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Investigation of Children and Adolescents' Mood and Self-Concept after Acquired Brain Injury

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Abstract

Few studies have examined the self-reported mental health of children with an acquired brain injury (ABI). The current study aimed to: 1) identify levels of child-reported depressive and anxiety symptoms and poor self-concept, 2) investigate demographic and injury-related factors associated with children's mood and self-concept, and 3) examine associations between children's self-reported mental health and parents' reports of children's emotional and behavioral functioning in children specifically with traumatic brain injury (TBI). 122 children (66% male) aged 8-16 years with ABI of mixed etiology were consecutively recruited through an outpatient rehabilitation clinic. Children were administered the Beck Youth Inventories – Second Edition, and parents completed the Adaptive Behaviour Assessment System and the Child Behaviour Checklist (CBCL). Relative to the norms, 16.4% of children scored in the clinical range for the depression and anxiety scales, and 24.6% reported clinically low self-concept. Children with lower functional status had greater anxiety symptoms. Older children (13-16 years) reported significantly higher depressive and anxiety symptoms and lower self-concept than younger children (8-12 years). A significant interaction between age and sex indicated that older girls reported greater depressive and anxiety symptoms than younger girls whereas no age-based differences were found for boys. Parent-reported total emotional and behavioral problems were positively associated with children's self-reported depressive and anxiety symptoms and were negatively correlated with self-concept. These findings indicate that adolescents, particularly girls, may be at heightened risk of poor mental health following ABI. Further research investigating the reasons for these demographic differences may inform developmentally sensitive interventions.

Key Words: Acquired Brain Injury, Mental Health, Mood, Self-Concept, Child, Adolescent.

Introduction

Acquired brain injury (ABI) is a broad term encompassing several different injury etiologies. ABI may arise from external mechanisms (i.e., traumatic brain injury [TBI]) or internal mechanisms such as stroke, infection or brain tumor (Australian Institute of Health and Welfare, 2007). As the most common cause of ABI worldwide, TBI has an estimated prevalence of 691 per 100,000 children, with those resulting in hospitalization estimated as 74 per 100,000 (Thurman, 2016). Children with ABI from both internal and external causes typically experience diverse functional effects extending across physical, cognitive and language, behavioral, and emotional domains (Forsyth & Kirkham, 2012).

Impairments in emotional and behavioral functioning in particular have been found to have adverse effects on children's psychosocial functioning (Anderson et al., 2013; Catroppa et al., 2015; Catroppa et al., 2017; Rosema, Crowe, & Anderson, 2012; Zyrianova, Alexander, & Faruqui, 2016). Parents commonly report emotion regulation difficulties for their children, such as irritability, agitation, reduced capacity to manage stress and frustration, and externalizing and internalizing problems (i.e., depression, anxiety, and withdrawal) (Catroppa et al., 2017; Max et al., 2012; Pastore et al., 2013; Pastore et al., 2014; Poggi et al., 2009). Such difficulties may arise from direct damage to fronto-limbic structures that underlie emotion processing and regulation and/or relate to a psychological reaction to their changing life circumstances (Jorge et al., 2004; Ownsworth et al., 2011). Children with ABI face the challenge of adjusting to their post-injury impairments and associated changes in lifestyle, family and peer relationships, and school and vocational pursuits (Wakefield et al., 2010; Bilbao et al., 2003; Pastore et al., 2014). In turn, children's psychological well-being, including their emerging self-concept or global beliefs

about their own competency and self-worth, can be negatively affected by ABI (Ownsworth, 2014).

To date, pediatric research has largely focused on the effects of ABI on neurocognitive function, adaptive functioning, and academic and social functioning, with studies typically highlighting enduring adverse effects (Babikian, & Asarnow, 2009; Catroppa, et al., 2017; de Kloet et al., 2015; Prasad, Swank, Ewing-Cobbs, 2017; Yeates et al., 2002). Fewer studies have investigated the impact of ABI on children's mental health and self-concept, and most existing studies have assessed these psychological outcomes using parent-report measures rather than self-report (Gomes, Rinehart, Greenham, & Anderson et al., 2014; Pastore et al., 2013; Yeates, Taylor, Walz, Stancin, & Wade, 2010). Studies employing clinician-rated interviews and/or parent reports have indicated that approximately 38-63% of children develop mental health conditions following TBI, which is considerably higher than rates (13-14%) following orthopedic injuries (Luis & Mittenberg, 2002; Max et al., 2012). Similarly, in a study on children with ABI of mixed etiology, nearly half (47.2%) demonstrated clinical levels of behavioral and emotional problems, as rated by parents (Pastore et al., 2014).

In a study using both child self-report and parent report measures (Kirkwood et al. 2000), children aged 6-12 years with moderate and severe TBI were at significantly greater risk of experiencing persisting depressive symptoms at 6 and 12 months post-injury than children with orthopedic injuries. Although levels of self-reported depression did not differ between the groups soon after injury, level of depressive symptoms remained relatively stable across time for the TBI group, but declined significantly between baseline and at 6 and 12 months post-injury for the orthopedic group (Kirkwood et al., 2000). Based on parent reports, children with severe TBI were six times more likely than children with orthopedic injuries to display clinically elevated

depressive symptoms at 6 months and were 2.6 times more likely to at 12 months. Child and parent reports of depression were significantly correlated in the TBI sample (r = .29-.39) but not in the orthopedic sample.

There has been a growing emphasis in wider pediatric and mental health research on the inclusion of children's perspectives on their own well-being, recognizing children as competent interpreters capable of communicating how they see and experience themselves (Mason & Danby, 2011; McDougall, Bedell, & Wright, 2013). However, in pediatric ABI research parent reports are often more relied upon to assess children's functioning, possibly due to concerns that children's self-awareness or capacity to accurately appraise and self-report their own functioning may be compromised (Butler & Gasson, 2005; Lloyd, Ownsworth, Fleming, & Zimmer-Gembeck, 2015). Although such issues provide a good rationale for the inclusion of parent or significant others' reports regarding children's functional status, seeking multiple perspectives including that of the child, is likely to provide a fuller picture of the mental health of children and adolescents with ABI (Dockett, Einarsdottir, & Perry, 2009; Lloyd et al., 2015; McDougall et al., 2013). The pediatric ABI research that has included child and parent-proxy reports of psychosocial functioning has generally found low to moderate associations between the two (Bell, Ownsworth, Lloyd, Sheeran, & Chambers, 2018), which is consistent with the general pediatric literature (De Los Reyes et al., 2015). Notably, parents typically report greater behavioral or externalizing problems than children with ABI, yet often rate their child's self-esteem higher than child self-reports (Bell et al., 2018).. Due to the inherently subjective nature of self-perceptions and mood symptoms it is possible that parents underestimate children's distress and the negative effects on their self-concept.

To date, relatively few studies have examined the impact of pediatric ABI on self-concept from the child's perspective. Existing studies indicate that children and adolescents with ABI report significantly lower self-esteem than age and sex-matched controls (Andrews, Rose, & Johnson, 1998; Hawley, 2012; Pastore et al., 2015). Andrews et al. (1998) found that children aged 6-18 years with TBI (n = 54) reported significantly lower levels of self-esteem than age and sex-matched controls, along with higher levels of loneliness and behavioral problems. Similarly, Hawley (2012) examined self-esteem in 96 children (5-15 years) with TBI and found that they reported significantly lower self-esteem than their typically developing peers. In one of the few studies to include children with brain injuries arising from differing etiologies, Pastore et al. (2015) found that adolescents (12-18 years) with TBI and stroke reported significantly lower self-esteem than age and sex-matched controls. Interestingly, only female adolescents with ABI rated their sexual attractiveness as lower than controls, whereas both females and males with ABI rated their physical appearance as significantly poorer than typically developing peers. Adolescents with TBI and stroke did not significantly differ in their self-perceptions (Pastore et al., 2015).

Diverse factors potentially influence children's self-perceptions, mood and broader psychological adjustment following ABI. A leading neuro-developmental theory on recovery and adjustment to brain injury contends that children injured at a younger age are more vulnerable to poor functional outcomes (Anderson, 2001; Anderson, Northam, Hendy, & Wrennall, 2017). More generally, research supports a "double hazard" model concerning the heightened vulnerability to poorer neurocognitive outcomes of children who sustain both an early and severe brain injury, due to the disrupted development of the maturing brain (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005). In their meta-analysis, Babikian and Asarnow (2009)

reported evidence of a widening gap from typical neurocognitive development over time for children sustaining a severe TBI at an early age. However, the picture is less clear when it comes to behavioral and psychological functioning. In their review of pediatric TBI literature Li and Liu (2013) found mixed findings regarding the impact of age at onset and injury severity on children's behavioral and psychological outcomes. Based upon the double hazard model, it is possible that age of onset and severity of injury/disability have additive effects on children's mental health outcomes, however these have yet to be investigated. In ABI resulting from multiple causes, functional status measures provide a better indication of severity of disability than Glasgow Coma Scale and duration of post-traumatic amnesia, as the latter indices are not typically obtained for children with causes of ABI other than TBI (e.g., stroke, infection, tumor, or hypoxia).

There is some preliminary evidence suggesting that psychological outcomes may differ according to etiology of ABI (Pastore et al., 2014; Pastore et al., 2018), although very few studies have specifically compared the outcomes of children with different causes of ABI (Pastore et al., 2013; Poggi et al., 2005). Most studies have focused on specific etiology groups to avoid the potentially confounding issue of different mechanisms of injury and pre-injury risk factors. Yet, etiology of ABI is an important consideration given that children with different causes of ABI are typically managed through the same pediatric rehabilitation services. Hence, identifying subgroups at greater risk of poor psychological outcomes is a priority for clinical management.

In summary, pediatric ABI has been found to have negative effects on mental health including children's emerging self-concept. However, there are significant gaps in understanding of children's own perspectives of their mental health after ABI.

Aims and Hypotheses

The primary objective of this study was to investigate the impact of ABI on children and adolescents' mental health, namely their self-reported mood (depressive and anxiety symptoms) and self-concept. The specific aims were to: 1) characterize the mood and self-concept of children and adolescents (aged 8-16 years) with ABI relative to the norms; and 2) investigate demographic and injury factors (e.g., etiology, age at onset, and functional status) related to children's mood and self-concept. The secondary objective was to examine associations between children's self-reported mood and self-concept, and parents' reports of children's emotional and behavioral functioning.

Due to the exploratory nature of this study, no specific hypotheses were made regarding the influence of etiology on mood and self-concept. However, in line with the double hazard model, it was hypothesized that children who sustained an ABI earlier in life and those with poorer functional status would report significantly greater depressive and anxiety symptoms and more negative self-concept than those who sustained ABI later in childhood, or those with better functional status. In relation to the second objective, we hypothesized that children's self-reported mood and self-concept would be significantly related to parent ratings of children's emotional and behavioural functioning. It was also hypothesized that rates of parent-reported externalizing problems would be higher than parent-reported internalizing problems.

Methods

Participants

Children and adolescents with ABI were consecutively recruited through an outpatient rehabilitation clinic at a major metropolitan hospital in Brisbane, Australia, between January

2016 and February 2017. Children with TBI were recruited as part of a broader study that examined factors related to self-awareness (Lloyd, Ownsworth, Fleming, Jackson & Zimmer-Gembeck, 2019). Treating clinicians screened prospective participants based on the following inclusion criteria: history of ABI (i.e., brain injury sustained through internal or external mechanisms with onset > 40 days after birth); currently aged 8-16 years; absence of a major psychiatric disorder (e.g., psychosis) or neurodevelopmental disorder prior to injury; absence of significant sensory/perceptual deficits that would limit the individual's ability to complete self-report measures; and adequate understanding of spoken and written English. Children with a history of abuse or neglect (i.e., involvement in child protective services), or those presenting with extreme distress that warranted urgent psychiatric referral were excluded.

Sample Characteristics

As shown in Figure 1, of the 306 children receiving rehabilitation from the outpatient clinic during the recruitment period, a total of 224 children met the eligibility criteria, of which 46 did not participate; 26 declined and 20 were missed in recruitment due to not attending their scheduled appointment. Data were not available for a further 56 children who consented to participate but subsequently withdrew (n = 18) or did not complete the key measure (BYI-II) relevant to this study (n = 38). Consequently, the final sample included 122 children. Independent t-tests and chi-square tests showed that there were no significant differences between the final sample (n = 122) and children who were eligible but did not participate (n = 102) in terms of participant's age at injury, $t(206) = -.20$, $p = .84$; age at assessment, $t(212) = -1.83$, $p = .98$; time since onset , $t(206) = .69$, $p = .49$, or etiology in terms of TBI versus other ABI ($\chi^2(1, 215) = 1.20$, $p = .27$).

Insert Figure 1 here

As shown in Table 1, the ABI sample included 41 female and 81 male children, who sustained their injury from five causes, including TBI (52%), stroke (17%), brain tumor (15%), infection (13%) and hypoxia (3%). Hence, 63 children sustained a TBI and 59 had other causes (other ABI). Children's age at assessment ranged from 8 to 16 years and age at injury ranged from one month to 16.5 years.

Insert Table 1 about here

Measures

Mental health and self-concept: Beck Youth Inventories – Second Edition (BYI-II). The BYI-II (Jolly, & Steer, 2005) is a widely used self-report measure of mood and self-concept in children aged 7-18 years. The BYI-II is comprised of five self-report inventories: depression, anxiety, anger, disruptive behavior, and self-concept. Only the depression, anxiety and self-concept inventories were administered in this study. Each inventory consists of 20 statements (e.g. "*I have trouble sleeping"*) which children rate according to the frequency with which the statement applied to them ("*never*" = 0, "*sometimes*" = 1, "*often*" = 2, "*always*" = 3). Raw scores are calculated by summing all item responses for each scale (range: 0-60) and then converted to *T*-scores, based on sex and age norms. For the Depression (BDI) and Anxiety (BAI) inventories, *T*-scores of <55 indicate '*average*' symptomatology, 55-59 = '*mildly elevated'*, 60-69 = '*moderately elevated*' and 70+ = '*extremely elevated'*. *T*-scores of $\geq$ 60 were considered clinically significant. For the Self-concept inventory (BSCI), *T*-scores < 40 indicate '*much lower than average'* self-concept, 40 to 44 = '*lower than average'*, 45 to 55 = '*average',* and >55 = '*above average'. T*-scores of < 45 indicated clinically low levels of self-concept (Jolly, & Steer, 2005).

Strong psychometric properties have been reported for the BYI-II, including good internal consistency (α = .86-.96), test-retest reliability (r = .74-.93) and validity, and it has been used extensively in research with both typically developing and chronic illness populations (Jolly, & Steer, 2005; Thabrew, McDowell, Given & Murrell, 2017). Internal consistency for the BYI-II in the current ABI sample ranged from good to excellent (BDI α = .91; BAI α = .85; BSCI α = .88).

Functional status: Adaptive Behaviour Assessment System – Third Edition (ABAS-3). The ABAS-3 (Harrison & Oakland, 2015) is a multidimensional norm-referenced (birth to 89 years of age) measure. The parent/primary caregiver form (Ages 5-21 years) was used to assess children's functional status or daily living skills across three domains (conceptual, social and practical) that comprise 10 skill areas (communication, community use, functional academics, health and safety, home or school living skills, leisure, self-care, self-direction, social, and work). In addition to the overall age-standardised score (Global Adaptive Composite or GAC), index scores for the conceptual, social and practical domains were derived. The ABAS is a widely used measure in pediatric ABI research (Catroppa et al., 2017; McCauley et al., 2012). Sound internal consistency (α = .72 – .99), and test-retest reliability (r = .70-0.89) have been reported for this measure (Harrison & Oakland, 2015).

Emotional and behavioural functioning: Child Behaviour Checklist (CBCL). The CBCL (Achenbach & Rescorla, 2001) is a widely used 113 item measure of internalizing and externalizing behavior in children aged 6-18 years. As data were collected as part of a broader TBI study (Lloyd et al., 2019) which did not include the Youth Self-Report (for ages 11-18 years), only parents of children with TBI completed the CBCL. Using age and sex norms, raw scores are converted to *T*-scores for the three summary scales (Internalizing, Externalizing, and

Total Problems) and eight syndrome subscales (Withdrawn/Depressed, Somatic Complaints, Anxiety/Depression, Social Problems, Thought Problems, Attention Problems, Rule-Breaking Behavior, Aggressive Behaviour). Two summary scales incorporate a number of these; *Internalising Problems* (Anxious/Depressed, Withdrawn/Depressed, Somatic Complaints) and *Externalising Problems* (Rule-Breaking Behavior and Aggressive Behavior). The Total Problems score is a composite of all problem behavior subscales. Standardised scores of $T \geq 60$ are considered to fall in the clinical range for summary scales. Excellent internal consistency (α = .78-.97), test-retest reliability (r = .90), and inter-rater reliability (r = .93) have been reported for the CBCL (Achenbach & Rescorla, 2001), which is commonly used with pediatric brain injury populations (Catroppa et al., 2015; McCauley et al., 2012).

Procedure

Ethical approval was obtained from both hospital and university human ethics committees. Treating clinicians screened children for eligibility and approached prospective participants. Both the participating parent/caregiver and child/adolescent were asked to provide informed consent. Children were administered the Self-Concept, Depression and Anxiety scales of the BYI-II in person, with a clinician available to assist as needed. Parents/caregivers completed the ABAS-3 in person or over the telephone (as preferred). Similarly, parents/caregivers of children with TBI were also administered the CBCL in person or over the telephone. Information pertaining to children's ABI was accessed from medical records.

Data Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences version 24. Missing data and assumptions for parametric analyses were examined and managed according to procedures outlined by Tabachnick and Fidell (2013). Independent *t*-tests or one-

way ANOVA were conducted to examine between-group differences in children's mood and self-concept according to etiology of ABI, age at onset, current age, and sex. For age at onset and current age children were grouped into age bands as guided by prior research and developmental literature, with the following bands for age at onset: < 4, 4 to 7, 8 to 12, 13 to 16 years (Anderson et al., 2001; Harter, 2012). For significant between-group differences, chi-square tests were used to compare the proportion of children with clinically elevated levels of depression, anxiety and low self-concept. Pearson's correlations were used to examine associations between other demographic and injury-related variables and mood and self-concept. To examine additive effects or potential interactions between demographic and injury variables related to mood and self-concept, two-way ANOVA (categorical variables) or moderated hierarchical regression analyses (continuous variables) were conducted.

Results

Self-reported Mental Health and Self-Concept

Descriptive data on children's mood, self-concept and adaptive behavior are summarized in Table 2. For the total sample, TBI and other ABI groups, the mean *T*-scores were all in the average range for the BYI-II indices. Overall, 16.4% participants scored in the clinical range ($T \geq 60$) for depression and anxiety. A slightly higher proportion (24.6%) reported clinically low self-concept. Thirteen of the 20 children scoring in the clinical range for depression also scored in the clinical range for anxiety. Fourteen of the 30 children scoring in the clinical range for self-concept also scored in the clinical range for depression, and 10 children scored in the clinical range on all three scales.

Insert Table 2 about here

Demographic and injury-related factors associated with mood and self-concept

Due to the small number of children with hypoxia (n = 4), these children were omitted from the etiology specific comparisons; however, they were included in the "other ABI" subgroup for comparisons with children with TBI. No significant differences were found according to etiology subgroup (Infection, Stroke, Tumor, TBI) for children's self-reported depressive symptoms, $F(3, 118) = .85$, $p = .47$, $n_p^2 = .02$; anxiety symptoms, $F(3, 118) = 1.12$, $p = .35$, $n_p^2 = .03$; or self-concept, $F(3, 118) = 1.73$, $p = .17$, $n_p^2 = .04$. There were also no significant differences between the other ABI and TBI subgroups for self-reported depressive, $F(1, 121) = 1.40$, $p = .24$, $n_p^2 = .01$; anxiety symptoms, $F(1, 121) = 2.19$, $p = .14$, $n_p^2 = .02$; or self-concept, $F(1, 121) = 1.44$, $p = .23$, $n_p^2 = .01$.

Further, no significant differences were found according to age at onset for depressive symptoms, $F(3, 121) = 1.59$, $p = .20$, $n_p^2 = .04$; anxiety symptoms, $F(3, 121) = 1.59$, $p = .20$, $n_p^2 = .04$; or self-concept, $F(3, 121) = .38$, $p = .77$, $n_p^2 = .01$. However, there was a significant difference according to participants' current age, with older children (13-16 years) reporting significantly higher depressive symptoms (M = 52.04, SD = 10.84) than younger children (8-12 years; M = 45.47, SD = 8.60), $F(1,121) = 13.89$, $p <.001$, $n_p^2 = .10$. Similarly, older children reported significantly higher anxiety symptoms (M = 52.45, SD = 10.30) than younger children (M = 47.78, SD = 9.87), $F(1,121)= 6.11$, $p = .02$, $n_p^2 = .05$, as well as significantly poorer self-concept (M = 48.90, SD = 9.07) than their younger counterparts (M = 53.03, SD = 8.79), $F(1,121) = 4.78$, $p = .03$, $n_p^2 = .04$. Furthermore, a significantly higher proportion of older children (26.8%) scored in the clinical range for depression compared to younger children (7.6 %), $\chi^2(1, n = 122) = 8.16$, $p < .01$. The age groups did not significantly differ in the proportion of participants scoring in the clinical range for anxiety or self-concept ($p >.05$). No significant

differences were found according to children's sex for self-reported mood or self-concept (p >.05).

Table 3 displays the correlations between demographic and injury-related factors and the depression, anxiety, and self-concept indices of the BYI-II. Children with better functional status on the ABAS GAC, conceptual and practical domains reported fewer anxiety symptoms (r = -.22, p <.05). Further, there was a significant association between functional status on the ABAS social domain and self-concept (r = .20, p < .05), indicating that children with better social functioning had more positive self-concept. There were no other significant associations between the demographic and injury-related factors and mental health outcomes. Children's self-concept was significantly and negatively associated with depressive (r = -.58, p<.001) and anxiety (r = -.43, p<.001) symptoms. Further, anxiety and depressive symptoms were significantly and positively associated (r = .73, p <.001).

Insert Table 3 about here

Interactions between demographic and injury-related variables for mood and self-concept

As shown in Table 4, the regression analyses indicated that functional status (ABAS GAC) and age at onset were not significantly related to depressive symptoms or self-concept (p >.05). However, poorer functional status was significantly related to greater anxiety symptoms (p<.01) independent of age at onset. There were no significant interactions between functional status and age at onset (p >.05).

Insert Table 5 about here

Due to the significant univariate associations between functional status and current age and children's mood and self-concept, further analyses were conducted to determine whether these relationships were moderated by other demographic and injury-related factors. There were

no significant interactions between functional status and current age and the variables of sex, education, time since injury, and cause of ABI (TBI vs. other ABI) for mood or self-concept (p>.05).

However, there was a significant interaction between current age (8-12 vs. 13-16 years) and sex for depressive symptoms ($F(3, 121) = 4.34$, $p < .05$, $n_p^2 = .04$) and anxiety symptoms ($F(3, 121) = 5.08$, $p < .05$, $n_p^2 = .04$), but not for self-concept ($F(3, 121) = .26$, $p = .61$, $n_p^2 = .00$). As shown in Figure 2, pairwise comparisons identified that younger females reported significantly lower depressive (BDI: $t[39] = -3.44$, $p = .001$, $d = 1.11$) and anxiety symptoms (BAI: $t[39] = -3.66$, $p = .001$, $d = 1.19$) than older females. However, there were no significant differences in depressive and anxiety symptoms between younger and older males (BDI: $t[79] = -1.75$, $p > .05$, $d = 0.40$; BAI: $t[79] = -0.82$, $p > .05$, $d = 0.18$).

Insert Figure 2 about here

Associations between children's self-reported mood and self-concept and parent ratings of children's emotional and behavioral functioning (TBI only)

Data were missing for eight parents on the CBCL. Descriptive data on the CBCL for 55 children with TBI are reported in Table 5. Overall, 54.5% of children with TBI were in the clinically significant range on the CBCL total problems scale ($M = 58.89$, $SD = 11.15$) and the internalizing scale ($M = 58.89$, $SD = 12.98$). A lower percentage (32.7%) were in the clinically significant range for externalizing problems ($M = 55.73$, $SD = 9.90$). Sixteen of the 30 children scoring in the clinical range for internalizing problems also scored in the clinical range for externalizing problems. All but one of the children who scored in the clinical range for externalizing problems also scored in the clinical range for internalizing problems.

As reported in Table 5, significant correlations were found between the BYI-II scales and many of the parent-reported scales on the CBCL (p <.05). Focusing on summary scales, moderate sized correlations were generally found between parent-reported CBCL total problems and internalizing problems and children's self-reported depressive and anxiety symptoms, and self-concept. Parent-reported externalizing problems on the CBCL were only significantly correlated with children's self-concept, with higher levels of externalizing behavior associated with less positive views of self.

Insert Table 5 about here

Further analysis was conducted to identify demographic and injury variables associated with parent reports of children's emotional and behavioral functioning. Greater total problems on the CBCL were significantly associated with sustaining an injury at an earlier age (r = -.29, p<.05), greater time since injury (r = .36, p<.05) and more severe TBI (r = .33, p<.05). Externalizing problems were positively associated with time since injury (r = .33, p<.05), and severity of injury (r = .34, p<.05). Internalizing problems were not significantly correlated with any demographic or injury variables (p >.05). However, there was a significant interaction between current age (8-12 vs. 13-16 years) and sex for the internalizing scale of the CBCL, $F(3, 54) = 4.25$, $p < .05$, $n_p^2 = .08$. There was a tendency for older females to have greater internalizing problems (M = 62.54, SD = 11.0) than younger females (M = 54.1, SD = 18.1), whereas younger males had greater internalizing problems (M = 61.88, SD = 10.3) than older males (M = 55.35, SD = 13). However, none of these pairwise comparisons were significant (Females: $t[19] = -1.31$, p >.05; Males: $t[32] = 1.61$, $p > .05$).

In summary, there was a significant age x sex interaction for self-reported depressive and anxiety symptoms for the broader ABI sample. Similarly, when examining parent-reported

emotional and behavioral functioning for the TBI subgroup, a significant interaction between current age and sex was found on the internalizing scale of the CBCL, although the pairwise comparisons were not significant.

Discussion

The present study aimed to investigate the impact of ABI on the self-reported mood and self-concept of children and adolescents, and to investigate demographic and injury-related factors related to these mental health outcomes. Overall, 16.4% of children scored in the clinical range for depressive and anxiety symptoms, while 24.6% of children reported clinically low self-concept. Thus, the majority of children and adolescents were not experiencing clinically elevated mood symptoms or poor self-concept. There were no significant differences in mood or self-concept according to etiology of injury. In relation to the first hypothesis, poorer functional status was significantly related to higher anxiety symptoms; however, age at injury was not significantly related to mood symptoms or and self-concept. A key finding was that adolescent girls reported greater symptoms of depression and anxiety than younger girls, whereas no age difference was found for boys. In support of the second hypothesis, significant associations were typically found between children's self-reported mood and self-concept and parents' reports of emotional and behavioral functioning (CBCL total and internalizing scales). Contrary to the third hypothesis, rates of parent-reported internalizing problems were higher than their reports of externalizing problems.

Approximately one in four (self-concept) and nearly one in five (depression/anxiety) children reported clinically significant levels of poor self-concept and/or mood symptoms, respectively. Such rates are higher than rates of anxiety and depression reported for children and

adolescents in the general community based on both Australian (6.9-7.7%; Lawrence et al., 2016) and US (3.2-7.1%; Ghandor et al., 2018) data. Yet, these rates are lower than those cited in other pediatric ABI research (35-49%; Kirkwood et al., 2000; Luis & Mittenberg, 2002; Max et al., 2012). A potential explanation for the lower rates compared to other pediatric ABI research relates to methodological differences such as the inclusion/exclusion criteria, use of the BYI-II and the sample characteristics. For instance, the current study excluded children experiencing extreme levels of distress that warranted psychiatric referral, which is likely to have resulted in an underrepresentation of the proportion of children experiencing distress in the clinical population. Further, the BYI-II may be less sensitive to indicators of clinical distress than a semi-structured interview approach incorporating both child and parent perspectives, such as that used by Max et al. (2012).A further key difference is that the current study included children at much longer time since onset (1 month to 16 years post-onset), compared to previous studies, which were conducted more uniformly at early phases of recovery (3 or 6 months post-injury; Kirkwood et al., 2000). Thus, the lower levels of mood symptoms and poor self-concept may reflect long-term adjustment to their post-injury circumstances. Consistent with Pastore et al. (2015), there were no significant differences in mood symptoms or self-concept according to etiology of injury. As such, it may be more meaningful to focus on the variability in children's mental health outcomes within each etiology group, to determine risk factors for poor psychological adjustment (see Bell et al., 2018).

Overall, there was partial support for the hypothesis that children with lower functional status have poorer mental health outcomes, in terms of anxiety symptoms. Additionally, lower functioning on the ABAS social domain was significantly associated with more negative self-concept. Caution is needed in inferring the direction of association between these constructs. For

example, greater social competency may foster more positive self-perceptions. Alternatively, having a more positive self-view may facilitate greater skill development in social situations. Notably, age at injury was positively associated with functional status (r = .51). It is possible that the impact of age at injury and functional status on children's mood and self-concept is moderated by their self-awareness. Indeed, Lloyd et al., (2017) found that children injured at a younger age had poorer self-awareness than those injured in later childhood. Therefore, children injured at a younger age with poor functional status may have less insight into their functional impairments, thus buffering against negative impacts on their mood or self-concept. Further research is needed to test the potential moderating role of self-awareness in the relationship between the variables of age at injury and functional status and mental health.

A key finding of the current study is that older children (13-16 years) reported significantly higher depressive and anxiety symptoms and lower self-concept than younger children (8-12 years). Importantly, this finding was qualified by a significant interaction between age and sex for depressive and anxiety symptoms; specifically, older girls reported greater depressive and anxiety symptoms than younger girls, whereas no age-based differences were found for boys. A similar trend was found for parents' reports on the CBCL for children with TBI, with a significant interaction evident between age and sex for internalizing problems of the CBCL. Other studies have similarly found higher rates of anxiety and poorer psychosocial outcomes in older children than younger ones following TBI (Di Battista, Godfrey, Soo, Catroppa & Anderson, 2014; Friefeld, Westmacott, Macgregor & Deveber, 2011; Gomes et al., 2014; Neuner et al., 2011). Relative to younger children, who often have an inflated sense of their capabilities and attributes, adolescents tend to have more complex and realistic self-perceptions that are informed by real-world feedback (Damon & Hart, 1982; Harter, 2012;

Marsh & Ayotte, 2003). Further, previous research has found that females with TBI have a heightened vulnerability for developing mental health conditions when compared to males (Gerring et al., 2009; Grados et al., 2008; Li & Liu, 2013). Adolescent girls are found to be more self-conscious, vulnerable to criticism and concerned with interpersonal relationships than adolescent boys (O'Dea & Abraham, 1999; Rosenberg & Simmons, 1975). Given the functional impairments experienced after ABI, and the potential to receive negative feedback from one's peers, it is possible that ABI amplifies the risk of mood symptoms for adolescent girls during a developmental period of heightened self-consciousness. Further research investigating the mechanisms underlying the interactive effects of age and sex on mood symptoms is needed to guide intervention efforts.

Parents of children with TBI reported higher levels of internalizing problems (55%) than externalizing problems (33%), with both rates higher than levels of distress reported by children with ABI on the BYI-II. Given that internalizing problems are less observable than externalizing symptoms (De Los Reyes et al., 2015), these findings may suggest that parents misinterpret and overestimate their children's distress. Alternatively, it is possible that children lack insight into their own internal states, and thus underreport emotional difficulties. Overall, children's self-reported mood and self-concept were moderately associated with parents' reports of internalizing problems. However, only children's self-concept was significantly associated with externalizing problems. Although these findings do not reflect concordance or agreement between self and proxy ratings on the same tool, such results indicate that children's mood symptoms and self-concept are generally consistent with parents' observations of their children's internalizing symptoms. Hence, children and parents appear to have similar yet unique perspectives on the child's mental health.

Interestingly, poorer self-concept in children was significantly related to greater parent-rated externalizing problems but not internalizing problems. Greater externalizing problems were related to more severe TBI and longer time since injury, thus supporting the view that emotional and behavioral disorders may emerge over time following brain injury (Li & Liu, 2014). Externalizing behaviors may reflect the primary impact of injury or secondary impact (i.e., psychological reactions to functional impairments and their everyday implications). It is possible that problem behaviors such as rule breaking and aggression negatively impact children's participation in social activities and the quality of social interactions, which in turn lowers their self-worth (Ownsworth, 2014). The importance of children's social participation to their emerging self-concept is supported by the significant positive correlation between social functioning on the ABAS and self-concept.

Overall, the findings of the current study highlight the need to screen for and monitor children's mood and self-concept after ABI. Adolescent females may be particularly vulnerable to depressive and anxiety symptoms and, as such, may warrant more comprehensive psychological assessment and early intervention. There is sound evidence supporting the efficacy of online psychological interventions for adolescents with ABI, such as the Teen Online Problem Solving (TOPS) program, which focuses on problem-solving, communication skills, and self-regulation (Ross, Dorris, McMillan, 2011; Wade et al., 2012). It may also be beneficial to inform parents and teachers of the increased vulnerability of adolescents (girls especially) to mood and self-concept difficulties after ABI, to aid in the early identification of difficulties and subsequent engagement with appropriate supports.

Limitations

Several limitations need to be acknowledged in the current study. First, the absence of a demographically matched neurological healthy or orthopedic injury control group limits the conclusions that can be drawn about the impact of ABI on mood and self-concept. Second, the study employed a cross-sectional design, thus limiting understanding of the adjustment trajectory of children and adolescents over time with respect to their mood and self-concept. Third, due to the broad clinical sample, there was significant diversity regarding age at injury, time since injury and etiology. There was a strong negative correlation between age at onset and time since injury (r = -.85), indicating that children injured at a younger age were more long-term post-injury. Further, poorer functional status was related to younger age at injury (r = .51) and longer time since injury (r = -.51). More specifically, children receiving long-term follow-up in the outpatient clinic were more likely to have severe disability resulting from an injury at a younger age. The inter-relatedness of these characteristics may have confounded the analysis on the additive effects of age at injury and functional status on children's mental health outcomes. Further, children displaying extreme distress (e.g., acute suicidal ideation) that warranted psychiatric referral were excluded from the current study, which may have contributed to the relatively low rates of clinically significant distress. Overall, clinical ascertainment bias and the heterogeneity of sample characteristics may affect the generalisability of findings to other pediatric brain injury settings. Finally, as the data were collected as part of a broader study that primarily focused on children with TBI, the CBCL was only administered to parents of children with TBI, and thus direct comparison of parent and child perspectives was not possible in this study. The smaller sample size for the analyses involving the CBCL may also have affected statistical power.

Although only a minority of children aged 8-12 years were in the clinical range for self-reported mood symptoms and poor self-concept, approximately one quarter to one third of children aged 13-16 years experienced clinically significant mood symptoms or poor self-concept. Further research is necessary to understand the factors underlying the heightened risk of poor mental health outcomes for adolescents, and girls in particular. Longitudinal research investigating the role of self-awareness and social feedback in the development of mood symptoms and poor self-concept may guide the focus of developmentally sensitive psychological interventions. In addition to identifying risk factors for poor mental health outcomes, the protective factors underlying positive psychological adjustment need to be understood to inform resilience-focused interventions (for a review, see Dray et al., 2017) for the paediatric ABI population.

Conclusion

Overall, the current findings indicated that most children with ABI did not report clinically significant mood symptoms or poor self-concept. The key factors related to children's self-reported mental health included functional status and current age, with the later moderated by sex. Female adolescents were found to be at significantly higher risk of experiencing depressive and anxiety symptoms than younger females. For the TBI sample, there were typically moderate associations between children's self-report and parent reports of the child's emotional and behavioral functioning. In terms of clinical implications, these findings support the need for routine assessment of mood symptoms and self-concept, particularly for adolescents, and especially females, in order to provide timely psychosocial interventions.

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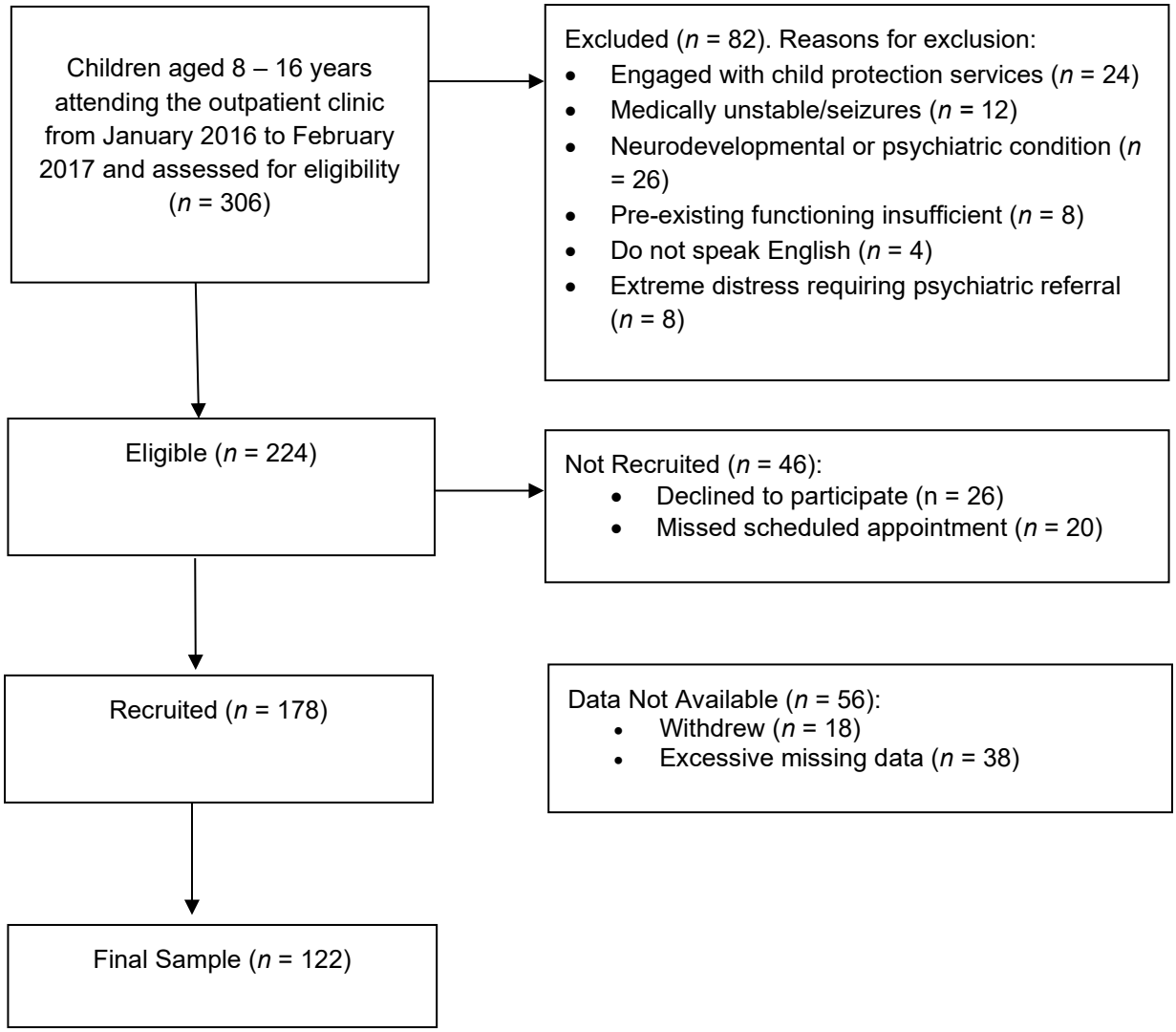
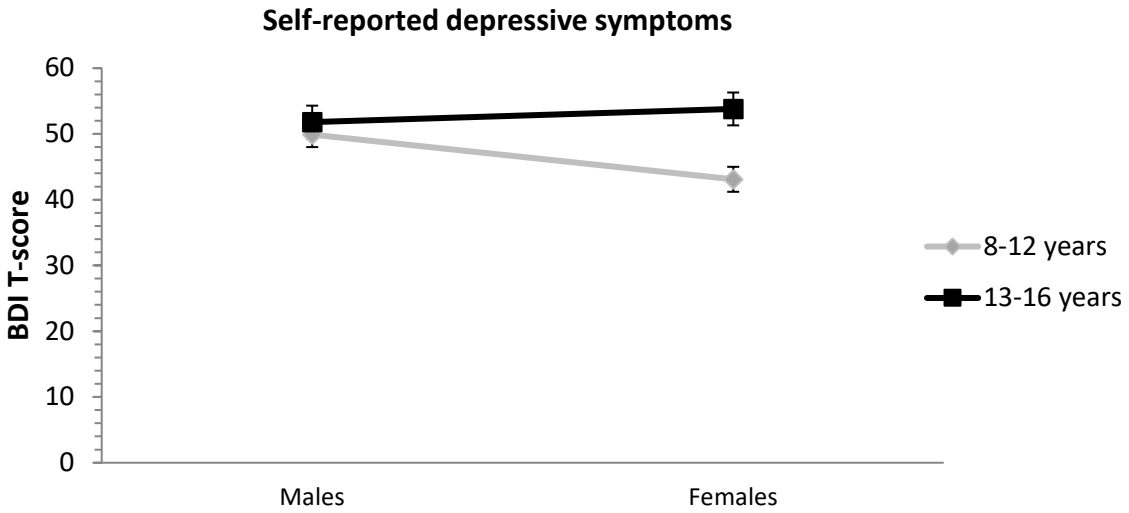


Figure 1.

Recruitment flow diagram for children with ABI



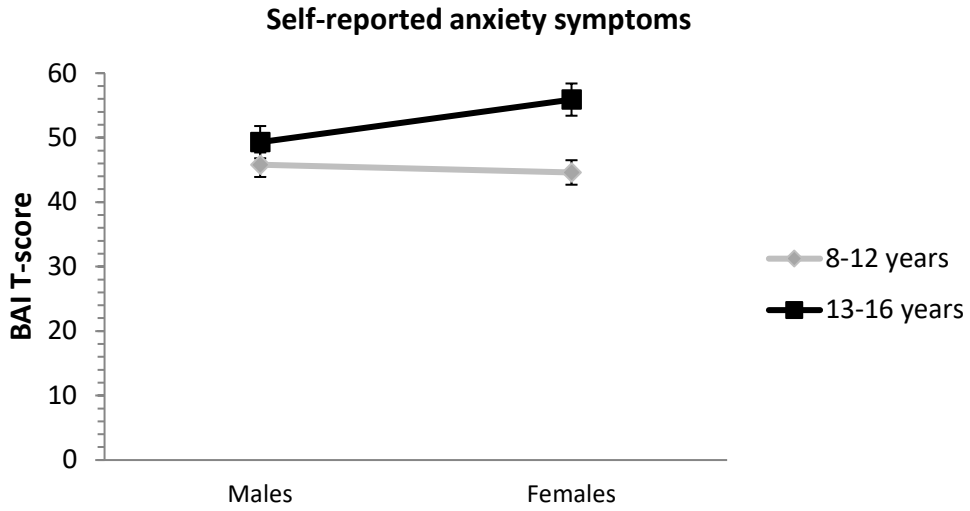


Figure 2.

Mean BDI-Y and BAI-Y scores for younger and older female and male children (note: error bars represent standard errors).

Table 1.

Children's' Demographic and Injury Characteristics

	Total Sample	Other ABI	TBI	Infection	Stroke	Tumor	Hypoxia
	n = 122	*n* = 59	*n* = 63	*n* = 16	*n* = 21	*n* = 18	*n* = 4
	M (*SD*), *n* (%)	*M* (*SD*), *n* (%)	*M* (*SD*), *n* (%)	*M* (*SD*), *n* (%)	*M* (*SD*), *n* (%)	*M* (*SD*), *n* (%)	*M* (*SD*), *n* (%)
Age at Assessment (years)	12.63(2.40)	12.43 (2.45)	12.82 (2.36)	12.50 (2.45)	11.64 (2.40)	12.67 (2.36)	15.22 (1.03)
8-12	66 (54%)	36 (61%)	30 (48%)	9 (56%)	16 (76%)	11 (61%)	0 (0 %)
13-16	56 (46%)	23 (39%)	33 (52%)	7 (44%)	5 (24%)	7 (39%)	4 (100%)
Age at Onset (years)	8.35 (4.78)	7.14 (4.88)	9.49 (4.43)	6.09 (5.21)	6.74 (4.38)	8.43 (4.44)	7.57 (8.18)
< 4	33 (27%)	23 (39%)	10 (16%)	9 (56%)	8 (38%)	4 (22%)	2 (50%)
4-7	19 (16%)	8 (14%)	11 (18%)	1 (6%)	3 (14%)	4 (22%)	0 (0 %)
8-12	45 (37%)	18 (31%)	27 (43%)	3 (19%)	9 (43%)	6 (33%)	0 (0 %)
13-16	25 (20%)	10 (17%)	15 (24%)	3 (19%)	1 (5 %)	4 (22%)	2 (50%)
Time Since Onset (years)	4.28 (4.30)	5.29 (4.42)	3.33 (3.98)	6.41 (5.20)	4.90 (3.65)	4.24 (3.17)	7.65 (8.66)
Sex							
Female	41 (34%)	19 (32%)	22 (35%)	4 (25%)	7(33%)	7 (39%)	1(25%)
Male	81 (66%)	40 (68%)	41 (65%)	12 (75%)	14 (67%)	11 (61%)	3 (75%)
Parental Education (years)	13.90 (2.84)	14.03 (2.86)	13.77 (2.84)	13.81 (2.81)	15 (2.70)	13.24 (3.09)	13.25 (2.22)
Household Income (median)[a]	3	3	3	4	5	5	5

[a] Household income was coded as follows: 1 = <$40,000, 2 = $40,000 - $60,000, 3 = $60,001 - $80,000, 4 = $80,001 - $100,000, 5 = $100,001 - $120,000, 6 = $120, 001 - $140, 000, 7 = $140, 001 – $160, 000, 8 = $160, 001 – $180, 000, 9 = $180, 001 – $200, 00, 10 = > $200,000.

Table 2

Descriptive Data on Children's Mental Health and Adaptive Behavior

	Total Sample *M* (*SD*), *n* (%) range	Other ABI *M* (*SD*), *n* (%) Range	TBI *M* (*SD*), *n* (%) Range	Infection *M* (*SD*), *n* (%) Range	Stroke *M* (*SD*), *n* (%) range	Tumor *M* (*SD*), *n* (%) Range	Hypoxia[a] *M* (*SD*), *n* (%) range
BYI (T-scores)							
Depression	48.48 (10.20) 34 - 80	47.36 (10.27) 35 – 80	49.54 (10.10) 34 – 73	49.50 (9.06) 37 – 68	46.86 (10.77) 35 - 71	45.83 (11.20) 35 – 80	48.25 (10.21) 63 - 60
Number (%) in clinical range	20 (16.4)	9 (15.3)	11 (17.5)	2 (12.5)	3 (14.3)	3 (16.7)	1 (25)
Anxiety	50.15 (10.41) 31-88	48.71 (10.59) 31 – 88	51.49 (10.15) 32 – 77	50.25 (11.11) 40 – 88	47.76 (9.11) 34 - 70	47.44 (12.05) 31 – 71	53.25 (10.94) 44 - 68
Number (%) in clinical range	20 (16.4)	8 (13.6)	12 (19)	1 (6.3)	2 (9.5)	4 (22.2)	1 (25)
Self-Concept	50.91 (9.11) 30-70	51.93 (8.86) 30 – 70	49.95 (9.30) 34 – 70	47.69 (5.52) 42 – 57	53.71 (10.23) 32 - 70	52.28 (8.53) 30 – 65	58 (9.42) 47 - 70
Number (%) in clinical range	30 (24.6)	11 (18.6)	19 (30.2)	5 (31.3)	4 (19)	2 (11)	4 (100)
ABAS							
GAC	91.02 (17.02) 49 - 120	88.58 (15.83) 49 – 120	93.64 (17.98) 50 – 120	86.13 (15.06) 65 – 120	92.38 (14.61) 70 - 120	88.39 (17.24) 49 – 120	79.25 (18.88) 61 - 97
Conceptual	89.93 (17.17) 49 - 120	88.12 (15.11) 49 – 120	91.87 (19.08) 51 – 120	84.25 (13.51) 63 – 116	93.57 (13.34) 74 - 120	87.39 (17.23) 49 – 120	78.25 (14.64) 63 - 94
Social	92.86 (17.14) 34 – 120	92.44 (14.25) 59 – 120	93.30 (19.86) 34 – 120	88.94 (13.90) 75 – 120	98.52 (12.77) 77 - 120	90.17 (14) 59 – 120	84.75 (18) 66 - 103
Practical	91.23 (17.58) 50-120	88.29 (17.30) 50 – 120	94.32 (17.68) 53 – 120	88.13 (15.82) 64 – 120	90.10 (17.44) 64 - 120	88.11 (18.13) 50 – 120	80.25 (20.57) 62 - 100
Number (%) below average	60 (52.63)	35 (59.3)	25 (45.5)	11 (68.8)	12 (57.1)	10 (55.6)	2 (50)

[a] data for participants with hypoxia were included in TBI vs Other ABI comparison, but were excluded in etiology specific subgroup analysis due to small sample size; ABAS = Adaptive Behavior System – Third Edition (ABAS-3); BYI = Beck Youth Inventories – Second Edition (BYI-II); GAC = Global Adaptive Composite.

Table 3.

Correlations between Children's Demographic and Injury Characteristics, Adaptive Behavior (ABAS) and Mental Health (BYI) (n = 122)

	BDI-Y	BAI-Y	BSCI-Y
Parental Education	.04	.04	-.08
Time Since Onset	.04	.04	-.08
Household Income[a]	-.02	-.11	.13
GCS (TBI only)	-.09	-.01	.15
PTA (TBI Only)	-.02	-.19	.14
ABAS GAC	-.10	-.22*	.14
Conceptual	-.11	-.22*	.18
Social	-.09	-.14	.20*
Practical	-.09	-.22*	.09

* $p < .05$, ** $p < .01$. [a] Spearman's rho was used for this ordinal variable; ABAS GAC = Adaptive Behavior System – Third Edition, Global Adaptive Composite; BDI-Y = Beck Depression Inventory for Youth; BAI-Y = Beck Anxiety Inventory for Youth; BSCI-Y = Beck Self-concept Inventory for Youth. GCS = Glasgow Coma Scale; PTA = Post-traumatic Amnesia.

Table 4.

Regression Coefficients for Moderation Models of Children's Functional Status (ABAS GAC) and Age of Onset on Self-Reported Depressive and Anxiety Symptoms, and Self-Concept

Interaction	R^2 / ΔR^2	*F*	*B*	SE	95% CI
BDI-Y					
Step 1	.04	1.52			
Age at onset			.032	.012	[-.007, .072]
ABAS GAC			-.078	.138	[-.246, .014]
Step 2					
ABAS GAC x Age of onset	.001	0.12	.001	.001	[-.003, .002]
BAI-Y					
Step 1	.09	3.64*			
Age at onset			.038	.020	[-.001, .077]
ABAS GAC			-.134**	.136	[-.326, -.069]
Step 2					
ABAS GAC x Age of onset	.003	0.34	-.001	.001	[-.003, .002]
BSCI-Y					
Step 1	.03	1.26			

Age at onset			-.004	.018	[-.039, .032]
ABAS GAC			.078	.059	[-.039, .194]
Step 2					
ABAS GAC x Age of onset	.012	1.33	.001	.001	[-.001, .003]

*p<.05; **p<.01; ABAS GAC = Adaptive Behavior System – Third Edition, Global Adaptive Composite. BDI-Y = Beck Depression Inventory for Youth; BAI-Y = Beck Anxiety Inventory for Youth; BSCI-Y = Beck Self-concept Inventory for Youth.

Table 5.

Correlations between Child-Reported Mental Health and Parent-Reported Emotional and Behavioral Functioning in the TBI sample (n = 55)

Parent report		Children's self-reports		
CBCL Subscales	CBCL *M* (*SD*), range	BDI-Y	BAI-Y	BSCI-Y
Total	58.89 (11.15), 31-81	.35**	.37**	-.33*
Internalizing	98.89 (13), 34-90	.43**	.44**	-.33*
Anxious/Depressed	59.09 (9.99), 50-86	.35**	.35**	-.24
Withdrawn/Depressed	58.44 (8.40), 50-90	.47**	.42**	-.27*
Somatic Complaints	63.38 (10.27), 50-88	.35**	.33*	-.27*
Social Problems	59.75 (8.70), 50-78	.31*	.31*	-.35**
Thought Problems	60.55 (9.42), 50-80	.29*	.32*	-.27*
Attention Problems	61.84 (10.44), 50-88	.37**	.25	-.27*
Externalizing	55.72 (9.90), 34-81	.27	.22	-.35**
Rule-Breaking Behavior	56.09 (6.70), 50-76	.21	.18	-.27*
Aggressive Behavior	58.02 (7.91), 50-93	.26	.20	-.33*

* $p < .05$, ** $p < .01$, (2-tailed). CBCL = Child Behavior Checklist; BDI-Y = Beck Depression Inventory for Youth; BAI-Y = Beck Anxiety Inventory for Youth; BSCI-Y = Beck Self-concept Inventory for Youth