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The family environment predicts long-term academic achievement and classroom behaviour following traumatic brain injury in early childhood

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Abstract

Objective—This study examined how the family environment predicts long-term academic and behavioural functioning in school following traumatic brain injury (TBI) in early childhood.

Method—Using a concurrent cohort, prospective design, 15 children with severe TBI, 39 with moderate TBI, and 70 with orthopedic injury (OI) who were injured from 3–7 years of age were compared on tests of academic achievement and parent and teacher ratings of school performance and behaviour on average 6.83 years post injury. Soon after injury and at the longer-term follow-up, families completed measures of parental psychological distress, family functioning, and quality of the home environment. Hierarchical linear regression analyses examined group differences in academic outcomes and their associations with measures of the early and later family environment.

Results—The severe TBI group, but not the moderate TBI group, performed worse than the OI group on all achievement tests, parent ratings of academic performance, and teacher ratings of internalizing problems. Higher quality early and late home environments predicted stronger academic skills and better classroom behaviour for children with both TBI and OI. The early family environment more consistently predicted academic achievement, while the later family

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environment more consistently predicted classroom functioning. The quality of the home environment predicted academic outcomes more strongly than parental psychological distress or family functioning.

Conclusion—TBI in early childhood has long-term consequences for academic achievement and school performance and behaviour. Higher quality early and later home environments predict better school outcomes for both children with TBI and children with OI.

Keywords

home environment; academic achievement; behavioural functioning; parents

INTRODUCTION

Children's home environments play a critical role in fostering their school outcomes (Al-Nhar, 1999; Marjoribanks, 2005). Family variables, such as scholastic guidance and support and the discussion of events and ideas, support children's learning and school-related outcomes (Kellaghan, Sloane, Alvarez, & Bloom, 1993). In a ten-year longitudinal study of family environment and children's outcomes, Câmara-Costa, Pulgar, Cusin, & Dellatolas (2015) found that "parental education level, family situation, language-based bedtime routines, and type of early childcare significantly predicted later academic achievement at grade 9" (p. 135).

Traumatic brain injury (TBI) during childhood frequently interferes with school functioning (Catroppa & Anderson, 2007; Vu, Babikian, & Asarnow, 2011). School performance is considered a key component for "educational attainment, psychosocial adjustment, and eventual vocational adaptation" (Levin, Ewing-Cobbs et al., 2004, p.108). Many children with TBI, however, exhibit deficits in cognitive processes that are foundational to their educational success, including language skills, attention, memory, and executive functions (Anderson, Catroppa, Haritou, Morse, & Rosenfeld, 2005; Gerrard-Morris et al., 2010; Yeates et al., 2005). Thus, many children with TBI demonstrate deficits on standardized achievement tests assessing reading, written language, and math skills (Aldrich & Obrzut, 2012; Ewing-Cobbs et al., 2004).

Children's age at injury has been associated with long-term scholastic outcomes, with earlier TBI linked to greater academic difficulties, likely due to the disruption of early pre-academic skill acquisition (Barnes & Dennis, 1999). Catroppa and colleagues (2009) found a main effect of age at injury, such that children injured between the ages of 3–7 years performed worse than children injured between the ages of 8–12 years, on a reading assessment 7 years post injury. This finding, however, did not extend to tests of spelling or arithmetic. Children who sustain an earlier childhood TBI also demonstrate a slower rate of growth in their academic skills (Ewing-Cobbs et al., 2004), suggesting that age at injury is related to both lower academic achievement and persistent academic struggles.

Children with TBI also display problematic behaviours in school, including interrupting the class and not listening to instructions, that can interfere with their classroom performance (Hawley, 2005). Thaler and colleagues (2012) determined that the problematic classroom

behaviours seen after childhood TBI encompass both externalizing and internalizing difficulties and fall within the at-risk to clinically elevated range. Furthermore, they noted that the behavioural profile of children with TBI differs from that of other clinical samples of children, such as those with epilepsy or learning disabilities, in that children with TBI demonstrate a unique combination of learning difficulties and externalizing behaviours, in addition to moderate levels of internalizing behaviours. Poorer classroom adjustment after TBI is predictive of both worse academic performance and an increased likelihood of educational intervention (Yeates & Taylor, 2006).

Research on childhood TBI has increasingly focused on the factors that may moderate its negative effects. The family environment has been shown in multiple studies to moderate the effects of childhood TBI, with better family functioning predicting less pronounced behavioural problems (Yeates et al., 2010) and greater social competence (Yeates et al., 2004) relative to healthy children or those with injuries not involving the head. The family environment may also play an important role in accounting for children's academic outcomes after TBI. Rivara and colleagues (1994) found that children who had better preinjury family functioning and stronger family relationships had better academic outcomes one year after their injury. In a five-year post-injury follow up, Catroppa and colleagues (Catroppa, Anderson, Morse, Haritou, & Rosenfeld, 2008) found that family functioning was a significant predictor of children's arithmetic skills, but not their reading or spelling skills. In a 10-year follow-up by the same investigators (Catroppa et al., 2012), preinjury family functioning did not predict children's reading, spelling, or arithmetic scores. Taken together, these results suggest that better preinjury family functioning may be predictive of positive academic outcomes in children with TBI, but perhaps only during the first few years after injury.

Across the TBI literature, however, relatively few studies have examined the family environment and how it relates to children's school performance after a TBI (Rivara et al., 1994). This is especially relevant for children with early childhood TBI, given that younger age at injury may have more severe and long-lasting consequences for children's academic performance. Additionally, even fewer studies have examined how the family environment may influence both children's academic performance and their behaviour in school settings (Arroyos-Jurado, Paulsen, Merrell, Lindgren, & Max, 2000). Taking into account the long-term implications of children's educational success for their broader social, cognitive, and psychological development, further research is needed to explore the family environment's role in predicting school outcomes after TBI. In particular, research is needed to examine the relative importance of the immediate post-injury family environment versus the family environment in later years as predictors of long-term academic outcomes, to help determine the optimal timing of family-based interventions designed to foster better child outcomes after early TBI (Brown, Whittingham, Boyd, & Sofronoff, 2012).

The present study therefore sought to examine the influence of children's family environments on their longer-term academic and behavioural functioning in school after sustaining a TBI during early childhood. More specifically, drawing on data from a larger, prospective longitudinal study, we explored how measures of the family environment, collected shortly after injury and again an average of 6.83 years later, were associated with

children's academic achievement and school performance on average 6.83 years after either a TBI or an orthopaedic injury (OI) not involving the head. School performance was assessed using direct measures of academic performance, as well as parent and teacher reports, thereby helping to avoid the problem of shared rater variance that can arise when outcomes are assessed using a single source (Silberg, Tal-Jacobi, Levav, Brezner, & Rassovsky, 2015).

Based on the prior literature, we had three major hypotheses:

1. Moderate and severe TBI during early childhood will be associated with long-term academic deficits and behavioural problems in school relative to OI.
2. Family environments will predict academic and behavioural functioning in school, for both children with TBI and those with OI.
3. Children's family environments immediately after injury will be a more consistent predictor of school performance than their later family environments.

We also explored potential moderating effects of the family environment on the effects of TBI, predicting that the effects of TBI on school performance would be more pronounced among children from less advantaged family environments and, conversely, less pronounced among children from more advantaged family environments.

METHOD

Study Design, Participants, and Procedures

Data for the present study were drawn from a larger parent study that used a concurrent cohort prospective design to examine the outcomes of TBI versus OI in children injured from 3–7 years of age (Taylor, Swartwout, Yeates, Walz, Stancin, & Wade, 2008; Yeates, Taylor, Walz, Stancin, & Wade, 2010). Children with OI were used as a comparison group to control for the potential impact of acute hospitalization and for background characteristics that increased children's risk of accidental injury.

Children and their families were invited to participate in the study at the time of hospitalization, once children were deemed medically stable. In the parent study, 206 children were recruited from three children's hospitals and one general hospital in the Midwestern United States. Study approval was obtained from the Institutional Review Boards at each site, and parents provided written consent at the time of recruitment. Children were eligible for the TBI group if they sustained a blunt head trauma resulting in a moderate to severe TBI and they required at least an overnight hospitalization. Injuries resulting in a Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) of < 9 were classified as severe, whereas those with a GCS score of 9–12 or of 13–15 in association with abnormal neuroimaging were classified as moderate. Children in the OI group sustained a bone fracture, excluding skull fractures, and experienced no alteration in consciousness or indications of head trauma. Children were excluded if they had a preinjury history of neurological or developmental impairments, their injury was a result of child abuse, or English was not the primary language spoken at home.

At an early assessment about 3 weeks post-injury, the family environment was evaluated using both parent questionnaires and a home visit. A long-term assessment of the family environment using the same measures was conducted on average 6.83 years ($SD = 1.13$, range = 4.47 to 10.58 years) following the baseline assessment. This assessment also evaluated children's academic skills, and elicited parent ratings of children's school performance and teacher ratings of children's academic and behavioural functioning. Of the 206 recruited participants, 163 (79%) were successfully contacted, 146 (71%) returned for the long-term assessment, and 124 (60%) completed both early and long-term assessments and had all data needed for the current analyses. Families who were successfully contacted but opted not to complete the long-term assessment generally said they were too busy or that their children did not wish to continue with the assessments. Children who did and did not complete both assessments did not differ in sex, race, type of injury, age at injury, baseline socioeconomic status, or on measures of the early family environment. Table 1 summarizes demographic and injury characteristics of the OI ($n = 70$), moderate TBI ($n = 39$), and severe TBI groups ($n = 15$) included in the current study.

Of the 124 participants in the current sample, 74 had teacher ratings of academic performance and classroom behaviour. Children with and without teacher ratings did not significantly differ in terms of sex, race, type of injury, or age at injury. Compared to children with teacher ratings, children without teacher ratings were significantly older and came from lower socio-economic environments. They also scored lower on tests of arithmetic and written expression, but not on a reading test or in terms of academic performance as rated by parents and teachers. Additionally, parents of children without teacher ratings reported higher levels of distress at both baseline and long-term assessments than parents of children with teacher ratings, but the two groups did not differ in early or later family functioning or in the quality of the early or later home environment.

Measures

Academic Performance—Children's academic skills were assessed at the long-term assessment using the Woodcock-Johnson Tests of Achievement – Third Edition (WJ-III; Woodcock, McGrew, & Mather, 2001). The WJ-III is a widely used measure of children's academic abilities, demonstrating high test-retest reliability and criterion validity (Woodcock, McGrew, & Mather, 2001). Children completed the Letter-Word Identification and Calculation subtests, as well as the Writing Fluency and Writing Samples subtests, which together compose the Written Expression composite.

Teacher ratings of children's academic performance were collected using the Child Behaviour Checklist – Teacher's Report Form (TRF; Achenbach, 1991a). The TRF demonstrates strong psychometric properties, with high levels of internal consistency and test-retest reliability (Achenbach & Rescorla, 2001). The Academic Performance scale of the TRF was used to measure children's overall school performance. Parent ratings of school performance were obtained using the School Competence subscale of the Child Behaviour Checklist (CBCL; Achenbach, 1991b). The CBCL is a well-validated measure used to assess psychosocial adjustment in school-aged children.

Behavioural Functioning—Teacher ratings of children’s behavioural functioning in school were collected at the long-term evaluation using the TRF. For the purposes of the current study, the Attention, Internalizing, and Externalizing scales of the TRF were examined as outcomes.

Family Environment—Three measures were included to evaluate the family environment. The Early Childhood (EC) HOME Inventory (EC-HOME; Caldwell & Bradley, 1984) was used to evaluate the quality of the home environment at the time of the early assessment. This instrument consists of an observation of the home and a semi-structured interview with the primary caregiver, who in most cases was the mother ($n = 120$). If mother ratings were unavailable, ratings were taken from the father ($n = 1$) or grandmother ($n = 3$). The total EC-HOME score was used to provide a comprehensive measure of the quality of the home environment, taking into account eight different factors: (1) learning materials, (2) language stimulation, (3) physical environment, (4) parental responsiveness, (5) learning stimulation, (6) modeling of social maturity, (7) variety in experience, and (8) acceptance of child.

To obtain a similar measure of the quality of the home environment at the long-term assessment, the Early Adolescent HOME Inventory (EA-HOME; Bradley, Corwyn, Caldwell, Whiteside-Mansell, & Mink, 2000) was administered. This instrument also combines both a home observation and semi-structured interview with the primary caregiver. The total EA-HOME score was used, which reflects the quality of the home environment across the following dimensions: (1) physical environment, (2) learning materials, (3) modeling, (4) instructional activities, (5) regulatory activities, (6) variety of experience, and (7) acceptance and responsibility. EA-HOME ratings were provided predominantly by mothers ($n = 116$), followed by fathers ($n = 7$), then grandmothers ($n = 1$). The EC-HOME and EA-HOME have shown appropriate levels of inter-rater reliability, with agreement falling between .85 - .90 (Bradley, 1993) and have been widely used in both research and clinical settings (Bradley et al., 2000; Sugland et al., 1995). The EC-HOME and EA-HOME were positively correlated ($r = .746$) across the six year interval in the current sample.

The McMaster Family Assessment Device (FAD; Epstein, Baldwin, & Bishop, 1983) was used to assess the overall level of family functioning at both assessments. The FAD demonstrates acceptable levels of reliability and validity. For the purposes of this study, only the General Functioning subscale was used; higher scores denote worse family functioning. The early and late FAD were moderately correlated ($r = .476$) across the six year interval in this study.

Finally, the Global Severity Index (GSI) of the Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983) was used to measure parental psychological distress at both assessments. The BSI shows high levels of internal consistency and criterion validity (Meachen, Hanks, and Millis, 2008). The early and late BSI were moderately correlated ($r = .545$) across the six year period. Mothers most often completed the FAD and BSI ($n = 121$), but in a few cases where the mother was unavailable, another primary caretaker, such as the grandmother ($n = 1$) or father ($n = 1$), provided these ratings.

Analyses

Initially, differences between the severe TBI, moderate TBI, and OI groups were examined on measures of the family environment (early and late HOME, BSI, FAD) using a series of analyses of variance (ANOVA). Significant group differences were followed by Bonferroni-corrected post hoc comparisons. Next, eight hierarchical linear regression analyses were conducted to determine whether school outcomes differed across groups and whether the early and late family environment predicted children's school outcomes, over and above any group differences. Dependent variables included three WJ-III achievement test scores, four TRF scales based on teacher ratings, and the parent rating of School Competence on the CBCL. In each regression analysis, the first set of predictors included two dummy variables comparing the severe TBI and moderate TBI groups to the OI group. The second set of predictors included the EC-HOME, BSI, and FAD from the baseline assessment, and the third set included the EA-HOME, BSI, and FAD from the long-term assessment. Finally, group by family environment interaction terms were entered, first for the baseline assessment and then for the long-term assessment. The interaction terms were constructed by multiplying each of the group dummy variables by each of the measures of the family environment. Thus, six interaction terms were entered for the fifth and sixth steps in the regressions. The interaction terms allowed us to explore whether group differences in school outcomes varied as a function of the family environment. Examination of variance inflation factors and condition indices suggested that multicollinearity was not problematic. All analyses were conducted using IBM® SPSS® Statistics 22.

The Benjamini and Hochberg procedure was followed to control for multiple comparisons across the regression analyses (Benjamini & Hochberg, 1995). Significance levels correcting for the false discovery rate were calculated for each predictor across regression analyses separated into two families of outcomes, representing academic achievement (5 variables) and classroom behaviour (3 variables). All significant *p* values reported control for the false discovery rate.

RESULTS

Group Differences in the Family Environment

Table 2 reports the means of the severe TBI, moderate TBI, and OI groups across the family environment variables. For the early family environment, significant group differences were found for parental psychological distress ($p = .030$), such that parents of children with severe TBI reported significantly more distress than parents of children with OI. For the late family environment, significant group differences again existed for parental psychological distress ($p = .041$). Post-hoc comparisons show that parents of children with severe TBI reported marginally greater psychological distress than parents of children with OI. The groups did not differ in quality of the home environment or family functioning at either assessment.

Prediction of Long-Term Academic Outcomes

The results of the regression analyses are summarized in Tables 3 and 4. Detailed results of each regression are available in Supplementary Tables 5–12. In the first step of the regression analyses, the two dummy variables representing group comparisons accounted for

significant variance in the Calculation and Written Expression scores, as well as the CBCL School Competence scale. The severe TBI group performed significantly more poorly than the OI group on all three measures of academic achievement, as well as the CBCL School Competence and TRF Internalizing scores. Group differences were not significant for the TRF Academic Performance, Attention, or Externalizing scales.

The addition of the early family environment variables (EC-HOME, early BSI, early FAD) in the second step of the regression analyses accounted for significant incremental variance in all three achievement test scores, as well as the CBCL School Competence score and the TRF Academic Performance and Externalizing scales. The EC-HOME accounted for significant unique variance in all three WJ-III test scores, the CBCL School Competence scale, the TRF Attention, and the TRF Externalizing scales, such that higher quality home environments predicted better achievement and classroom performance, as well as fewer behaviour problems. The early BSI and early FAD were not significant predictors for any of the outcomes at this step. The early family environment predictors did not account for significant incremental variance in the TRF Internalizing scale.

In the third step in the regressions, the late family environment variables (EA-HOME, late BSI, late FAD) accounted for significant incremental variance in only the TRF Attention scale. The EA-HOME accounted for significant unique variance for the TRF Academic Performance, Attention, Internalizing, and Externalizing scales, with higher quality homes predicting better classroom outcomes. The late BSI and late FAD were not significant predictors for any of the outcomes at this step.

The group by early family environment interaction terms were entered at step four in the regressions to explore the potential moderating role of the family environment in predicting school outcomes after early childhood TBI. The addition of the six interaction variables did not account for significant incremental variance in any of the dependent variables. However, the EC-HOME may serve as a potential moderator of the difference between the severe TBI and OI groups on the CBCL School Performance Scale scores, because group differences became more apparent as the quality of the home environment increased. No other significant interactions were found.

Finally, the group by late family environment interaction variables were entered in the fifth step of the regression analyses. The addition of the six interaction variables did not account for significant incremental variance in any of the dependent variables. Similarly, none of the interactions accounted for unique variance in children's academic or classroom outcomes.

Discussion

The current study explored the association between family environments and longer-term academic and classroom behaviour following a TBI during early childhood. Our first hypothesis was partially supported, in that children who sustained a TBI demonstrated greater academic deficits and poorer classroom behaviours than children who sustained an OI, although this generally held true for children with severe TBI but not for those with moderate TBI. Specifically, children with severe TBI, compared to those with OI, performed

worse academically (i.e., Letter-Word Identification, Calculation, Written Expression) and behaviourally (i.e., School Competence, Internalizing). Children with moderate TBI did not differ from children with OI across their academic achievement and classroom behaviours. This indicates that children with severe TBI experience pronounced and longstanding scholastic difficulties, including weaknesses in academic skills and classroom behaviour.

Consistent with our predictions, higher quality home environments were predictive of better academic skills and classroom functioning. Specifically, the quality of the early home environment was a significant predictor of all but one outcome (i.e., Internalizing), and the quality of the late home environment predicted better classroom functioning but not academic achievement. Our prediction that the early home environment would be a more consistent predictor of children's school functioning than the late home environment therefore received partial support. The early family environment was a more consistent predictor of academic achievement, while the late family environment was a more consistent predictor of classroom behaviours. That is, the EC-HOME predicted all academic achievement outcomes and most classroom behaviours, whereas the EA-HOME predicted all outcomes except those that primarily reflect academic skills (i.e., Letter-Word, Calculation, Written Expression, School Competence). This finding not only reflects the importance of the early home environment in shaping children's long-term school functioning, but also suggests that high quality early home environments may benefit younger children academically by supporting development of basic academic skills, whereas high quality late home environments may better support children's classroom behaviours (Marjoribanks, 2005).

The influence of the early home environment on children's school outcomes may be partially mediated by the later home environment. Generally speaking, the EC-HOME no longer accounted for significant variance in children's academic achievement after the EA-HOME was added to the regression analysis. This finding highlights the particular importance of the late home environment for children's educational success, not only as a direct predictor, but also as a potential mediator of the early home environments' effects.

Certain aspects of the family environment were more strongly associated with children's academic and behavioural functioning than others. In particular, the quality of the home environment consistently accounted for more variance in academic outcomes than parent psychological distress or family functioning. Similar results have been found in other TBI research (see Rivara et al., 1994; Yeates, Taylor, Walz, Stancin, & Wade, 2010). This finding may reflect the extent to which the HOME captures information about learning materials and instructional activities, which could have more direct relations to children's academic skills than measures of family functioning or parental distress. For example, the home learning environment has been strongly associated with children's long-term literacy and mathematic achievement (Ciping, Silinskas, Wei, & Georgiou, 2015; Melhuish et al., 2008). Ultimately, the finding that the quality of both the early and later home environment is associated with better academic outcomes for children with TBI and OI provides evidence that interventions designed to improve academic outcomes after TBI should focus on the quality of the home environment, both post-injury and in the long-term.

We also anticipated that the effects of TBI on school outcomes would be more pronounced among children from less advantaged home environments and, conversely, less pronounced among children from more advantaged home environments. Our hypothesis was not supported, in that only one interaction was significant, and it ran contrary to our expectations, with differences between the severe TBI And OI group in classroom performance becoming larger as the quality of the early home environment increased. Thus, the home environment does not appear to be a consistent moderator of the effect of TBI on children's school outcomes. Instead, based on the current findings, children with severe TBI generally tend to fare worse academically than children with moderate TBI or OI, and the home environment predicts various facets of educational outcomes for both children with TBI and those with OI. However, given the sample size, the statistical power for testing interactions was relatively low, and future research should continue to explore the possible impact of the home environment as a moderator of the effects of TBI on children's academic outcomes.

The findings of the current study should be interpreted in light of several other limitations. One involves the use of different measures to evaluate the family environment for preschool versus older children. The subscales that comprise the EC-HOME versus the EA-HOME, while very similar, are not identical, and thus may have captured slightly different aspects of home environment quality depending on the age of the child; however, the strong correlation between the EC-HOME and EA-HOME over a 6 year interval suggests substantial overlap. As well, the inclusion of only those children who completed both the early and long-term assessments may have resulted in a less representative sample. Although children who did and did not complete both assessments did not differ on a variety of individual and family characteristics, they may have differed on other, unmeasured characteristics. Finally, only a limited number of participants had teacher ratings, and they had better academic outcomes than those who did not. Thus, the analyses of teacher ratings suffers from both a small sample size, especially for the severe TBI group, as well as potential selection bias. The statistical power of analyses involving the teacher ratings was reduced, which may have contributed to our inability to find associations in some analyses (i.e., early home environment and children's internalizing behaviours).

In summary, children who sustain a severe TBI in early childhood exhibit long-term deficits in their academic skills and classroom behaviours relative to children with OI. High quality family environments are predictive of better school outcomes for children with both TBI and OI, with the quality of the home environment serving as the strongest family environment predictor of children's academic outcomes. Overall, these results provide support for the implementation of interventions soon after injury to improve the quality of the home environment as a means of lessening the negative impact of TBI on children's academic outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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PUBLIC SIGNIFICANCE STATEMENT

The family environment may play a critical role in how young children recovery from early traumatic brain injuries. We studied how the family environment is related to children's academic performance and behaviour in school nearly 7 years after they sustained traumatic brain injuries between ages 3 and 7. We found that both better early home environments, measured soon after the injury, and better late home environments, measured nearly 7 years after the injury, are related to better school outcomes for children with traumatic brain injuries. The findings suggest that interventions to improve the quality of the home environment, both early after injury and later after injury, may help to lessen the negative impact of traumatic brain injury on children's academic outcomes.

Table 1

Summary of Demographic and Injury Characteristics for Sample Population

Sample Characteristics	Group		
	Severe TBI	Moderate TBI	OI
Group Size, <i>n</i>	15	39	70
Sex, <i>n</i> (% female)	6 (40)	17 (43.6)	33 (47.1)
Race, <i>n</i> (% Caucasian)	9 (60)	29 (74.4)	54 (77.1)
Baseline socioeconomic status, <i>z-scores</i>	-.368	.117	.126
Age at injury in years, <i>M</i> (<i>SD</i>)	4.94 (.92)	5.12 (1.22)	5.06 (1.07)
Time since injury to initial assessment in days*, <i>M</i> (<i>SD</i>)	53.29 (43.69)	45.19 (23.70)	34.20 (14.95)
Time since injury to long-term assessment in years, <i>M</i> (<i>SD</i>)	6.93 (1.13)	6.82 (1.13)	6.85 (1.03)

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Table 2

Group Means on Predictor and Outcome Variables

Child outcome domain and measure	Group		
	Severe TBI	Moderate TBI	OI
Family environment EC-HOME	40.07(7.51)	41.28(6.64)	43.14(7.85)
Early BSI*	56.87(12.03)	50.95(11.06)	48.66 (10.49)
Early FAD	1.77(.56)	1.57 (.39)	1.50(.43)
EA-HOME	45.33(6.02)	45.90(8.80)	49.49 (7.28)
Late BSI*	57.07(9.52)	52.69(12.03)	49.13(11.98)
Late FAD	1.87(.47)	1.66(.38)	1.60(.37)
Academic achievement			
WJ-III Letter-Word Identification	92.87(12.48)	101.85(10.63)	101.36(13.07)
WJ-III Calculation	89.07(14.21)	99.87(12.17)	103.54(15.77)
WJ-III Written Expression	88.27(12.94)	99.49(14.48)	98.91(13.96)
CBCL School Competence	41.33 (9.62)	46.67 (7.50)	49.74(7.37)
TRF Academic Performance	44.63(7.56)	50.43(10.88)	50.91(8.95)
Behavioural functioning			
TRF Attention	58.11(7.37)	54.05(5.36)	54.64(9.47)
TRF Internalizing	54.22(10.43)	50.30(9.81)	45.96(8.47)
TRF Externalizing	54.00(7.02)	47.95(7.63)	49.62(9.34)

Note. Data presented are standard scores for the WJ-III, CBCL, TRF (standard deviation), and raw scores for the HOME and FAD (standard deviation). OI = orthopaedic injury. WJ-III = Woodcock-Johnson Tests of Achievement Revised. CBCL = Child Behaviour Checklist. TRF = Child Behaviour Checklist–Teacher’s Report Form. EC-HOME = The Early Child Home Inventory. BSI = Global Severity Index (GSI) of the Brief Symptom Inventory. FAD = McMaster Family Assessment Device. EA-HOME = Early Adolescent Home Inventory.

* $p < .05$ for group main effect

Table 3

Summary of Hierarchical Regression Analyses with Early and Long-Term Family Environment as Predictors of Achievement Test Scores and Parent Ratings of Academic Performance

	WJ-III Letter-Word Identification	WJ-III Calculation	WJ-III Written Expression	CBCL School Competence
Step 1 β				
TBIS vs OI	-.222 *	-.313 *	-.243 *	-.341 *
TBIM vs OI	.018	-.113	.019	-.177
R^2 for Step 1	.040	.093 *	.062 *	.116 *
Step 2 β				
EC-HOME	.312 *	.293 *	.307 *	.343 *
Early BSI	-.139	-.115	-.110	-.004
Early FAD	.138	.135	.051	-.114
R^2 for Step 2	.117 *	.100 *	.107 *	.141 *
Step 3 β				
EA-HOME	.155	.069	.256	.238
Late BSI	-.242	-.218	-.156	-.189
Late FAD	.042	.249	.039	.018
R^2 for Step 3	.048	.060	.043	.049
Step 4 β				
TBIS x EC-HOME	-.870	-.558	-.703	-1.445 *
TBIS x Early BSI	-.228	.599	-.251	-.552
TBIS x Early FAD	.462	-.116	.373	-.244
TBIM x EC-HOME	-.287	-.259	-.434	-.349
TBIM x Early BSI	-.356	.984	.214	-.273
TBIM x Early FAD	.364	-.166	.220	.028
R^2 for Step 4	.049	.050	.035	.059
Step 5 β				
TBIS x EA-HOME	-1.499	-1.184	-.677	.134
TBIS x Late BSI	1.948	1.093	.866	1.326
TBIS x Late FAD	-2.222	-1.882	-1.120	-1.394
TBIM x EA-HOME	-.089	.287	1.302	1.183
TBIM x Late BSI	.360	-.307	-.503	.096
TBIM x Late FAD	-.199	-.010	.610	.073
R^2 for Step 5	.097	.058	.065	.062

Note. All values for individual predictors are standardized beta weights, which are reported only for those variables added at each step in the analysis. WJ-III = Woodcock-Johnson Tests of Achievement-Revised. CBCL = Child Behaviour Checklist. EC-HOME = The Early Child Home Inventory. BSI = Global Severity Index (GSI) of the Brief Symptom Inventory. FAD = McMaster Family Assessment Device. EA-HOME = Early Adolescent Home Inventory.

* Indicates significant p value after False Discovery Rate correction

Table 4

Summary of Hierarchical Regression Analyses with Early and Long-Term Family Environment as Predictors of Teacher-Rated Academic Performance and Classroom Behaviour

	TRF Academic Performance	TRF Attention	TRF Internalizing	TRF Externalizing
Step 1 β				
TBIS vs OI	-.206	.137	.288*	.165
TBIM vs OI	-.023	-.032	.079	-.086
R^2 for Step 1	.041	.022	.099	.041
Step 2 β				
EC-HOME	.400*	-.352*	.126	-.405*
Early BSI	.122	.006	.676	-.105
Early FAD	-.041	-.036	-.058	.001
R^2 for Step 2	.148*	.115	.007	.155*
Step 3 β				
EA-HOME	.511*	-.613*	-.439*	-.398*
Late BSI	-.033	.180	.038	.123
Late FAD	.090	-.091	-.120	.091
R^2 for Step 3	.103	.168*	.085	.087
Step 4 β				
TBIS x EC-HOME	-1.441	1.493	.825	.853
TBIS x Early BSI	.093	.370	.084	-.036
TBIS x Early FAD	-.602	-.346	.286	.090
TBIM x EC-HOME	-.952	.992	-.058	1.103
TBIM x Early BSI	-.664	.296	-.112	-.695
TBIM x Early FAD	.102	.068	.096	-.149
R^2 for Step 4	.071	.074	.014	.047
Step 5 β				
TBIS x EA-HOME	-4.055	5.755	6.624	4.747
TBIS x Late BSI	-.579	.581	1.363	1.173
TBIS x Late FAD	-3.291	3.066	4.369	2.815
TBIM x EA-HOME	1.201	1.322	-.791	1.884
TBIM x Late BSI	-.617	.249	.734	.104
TBIM x Late FAD	-.128	.100	.979	.748
R^2 for Step 5	.058	.066	.138	.088

Note. All values for individual predictors are standardized beta weights, which are reported only for those variables added at each step in the analysis. TRF = Child Behaviour Checklist – Teacher’s Report Form. EC-HOME = The Early Child Home Inventory. BSI = Global Severity Index (GSI) of the Brief Symptom Inventory. FAD = McMaster Family Assessment Device. EA-HOME = Early Adolescent Home Inventory.

* Indicates significant p value after False Discovery Rate correction