8-7-2020

Return to school 1 year after traumatic brain injury: A study using the Traumatic Brain Injury Model Systems National Database

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Return to School 1 Year after Traumatic Brain Injury: A Study Using the Traumatic Brain Injury Model Systems National Database

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A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

In

Partial Fulfillment of the Requirements

for the degree of

Master of Arts

Department of Graduate Psychology

August 2020

FACULTY COMMITTEE:

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Acknowledgements

The Traumatic Brain Injury (TBI) Model Systems National Database is a multicenter study of the TBI Model Systems Centers Program, and is supported by the National Institute on Disability, Independent Living and Rehabilitation Research (NIDILRR) a center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). However, these contents do not necessarily reflect the opinions or views of the TBI Model Systems Centers, NIDILRR, ACL or HHS.

I would like to thank my advisor and thesis chair, Dr. Bernice Marcopulos, for pushing me to be a better critical thinker and researcher. I'm grateful to have gotten the opportunity to learn from one of the best clinical neuropsychologists in the field. I would also like to thank the other members of my thesis committee, Dr. Bryan Saville and Dr. Kethera Fogler, for their expertise, understanding, and encouragement. Finally, I would like to thank Dr. Dena Pastor for her assistance with data processing and for helping me cultivate a strong data management skillset. It has been an absolute pleasure to collaborate with all of you.

Because of this program, I was fortunate enough to be surrounded by the kindest, sassiest, most supportive cohort imaginable. I am so incredibly grateful for the friends that I have made throughout the last two years. From them I learned that tragedy creates a sense of unparalleled community. I am appreciative beyond words. Finally, I would like to thank my brother, Brian, and my parents, Lisa and Bob, for their endless support and for encouraging me to pursue my passion.

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Abstract

For many individuals, recovery from moderate to severe brain injuries involves returning to a level of pre-injury productivity. Specifically, previous research has focused extensively on factors predicting return to employment, where students are inconsistently categorized with those in competitive employment. Moreover, research dedicated to return to school for students in secondary and tertiary education is largely qualitative; very few studies have utilized predictive modeling on a sample composed solely of students. For this study, a model including days of post-traumatic amnesia (PTA), length of stay (LOS), rehabilitation discharge Disability Rating Scale (DRS) scores, and educational level was used to predict return to school one year post-injury in a sample of 196 students within the Traumatic Brain Injury Model Systems National Database. For this sample, the overall return to school rate was 63.78%. Logistic regression results indicated that lower scores on the DRS and being in high school pre-injury resulted in the highest probabilities of returning to school one year post-injury. Results also suggested that for some, productivity post-injury was possible outside of the school setting, and for others, returning to school did not indicate long-term productivity, which highlights that productivity defined within a school setting and within a work setting may be somewhat distinct concepts. College students were much less likely to return to school within a year following injury than high school students. Consequently, more outreach and support for those students may improve awareness of disability services and heighten the return to school rate in the future. Further implications and suggestions by which to improve future models are discussed.

Keywords: traumatic brain injury, TBI, productivity, outcome, students, functional status, education, rehabilitation, school

I. Overview of the Literature Review

According to a recent report by the Centers for Disease Control and Prevention, in 2014 alone, there were 2.87 million incidences of emergency department visits, hospitalizations, and deaths due to traumatic brain injury (TBI) (Peterson et al., 2019). Notably, this incidence estimate has increased by 53% from 2006, which suggests TBIs are a growing presence for the medical community. Brain injuries can affect a variety of domains, including physical, psychological, and behavioral (Mahar & Fraser, 2012). Moderate to severe TBIs typically have more intensified sequelae, and changes in mood and personality are common (McAllister, 1992), affecting not only the person impacted by the brain injury, but also their close family and friends. For those engaged in rehabilitation, a return to productivity is a common goal, meaning that they wish to engage in the activities they had been engaged in prior to their injury. Whether those goals are directed toward work, school, leisure, or household roles greatly varies depending on the individual. For many, this means returning to work or school; however, a variety of factors affect the relative success of an individual in achieving that goal, some of which are discussed here.

A major focus of return to productivity involves studies of return to work (RTW) and building predictive models to determine whether someone is able to return to competitive employment. Much less is known regarding predictive modeling for students attempting to return to school after brain injury. Therefore, the primary goal of this study was to determine whether variables commonly used in studies of RTW can also predict return to school for students.

1.1 Cognitive Functioning

After TBI, deficits pertaining to cognitive functioning, including attention, verbal and visual memory, visual-spatial construction, and executive functioning are common, which can have a substantial influence on daily living (Marsh et al., 2016). These difficulties can have a prolonged effect. In one study, individuals who were 5 years post-injury still reported deficits pertaining to cognitive domains (Marsh et al., 2016). Research suggests that, although those with moderate to severe injuries report improvements in cognitive domains, a full recovery of cognitive abilities is rare (Dikmen et al., 2009). Those who have experienced cognitive deficits have a more challenging rehabilitation experience, and previous research has shown that although physical impairments are disruptive for caregivers, behavioral changes are more devastating (Marsh et al., 1998a; Marsh et al., 1998b).

One area of cognitive impairment commonly cited after brain injury is executive functioning. Executive functioning generally describes a person's higher-order cognitive functions that "enable us to formulate goals and plans, remember these goals across time; choose and initiate actions to help us achieve these goals; and monitor and adjust our behavior, as necessary, until we complete or fail at them" (Aron, 2008, p. 124). A review that summarized literature from 2000 to 2010 has also revealed that deficits in initiation, sustained and allocated attention, working memory, task switching and flexibility, disinhibition, and planning have also been cited, and are common areas of interest in neuropsychological assessment (Wang et al., 2014). Impairment in executive functioning has been commonly cited as a predictor affecting RTW (Ownsworth & McKenna, 2004).

Moreover, unawareness of injury sequelae, also known as anosognosia, may also occur, which hinders recovery post-injury (Sherer et al., 1998). These individuals are harder to manage in rehabilitation settings because they may be less likely to believe they could benefit from rehabilitation or the use of compensatory strategies, are less likely to comply with medication management, and are harder to care for in home settings (Gasquoine, 2016; Turro-Garriga et al., 2013). Being unaware of deficits suggests that these individuals lack an adequate understanding of their limitations. Consequently, they pose an increased safety risk, as they may take on tasks that are beyond their means or are inappropriate given their level of functioning (i.e., driving a car, most commonly), and may lack an understanding of how their brain injury may be affecting themselves and those around them (Sherer & Fleming, 2014). Kelley et al. (2014) found that patients 5 years post-injury and beyond still underreported cognitive abilities and overestimated performance on certain tasks common in both work and home environments. Consequently, research suggests that there is a positive relation between self-awareness and employment outcome (Kelley et al., 2014; Sherer et al., 1998).

Research frequently suggests that cognitive functioning improves following TBI and follows an asymptotic shape, meaning that initial progress occurs rapidly, but eventually plateaus. However, a distinction between cognitive functioning assessed globally versus domain-specifically results in mixed findings regarding when this plateau occurs. Some studies of global cognitive functioning have posited that recovery continually improves over the course of the first 2 years (Hammond et al., 2001; Sbordone et al., 1995), whereas others suggest recovery slows after 1-year post-injury (Hammond et al., 2004). Conversely, studies that assessed more specific cognitive domains 1-year post-injury suggest that different cognitive domains may recover at different rates and vary widely across individuals (Brooks & Aughton, 1979; Christensen et al., 2008; Kersel et al., 2001; Marsh et al., 2016). In either case, whereas some individuals appear to exhibit marked improvements in cognition, others do not, and while cognitive functioning may plateau, it is unlikely to rival its pre-injury level within the first year following injury (Christensen et al., 2008).

Many rehabilitation programs highlight the importance of cognitive functioning, as the benefits of cognitive rehabilitation appear to extend beyond cognitive functioning itself. For example, improvements in attention, memory, and concentration may increase an individual's ability to comply with medication management, keep track of schedules, and improve decision-making (Tsaousides & Gordon, 2009). One systematic review found that just over one third of the pertinent studies argued for the relative success of cognitive rehabilitation programs in aiding RTW after brain injury (Mani et al., 2017).

1.2 Functional Status

In the last 20 years, the International Classification of Functioning, Disability, and Health (ICF) has been established as a holistic model framework for functioning, disability, and health (World Health Organization, 2001). The World Health Organization (WHO) proposed that the ICF be used in conjunction with the International Statistical Classification of Diseases and Related Health Problems (ICD-10) both to elaborate on and to classify more specifically descriptions of functioning and disability in persons with varying health conditions (Bernabeu et al., 2009). The ICF is broken down into the following components: body functions, body structures, activity and participation, and environmental factors. Generally speaking, the ICF allows clinicians and researchers to generate a conceptual framework of symptoms/constructs most often reported by patients with certain conditions, in order to build a relevant set of variables that can then be defined, shared, and targeted by researchers and rehabilitation programs (Bernabeu et al., 2009).

Bearing this purpose in mind, the ICF differentiates between impairment, disability, and handicap (World Health Organization, 2001). Impairment is defined as "a loss or abnormality in body structure or physiological function (including mental functions)" (p. 221). Disability is defined as "an umbrella term for impairments, activity limitations, and participation restrictions…the negative aspects of the interaction between an individual and that individual's contextual factors" (p. 221). Finally, handicap is defined uniquely in that it has since been replaced by the term "participation restrictions" which are defined as "problems an individual may experience in involvement in life situations…determined by comparing an individual's participation to that which is expected of an individual without disability in that culture or society" (p. 221). In 2010, field experts agreed upon a comprehensive core set of 139 ICF categories for TBI, as well as a brief core set of 23 ICF categories. However, these are preliminary, and few studies have been completed. Initial reports of what to include in the TBI framework came from a study by Koskinen and colleagues (2007).

Of those that have explored the ICF framework of TBI disability, prevalence rates vary across studies, but previous research suggests that patients with TBI exhibit impairments in many of the categories. Common problems in the body functions component include deficits in mental and mobility functioning (Ptyushkin et al., 2010; Svestkova et al., 2010). More specifically, one study found that over 50% of participants expressed problems related to memory and higher-level cognitive functions, attention, emotional functions, energy and drive, language, sleep, and pain (Koskinen et al., 2007).

Previous studies have found that improvements in physical functioning were common, but less success was seen in mental functioning (Andelic et al., 2010; Ptyuskin et al., 2010). Problems in the body structure component were more dependent upon the injury itself, or pre-established comorbidities (Ptyushkin et al., 2010), but commonly reported problems include balance and vision (Koskinen et al., 2007). In the activities and participation component, improvements were relatively small and were mainly dependent upon mental functioning and mobility. Commonly reported problems included deficits in communication, relationships, and work domains (Koskinen et al., 2007). One study of employment outcomes based on the ICF domains found that the domains explained 57% of the variance in employment 1-year post-injury (Andelic et al., 2012). These studies further support the conceptual framework of the ICF, as problems with body structures, functions, and participation were confirmed by participants.

The ICF also illuminates the mediating role that environmental factors have on the relation between overall health status and disability (Ptyushkin et al., 2010; Svestkova et al., 2010). Including environmental factors in a disability framework allows clinicians to observe external influences that may either assist or hinder certain aspects of daily living, thereby indirectly affecting an individual's general outcome. For example, the role of the immediate family, services, systems and policies, and technology have been shown to impact recovery (Koskinen et al., 2007). Driving independence has also been shown to be an environmental factor that can impact the perceived success of rehabilitation and recovery post-injury (Kreutzer et al., 2003).

Research has also shown that functional abilities are closely tied to cognitive abilities post-injury (Bercaw et al., 2011; Ponsford et al., 2008). Bercaw and colleagues

(2011) found that cognitive progression, specifically for learning and processing speed, that occurred between inpatient rehabilitation status and 1-year post-injury predicted functional outcome at 2 years post-injury. Ponsford et al. (2008) found similar results even 10 years post-injury. In addition to the established relationship between cognitive measures and functional outcome, Ponsford et al. also found that days of post-traumatic amnesia (PTA), a lower education level, and increased anxiety were related to poorer outcome. In a study of participants tested within 1-year post-injury, Spitz et al. (2012) found consistent results, and that a model containing cognitive ability, especially executive function, predicted functional outcome better than a model that included measures of demographic information and injury severity. Overall, functional outcome improved throughout the initial year post-injury. Together, these results suggest that functional outcome and cognitive ability are connected, such that models including cognitive abilities provide a more realistic picture of functional outcome post-TBI, regardless of time since injury.

1.2.1 Popular Outcome Measures

The two primary acute measures of post-injury functional status are the Functional Independence Measure (FIM) and the Disability Rating Scale (DRS). The FIM is a scale used universally throughout the rehabilitation community. The FIM has 18 items that are broken down into two domains: 13 items reflect a motor domain, and 5 items reflect a cognitive domain (Linacre et al., 1994; Smith-Knapp et al., 1996). Items cover topics such as self-care, sphincter control, mobility, locomotion, communication, and social cognition (Heinemann et al., 1993). Responses range on a scale from 1 to 7 (where 1 = *total assistance* and 7 = *complete independence*) such that higher scores reflect more independence (Heinemann et al., 1993).

Researchers found that ceiling effects are common by inpatient rehabilitation discharge, where approximately half of the patients exhibited average scores of 6 or 7 on a majority of the 18 items (Hall et al., 1996). A similar trend existed at 1-year post-injury. Together, researchers suggested that the FIM may not be able to detect nuanced differences in disability after discharge from rehabilitation. However, Hammond et al. (2001) found that the FIM is sensitive to changes in functional ability between rehabilitation discharge and 1-year post-injury.

The DRS is another widely used outcome measure and is advertised as being able to assess changes in patients from coma to community (Rappaport et al., 1982). It is appealing to clinicians and patients because of its conciseness, including just 8 items targeted to assess progress from rehabilitation admission to community living. An advantage of the DRS is that it reports on all 3 domains described by the ICF (Shukla et al., 2011). More specifically, the DRS includes 3 items that mirror the Glasgow Coma Scale, 3 self-care items, 1 item that assesses dependence on others, and 1 item that assesses psychosocial adaptability as expressed through an individual's employability. Items are rated on a scale from 0 to 3, 4, or 5 depending on the item. Scores range from 0 to 29, where a score of 0 indicates no disability and a score of 29 indicates an extreme vegetative state. Regarding mild to moderate disabilities, Hammond et al. (2001) and Kreutzer et al. (2003) utilized a categorization where scores between 1 and 3 indicated mild disability, and 4 through 6 indicated moderate disability. Kreutzer et al. categorized all scores greater than 6 as severe disability, but Hammond et al. specified further, into moderately severe (7-11), severe (12-16), and extremely severe (17-21) disability, as well as vegetative state (22-24), and extreme vegetative state (25-29). A variety of studies have supported interrater and test-retest reliabilities of the DRS (Gouvier et al., 1987; Novack et al., 1992; Rappaport et al., 1982;), and scores can be obtained via self-administration or through interview with the patient or a close caregiver.

Overall, Hall et al. (1993) found that measures of disability (both the DRS and FIM) were most strongly correlated with days of PTA, followed by length of coma, then GCS scores. They suggested that the DRS was the most practical for tracking functional progress during acute rehab and community-based assessment. Hammond et al. (2001) also found that the DRS, when compared to the FIM, is more sensitive to changes in short- and long-term time frames. Similarly, in comparison to matched non-TBI patients, Cullen et al. (2008) found that TBI patients exhibited better functional outcomes throughout rehabilitation; however, only scores on the DRS differed significantly between groups at 1-year follow-up, whereas there were no group differences on FIM scores.

Ponsford et al. (1995) found that DRS admission scores contributed the most in predicting employment status 2 years post-injury. Remarkably, they found that a model containing only DRS admission scores was able to correctly classify 63% of individuals in the preliminary sample and 61% of individuals in a second sample used for cross-validation. Other variables included in the model were age and GCS scores, which together, classified an additional 7% of participants.

On the other hand, Gollaher et al. (1998) found DRS discharge scores to be more successful than DRS admission scores in predicting employment status. They suggested that cognitive recovery continues throughout the rehabilitation process, therefore making it a stronger indicator than scores upon admission. Similarly, Kreutzer et al. (2003) found that DRS scores at 1-year post-injury were highly related to employment stability, such that those with no functional impairment were more likely to be employed across all selected timepoints, whereas those with severe functional impairments were more likely to be unemployed across all timepoints.

1.3 Employability

One common goal after sustaining a brain injury is to return to employment. One study found that approximately half of employees endorsed a substantial improvement in quality of life upon returning to employment (Ruet et al., 2018). However, it is well-established that employment rates have been shown to drop dramatically after brain injury. A study by Grauwmeijer et al. (2012) found that, at a 3-month follow-up employment rates dropped by 65% after moderate to severe TBIs. They followed their sample for 3 years after their injury and found that employment rates only improved from 3 months to 1-year post-injury. On the other hand, other studies have found that employment rates increase, albeit minimally, over the course of first 3 years following injury (Kreutzer et al., 2003). Ultimately, employment rates remain lower than pre-injury employment rates. A similar trend was found by Mailhan et al. (2005), who found that prior to injury, 88% were classified as full-time employees or students. Conversely, at the time of the study, they found that 60% of their participants were neither employees nor students. These results are similar to those indicated by Ip et al. (1995), Ponsford et al. (1995), and Hart et al. (2019), who found that 58%, 60%, and 61% of participants, respectively, failed to return. One study of participants at 1-year post-injury found that approximately 45% failed to return to work (Sigurdardottir et al., 2018).

However, as interest surrounding vocational outcomes in TBI research grows, a major caveat in RTW studies has appeared. A systematic review by van Velzen et al. (2009) highlighted the discrepancies in return rates across 35 studies of TBI participants, where the overall RTW rates ranged from 0-84%. After eliminating outliers, researchers determined the overall estimate of RTW 1-year post-injury to be approximately 40%. Nevertheless, differences in samples, demographics, inclusion and exclusion criteria, and rehabilitation access has made comparability across studies extremely limited.

Previous research has also surveyed the prevalence of individuals with TBIs to return to a previous employer versus exploring work with a new employer. In one study, Wong et al. (2019) found that 25% of their participants returned to work at their previous employer, but roughly one third of those that returned transitioned from full- to part-time work. They found that those that were able to RTW within 3 months tended to return to their previous employer, whereas those who took over 1 year to return were more likely to seek part-time work with a new employer. Similar results were found by Simpson and colleagues (2018), whose study of Australian participants found that the amount of time it took to RTW was much longer for those who sought new employment. They found that those seeking new opportunities were more likely to be characterized by greater injury severity, younger age, fewer years of education, and increased behavioral problems; as a result, employment stability was much poorer.

Many key attributes related to successful job performance are impaired after brain injury, such as a person’s ability to maintain focus, keep track of schedules, multitask, and problem-solve (Bootes & Chapparo, 2010; Mahar & Fraser, 2012). Workdays can become increasingly more difficult for those who have jobs which require them to handle multiple tasks simultaneously, or to approach and execute novel tasks independently with intention (Bootes & Chapparo, 2010), which may make them more error-prone and in need of additional support. Common problems reported by working individuals suggest that fatigue, slowness, and concentration problems contributed to difficulties while on the job (Ruet et al., 2018). Interestingly, Brooks et al. (1987) conducted interviews with relatives of those with severe TBIs and found that, for those in higher social classes that had returned to work, co-workers were much more willing to assist with work duties. They also found that individuals with deficits in receptive communication and interpersonal skills were much less likely to RTW.

One commonly cited link between cognitive functioning and RTW is executive functioning. Overall, there appears to be strong support for the positive relation between cognitive function and employment outcome (Grauwmeijer et al., 2012; Wong et al., 2019). In particular, scores on executive function measures like the Dysexecutive Questionnaire (DEX) have been shown to predict overall employment status as well as job stability over the course of the first 4 years post-injury (Ruet et al., 2018). Other researchers have also emphasized the role of cognitive measures either via questionnaires or neuropsychological testing in predicting RTW above and beyond other factors such as demographic characteristics and measures which assess functional capabilities (Fabiano & Crewe, 1995; Ip et al., 1995; Sherer et al., 2002). For example, measures of verbal learning, attention, and perceptuomotor skills have proven particularly useful (Brooks et al., 1987). Similarly, individuals with better metacognitive skills are more likely to RTW (Sigurdardottir et al., 2018).

Psychological well-being has also proven to be a relevant factor in RTW. Studies have found that unemployed participants reported higher levels of anxiety and depression (Franulic et al., 2004; Sigurdardottir et al., 2018) and that those who exhibited increased engagement in employment 10 years post-injury reported fewer depression symptoms (Tsaousides et al., 2008). The relation between RTW and symptoms of depression and anxiety was further supported by Xiong et al. (2016). They found that those who received disability benefits and were not working exhibited clinically significant levels of depression and anxiety, and also experienced more psychosocial limitations relative to those who had returned to work. Similarly, McCrimmon and Oddy (2006) found that those who had not returned to work scored higher on measures of depression and mood disturbance than those who had returned to work. Interestingly, they found that levels of anxiety were not significantly different between groups, nevertheless, both groups presented clinically significant levels of anxiety. Participant comments reflected a sense of insecurity regarding their abilities and how they were seen by others. Research has also shown that volunteer work may benefit psychosocial adjustment for those who are on long-term disability and cannot return to employment (Ouellet et al., 2009).

Cifu et al. (1997) found that those who performed better on measures of physical, cognitive, and behavioral functioning during rehabilitation admission and discharge were more likely to be employed 1-year post-injury. A systematic review by Mani et al. (2017) also noted relevant predictors of RTW post-TBI, including disability, attention, memory, verbal skills, global cognitive functioning, perceptual ability, and processing speed.

Other studies have tracked employment status longitudinally, in order to provide information on employment stability across time (Grauwmeijer et al., 2012; Kreutzer et al., 2003). Overall, studies suggest that employment rates tend to increase slowly over time (Kreutzer et al., 2003; Pössl et al., 2001). A study by Kreutzer at al. (2003) found that disability upon 1-year follow-up was a significant predictor of job stability, such that those with severe impairments were much more likely to be unemployed at 2, 3, and 4 years post-injury. Another study of participants 1, 2, and 3 years post-injury who were previously employed found that employment rates dropped to approximately 56%, although only 44% of participants were employed at all three timepoints, and 32% remained unemployed at all timepoints (Ponsford & Spitz, 2015). Additionally, employment patterns were very unstable, as a small proportion of participants transitioned from employed at one timepoint to unemployed at another, or vice versa. Similar trends were displayed in by Kreutzer et al. (2003). This suggests that while some are successfully able to return to employment, there are others that never do, or do so relatively inconsistently. Cuthbert et al. (2015) tracked employment trajectories from 1- to 10-years post injury and found that the probability of employment declines 5-10 years post-injury. This trend was further supported during a partial replication study by Grauwmeijer et al. (2017). According to Cuthbert et al., the existing economic climate at the time may have contributed to the decline in employment trajectories or may have been a result of the lingering difficulties associated with the TBI. Grauwmeijer et al. found that cognitive functioning, injury severity, length of stay (LOS), and pre-injury employment status were able to predict employment outcomes 10-years post-injury.

RTW and employment stability are also related to pre-injury occupation, where those who held professional and managerial positions were more likely to return following TBI than those who worked in manual labor pre-injury (Ponsford & Spitz. 2015; Walker et al., 2006). Physical impairments resulting from brain injury are also more likely to affect the employability of manual laborers over managers at a single timepoint as well as over multiple timepoints (Ponsford & Spitz, 2015). Furthermore, difficulties with memory, planning, processing speed, and increased feelings of depression and anxiety also impacted participants' employment stability 1-year post-injury.

Education is also a predictor of employment and stability of employment, where those with a higher level of education were more likely to remain employed (Ponsford & Spitz, 2015). Researchers were best able to predict employment stability over time using a model that included cognitive factors, injury severity, mobility, and pre-injury education and occupation. Behavioral variables and measures of anxiety and depression did not increase the predictive utility of the model.

While RTW has been extensively studied, discrepancies in sample demographics, the way in which researchers define employment, the amount of time post-injury, and the scales used makes comparisons between studies less interpretable. Even studies of the TBI Model Systems National Database (TBIMS NDB) used contrasting definitions for employment. For example, Keyser-Marcus et al. (2002) included those who were competitively or specially employed, students, and those who worked in a sheltered workshop as "employment and productivity" whereas Walker et al. (2006) and Kreutzer et al. (2003) classified "employed" as only those who were competitively employed, and

Gollaher et al. (1998) classified “employed” as those who were either competitively employed or students. Consequently, generalizability of findings is limited.

1.4 Student Outcomes

Individuals aged 15-19 and 20-24 are among the second and third highest groups, respectively, that report to an emergency department due to brain injury (Faul et al., 2010). Therefore, the effect of brain injuries on educational pursuits primarily in secondary, post-secondary, and graduate school is of particular importance. For those in secondary education, academic rigor begins to increase, as do activities in extracurriculars. College and university settings provide students with the opportunity to widen their educational, social, and vocational experiences (Stewart-Scott & Douglas, 1998). Notably, there is an important distinction between early schooling experiences versus later schooling experiences. For example, experiences in college require a greater sense of independence, more responsibility is given, learning content becomes more advanced, and structured days are loosened relative to experiences in elementary and middle school. College and university programs also necessitate successful goal-setting and the use of time management strategies, as students often juggle assignments, socialization, and/or employment (MacLennan & MacLennan, 2008). Many of those skills are affected, or become more difficult, after brain injury, and difficulties can linger even 2 years later (Willmott et al., 2014). Similar complaints have been described by college students regardless of injury severity (Childers & Hux, 2016).

Research has shown that knowledge and conceptualization of brain injuries can be misconstrued and inaccurate. The pioneering study regarding misconceptions of brain injury was conducted by Gouvier et al. (1988), who found that conceptual understanding surrounding unconsciousness, amnesia, and recovery was extremely poor. Approximately 59% and 41% of people, respectively, believed that an individual could emerge from a coma without lasting deficits and could immediately identify and converse with others. Most shockingly, 46% of people believed that an amnestic individual's memories could be regained if they suffered a second hit to the head.

A more recent review by Block et al. (2016) highlighted the misconceptions about brain injury. In the review, they described how misconceptions may arise partially from pop culture and how these misconceptions negatively reflect the experiences of people recovering from brain injury. For example, descriptions portrayed through social media or TV are likely highly exaggerated, dramatized, or stem from misinformation. From an earlier study, Block et al. (2013) outlined specifically where a group of veterans and their friends/family had gotten exposure to TBI. Over 75% of the veterans reported that they had not spoken to a physician, therapist, or other professional about brain injury, nor had they learned about brain injuries while in the military. Rather, they endorsed observing TBI on television shows such as *Grey's Anatomy*, *House*, *Mystery Diagnosis*, and *Trauma in the ER*, as well as through boxing and football programming. They also found support for the idea that people believe concussions are a separate entity from TBI.

Block et al. (2016) also highlighted the effect of an "invisible" injury and how lingering symptoms resulting from brain injuries may be interpreted as representative, typical behavior and may contribute to a lack of empathy from others compared to injuries that are visible. At a time when peer judgments are prioritized, it may be likely that high school and college students are particularly volatile to these misconceptions.

1.4.1 Common Problems Reported

Common cognitive problems for students returning to school include reduced concentration (Sharp et al., 2006; Stewart-Scott & Douglas, 1998), memory and attention problems (Kennedy et al., 2008; Kramer & Davies, 2016; Sharp et al., 2006; Stewart-Scott & Douglas, 1998; Todis & Glang, 2008; Willmott et al., 2014), reduced organization and time management (Kennedy et al., 2008; Stewart-Scott & Douglas, 1998), problems making decisions (Kennedy et al., 2008), difficulty interpreting and extracting relevant information (Sharp et al., 2006; Stewart-Scott & Douglas, 1998), and keeping up with the work-load (Willmott et al., 2014). For those returning to secondary education, Sharp et al. (2006) stressed the importance of elaborate planning preceding students' return in order to make the transition a more positive experience.

For students who choose to prioritize time spent on academics, they may often sacrifice opportunities for social engagement, which can contribute to feelings of isolation (Cahill et al., 2014). Other psychosocial problems commonly reported by students include decreased opportunities to socialize as a result of partial attendance or rehabilitation, communication problems, and decreased involvement in extracurricular activities (Stewart-Scott & Douglas, 1998). In one study, parents of students with TBIs reported that communication difficulties, a lack of understanding about brain injury, and patience from peers often results in fewer friendships (Hux et al., 2010).

Emotional problems including increased anxiety, depression, anger, and mood swings are also reported (Kennedy et al., 2008; Sharp et al., 2006; Stewart-Scott & Douglas, 1998), as well as impulsivity (Hux et al., 2010; MacLennon & MacLennon, 2008; Todis & Glang, 2008). Research also suggests that difficulties with executive functioning contribute to problems with emotion regulation and social relationships (Kramer & Davies, 2016). In regard to academic performance, Kennedy et al. (2008) suggested that students reported feelings of test anxiety and being overwhelmed by studying. The degree of satisfaction with their studies has also been shown to decrease (Willmott et al., 2014). Overall, students may experience difficulties managing lasting effects of their injury, and increased challenges in academia and in relationships can negatively affect self-confidence and self-esteem (Cahill, et al., 2014; Stewart-Scott & Douglas, 1998).

Physical problems may impact a student's ability to succeed in the classroom. Recurring problems with affected upper extremities can make typing and writing more difficult (Hux et al., 2010; Stewart-Scott & Douglas, 1998), and frequent headaches can also impact a student's ability to work for long periods of time without breaks (Stewart-Scott & Douglas, 1998). Fatigue and dizziness are also common (Kennedy et al., 2008; Sharp et al., 2006; Willmott et al., 2014), as are balance and gait problems (Sharp et al., 2006).

1.4.2 Rates of Return to School

The first study to use predictive modeling to predict return to school/work was conducted by Ip et al. (1995), who found that, of the 12 students who were enrolled pre-injury, four returned to school, two went to work, and the rest did not fit either category. In a review of secondary and post-secondary students in Australia, Stewart-Scott and Douglas (1998), students reported returning to school an average of 10.7 months (*SD* = 5.9) post-injury, but 85% of the students had returned to school by 3 years post-injury. This result is similar to that found by Willmott and colleagues (2014), who reported an overall return to study rate of 83% 3 years post-injury. In regard to their academic performance, approximately half reported that their grades had declined; however most reported that they had to exert an extreme amount of effort in order to pass a course. Increased effort is a common theme reported by TBI students (Cahill et al., 2014; Hux et al., 2010; Todis & Glang, 2008; Willmott et al., 2014). Kennedy et al. (2008) found that, of those who changed their academic status, 81% did so because of problems related to their injury. Changes included reducing the course load, transitioning from full- to part-time, or taking a leave of absence.

According to Sharp et al. (2006), the relative success of return to school is largely influenced by educating peers and teachers. Adequate preparation of an educational department is necessary to provide more positive experiences. According to Sharp et al. (2006), it is important for the student's teachers to be aware of what to expect from them; simply informing the principal, counselors, and advisors is not as effective. Likewise, it is helpful for staff, families, and the student with the TBI to recognize the distinction between their disability relative to other learning disabilities (Vaidya, 2002), and researchers have introduced various frameworks for facilitating this transition back to school after brain injury (Clark, 1996; Ylvisaker et al., 1995), as well as during the transition period from high school to college (Kramer & Davies, 2016). These guidelines have emphasized individualized education plans, raising awareness of parents, peers, and school staff regarding abilities and challenges post-injury, as well as discussing access to disability services. However, in cases where these support systems either are not in place or are ineffective during the transition from the hospital to school, students and their parents have expressed concerns and increased feelings of stress in regard to schooling and future job opportunities (Backhouse & Rodger, 1999). Focus groups of brain injured students and families have shared the impact that hurtful comments from peers and teachers had on their perceived experience returning to school (Backhouse & Rodger, 1999; Hux et al., 2010).

For students that are able to return to school, it may still be a frustrating and confusing process. Cahill et al. (2014) described the experiences of college students that returned to school and found a disconnect between internal and external expectations. The participants also described their confusion over whether certain challenges were a consequence of their injury or were merely ordinary college student obstacles.

1.4.3 Academic Services and Accommodations

In 1991, the Individuals with Disabilities Education Act (IDEA) listed TBI as an eligible category for which students could receive services including an Individualized Education Program (IEP), as well as an array of supports and therapies for speech, behavior, occupational, and physical difficulties resulting from TBI (US Department of Education, 2004). An update to the IDEA permitted students who were 16 years of age and had IEPs to continue to receive services throughout the transition period from high school to adulthood.

While policies such as the IDEA are designed to increase the support that high school students with TBIs receive, a few studies have suggested that school support is received to a varying degree. For example, while some parents have boasted the response of a school in enacting services and accommodations for their child, other parents have described the school setting as a barrier, where services were never implemented, even if parents vouched for them prior to their child's return to school (Sharp et al., 2006).

Therefore, it is very likely that while some students are accommodated appropriately, others are drastically under-accommodated.

Alternatively, Todis and Glang (2008) reported instances where high school staff neglected to provide work for or inflated the grades of their junior or senior TBI students because they prioritized the student graduating with their designated class over learning the material. Therefore, there may be instances in which students with TBIs may, occasionally, be over-accommodated. Researchers suggested that while in high school, over-accommodation may simply be a consequence of misinformation or lack of training on the part of the staff.

A study by Harris and DePompei (1997) surveyed the Office of Disability Services in 74 colleges in Ohio and found that disability service manuals defined TBI as a diagnostic category in less than 9% of the colleges. Moreover, less than 40% of colleges had counselors with abilities to work with students with TBI. Conversely, a more recent study by Hux et al. (2010) described numerous accommodations self-reported by college students, including note takers, extended time and/or a separate room for exams, priority registration, scribes for short-answer tests, and help filling out scantrons. Hux et al. (2010) also provided examples of informal strategies that students developed on their own that seemed to improve academic performance, including study groups, flashcards, having family members assist in studying, and taking the time to get to know the professor. However, when people associated with the students were asked similar questions about the student's abilities and performance, often the associate had different perceptions. Notably, they also recorded instances of over-accommodation for a few students.

In order to qualify for services through a university, students must self-advocate for themselves and their disability; however, while some students are direct, others may not know how to do so, or they may not want to advocate for themselves for a number of reasons. Kennedy et al. (2008) found that 80% of college students reported difficulties in academics, yet only 45% utilized campus-provided disability services, and 20% were unaware of the aids altogether. A similar rate of the use of disability services was reported by Todis and Glang (2008). Additionally, while some students consistently utilize services, others do not (Hux et al., 2010). However, there are studies that have reinforced the relative success of accommodations, such as Willmott et al. (2014), where approximately 63% of the students in high school and college had applied for services.

A study by Cahill et al. (2014) suggested that accommodations may be seen as polarizing by college students. Some participants interpreted support services as helpful, and as a way to improve performance, thereby reducing any stigma against disability. However, others felt that advocating for alternate services meant they would be treated differently by staff and peers. The stigma associated with disability impacted their willingness to disclose their disability and to seek services. On the surface, many of these students physically appear normal, which can translate into peers and teachers holding identical expectations for them as they did prior to injury, which can increase feelings of stress for these students. Nevertheless, while some students view services as helpful, others may avoid identifying themselves as someone who needs services simply due to stigma.

Students, in particular, appear to be very affected by the thoughts of their peers. Worry of being judged as someone who requires disability services may largely impact a proportion of students who would benefit from services yet do not request them. Not only that, self-perception also appears to be an important factor in the way students view their recovery process. A review by Mealings et al. (2012) emphasized a two-fold process that occurs throughout recovery in which students who successfully return to either high school or college face these new adjustments and seek to redefine success within the classroom through the help of accommodations. For these students, a reconceptualization of their identity has shown to be particularly useful.

In conclusion, it appears as though, throughout both high school and college, accommodations occur on a spectrum from under- to over-accommodation. While failure to receive accommodations was occasionally due, in part, to the student rather than institution in an attempt to avoid stigma, there are also instances in which the institution failed to respond appropriately. However, one could argue that over- and under-accommodation may be equally as harmful. Though under-accommodation neglects to provide appropriate assistance to students based on their current needs, over-accommodation may misguide the student's perceptions of their abilities and their preparation for the next step, whether it be employment or future schooling. The former was of which was discussed by Hux et al. (2010).

1.5 Relevant Pre-Injury and Injury-Related Variables

Previous research has suggested that, along with functional capabilities, an individual's demographic, vocational, and injury information prior to injury has proven effective in contributing to the predictive utility of acute models of RTW. There have been a few investigations and systematic reviews conducted on the efficacy of these predictors (Ownsworth & McKenna, 2004; Scaratti et al., 2017), the most popular and relevant of which are discussed in further detail below.

1.5.1 Pre-Injury Demographic Variables

Age at injury is a common predictor of impairment after brain injury. In one longitudinal study, researchers found that age was the only predictor that remained significant across the majority of timepoints (Keyser-Marcus et al., 2002). More specifically, individuals who sustained their brain injury when they were younger than 40 had better employment outcomes during the first four out of five years post-injury compared to those who were over 40. This conclusion has been supported by others as well (Brooks et al., 1987; Keyser-Marcus et al., 2002; Ponsford et al., 1995). Other research has described the relation between age and employment outcome as nonlinear, such that those who were between 17 and 25 years of age at injury exhibited better employment outcomes compared to those 8-16 years of age as well as those who were 26 or older at the time of injury (Asikainen et al., 1996). There is an abundance of research on the negative consequences of childhood TBI on employment or school outcomes (Anderson et al., 2009; Asikainen et al., 1996; Hawley, 2004). Together, these findings suggest that individuals aged 17 to 25 are more likely to RTW compared to age groups that are significantly younger or older at the time of injury.

However, there are mixed results regarding the contribution of age at the time of injury, such that some studies did not find an association with RTW (Gollaher et al., 1998; Ponsford & Spitz, 2015; Walker et al., 2006). Gollaher et al. (1998) suggested that a sample with a limited age range was more likely to result in poor predictive utility, especially when only a small proportion of the sample is older than 40 years old at the time of injury. Another study found that age, when considered individually, was not significantly predictive of RTW, although when considered in combination with other predictors, age became a significant predictor (Walker et al., 2006).

In regard to gender, men are much more susceptible to sustaining TBIs compared to women across all age groups and are much more likely to visit the emergency room due to head injury (Faul et al., 2010). Consequently, samples of participants in RTW studies are disproportionately male-dominant. Samples ranging from 64 to 84% male have been cited (Andelic et al., 2012; Cuthbert et al., 2015; Grauwmeijer et al., 2012; Howe et al., 2018; Ip et al., 1995; Keyser-Marcus et al., 2002; Ponsford et al., 1995; Ruet et al., 2018; Walker et al., 2006; Willmott et al., 2015). However, a majority of studies suggest that gender is not a significant predictor of RTW following TBI. Additionally, one study with significant findings found that gender differences did not occur at 1-year post-injury but became increasingly more present over the next 10 years (Howe et al., 2018).

Researchers have also extensively studied pre-injury educational level as a factor related to RTW. As a dichotomized variable, research has shown that those with a high school diploma have better employment outcomes at one time period as well as better employment trajectories over time compared to those without a high school diploma (Kreutzer et al., 2003; Walker et al., 2006). Previous research has also shown that those with some college education or beyond reported better productivity outcomes 1-year post-injury, whereas individuals with any level of education below that did not report significantly different outcomes (Keyser-Marcus et al., 2002; Sherer et al., 2002).

Occupational status is another highly cited predictor of employment outcomes. This could be defined in regard to occupational category, as in Walker et al. (2006) or Ponsford and Spitz (2015), where a general trend existed where those employed in jobs that were classified as professional or managerial were more likely to return than those who worked in skilled or manual labor positions. A similar trend has been shown for those who are white collar versus blue collar workers (Forslund et al., 2014). Xiong and colleagues (2016) found a similar trend, but only for male participants. To explain why this may be the case, Walker and colleagues (2006) proposed that employees that are viewed as more valuable relative to others may be met with more accommodations from an employer, or that those driven by a substantial salary may be more willing or hasty to return to employment. However, as previously mentioned, it is important to note that physical impairments as a result of injury are more detrimental for those who work in more physically demanding positions.

Occupational status defined in terms of general productivity pre-injury has also been explored. For example, for those who were working, in school, or homemakers prior to injury, the odds of being productive at 1-year follow-up are significantly higher (Sherer et al., 2002). Additionally, those who are employed pre-injury have better odds of returning to work 1, 2, 3 (Andelic et al., 2012; Keyser-Marcus et al., 2002), and 5 years post-injury (Forslund et al., 2014) relative to those who are unemployed pre-injury.

1.5.2 Injury-Related Variables

Models relying purely on demographic information are not particularly successful in classifying individuals in RTW studies. For example, one study found that a model containing only demographic variables was unsuccessful at categorizing those who were and were not productive 1-year post-injury (Willmott et al., 2015). Consequently, research has shown that models increase their ability to predict group membership if they include variables that refer to the injury itself.

One of the most valuable factors to consider is injury severity, which is highly related to outcome, including cognitive impairment and disability. However, injury severity has been defined in a variety of ways across studies, most commonly by using GCS scores, days of PTA, duration of unconsciousness (a.k.a. time to follow commands), and coma duration, to name a few.

Using Glasgow Coma Scale (GCS) scores as an index for injury severity is perhaps the most common method. The scale allows medical professionals and first responders to determine an individual's motor functioning, verbal abilities, and eye movements (Teasdale & Jennett, 1974). Individuals receive a score for each component, and scores are summated to create a total score, where scores can range from 3-15, and lower scores signify a more severe injury. Specifically, a score of 8 or less indicates a severe head injury, a score of 9-12 indicates a moderate head injury, and a score of 13-15 indicates a mild head injury. One major advantage of the GCS is that individuals can be assessed multiple times, whereas other indices may only be assessed once (Corrigan et al., 2014). For example, time to follow commands can only be established once, in most cases. Therefore, in comparison to measures like PTA or duration of unconsciousness, it can be argued that GCS scores are more useful. However, one major disadvantage of the GCS is that it is unable to determine an individual's initial injury severity if they are sedated or intubated because it makes assessment for one or more of the subscales inapplicable. Additionally, when studies contain participants within a certain injury severity range, there is a restriction of range issue, which typically results in GCS scores that fail to reach statistical significance as a predictor (Gollaher et al., 1998), which suggests that GCS scores may be best suited for studies of participants that span the full spectrum of injury severity. Nevertheless, studies have supported the use of the GCS in predicting short-term outcomes (Corrigan et al., 2014). In regard to its predictive utility for employment outcome, GCS scores have been used extensively (Asikainen et al., 1996; Cifu et al., 1997; Ponsford et al., 1995), and results have suggested that those with higher GCS scores have better employment outcomes both at one time-point and across multiple time-points.

PTA is defined as "the period of disorientation and disturbed memory function after neurotrauma" (Forrester et al., p. 175). PTA can be assessed a number of ways, either by the Westmead PTA scale (Shores et al., 1986), the Galveston Orientation and Amnesia Test (GOAT) (Levin et al., 1979), the Revised GOAT (Bode et al., 2000), the Orientation-Log (O-Log) (Jackson et al., 1998), or others. In each aforementioned case, an individual must achieve a certain benchmark score two consecutive times, with assessments conducted less than 2 days apart, in order to have emerged from PTA. Ideally, the chosen scale is administered daily. In the TBIMS NDB, it may also be assessed via clinical judgment or via chart review. The strengths and weaknesses of the GOAT and the Westmead PTA scale as prospective measures of PTA are outlined by Forrester et al. (1994).

Results from Willmott et al. (2014) proposed that days of PTA was the only significant difference between those who had successfully returned to school and those who had not. Previous research has shown that when it comes to measures of injury severity, days of PTA has more predictive utility than GCS scores when predicting outcome (Brown et al., 2005). A more recent investigation found that, in terms of univariate analyses, days of PTA was the strongest predictor of successful RTW, where individuals with PTA lasting less than 4 weeks exhibited better employment outcomes (Sigurdardottir et al., 2018). However, the point at which to dichotomize PTA likely depends on sample characteristics, as Forslund et al. (2014) described a similar trend with a dividing point at its average of 3 weeks.

Notably, GCS and PTA are frequently used in conjunction in studies of RTW (Cifu et al., 1997; Forslund et al., 2014; Ponsford et al., 1995). In many cases, both PTA and GCS scores are statistically significant predictors of RTW. However, when combined with neuropsychological measures of memory, processing speed, and executive functions, then PTA failed to reach significance, which suggests that the two factors share variance, or that neuropsychological measures are better predictors. Similarly, another study failed to include PTA in its model due to its high correlation with DRS total scores (Ponsford et al., 1995). They initially included GCS scores and days of PTA as predictors and argued that conclusions regarding GCS as a better predictor of future employment should be made with caution due to the fact that PTA was removed due to its high correlation with DRS scores, not because it was not a successful predictor. Therefore, it could be worthwhile to address that DRS scores and PTA may not both contribute uniquely in a model.

Time to follow commands (TFC) is another potential avenue by which to assess injury severity. In studies conducted by Kreutzer et al. (2003) and Walker et al. (2006), TFC was defined as the amount of time required for an individual to obtain a GCS motor score of 6. When considered on its own, Walker et al. (2006) found that time to follow commands significantly predicted RTW; however, when entered into a multivariate model with other variables such as education, pre-injury employment status, discharge FIM scores, and marital status, time to follow commands failed to reach statistical significance (Walker et al., 2006), which suggests that it may not be an adequate predictor after taking other, more important predictors, into account. Nevertheless, when considered in a more parsimonious model, as in the case of Kreutzer et al. (2003), where TFC was one of three variables used in a RTW model, it was able to significantly predict RTW. Similarly, findings also appear to be mixed regarding the predictive utility of coma duration. While some conclusions suggested a negative relationship between coma duration and employment outcomes (Cifu et al., 1997; Fabiano & Crewe, 1995; Ruff et al., 1993), others have failed to identify a similar trend (Hanlon et al., 1999; Ruffolo et al., 1999). Together, these findings suggest that time to follow commands and coma duration may not be consistently effective measurements of injury severity for RTW studies.

LOS is another commonly cited predictor in RTW studies and is generally distinguished from measures of injury severity. LOS may be defined in terms of the length of time spent in acute care hospitals, inpatient rehabilitation facilities, or the total length of time spanning both facilities. Studies have shown that those who were employed at 1-year follow-up spent fewer days in rehabilitation settings compared to those who were unemployed at follow-up (Keyser-Marcus et al., 2002). Similarly, those who spend less time overall in inpatient facilities (spanning the length of acute care admission to rehabilitation discharge) have been shown to be about three times less likely to RTW 1-year post-injury (Walker et al., 2006). These findings are consistent with Cifu et al. (1997). LOS in acute settings has even been shown to predict long-term employment outcomes, as research has shown LOS to be a significant predictor 4 years (Ruet et al., 2018), and even 10 years post-injury (Grauwmeijer et al., 2017).

II. The Current Study

A majority of the existing literature primarily involves RTW for employed adults. However, differences in scale measurements, sample demographics, and how researchers define exactly what constitutes “employment” creates large variability between studies and those differences likely carry over into the results and implications. Moreover, while there are studies that incorporate students into investigations of RTW, reports of return to school for students in secondary and tertiary education are largely qualitative. While studies of academic accommodations and student perceptions regarding return to school are meaningful, there are very few that incorporate predictive modeling in a sample composed entirely of students in order to determine whether a framework can be applied through which to determine the relevant factors in predicting return to school.

Likewise, individuals between the ages of 15 and 24 are among the most susceptible age groups to sustain TBIs yet have traditionally been underrepresented in the literature; therefore, a study dedicated solely to students is of particular importance. A potential barrier to conducting this kind of study in the past could have been due to a restricted sample size, as the proportion of students in studies of RTW have been miniscule, as in the case of Walker et al. (2006), Ip et al. (1995), and Ruff et al. (1993). The use of the TBIMS NDB is a potential solution to this problem, as the database is the largest longitudinal database in the world and contains information on patients all across the country. Despite the fact that students make up a very minimal proportion of the database, the sample size is still likely larger than any other studies, which introduces the unique opportunity to explore predictive modeling.

The pre-injury predictors most consistently used in models of RTW include age, education, and occupational status, while gender has demonstrated less value in predicting RTW. For the purposes of this study, occupational status is also not relevant because this is a study of return to school. Therefore, all the participants have the same occupational status: student. Similarly, the ideal sample will include individuals whose age fits that of the traditional student trajectory; consequently, the age demographic of interest is individuals who are between 16 and 35 years of age. Thus, age is used as an eligibility criterion, rather than as a predictor.

The injury-related predictors most consistently used in models of RTW are GCS scores, days of PTA, inpatient LOS, DRS scores, and FIM scores. Less commonly used are time to follow commands (TFC) and coma duration. For injury severity, days of PTA was chosen over GCS scores due to the proportion of participants (~55%) who were excluded because they were either intubated or chemically sedated. Additionally, days of PTA has shown to be particularly useful for studies of RTW as well as studies of return to school. LOS has proven useful in terms of predicting 1-year outcomes as well as more long-term outcomes, and it appears to be backed more consistently in the literature compared to TFC and coma duration.

For functional capabilities, the DRS was chosen over the FIM due to its ability to detect more subtle changes in patient functional abilities. Likewise, while it appears the FIM prioritizes self-care functioning and activities of daily living, the DRS covers a broader scope, including items that act as derivatives of the GCS, as well as items for employability and independence. A particular asset of the DRS is that it overlaps with all three functional domains described by the ICF, whereas the FIM simply addresses the disability domain (Shukla et al., 2011).

While estimates of cognitive functioning are very useful in predicting RTW, the TBIMS NDB does not have access to a direct way of assessing cognitive functioning, either through neuropsychological testing or a suitable alternative. Likewise, socioemotional factors have been extensively cited in studies of RTW and also play a role in the relative success of students returning to school; however, the purpose of this study is to build a model of acute predictors of return to school at 1-year post-injury, and these factors would likely be assessed upon follow-up and would therefore not be considered acute predictors.

2.1 Research Questions

1) Can a model using educational level, days of PTA, inpatient LOS, and DRS discharge scores predict return to school 1-year post-injury for full-time students who sustained a brain injury?
2) Are students in high school more likely to return to school versus students in college or graduate school pre-injury?

2.2 Hypotheses

Considering the variety of studies encompassing models RTW, patterns have emerged, such that demographic variables, injury-related variables, and disability variables (either physical, cognitive, or both) create the basic framework for these predictive models. However, given the variety of ways in which these predictors can be measured, it is possible that other models may contain options with more utility than the ones chosen here, especially in regard to injury severity and level of functioning.

To my knowledge, the first study of modeling RTW or school was conducted by Ip and colleagues (1995). However, although they were the first to do so, there were only 12 students in their sample and 65 total participants. They found that age, marital status, cognitive functioning (as assessed by Performance IQ on the WAIS-R), and the presence of alcohol abuse were among the significant predictors, while gender, injury severity, time post-injury, physical impairment, educational status, and occupational category were not significant predictors. The predictor with the most predictive utility was the Performance IQ score. Ip et al. found a trend that increased education suggested a successful return to school, but this trend did not reach statistical significance. Nevertheless, it is possible that these findings were largely influenced by their small sample size.

A more recent study conducted by Willmott et al. (2014) provided a more extensive longitudinal study of 295 students with moderate to severe head injury. They found that 43% of participants never returned to school, and these participants had longer PTA. Consistent with previous research, approximately one third of students transitioned from full- to part-time. Over the course of 10 years, they also found that rates of return to school declined, which suggests that these students may have transitioned to the work force.

To date, the most relevant study of educational and vocational outcomes in students was conducted by Willmott et al. (2015). In their model, they included pre-injury demographic variables (gender, living situation, age at injury, and level of study), injury-related variables (days of PTA and limb injury), and post-injury variables (independence, cognitive changes, as well as behavioral and emotional well-being, all of which were assessed using the Structured Outcome Questionnaire) in order to predict productivity 1-year post-injury in 145 Australian students who were currently enrolled in secondary or tertiary education. At follow-up, 60% of participants had returned to school, 19% had transitioned to the workforce, and 21% were categorized as unemployed or non-vocational. The only acute pre-injury or injury-related predictor that differed significantly between groups was days of PTA, where those who had returned to school or work experienced PTA that was 20 days shorter, on average. Model comparisons found that PTA and scores on behavioral items assessing self-centeredness and initiative explained significantly more variance compared to models based in demographic, emotional, neurological, physical, and social variables.

In conclusion, researchers suggested that injury severity may be the predominant factor of return to school for students, whereas return to employment may rely on a more complicated interplay of factors. However, Willmott et al. did not include any acute measure of functional status, which may have increased the predictive power of the model and have been shown to be a valuable asset in RTW studies. Although results from Willmott et al. (2015) did not find differences in rates of return to school for secondary and tertiary students, it is worthwhile to re-investigate this relation in a national US sample.

It appears as though high school students receive more formalized accommodations compared to those in college. IEPs and increased support received from living at home may increase the chances of those injured in high school to return, whereas in college, the combination of self-advocacy, independence, and less reliance on support from home (due to the idea that most college students either live in dorms or in off-campus apartments) may make them less susceptible to returning to school. According to Keyser-Marcus et al. (2002) and Sherer et al. (2002), those with a at least a college education exhibited better productivity and employment outcomes 1-year post-injury; however, it is possible that the relationship between education and return to school differs from the relation between education and employment outcomes.

Students have traditionally been excluded from studies about RTW; however, many of the key attributes related to successful job performance (i.e. maintaining focus, keeping track of schedules, multi-tasking, problem solving, socializing, etc.) are also relevant skills for successful performance while in school. Likewise, many of the deficits reported after brain injury are consistent across young adult and adult age groups; therefore, it is plausible that there may be likenesses regarding the factors that are relevant for return to school for students and for those in competitive employment pre-injury. Consequently, I hypothesize that a model of return to school containing educational level, days of PTA, inpatient LOS, and DRS discharge scores should classify students with comparable accuracy. A similar study strictly dedicated to observing outcomes in students will provide additional insight on quantitative measures of return to school, which as of yet, have been very under-represented in the literature.

III. Method

3.1 The Current Study

3.1.1 The Traumatic Brain Injury Model Systems National Database

All participants are part of a large prospective database within the National Institute on Disability and Rehabilitation Research (NIDRR) Traumatic Brain Injury Model Systems (TBIMS) (Dahmer et al., 1993). The database is the largest longitudinal database in the world and includes data on pre-injury, injury, acute care, rehabilitation, and outcomes at 1, 2, and 5 years post-injury, and every 5 years thereafter. Patients at each of the TBIMS rehabilitation centers also receive access to occupational and physical therapy, psychiatric care, psychology and neuropsychology services, therapeutic recreation, social services, and speech and language therapy. Studies of the representativeness of the database have found that the database aligns with the general trends of those 16 and older who get admitted to inpatient rehabilitation sites in the United States, with the exception of those 65 and older, who appeared to be underrepresented in the database as of 2010 (Corrigan et al., 2012; Cuthbert et al., 2012). Although a minor difference, when collapsed across age groups, Corrigan et al. (2012) found that the TBIMS NDB includes more African Americans and fewer Caucasians compared to those in the US TBI rehabilitation population.

In order to become a participant in the database, a set of inclusion criteria must be met. The participant: 1) must have sustained a moderate to severe TBI, as defined by PTA longer than 24 hours, a loss of consciousness longer than 30 minutes, a Glasgow Coma Scale (GCS) score less than 13, or intracranial neuroimaging abnormalities; 2) was admitted to the emergency department at one of the 16 institutions that are a part of the TBIMS within 72 hours of their injury; 3) was 16 years or older at the time of injury; 4) received services within the model system facility including acute care and inpatient rehabilitation; 5) gave informed consent, either personally, or by a family member or guardian.

In addition to providing clinical care for patients, each of the facilities that are a part of the TBIMS must follow a set of criteria as well, a majority of which reflect research efforts for generating center-specific and multicenter studies and collaborating with the Model Systems Knowledge Translation Center. Projects in recent years include studies on drug intervention, instrument development, and developing interventions specifically targeted toward the acute phase post-injury. Currently, there are 16 centers that makeup the TBIMS, 13 of which are currently funded, and 3 of which are follow-up centers. Approximately two thirds of the centers lie east of the Mississippi River.

The database itself contains variables assessed during inpatient rehabilitation discharge (called Form I variables), as well as follow-up data (called Form II variables). Examples of Form I variables include information on various demographic characteristics, causes of injury, injury severity, health behaviors, substance abuse, premorbid and comorbid diagnoses, surgical procedures, and rehospitalizations. Examples of Form II variables include information on impairment, disability, health behaviors (i.e. anxiety, depression, general health, etc.), and participation in the home, in relationships, and in the community. The data are periodically screened by coders and checked for consistency, and errors or blanks are corrected.

3.2 Variables of Interest

3.2.1 Pre-Injury Demographic Variables

Demographic variables including education, sex, age, race/ethnicity, and pre-injury employment status were collected. Pre-injury employment status reflects an individual's employment status in the month prior to injury. Primary and secondary employment statuses are available in the database, and for the purposes of the current study, participants were selected for inclusion if their primary employment status was full-time student. Specifically, because the database starts at 16 years old, students must have the years of education typical for their age. For example, a typical student who is 16 years old is in the 10^{th} or 11^{th} grade. This is an attempt to eliminate those with fewer years of education because these individuals may not fit the trajectory for a typical student. Similarly, in order to specifically investigate the trajectory of the traditional student, those older than 35 years of age were excluded.

3.2.2 Injury-Related Variables

Inpatient LOS is defined as the number of days from acute care admission to rehabilitation discharge. Days of PTA is determined by the number of days required for an individual to achieve a certain benchmark score on a scale, either the O-Log, GOAT, or GOAT-R for 2 consecutive days, or assessed via clinical assessment or chart review. All individuals who had not emerged from PTA at the time of rehabilitation discharge were excluded. Discharge DRS scores were also used to capture the functional capabilities of each individual upon discharge from rehabilitation.

IV. Results

4.1 Preliminary Analyses

Upon first inspection, 758 individuals were classified as full-time students and had at least 10 years of education, placing them on the conventional trajectory for those 16 years of age. After surveying for valid information on each of the predictors, 190 participants were excluded. Of the 568 individuals remaining, an additional 363 did not have 1-year follow-up data, leaving the total eligible sample at 205 individuals.

Additionally, four individuals were excluded because they exceeded the age range—two were excluded due to unknown employment information at follow-up, and three were excluded due to suspected mistakes in regard to coding. Altogether, 196 valid participants remained.

Comparisons were conducted between those who had 1-year follow-up data and those that did not, and an alpha level of 0.05 was used for all inferential tests. Results showed that the groups did not differ on days of PTA, $t(566) = 0.93$, $p = .36$;, LOS, $t(345.77) = 1.71$, $p = .09$;, discharge DRS scores, $t(566) = 0.75$, $p = .45$;, or educational level, $M^2(1) = 2.19$, $p = .14$. Therefore, those with 1-year follow-up data were also representative of those without 1-year follow-up data on all predictors.

In total, there were 132 men and 64 women, which is in accordance with previous trends that have consistently displayed a male-dominant sample. Approximately 60.2% of individuals identified themselves as White, 23.5% identified as African American, 7.6% identified as a Hispanic Origin, 6.1% as Asian/Pacific Islander, 2% identified as Other and 0.5% identified as Native American. A majority of participants (95.9%) were single at the time of injury, and the most commonly reported cause of injury was a motor vehicle accident (53.6%). Approximately half (51%) of individuals were high school students, followed by undergraduate students (32.1%), then Associate's students (14.8%), and finally, graduate students (2%). The average DRS discharge score was 5.28 (SD = 2.47), the average LOS was 46.24 days (SD = 35.60), and the average days of PTA was 24.09 days (SD = 22.04). According to the categorization provided by Hammond et al. (2001) and Kreutzer et al. (2003), the average DRS discharge score (M = 5.28) for this sample reflects moderate disability. The average DRS score is comparable to that of various employability studies (Cifu et al., 1993; Dams-O'Connor et al., 2019). The average days of PTA and LOS are also comparable with previous studies of those with moderate to severe injuries (Forslund et al., 2014; Keyser-Marcus et al., 2002; Kreutzer et al., 2003; Malec et al., 2019; Ponsford & Spitz, 2015), where variability is typically quite high. There were no significant differences between the eligible sample and the rest of the database sample in regard to days PTA, $t(12520) = -0.73$, $p = .46$, or LOS, $t(15895) = 0.26$, $p = .80$. There was a statistically significant difference in DRS discharge scores, $t(207.14) = 5.90$, $p < .001$, but the mean difference was 1.05 points and therefore was likely a consequence of the large sample size and is not practically significant. A more detailed description of pre-injury and injury-related demographic information for the study sample is depicted in Tables 1 and 2, respectively. Intercorrelations, descriptives, and group comparisons across predictors are depicted in Table 3.

Comparisons were also conducted between those who successfully returned to school versus those who did not, and an alpha level of 0.05 was used for all inferential tests. Results showed that the groups did not differ significantly on sex, $\chi^2(1) = 0.0034$, $p = .95$;, LOS, $t(194) = 1.45$, $p = .15$; or days of PTA, $t(194) = 1.19$, $p = .24$. There was a significant difference between groups on DRS discharge scores, $t(194) = 2.24$, $p = .03$, where those who returned scored significantly lower ($M = 4.98$, $SD = 2.48$) than those who did not return ($M = 5.79$, $SD = 2.36$). There was also a significant relation between whether an individual returned and educational level, $M^2(1) = 14.05$, $p < .001$, where returning to school was associated with lower levels of education. Specifically, significantly more high school students returned, and significantly fewer students pursuing their Associate's, undergraduate, or graduate degree returned than what would be expected if the two variables were unrelated.

4.1.2 Assumptions

The assumption of separation or quasi-separation was met for DRS discharge scores, days of PTA, and LOS; however, educational level did not initially meet this assumption because all four graduate students successfully returned to school. While this is a positive trend, collapsing undergraduate and graduate students into the category "undergraduate and beyond" was necessary in order to establish model convergence and to appropriately estimate parameters and their standard errors. After probing for linearity between each of the continuous predictors and logit, it is possible that DRS discharge scores may have a nonlinear relation with return to school; however, there was not enough departure to conclude that this relation was worth adjusting, and linearity was assumed. All other assumptions were met.

4.2 Primary Analyses

Predictor variables included educational level, days of PTA, inpatient LOS, and discharge DRS scores. The outcome variable, return to school, was defined dichotomously as returned to school versus did not return to school. Said another way, a "successful" case was either 1) a student who returned to school and is enrolled either full- or part-time 1-year post-injury or 2) returned to school and received their degree. Return to school was deemed successful even if the student transitioned from full- to part-time, because this transition has been of interest to researchers in the past (Kennedy et al., 2008) and will provide insight on how common this transition is for a national sample of students. A "failed" case would be considered as those who did not return to school and did not graduate. A combination of employment category as well as educational level was used to distinguish cases that were successful from cases that were failed. See Table 4 for more detail.

Single parameter hypothesis tests were conducted to compare the deviance accounted for by each predictor, individually, in comparison to an intercept-only model (see Table 5). Four separate likelihood ratio tests were conducted, and results suggested that a model containing discharge DRS scores, $G^2(1) = 4.88$, $p = .03$, and a model containing educational level, $G^2(2) = 18.50$, $p < .001$, fit significantly better than an intercept-only model. The predicted odds of returning to school when someone scores a 0 on the DRS is 3.62. For each additional point on the DRS, the odds of returning increase significantly 0.874 times (i.e. the odds decrease slightly). For a student in high school, the odds of returning is 3.55. The odds of returning for students pursuing their associates is 0.229 times that of those in high school, which is significantly lower. The odds of returning for students pursuing their undergraduate degree or beyond is 0.291 times that of those in high school, which is also significantly lower. A model including LOS, $G^2(1) = 2.04$, $p = .15$, and a model including days of PTA, $G^2(1) = 1.39$, $p = .24$, did not fit significantly better than an intercept-only model.

When all four predictors were entered simultaneously into one model, results suggested that the proposed model fit significantly better than an intercept-only model, $G^2(5) = 26.78$, $p < .0001$ (see Table 6). After controlling for other predictors, DRS discharge scores, $X^2(1) = 5.96$, $p = .01$, and educational level, $X^2(2) = 18.85$, $p < .0001$, were significant predictors of return to school, while LOS, $X^2(1) = 0.42$, $p = .52$, and PTA, $X^2(1) = 0.22$, $p = .64$, were not. For each additional point on the DRS, the odds of returning increase 0.825 times (i.e., the odds decrease slightly), controlling for other predictors. Additionally, controlling for all other predictors, the odds of returning for students pursuing their associates is 0.213 times that of those in high school, which is significantly lower, and the odds of returning for students pursuing their undergraduate degree or beyond is 0.247 times that of those in high school, which is also significantly lower. The probability of return as a function of educational level and discharge DRS scores is depicted in Figure 1.

The practical significance of the model was calculated via McFadden's R^2 and Tjur's R^2, which are the two effect sizes for logistic regression advocated for by Allison (2014). McFadden's R^2 indicated that the proportion of null deviance accounted for by the set of predictors was 0.104, which indicates adequate model-data fit. Secondly, Tjur's R^2 indicated that the difference in the average expected probabilities for those who returned versus did not return to school is 0.128.

For this sample, the overall return to school rate was 63.78%. Broken down by education level, 78% of high schoolers returned, 44.8% of Associate's students returned, 47.6% of undergraduate students returned, and 100% of graduate students returned. Of those who identified as a student at follow-up (n = 83), 83.13% remained at full-time student status, while 14.45% transitioned to part-time status, and 2.4% transitioned to special education or other non-regular education. A cross-tabulation of education level and student status at follow-up is provided in Table 7.

Furthermore, of those who were employed at follow-up (n = 59), 54.2% of individuals transitioned to employment without conferring a degree, whereas 45.8% of individuals received their degree prior to transitioning to the workforce. Of those who were unemployed at follow-up (n = 40), the majority (67.5%) did not return to school prior to transitioning to unemployment, whereas 32.5% of individuals received their degree yet were not employed (see Table 8 for more information). A chi-square test of independence was conducted, and results suggested that there was not a statistically significant relationship, $X^2(1) = 1.74$, $p = .19$, between employment (employed vs. unemployed) at follow-up and return to school. Of those who were not in school at follow-up, whether an individual had conferred a degree or not did not affect whether they were employed at follow-up.

A classification table is provided in Table 9. The overall predictive accuracy of the model was 67.86%. Without information from any predictors, there was a 63.78% chance of accurately predicting whether a student returned to school; however, approximately 11.27% of people not correctly classified by the null model were correctly classified by this proposed model. The sensitivity, or the proportion of those predicted to return who actually returned, was 0.840, while the specificity, or the proportion of those who were predicted not to return who actually did not return, was 0.394. The proportion of those predicted to return who did not return was 0.291, while the proportion of those predicted to not return who returned was 0.417.

V. Discussion

5.1 Hypotheses

The primary goal of this study was to investigate whether a model including LOS, days of PTA, educational level, and discharge DRS scores was able to adequately predict whether students in advanced stages of schooling returned to school 1-year post-injury. The results suggested that the proposed model fit the data significantly better than an intercept-only model, and two of the four predictors, educational level and discharge DRS scores, were significant when entered into models individually, as well as when all predictors were combined. Overall, lower scores on the DRS at rehabilitation discharge and being in high school pre-injury resulted in the highest probabilities of returning to school 1-year post-injury, while LOS and days of PTA did not predict whether students returned to school.

The proposed model was also able to correctly classify approximately 68% of individuals, and 11% of individuals incorrectly classified by an intercept-only model were able to be classified correctly using the proposed model. Therefore, results support the hypothesis that the model would be effective. However, while McFadden's R^2 indicated adequate model-data fit, there is much room for improvement. Specifically, the proposed model was more accurate in classifying those who successfully returned relative to those who did not return. To apply clinically, this model should be efficacious in identifying those who are predicted not to return so that clinicians and rehabilitation staff could provide additional directives and resources for those individuals. Based on the specificity proportion and false negative rate, the proposed model is fairly weak in correctly predicting who these individuals are; therefore, there are likely supplementary variables which would improve the predictive utility of future models that have not been included here.

The other objective was to determine whether there was a difference in return to school rates for those in high school and those in college. Results suggested that 78% of high schoolers successfully returned to school, while only 44.8% of Associate's students, and 47.6% of undergraduate students returned. While 100% of graduate students successfully returned, the small group size (*n* = 4) prevents any generalizations regarding the trends for this particular student category. Thus, the results support the hypothesis that high school students would have the highest return to school rates.

5.2 Comparison with Previous Literature

Previous models of RTW have boasted the contribution of injury severity measures. Results from employment studies have commonly found that days of PTA is a strong predictor of positive return (Brown et al., 2005; Forslund et al., 2014; Sigurdardottir et al., 2018). The few studies that exist that focus on return to school have also supported this claim (Willmott et al., 2014; Willmott et al., 2015). Findings from Willmott et al. (2015) identified injury severity, as assessed by days of PTA, as the primary factor in return to school for students. Specifically, they reported a mean difference of 20 days between those who did and did not return to school. In this study, the mean difference was approximately 4 days, which suggests that PTA may vary widely across samples, and as a consequence, the predictive utility may vary widely across samples.

Contrary to previous findings, results from this study do not support the contribution of days of PTA in predicting return to study. However, those few that have found PTA to be a significant predictor in employment studies chose to dichotomize the variable, whereas in this study, PTA was left continuous. For example, dichotomizing PTA at its average of 3 and 4 weeks has been cited in two separate studies (Forslund et al., 2014; Sigurdardottir et al., 2018). It is therefore reasonable to presume that only as a dichotomized variable is PTA a strong predictor of return to school or work. However, there are negative consequences to dichotomizing a continuous variable, and it is generally not recommended (see MacCallum et al., 2002 for more detail).

An alternative explanation that may justify the poor predictive utility of PTA lies in its measurement in the TBIMS NDB. According to the database, PTA can be assessed five different ways. In particular, three different scales could be used, or it could be determined by clinicians or chart review. Previous studies found that scores obtained from the O-Log and the GOAT are very highly correlated, although the O-Log may be better suited to predict rehabilitation outcomes (Frey et al., 2007; Novack et al., 2000). The project director decides which scale to use throughout the evaluation period. For those who have already emerged from PTA before rehabilitation admission, chart review of acute care records is used by a qualified clinician, and an established protocol is followed in order to approximate the date of PTA emergence. Nevertheless, it is plausible that PTA was not recorded reliably. Had it been recorded in a more universal and reliable way, it is possible that PTA may have shown higher predictive utility.

Similarly, previous research has also advocated for the effectiveness of LOS as a predictor of employment outcomes, where those with a shorter LOS are more likely to return to employment at 1-, 4- and even 10-years post-injury (Cifu et al., 1997; Grauwmeijer et al., 2017; Keyser-Marcus et al., 2002; Ruet et al., 2018; Walker et al., 2006). Like PTA, results from this study found that LOS was not a significant predictor of return to school 1-year post-injury. Inpatient LOS was defined as the length of time between acute care admission and rehabilitation discharge. While other studies have defined LOS in this way, others have focused solely on time acute care or time in rehabilitation, rather than time spent in both settings. Additionally, in this sample, LOS and PTA were moderately related (*r* = 0.691); therefore, it is possible that the inclusion of both predictors could have been redundant, especially because both variables are calculated in terms of length of time (days). Moreover, the range of values on each of these predictors was extremely large. LOS ranged from 6 to 275 days, while PTA ranged from 0 to 123 days. The large variability in LOS and days PTA likely contributed to the lack of significance of these predictors.

Additionally, LOS could be influenced by factors outside of brain injury. For example, two students could sustain very similar injuries, yet one may require a longer rehabilitation stay because they were in a car accident and needed corrective surgeries. Additionally, previous studies have documented a relation between LOS and insurance, where uninsured individuals are much more likely to be discharged to their homes rather than to rehabilitation settings (Nirula et al., 2009; Sacks et al., 2011).

One major finding of this study suggested that higher scores on the DRS at rehab discharge were associated with lower odds of returning to school, controlling for all other predictors. Previous research has supported the contribution of DRS scores, both upon rehab admission as well as discharge (Kreutzer et al., 2003; Ponsford et al., 1995). Likewise, the DRS captures all three domains of the ICF, thereby posing a holistic picture of an individual's handicap, disability, and impairment (Shukla et al., 2011). For this sample, the vast majority of DRS discharge scores fell between 1 and 9. Given the full range of possible scores on the DRS (0-29), the extent of disability for this sample is relatively mild to moderate, with very few individuals reporting severe disabilities. Interestingly, as shown in Figure 1, the effect of education on return to school diminishes greatly at very high values on the DRS. However, a study of the reliability, validity, and precision of the DRS performed by Hall et al. (1993) found that the DRS may not be suitable to assess functional impairments in individuals with extremely low (< 3) and extremely high scores (> 25). In this sample, the vast majority of DRS discharge scores fell within this range, which may explain why DRS scores were particularly effective. Likewise, DRS discharge scores were significantly related to LOS and days of PTA, which may also explain why LOS and PTA were not significant predictors when included in the full model. Previous research has highlighted the relation between the DRS and PTA (Hall et al., 1993) as well as with LOS (Keyser-Marcus et al., 2002), and results from this study identified the DRS as having the best predictive utility when used in combination with days of PTA and LOS.

The DRS includes three items that mirror the GCS, three items that assess the cognitive ability for self-care pertaining to feeding, toileting and grooming, one item that assesses the extent of dependence on others, and one item that assesses psychosocial adaptability as expressed through an individual's employability. According to Hammond et al. (2001), the first six items are better suited to assess acute recovery of function, whereas final two items provide an elevated estimate of functional status in the years following injury. These two items represent the capability of an individual to operate unrestrictedly in daily living, as well as the capacity of the individual to physically and cognitively contribute in a school, work, or home setting. Therefore, the information obtained from the DRS may be a more trustworthy reflection of an individual's status, and may be a more reliable indicator compared to LOS and days of PTA.

Studies have also frequently shown that having a higher educational level pre-injury resulted in better employment outcomes post-injury (Kreutzer et al., 2003;

Ponsford et al., 2008; Ponsford & Spitz, 2015; Sherer et al., 2002; Walker et al., 2006). Interestingly, results from this study suggest the opposite to be the case for academic outcomes. This opposing trend introduces the possibility that, conceptually, return to school and RTW may be two distinct concepts. Results from this study showed that students in high school had a much higher probability of returning to school post-injury. This finding is unique, as preliminary quantitative studies of return to school have found no differences in return to school rates depending on educational level (Ip et al., 1995; Willmott et al., 2015).

Previous research has highlighted the recovery process for students in high school and college as they attempt to return to school post-injury. Studies of high school students have stressed the importance educating teachers and peers, organizing and establishing, and then carrying out a plan (Sharp et al., 2006). While schools are not always successful in implementing these accommodations, IEPs provide more formalized assistance, and living at home provides an advantage in terms of advocacy as well as additional assistance completing schoolwork and providing further emotional support. Alternatively, college students are likely to develop informal strategies on their own in an attempt to improve their academic performance (Hux et al., 2010); however, the extent to which college students utilize formal accommodations provided by disability services varies greatly. Either due to stigma avoidance or blatant unawareness, previous research has cited, at best, only moderate usage of disability services by college students, which suggests that a number of college students are left unaccommodated (Kennedy et al., 2008; Todis & Glang, 2008; Willmott et al., 2014).

Regarding the transition from full- to part-time student status, results from this study support previous research. Of those who identified as a student at follow-up (*n* = 83), 83% remained full-time students, while 14.5% transitioned to part-time and 2.4% transitioned to special education or other non-regular education. These results are more promising than those of a previous study, which found that nearly one third of students transitioned to part-time (Willmott et al., 2014).

Surprisingly, results suggested that for those who were no longer in school, there was no relation between degree conferral and employment status at follow-up. Approximately 30.1% of people (*n* = 59) found employment post-injury, where the small majority (54.2%) found competitive employment despite the fact that they never conferred their pre-injury degree. Therefore, productivity post-injury is possible outside of the school setting. On the other hand, of those who were unemployed post-injury (*n* = 40), approximately one third had conferred their degree prior to unemployment, which suggests that returning to school, for some, may not indicate long-term productivity. In conclusion, for this sample, while obtaining a degree does not appear to enhance employability post-injury, the lack of relation between degree conferral and employment also suggests that not obtaining a degree does not appear to hinder employability post-injury.

This study may be the first to investigate the transition from school to employment based on degree conferral in a brain injury population. The idea that employment outcomes post-injury are unrelated to degree conferral provides further support that productivity defined within a school setting and within a work setting may be somewhat distinct concepts and should be treated differently in quantitative studies.

5.3 Limitations

Results of this study revealed that the proposed model was not particularly effective in successfully predicting whether an individual did not return to school. However, in total, only four acute predictors were chosen for this proposed model, and only two were significantly related to return to school; therefore, the inclusion of additional predictors may have resulted in better predictive utility and would have better classified those that did not return.

Participants who are a part of the TBIMS receive a comprehensive array of services during their time in the center. Therefore, these findings may not be generalizable to populations where individuals have not received such widespread and thorough care. Moreover, the small number of graduate students in the eligible sample ($n = 4$) consequently implies that any findings pertaining to that subgroup are not generalizable. It is plausible that graduate students differ in some ways from undergraduate students; however, collapsing these two groups in the predictor for educational level treats this group as homogenous, when it may not be.

Most importantly, analyses were conducted based on the reliance of a coding system that may not have been followed with the same standards from center to center. For example, three individuals were excluded due to suspected mistakes in coding; however, there may have been more individuals whose values on certain variables were not reflective of their current status.

5.4 Potential Implications and Recommendations for Future Research

Previous research has focused extensively on RTW, but much less is known regarding return to school for students in advanced stages of schooling. This study provides further insight into the acute factors related to return to school. Mainly, results illuminate the value in pre-injury educational level as well as functional capabilities at rehabilitation discharge in predicting whether an individual returns to school. This study also provides a basic estimate of return to school rates for a large, geographically diverse sample of TBI students in the US. However, because patients in the TBIMS receive such thorough care, it would be worthwhile to investigate whether the comprehensiveness of the services provided by the TBIMS explain the outcomes of this study by replicating this study with patients in hospitals not affiliated with the TBIMS.

A majority of the existing literature on return to school for students in high school and college includes studies that are largely qualitative. Using the TBIMS NDB allowed for a larger and more representative collection of information on students from varying backgrounds. Similarly, because studies of RTW vary so widely in scale measurements, sample demographics, and most importantly, operational definitions of "employment," generalizability is limited. A student sample is likely much more homogenous; therefore, the prospect of generalizability may be higher.

The TBIMS NDB does not provide a way by which to investigate whether students (if any) utilized some form of disability services or accommodations in order to aid the transition back to school. Previous research has shown that, for those who are able to establish and implement formal accommodations, the transition is a more positive experience (Mealings et al., 2012; Willmott et al. 2014). Consequently, an updated exploration of the use of services and its relation to the probability of returning to school is encouraged. In quantitative studies, the presence of accommodations would ideally better characterize those who returned to school. This would provide educators with validation that students are impacted by these accommodations in a positive way and would also help to combat the stigma surrounding disability services. Similarly, it is useful to consider the dynamic interplay between students' attitudes toward the effectiveness of these accommodations, the ease by which they are established, and the prevalence, as it is commonly cited that accommodations have been shown to be implemented to a varying degree and with varying success (Backhouse & Rodger, 1999; Sharp et al., 2006). In order for accommodations to be truly successful, they should be both effective and easily accessible.

Cognitive functioning is undoubtedly one of the most important contributors of return to productivity after brain injury. It has been repeatedly cited that deficits in attention, executive functioning, and memory can be major obstacles in returning to employment (Ownsworth & McKenna, 2004). While it is well-established that functional abilities and cognitive functioning are closely related (Bercaw et al., 2011; Ponsford et al., 2008), results from multiple studies have shown cognitive functioning to be the strongest predictor of RTW, even in the presence of variables that assess functional capabilities and injury severity (Ip et al., 1995; Spitz et al., 2012). Therefore, it is worthwhile to include some element of cognitive functioning in future models, as it will likely improve the predictive utility of the overall model. In particular, neuropsychological assessment tools have proven useful in assessing objective cognitive performance on a number of different tasks (Fabiano & Crewe, 1995; Ruff et al., 1993; Sherer et al., 2002). Neuropsychological assessment tools are able to evaluate an individual's ability to multitask, recall (both in the short and long term), process information, and exercise visuospatial skills, mental tracking, concentration, and attention, to name a few. Therefore, students that perform better on neuropsychological measures are more capable of withstanding the stressors that arise during advanced schooling.

Emotional well-being has been shown to relate to productivity outcomes after brain injury in both employed individuals and students recovering from brain injury (Franulic et al., 2004; Kennedy et al., 2008; Stewart-Scott & Douglas, 1998). Consequently, expanding predictive models to include post-injury indices of psychological well-being may be a means by which researchers can increase the predictive power of their models. Likewise, it may also be worthwhile to investigate general descriptive trends in groups that differ on educational level, employment status (student vs. employed vs. unemployed), and so on, in order to see whether factors related to well-being differ depending on the subgroup.

Research has primarily shown that in comparison to employed individuals, unemployed individuals score higher on measures of anxiety and depression (Franulic et al., 2004; Sigurdardottir et al.; 2018; Tsausides et al., 2008; Xiong et al., 2016); however, one study found that both unemployed and employed individuals did not score significantly differently on measures on anxiety, but both groups' anxiety scores were clinically significant (McCrimmon & Oddy, 2006). Feelings of frustration, anxiety, depression, isolation, and mood swings have also been frequently cited in student populations, although an investigation of these variables both within a varying student sample, as well as relative to an adult sample, has yet to be explored (Kennedy et al., 2008; Sharp et al., 2006).

While the framework of the proposed model was constructed based on models of RTW, the results of this study suggest there may be some fundamental conceptual differences in return to productivity in the context of school relative to employment. Further investigation is recommended in order to consolidate information regarding the relevant factors that contribute to return to school. Moreover, results suggest that college students are much less likely to return to school within a year following injury than high school students. Consequently, more outreach and support for TBI students in college may improve awareness of disability services and heighten the return to school rate in the future.

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Table 1
Pre-Injury Demographic Information

	Total Sample *n* (col %)	Returned *n* (row %)	Did Not Return *n* (row %)
Sex			
Male	132 (67.3)	84 (63.6)	48 (36.4)
Female	64 (32.6)	41 (64.1)	23 (35.9)
Race			
White	118 (60.2)	79 (66.9)	39 (33.1)
Black	46 (23.5)	23 (50)	23 (50)
Hispanic Origin	15 (7.6)	11 (73.3)	4 (26.7)
Asian/Pacific Islander	12 (6.1)	10 (83.3)	2 (16.7)
Other	4 (2)	1 (25)	3 (75)
Native American	1 (0.5)	1 (100)	0 (0)
Marital Status			
Single (Never Married)	188 (95.9)	124 (66)	64 (34)
Married	5 (2.5)	1 (20)	4 (80)
Separated	2 (1)	0 (0)	2 (100)
Widowed	1 (0.5)	0 (0)	1 (100)
Education			
High School	100 (51)	78 (78)	22 (22)
Associate's	29 (14.8)	13 (44.8)	16 (55.2)
Undergraduate	63 (32.1)	30 (47.6)	33 (52.4)
Graduate	4 (2)	4 (100)	0 (0)
Total	196 (100)	125 (63.8)	71 (36.2)

Table 2

Injury-Related Demographic Information

	Total Sample *n* (col %)	Returned *n* (row %)	Did Not Return *n* (row %)
GCS Score			
Mild	30 (15.3)	22 (73.3)	8 (26.7)
Moderate	23 (11.7)	10 (43.5)	13 (56.5)
Severe	38 (19.4)	18 (47.4)	20 (52.6)
Chemically Paralyzed or Sedated	54 (27.5)	40 (74.1)	14 (25.9)
Intubated	49 (25)	33 (67.3)	16 (32.7)
Unknown	2 (1)	2 (100)	0 (0)
Cause of Injury			
Motor Vehicle	105 (53.6)	66 (62.9)	39 (37.1)
Fall	24 (12.2)	12 (50)	12 (50)
Pedestrian	13 (6.6)	8 (61.5)	5 (38.5)
Gunshot Wound	12 (6.1)	5 (41.7)	7 (58.3)
Motorcycle	11 (5.6)	7 (63.6)	4 (36.4)
Winter Sports	8 (4.1)	7 (87.5)	1 (12.5)
Other Sports	6 (3.1)	6 (100)	0 (0)
Assault with Blunt Instrument	6 (3.1)	4 (66.7)	2 (33.3)
All-Terrain Vehicle (ATV) and All-Terrain Cycle (ATC)	4 (2)	4 (100)	0 (0)
Bicycle	3 (1.5)	3 (100)	0 (0)
Other Vehicular: Unclassified	2 (1)	1 (50)	1 (50)
Water Sports	1 (0.5)	1 (100)	0 (0)
Track/Field Sports	1 (0.5)	1 (100)	0 (0)
Total	196 (100)	125 (63.8)	71 (36.2)

Table 3

Predictor Descriptives, Group Comparisons, and Intercorrelations

	Total Sample	Returned	Did not Return	Group Comparisons		Intercorrelations		
	M (*SD*)	*M* (*SD*)	*M* (*SD*)					
Predictor	[min, max]	[min, max]	[min, max]	Test Statistic (df)	*p* value	1	2	3
1. Discharge DRS	5.28 (2.47) [0, 20]	4.98(2.48) [0, 20]	5.79(2.36) [2, 16]	$t(194) = 2.24$	.026*	1		
2. LOS	46.24 (35.60) [6, 275]	43.47 (32.94) [6, 227]	51.11 (39.64) [9, 275]	$t(194) = 1.45$	.149	0.238**	1	
3. Days PTA	24.09 (22.04) [0, 123]	22.68 (21.83) [0, 123]	26.56 (22.35) [1, 109]	$t(194) = 1.19$	.237	0.480**	0.691**	1
4. Education	--	--	--	$M^2(1) = 14.05$	.0002**	-0.110	0.037	-0.023

Note. DRS = Disability Rating Scale; LOS = Length of stay; PTA = Post-traumatic amnesia

* $p < .05$, ** $p < .001$

Table 4

Description of Employment and Education as a Way to Distinguish Successful and Failed Cases

	Employment Status		Education		
	No Change	Change	No Change	Change	Interpretation
Success	X		X		Student pre- and post-injury; same stage of schooling
Success	X			X	Student pre- and post-injury; different stage of schooling (i.e. high school to undergrad; undergrad to graduate, etc.)
Success		X		X	Student pre-injury, obtained degree, transitioned to other employment
Failure		X	X		Student pre-injury, no change in schooling, but transitioned to different occupation (left school without conferring degree)

Note. "No change" for employment includes those who remain at full-time student status as well as those who transition from full- to part-time student.

Table 5

Simple Logistic Regression Results: Each Predictor Individually

	Estimate	SE	G^2 (df)	*p* value	Odds Ratio
Discharge DRS	-0.135	0.063	4.876(1)	.0272*	0.874
LOS	-0.006	0.004	2.042(1)	.1531	0.994
PTA	-0.008	0.007	1.387(1)	.239	0.992
Education			18.502(2)	< .0001**	
Associate's	-1.473	0.445	10.980‡	.0009**	0.229
Undergrad and Beyond	-1.236	0.344	12.944‡	.0003**	0.291

Note. DRS = Disability Rating Scale; LOS = Length of stay; PTA = Post-traumatic amnesia

* $p < .05$, ** $p < .001$

‡ Values obtained using Wald tests

Table 6

Multiple Logistic Regression Results: Findings from Full Model

	Estimate	SE	X^2 (df) ‡	*p* value	Odds Ratio
Intercept	2.433	0.510	22.736	< .0001**	11.389
Discharge DRS	-0.192	0.079	5.958(1)	.0147*	0.825
LOS	-0.004	0.006	0.424(1)	.5150	0.996
PTA	0.005	0.011	0.218(1)	.6404	1.005
Education			18.850(2)	< .0001**	
Associate's	-1.546	0.462	11.210	.0008**	0.213
Undergrad and Beyond	-1.400	0.361	15.032	.0001**	0.247

Note. DRS = Disability Rating Scale; LOS = Length of stay; PTA = Post-traumatic amnesia

* *p* < .05, ** *p* < .001

‡ The results depicted reflect Wald tests; likelihood ratio tests were also conducted and findings did not differ

Table 7

Frequencies and Percentages of Student Status at Follow-Up by Educational Level

	Educational Level Pre-Injury				
Student Status at Follow-Up	High School *n* (col %)	Associate's *n* (col %)	Undergraduate *n* (col %)	Graduate *n* (col %)	Total *n* (col %)
Full-Time	41 (83.7)	5 (83.3)	20 (80)	3 (100)	69 (83.1)
Part-Time	6 (12.2)	1 (16.7)	5 (20)	0 (0)	12 (14.5)
Special Ed/Other	2 (4.1)	0 (0)	0 (0)	0 (0)	2 (2.4)
Total	49 (59)	6 (7.2)	25 (30.1)	3 (3.6)	83 (100)

Table 8

Employment Status at Follow-Up

	Total Sample *n* (col %)	Returned *n* (row %)	Did Not Return *n* (row %)
Full-time student	69(35.2)	69 (100)	0 (0)
Part-time student	12 (6.1)	12 (100)	0 (0)
Special Ed/Other	2 (1)	2 (100)	0 (0)
Employed	59 (30.1)	27 (45.8)	32 (54.2)
Unemployed	40 (20.4)	13 (32.5)	27 (67.5)
Retired	8 (4.1)	1 (12.5)	7 (87.5)
Volunteer	3 (1.5)	1 (33.3)	2 (66.7)
Homemaker	2 (1)	0 (0)	2 (100)
Refused	1 (0.5)	0 (0)	1 (100)
Total	196 (100)	125 (63.8)	71 (36.2)

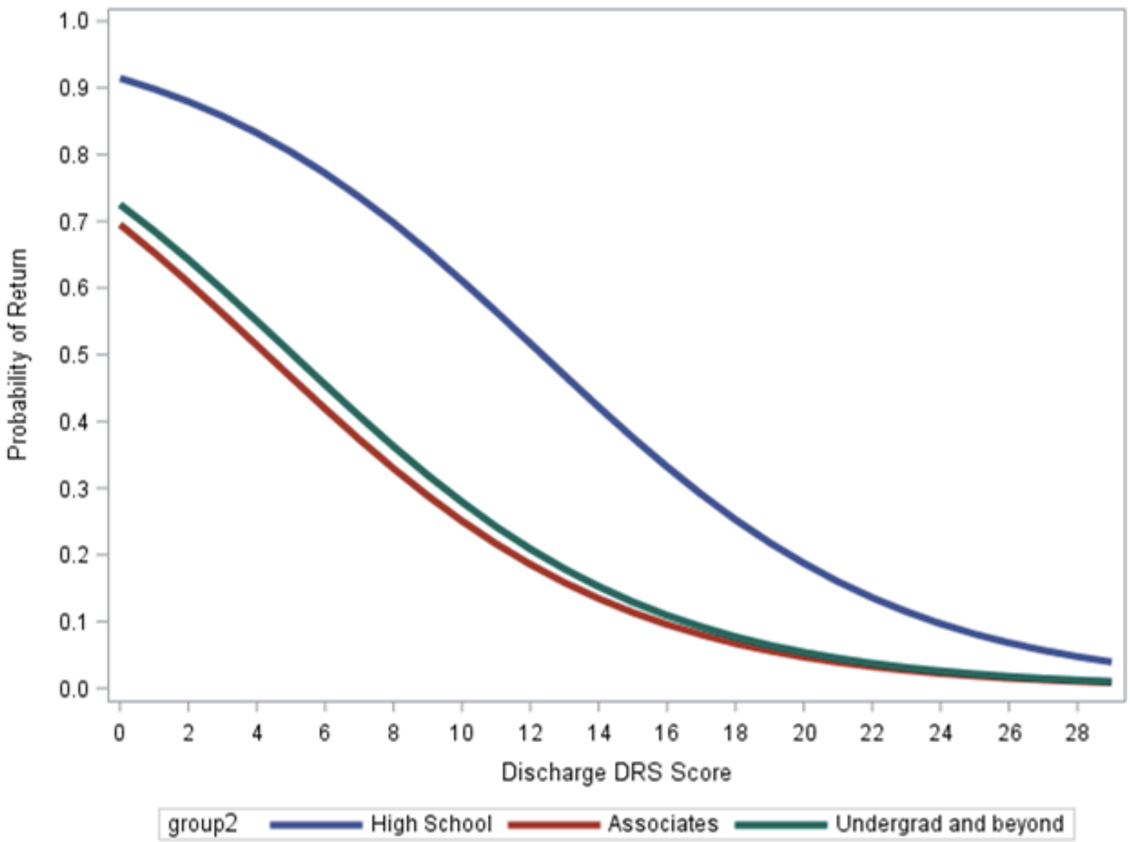
Table 9

Model-Predicted and Observed Frequencies

	Predicted		
Observed	Did Not Return	Returned	Total
Did not Return	28	43	71
Returned	20	105	125
Total	48	148	196

Figure 1

Probability of Return as a Function of Discharge DRS Scores and Educational Level



Note. This plot depicts the effects of DRS discharge scores and educational level, controlling for LOS and days of PTA.