

METHODS

Participants

All participants were part of a larger project examining cognitive and neuropsychological sequelae following mild, moderate, or severe TBI in children between 5 and 17 years of age. For a complete description of the cohort and study design, see Hanten et al. (2009). Briefly, children between the ages of 5–15 years, who had sustained a closed head injury, were recruited during their hospitalization after they had become medically stable. Recruitment occurred at five major medical centers (three in Texas, the University of California San Diego, and the Hospital for Sick Children in Toronto).

Participants had injuries ranging in severity from mild to severe based on the lowest postresuscitation Glasgow Coma Scale (GCS) score. The original study cohort was composed of children who experienced mild-to-severe closed head injuries and who had a recorded GCS (Teasdale & Jennett, 1974) score reported in hospital records. Mild TBI was defined by the lowest GCS score ranging between 13–15. Moderate TBI was defined by lowest GCS scores of 9 to 12 or by GCS scores of 13 to 15 with brain lesions (contusions, hematomas) indicated by computed tomography (CT) scans. GCS scores of 3 to 8 defined severe TBI. Children with a history of neurological involvement (e.g., previous head injuries of any severity, injuries resulting from child abuse, cerebral palsy, epilepsy, brain

tumors/stroke, hypoxia, etc.), those with significant sensory impairments (e.g., hearing loss requiring assistive devices or vision loss that was not normalized by corrective lenses), and significant developmental or psychiatric disorders (e.g., mental retardation, autism spectrum disorders, bipolar disorder, or schizophrenia) were excluded from participation in the study. An index score of socioeconomic status (SES) based on four factors (education, income, occupation, and occupational prestige) was measured by the Hollingshead Index (Hollingshead, 1975).

The entire cohort of the original study contained 173 children who had sustained mild ($n = 47$), moderate ($n = 60$), or a severe TBI ($n = 66$). As is typical for childhood TBI studies, the population contained more males ($n = 120$) than females ($n = 53$), although there were no gender differences by injury severity. All participants in the current article were drawn from the TBI group of the initial cohort. There were a total of 5 LBW participants with birth weights ranging between 1200 grams and 2500 grams (approximately 2.5 and 5.5 lbs.) in this prospective, longitudinal study. These participants were matched to 9 normal birth weight (NBW) participants. Participants were matched on age, estimated SES, and severity of TBI similar or worse than the LBW group. This procedure yielded a total of 14 children with mild-to-severe TBI. Of note, we were particularly interested in the impact of low birth weight on the trajectory of recovery from a later injury rather than on the impact of TBI on overall cognitive and academic development. Therefore, we chose to compare the LBW group to NBW participants who had also sustained a TBI; thereby partly controlling for injury-related factors.

Procedures

All study procedures were approved by and in accordance with the internal review board and human subjects guidelines of the participating institutions. After parental informed consent was obtained and documented, participating children were administered a battery of neuropsychological tests. Assessments occurred on five occasions: at baseline (within 1 month following the injury), 3 months, 6 months, 12 months, and 24 months. Most participants from both groups completed all assessments. Of note, despite some individuals not participating at all follow-up intervals, our rate of follow-up for the entire study was not significantly different from other studies of pediatric TBI.

Although other measures were given in the original study, five broad measures of executive and cognitive function were used in the current study, as these measures provide a general overview of a range of cognitive abilities and were the measures available at each of the time points for this relatively small sample. Specifically, we used standardized measures of academic functioning (i.e., Woodcock-Johnson Test of Academic Achievement—Revised [WJ-R] Letter-Word Identification and Calculations subtests [Woodcock & Mather, 1989]), adaptive functioning (i.e., Vineland Adaptive Behavior Scale [VABS; Sparrow, Balla, & Cicchetti, 1984]), language abilities (i.e., Clinical Evaluation of Language Fundamentals—3rd edition [CELF-III; Semel, Wiig, & Secord, 1995]), verbal memory (i.e., California Verbal Learning Test—Children's Version [CVLT-C; Delis, Kramer, Kaplan, & Ober, 1986]), and planning skills (i.e., Tower of London Test [TOL; Shallice, 1982]).

RESULTS

Because of the descriptive/preliminary nature of this investigation and small sample size, no inferential statistics were performed as any analyses would be hampered by

a lack of power. The LBW and NBW groups were similar in terms of age and estimated SES. Groups were less well matched in terms of injury severity with the NBW group having more severe injuries as a whole than the LBW group (see Table 1). At baseline, both groups exhibited similar scores on all measures except the CELF-III Formulated Sentences and VABS (see Table 1). Specifically, at baseline, the NBW group scored higher on the CELF-III Formulated Sentences test than the LBW group. The VABS Adaptive Behavior Composite also revealed baseline differences between the groups with the LBW group scoring higher on the measure than the NBW group. Group comparisons were also performed for the three subtests of the Vineland (see Table 1 for summary statistics). At baseline, group differences emerged on the socialization subdomain of the Vineland with LBW scoring higher than NBW, but baseline group differences on the other subdomains of communication and daily living skills were not observed.

Over the 2-year follow-up period, relative to the NBW group, the LBW group evidenced relative declines (i.e., declines in their standard scores) on both WJ-R subtests, as well as CVLT-C total correct, CELF-III Formulated Sentences, and VABS ABC and Socialization. Essentially, the difference between NBW and LBW groups was increasing with time postinjury especially on the WJ-R Calculations and VABS socialization (see Figure 1). LBW participants also exhibited notable decreases on the WJ-R Letter-Word Identification and CVLT-C total correct between baseline and 24 months postinjury compared to modest improvements in these measures within the NBW group (see Figure 1). No apparent differences on the TOL problem solving emerged. See Table 1 for a list of specific scores for LBW participants for each measure and occasion, for mean and median scores for both groups, and for Cohen's *d* with confidence intervals obtained via a bootstrap analysis that resampled the population 500 times with replacement.