCS), and records of neurological and radiological findings; (iv) no history of previous TBI, or pre-injury diagnosis of neurological or developmental disorder (including attention-deficit hyperactivity disorder or autism spectrum disorder); and (v) English speaking. TD children were required to meet inclusion criteria (i), (iv), and (v) above.

Children with TBI were classified as: (i) mild TBI ( $n = 66$ ): GCS 13–15 on initial hospital presentation, loss of consciousness (LOC) <1 hour, and skull fracture

not requiring surgical intervention; and (ii) moderate-severe TBI ( $n = 37$ ): GCS 3–12 on initial hospital admission, LOC of 1 hour or greater, surgical intervention required for skull fracture, and evidence of intracranial pathology on Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) scan.

## Measures

### Injury-related predictors

- (i) Injury characteristics. For participants with TBI, the following details were collected via standard clinical report forms: injury mechanism, lowest GCS in the 24 hours post-injury, duration of coma, and cause of injury.
- (ii) Structural Magnetic Resonance (MR). Images were acquired on a three Tesla Siemens Trio scanner (Siemens Medical Systems, Erlangen, Germany) fitted with a 32-channel matrix head coil. The location of neuroanatomical lesions were rated by a pediatric neuroradiologist and neuropsychologist who were blind to injury severity classification. Once lesions were identified based on visual inspection, they were coded according to location (frontal, extra-frontal, subcortical) using a modification of the Coffey classification System (Beauchamp et al., 2011; Coffey et al., 1991). Signal changes and volume loss were coded in gray and white matter in cortical and subcortical regions: frontal/temporal/parietal/occipital lobes, cerebellum, hippocampus, amygdala, corpus callosum, thalamus, and basal ganglia.

### Environmental predictors

- (i) Socioeconomic Status (SES). This was assessed at time of recruitment using the Australian and New Zealand Socioeconomic Classification of Occupations (ANZSCO; McMillan et al., 2009). A score from 0 (e.g., labourer) to 100 (e.g., medical practitioner) was assigned to the primary caregiver's occupation, where higher scores reflect higher occupational status.
- (ii) Parent mental health at 6 months post-injury. The General Health Questionnaire (GHQ; Jackson, 2007) is a 28-item self-report screen of caregivers' inability to carry out day-to-day tasks and emergence of new and distressing phenomena. For the present study, the Anxiety/Insomnia and Depression subscales were employed. The maximum score for each subscale is 7, with higher scores indicative of greater probability of psychological distress. *Primary outcome*
- (iii) Child self-esteem at 6 months post-injury. The Harter Self Perception Profile for Children (HSPPC; Harter, 1985) is a 36-item self-report questionnaire designed to measure child self-esteem across five specific domains: Scholastic Competence, Social Competence, Athletic Competence,

Physical Appearance, and Behavioral Conduct. It also includes a Global Self-Worth (GSW) subscale which measures the extent to which a child likes themselves as a person and is generally happy with the way they are. Thus, it provides a general perception of oneself and is independent from domain-specific ratings. Each subscale consists of six items rated on a 4-point Likert Scale, where “1” denotes the lowest level of perceived competence and “4” represents the highest level of perceived competence. All subscales were employed in the present study. Internal reliability was indicated by Cronbach’s alpha of 0.75–0.91 for all subscales (Harter, 2012).

### *Procedure*

This study was approved by the Human Research Ethics Committee, RCH, and the Department of Education and Training, Melbourne, Australia. Children with TBI were identified via daily emergency department admission records and screened for eligibility. Families meeting eligibility criteria were mailed information packs describing the study and requests for written consent. Research MR sequences were acquired at 2–8 weeks post injury. Parents and children completed standardized self-report measures (in hard copy format) of mental health and self-esteem, respectively, during a face-to-face visit to the hospital at 6-months post-injury. Although these questionnaires were completed independently of the study investigators, a research assistant supervised the administration of the questionnaires during the face-to-face visit.

### *Statistical analyses*

Independent samples *t*-tests and Chi square analyses were conducted to compare participating ( $n = 146$ ) and non-participating children ( $n = 9$ ) on injury and sociodemographic variables: lowest GCS score in 24 hours, family socioeconomic status, family functioning, age at injury, and sex. For participating children, we then explored group differences (i.e., TBI versus TD) using independent samples *t*-tests for (i) demographic factors; (ii) global and domain-specific self-esteem at 6 months post-injury. The effects of group membership (i.e., mild TBI vs moderate-severe TBI vs TD) on self-esteem were examined using analyses of variance (ANOVAs) and followed up with post-hoc comparisons. In addition, comparisons were conducted across TBI severity groups (mild vs moderate-severe TBI). Chi square and Fisher’s exact tests were employed to examine group differences for duration of coma, cause of injury, and MRI findings.

After checking for multi-collinearity using Variance Inflation Factor and Tolerance, 2-block hierarchical regression models were employed to evaluate the respective contribution of injury-related factors (Block 1: lowest GCS,

age at injury, and presence of frontal, extra-frontal, and subcortical neuro-pathology) and parent mental health symptoms (Block 2: GHQ Anxiety/Insomnia, GHQ Depression) to child-rated global and domain-specific self-esteem.

The alpha significance level was set to .05. Given the exploratory nature of our analyses, we did not correct for multiple comparisons.

## Results

### *Sample characteristics*

Initially, to identify any differences between study participants ( $n = 146$ ) and non-participants ( $n = 9$ ), we compared demographic and injury-related characteristics: lowest GCS score in 24 hours ( $p = 0.340$ ), family socioeconomic status ( $p = 0.856$ ), family functioning ( $p = 0.526$ ), age at injury ( $p = 0.613$ ), and sex ( $p = 0.722$ ).

We then compared TBI and TD participants on demographic characteristics (Table 1). There were no significant group differences in terms of pre-TBI child mental health, sex, or age at 6 month study participation. SES and IQ were significantly lower for the TBI group; however, were not adjusted for in analyses due to their potential influence on primary study outcomes (Dennis et al., 2009). Parent depression and anxiety/insomnia symptoms did not differ significantly between groups.

Injury characteristics for the TBI groups are displayed in Table 2. The mild and moderate-severe TBI groups showed expected differences for GCS and duration of coma. Cause of injury was predominantly falls/blows for children with mild TBI. For the moderate-severe TBI group, falls/blow and motor vehicle accidents were equally common. Presence of frontal and extra-frontal pathology was also more common in children with moderate-severe TBI than in children with mild TBI. The two TBI groups did not differ for age at injury.

**Table 1.** Demographic and parent characteristics of the sample.

	TD	TBI	$t/\chi^2$	$p$
<i>Demographics</i>				
<i>n</i>	43	103		
Sex (male), $n$ (%)	24 (56)	71 (69)	2.30	0.130
Age at 6 month testing (years), $M$ (SD)	10.25 (3.04)	10.89 (2.47)	-1.22	0.227
Time post-TBI at 6 month testing (months), $M$ (SD)	-	6.58 (0.97)	-	-
Pre-TBI child mental health (CBCL), $M$ (SD)	45.61 (7.23)	48.09 (10.16)	1.67	.099
Socioeconomic status, $M$ (SD)	76.75 (14.19)	66.53 (22.95)	3.23	0.001
Child IQ at 6 month testing (WASI), $M$ (SD)	106.35 (13.39)	97.70 (13.82)	-3.48	<.001
<i>Parent mental health</i>				
<i>n</i>	43	96		
6 month GHQ: Anxiety/Insomnia	0.81 (1.53)	0.51 (1.17)	1.16	0.251
6 month GHQ: Depression	0.02 (0.15)	0.17 (0.82)	-1.66	0.100

Note: TD: typically developing; TBI: traumatic brain injury; CBCL: Child Behavior Checklist; WASI: Wechsler Abbreviated Intelligence Scale; GHQ: General Health Questionnaire.

**Table 2.** Injury characteristics of the TBI sample.

	Mild TBI	Moderate-Severe TBI	$t/\chi^2$	$p$
<i>n</i>	66	37		
Age at injury (years), <i>M</i> ( <i>SD</i> )	10.41 (2.39)	10.24 (2.63)	0.34	0.734
Lowest GCS, <i>M</i> ( <i>SD</i> )	14.39 (1.11)	9.70 (3.31)	8.37	< 0.001
Duration of coma, <i>n</i> (%)			10.01	0.025
None	29 (43.9)	8 (21.6)		
<5 min	27 (40.9)	22 (59.5)		
>5 min, <24 h	3 (4.5)	1 (2.7)		
>24 h	0 (0.0)	3 (8.1)		
Unknown	7 (10.6)	3 (8.1)		
Cause of injury, <i>n</i> (%)			16.46	< 0.001
MVA (passenger, cyclist, pedestrian)	6 (9.1)	16 (43.2)		
Fall/blow	60 (90.9)	21 (56.8)		
Presence of pathology, <i>n</i> (%)				
Frontal	17 (26.6)	21 (60)	10.70	0.001
Extra-frontal	9 (14.1)	13 (37.1)	6.97	0.008
Subcortical	3 (4.7)	6 (17.1)	4.25	0.064

Note: TBI: traumatic brain injury; GCS: Glasgow Coma Scale; MVA: motor vehicle accident.

### *Child self-esteem at 6 months post-injury*

TBI and TD groups differed significantly on the HSPPC Scholastic Competence and Behavioral Conduct subscales, such that children with TBI rated their self-esteem for academic and behavioural domains to be significantly poorer than TD controls ( $p = 0.026$ ,  $d = 0.374$  and  $p = 0.035$ ,  $d = 0.386$ , respectively). There were no significant group differences between the TBI and TD groups on the remaining HSPPC subscales (Table 3). There was also no significant effect of TBI severity on global self-worth or domain-specific aspects of self-esteem (see Supplementary Table 1), suggesting that child ratings of self-esteem were comparable between the mild-TBI, moderate-severe TBI, and TD groups.

### *Predictors of child self-esteem in the TBI group*

Supplementary Table 2 presents preliminary bivariate correlational analyses, which explored relationships between self-esteem domains and each predictor of interest. Hierarchical regression models examined the contribution of injury-related factors and parent mental health to child self-esteem outcomes across global and functional domains (Table 4). As described above, injury-related

**Table 3.** Child ratings of global and domain-specific self-esteem at 6 months post-injury.

	TD <i>M</i> ( <i>SD</i> )	TBI <i>M</i> ( <i>SD</i> )	<i>t</i>	$p$	Cohen's <i>d</i>
HSPPC: Scholastic Competence	3.20 (0.65)	2.91 (0.82)	2.26	0.026	0.374
HSPPC: Social Competence	3.14 (0.56)	3.26 (0.60)	-1.12	0.265	-0.203
HSPPC: Athletic Competence	3.23 (0.68)	3.40 (0.59)	-1.51	0.132	-0.275
HSPPC: Behavioural Conduct	3.33 (0.58)	3.08 (0.67)	2.120	0.035	0.386
HSPPC: Physical Appearance	3.32 (0.59)	3.22 (0.62)	0.830	0.410	0.150
HSPPC: Global Self-Worth	3.48 (0.53)	3.35 (0.62)	1.220	0.223	0.222

Note: TD: typically developing; TBI: traumatic brain injury; HSPPC: Harter's Self Perception Profile for Children.

**Table 4.** Hierarchical regression analysis predicting child ratings of self-esteem from injury and parent mental health variables.

		Scholastic competence B, <i>p</i>	Social competence B, <i>p</i>	Athletic competence B, <i>p</i>	Behavioural conduct B, <i>p</i>	Physical appearance B, <i>p</i>	Global Self-Worth B, <i>p</i>
Step 1							
	Age at injury	-0.04, 0.257	0.03, 0.333	-0.04, 0.139	-0.07, 0.014	-0.05, 0.105	-0.03, 0.208
	Lowest GCS	0.04, 0.217	-0.01, 0.617	-0.01, 0.810	0.01, 0.835	-0.05, 0.036	-0.03, 0.252
	Frontal pathology	0.09, 0.618	0.10, 0.482	0.01, 0.955	0.12, 0.408	-0.08, 0.565	0.22, 0.122
	Extra-frontal pathology	-0.15, 0.476	0.04, 0.814	-0.05, 0.738	0.26, 0.138	-0.18, 0.282	-0.09, 0.574
	Subcortical pathology	-0.17, 0.574	-0.08, 0.733	-0.22, 0.329	-0.42, 0.082	0.05, 0.829	-0.12, 0.595
	Step <i>R</i> <sup>2</sup>	0.05, 0.476	0.02, 0.829	0.04, 0.563	0.15, 0.017	0.08, 0.196	0.07, 0.315
Step 2							
	Age at injury	-0.04, 0.243	0.03, 0.311	-0.04, 0.136	-0.07, 0.015	-0.04, 0.110	-0.03, 0.203
	Lowest GCS	0.04, 0.171	-0.01, 0.650	-0.01, 0.820	0.01, 0.795	-0.05, 0.041	-0.02, 0.284
	Frontal pathology	0.16, 0.367	0.14, 0.320	0.01, 0.955	0.16, 0.282	-0.01, 0.931	0.33, 0.018
	Extra-frontal pathology	-0.28, 0.194	-0.05, 0.767	-0.08, 0.624	0.20, 0.246	-0.24, 0.168	-0.21, 0.206
	Subcortical pathology	0.02, 0.938	0.08, 0.709	-0.14, 0.535	-0.36, 0.143	0.05, 0.823	-0.05, 0.828
	GHQ: Anxiety/Insomnia	-0.24, 0.003	-0.19, 0.002	-0.08, 0.217	-0.09, 0.200	-0.05, 0.442	-0.15, 0.016
	GHQ: Depression	0.13, 0.256	0.15, 0.086	0.10, 0.249	0.00, 0.976	-0.12, 0.189	-0.10, 0.261
	Step <i>R</i> <sup>2</sup>	0.15, 0.060	0.13, 0.105	0.07, 0.548	0.17, 0.029	0.12, 0.130	0.18, 0.016
	<i>R</i> <sup>2</sup> change	0.09, 0.012	0.10, 0.009	0.02, 0.366	0.02, 0.373	0.04, 0.146	0.12, 0.004

Note: B: Unstandardized coefficient; GCS: Glasgow Coma Scale; GHQ: General Health Questionnaire.

variables were entered in the first block and parent mental health symptoms in block 2.

For the HSPPC Behavioral Conduct subscale, Blocks 1 and 2 were statistically significant ( $p = 0.017$  and  $p = 0.029$ , respectively) and explained 15% and 17% of the total variance in child-rated behavioural self-esteem, respectively. Age at injury was the only significant predictor of outcome in Blocks 1 and 2, such that younger injury age was associated with higher child ratings of behavioural self-esteem (see [Table 4](#)).

For the HSPPC Global Self-Worth subscale, Block 1 of the hierarchical regression model was non-significant ( $p = 0.315$ ), with no injury-related variables contributing to outcome (see [Table 4](#)). The addition of parent mental health symptoms in Block 2 explained an additional 12% of variance ( $p = 0.004$ ), with the overall model explaining 18% of total variance ( $p = 0.016$ ). In the final model, presence of frontal pathology made the largest individual contribution to outcome, followed by parental anxiety/insomnia symptoms. Frontal pathology was associated with higher, whereas parental anxiety/insomnia predicted lower, child ratings of global self-esteem.

For the HSPPC Scholastic Competence, Social Competence, Athletic Competence, and Physical Appearance subscales, Block 1 models were non-significant ( $p = 0.476$ ,  $p = 0.829$ ,  $p = 0.563$  and  $p = 0.196$ , respectively), as were Block 2 results ( $p = 0.060$ ,  $p = 0.105$ ,  $p = 0.548$  and  $p = 0.130$ , respectively; see [Table 4](#)). Nevertheless, parental anxiety/insomnia symptoms made a significant contribution to both child-rated scholastic and social self-esteem, such that greater parental anxiety/insomnia symptoms were associated with lower academic and social self-esteem as rated by children. Similarly, TBI severity (lowest GCS) was a significant predictor of child-rated physical self-esteem, such that more severe TBI was associated with better child ratings of their physical appearance (see [Table 4](#)).

## Discussion

The purpose of this study was to evaluate the impact of pediatric TBI on global and domain-specific aspects of self-esteem relative to TD controls at 6 months post-injury and to examine the respective contribution of injury-related factors and parent mental health to child self-esteem across these dimensions. Partially consistent with expectations that children with TBI would rate their self-worth poorly, both academic and behavioral self-esteem were significantly lower for the TBI group relative to TD children. Age at injury, TBI severity, location of pathology, and parent mental health contributed to child ratings of self-esteem across multiple domains.

Our results show that global self-worth and self-esteem for athletic, social, and physical domains were comparable between TBI and TD groups at 6 months post-TBI, suggesting that self-esteem in children with TBI is largely preserved at this early stage of recovery. These findings are consistent with some (Hendry et al.,

2020; Meadows et al., 2017) but not all (Hawley, 2012; Pastore et al., 2015) previous research, perhaps owing to methodological differences including questionnaires used to measure child perceptions of self-worth across life domains and recruitment of heterogeneous ABI samples. Moreover, in the present study, children with TBI endorsed poorer scholastic and behavioral self-esteem at 6 months post-TBI, converging with prior evidence of objective difficulties in these domains (Catroppa et al., 2008, 2012; Fischer et al., 2018; Königs et al., 2016; Max et al., 2012). Given preliminary evidence for associations between low self-worth and mental health difficulties in children with TBI (Hawley, 2012), and growing consensus from developmental literature that self-esteem has direct implications for important life outcomes (Marshall et al., 2014; Sowislo & Orth, 2013; Trzesniewski et al., 2006), it is imperative to devise strategies that bolster children's perceptions of self-worth after childhood TBI.

Examination of predictors of self-esteem in the post-acute phase after pediatric TBI revealed that a combination of demographic, injury, and environmental factors contribute to children's self-esteem across global and functional domains. The impact of injury age on child self-worth was limited to child ratings of behavioral competence, which were higher in children with younger age at TBI. Clinical indicators of injury severity (GCS) and the presence of neuropathology made a small contribution, with lower acute GCS associated with higher child-rated physical self-esteem and presence of frontal pathology related to higher child-rated global self-esteem, consistent with findings that more severe insult is associated with poorer self-awareness (Lloyd et al., 2021). In other words, children with reduced insight regarding their performance across life domains might over-estimate their degree of competence. Further, frontal pathology has been linked to impaired social cognition (Blakemore, 2008; Ryan et al., 2016), and so, when present, may disrupt children's interpretation of social feedback and thus their self-representations (Wolfe et al., 2015).

Consistent with previous studies highlighting the importance of a well-functioning proximal environment for optimizing child outcomes after TBI (Hawley, 2012; Micklewright et al., 2012; Ryan et al., 2017; Schorr et al., 2020; Wade et al., 2016), the mental health status of parents significantly contributed to child self-esteem in our present study, with parent anxiety/insomnia symptoms predicting child-rated global self-worth and self-esteem for academic and social domains. Contrary to recent reports on the impact of maternal depression on self-esteem in adolescents (Krauss et al., 2020; Orth et al., 2014), our results found no link between parental depressive symptoms and children's global and domain-specific self-esteem.

## Limitations

Whilst the present study is one of the first to comprehensively assess global and domain-specific aspects of self-worth in the post-acute phase after

childhood TBI, it is not without limitations. The preponderance of mild TBI in our injury group may not accurately reflect self-esteem in children with more severe insults. Further research with greater representation of moderate and severe TBI participants may improve the generalizability of findings. Due to the dearth of literature in this area and the exploratory nature of our study, we did not correct for multiple comparisons. This might have increased the risk of Type 1 errors and results should be interpreted in light of this important caveat. While global ratings of pre-injury behaviour were collected in the study, we have no measures of pre-injury self-esteem. Developmental theorists (Harter, 1999, 2006) and longitudinal studies (Orth et al., 2018; Young & Mroczek, 2003) suggest that adolescence represents a critical period where self-esteem for key domains, such as social competence and physical appearance, tends to become salient. Due to small numbers in our TBI subgroups, we were unable to investigate whether a child's developmental stage interacts with TBI factors to influence self-esteem ratings. Future research with a larger sample size, stratified by age, is needed to explore these age effects.

In our study, child self-esteem ratings were assessed cross-sectionally at 6 months when awareness deficits are likely impacted by multiple factors including ongoing neural and cognitive recovery (Pan et al., 2016), missed school, limited social participation, and the challenges of reintegration. We used a screening tool to assess parent mental health and further research is warranted to examine its relationship more comprehensively with child self-esteem. Our findings suggest that more severe injury and poorer family function are associated with risk for lower self-worth in children with TBI. Future studies incorporating longitudinal design, measures of pre-TBI self-esteem, and additional predictors, such as child mental health, cognitive ability, and social competence, are needed to better understand the evolution of self-esteem trajectories. Additional research is also needed to examine relationships between self-esteem and broader aspects of functioning (e.g., behavior, activities of daily living), which can be detrimentally impacted after pediatric TBI (Keenan et al., 2019; Krenz et al., 2021)

## Implications

Our findings are consistent with the HMSC model and suggest that a complex interplay of injury and environmental factors (i.e., parent mental health) determine outcomes after pediatric TBI, including child self-worth. Evidence that children with TBI report poorer self-esteem for both academic and behavioral domains 6 months post-injury underscores the importance of early access to remediation and rehabilitation programmes which specifically target objective performance in these functional dimensions, which may in turn improve self-esteem.

Our results show that some aspects of self-esteem are preserved at 6-months post-TBI, but other aspects are vulnerable to the influence of family factors and parent mental health issues more specifically. Such findings suggest that supporting parents and their mental health during the post-acute phase, through a family-centred model of care, may confer resilience and potentially mitigate risk of poorer life outcomes typically associated with low self-esteem in developmental (Marshall et al., 2014) and pediatric TBI literature (Hawley, 2012).

## Conclusion

At 6 months post-injury, children with TBI rated their self-esteem for academic and behavioral domains to be significantly poorer than TD controls. In contrast, global self-worth and self-esteem for social competence, athletic ability, and physical appearance were comparable between TBI and TD groups, suggesting that some aspects of self-esteem are relatively intact at 6-months post-TBI. Results indicated that injury severity, age at injury, the presence of frontal neuropathology, and parental symptoms of anxiety/insomnia contributed significantly to global and domain-specific self-esteem, thus cautioning against relying exclusively on injury-related factors when predicting outcomes. Our findings highlight the significance of post-acute family environmental variables for child perceptions of self-worth after pediatric TBI. Supporting parent mental health post-child TBI offers a promising target for clinical interventions designed to optimize self-esteem after pediatric TBI.

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## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Data availability statement

Source data will not be made available since no patient approval was obtained for sharing anonymized data. However, detailed analytic methods and study materials, including output files of statistical analyses, will be made available to other researchers on request to the first author.

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