Functional Change from 5 to 15 Years Following Traumatic Brain Injury

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5 to 15-Year Functional Change after TBI

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TITLE

Functional Change from 5 to 15 Years Following Traumatic Brain Injury

ABSTRACT

Few studies have assessed the long-term functional outcomes of traumatic brain injury (TBI) in large, well-characterized samples. Using the TBIMS cohort, this study assessed the maintenance of independence between years 5 and 15 post-injury and risk factors for decline. The study sample included 1381 individuals with TBI who received inpatient rehabilitation, survived to 15-years post-injury, and were available for data collection at 5 or 10 years and 15 years post-injury. Functional Independence Measure (FIM) and Disability Rating Scale (DRS) were used to measure functional outcomes. The majority of participants had no changes during the 10-year timeframe. For FIM, only 4.4% showed decline in Self-Care, 4.9% declined in Mobility, and 5.9% declined in Cognition. Overall, 10.4% showed decline in one or more FIM subscales. Decline was detected by DRS Level of Function (24% with >1-point change) and Employability (6% with >1-point change). Predictors of decline factors across all measures were age older than 25 years and, across most measures, were having less than or equal to a high school education. Additional predictors of FIM decline included male gender (FIM Mobility and Self-Care) and longer rehabilitation length of stay (FIM Mobility and Cognition). In contrast to studies reporting change in the first five years post-TBI inpatient rehabilitation, a majority of those who survive to 15 years do not experience functional decline. Aging and cognitive reserve appear to be more important drivers of loss of function than original severity of the injury. Interventions to identify those at risk for decline may be needed to maintain or enhance functional status as persons age with a TBI.

Key Words: Brain injuries; Rehabilitation outcome; Cognition; Function; Prognosis, Disabled persons

INTRODUCTION

Considerable evidence indicates that traumatic brain injury (TBI) is an evolving condition with a range of signs and symptoms which can contribute to long term impairment and disability with disparate functional trajectories, rates of change, predisposition to injuries, and associated adverse health conditions.[1,2] Conceptualizing TBI as a dynamic process allows examination of factors that influence change and suggest interventions that may facilitate prophylaxis against decline or augment neurorecovery.

The literature reveals variable patterns of TBI outcome trajectories in the years after injury with the overall picture being that approximately half experience functional changes while half do not change, as measured with broad outcome scales. Using the Functional Independence Measure (FIM) cognitive and motor subscales, Lu et al [3] characterized recovery trajectories from 3 months and 1 year to 5 years post-TBI of persons with moderate to severe TBI admitted to a trauma hospital and found patterns of functional recovery (stable low, delayed moderate, elevated good, and stable good recovery) with stable good recovery being the most common trajectory. Forslund et al[4] assessed recovery trajectories between 5 and 10 years in individuals after moderate to severe TBI utilizing the Glasgow Outcome Scale-Extended (GOS-E) and found only a small percentage improved (7%), while the vast majority (56%) showed no change, and 37% deteriorated. Better trajectories were most predicted by younger age, pre-injury employment, and shorter post-traumatic amnesia (PTA) length. Studying outcomes over a 20-year timeframe post-injury, Andelic et al[5] similarly assessed functional outcomes and health-related quality of life following moderate to severe TBI utilizing the GOS–E, Community Integration Questionnaire, and Short Form–36 Survey and observed that most patients showed a good recovery or moderate disability. Disability levels remained stable between and within severity groups from 10-20 years post-TBI while community integration tended to improve over time. Poor mental health tended to be more prevalent in those depressed at 10 years post injury and in participants who were female, while better physical and mental health at 20 years post-injury was predicted by productive activity at 10 years post-injury.

A small number of studies have addressed the issue of long-term cognitive, affective, and psychosocial outcome following moderate to severe TBI.[6-9] Himanen et al[9] evaluated cognitive changes on a variety of neuropsychologic measures over 3 decades following "substantial" TBI. There was a general pattern of slight cognitive decline during the follow-up period although semantic memory generally improved. The study also concluded that younger patients were likely to maintain or even improve their cognitive functioning over time compared to older patients with most patients evidencing some mild cognitive decline over time which was influenced by both gender and age at injury. Comparing TBI to non-brain trauma (fracture) among individuals $\geq$ 55 years old without baseline dementia who survived inpatient hospitalization for TBI versus non-brain trauma (fracture), Gardner, et al. found increased risk of developing dementia for those age $\geq$ 55 with moderate-severe TBI and those age $\geq$ 65 with mild TBI.[10] Functional decline may include employment with a statistically significant decline in employment from 57% at year 2 to 43% at year 10 post-injury observed by Graumwmeijer, et. al.[11] which was predicted by injury severity, function at hospital discharge, and pre-injury employment status.

The Traumatic Brain Injury Model Systems (TBIMS) cohort of more than 18,000 people 16 years and older who were hospitalized and received inpatient rehabilitation for moderate to severe TBI have provided significant insight into the outcomes and patterns of functional and neurorecovery by five years post-injury and highlighted important prognostic information in this population, including the role of age, pre-injury factors, and functional measures.[6-8, 12-14] Hammond, Grattan, et al[13] showed that functional changes (improvement and decline examined together) occur from year 1 to year 5 post injury as measured by the FIM and Disability Rating Scale (DRS), despite the high ceiling effects for measurement later post-injury. Looking at FIM Cognitive Subscale scores, Hammond, Hart, et al[8] found 61% stayed the same, 26% improved and 14% worsened from year 1 to year 5. Examination of FIM Cognitive items showed that change (both improvement and decline) was most commonly occurring in the area of memory and problem solving where fewer were at ceiling while social interaction scores less commonly changed. Marquez de la Plata et al[14] found that older patients showed greater decline on DRS over the first 5 years after TBI compared to younger patients. Additionally, younger patients made greater progress in terms of disability based on analysis of serial DRS scores, FIM instrument cognitive items and GOS–E. Corrigan, et al[8] found that among those with TBI five years prior, approximately 20% were dead; 12% were institutionalized; and one-third were not independent in activities of daily living. Additionally, 8% were depressed; 29% were dissatisfied with life; 50% were hospitalized at some point; 57% had moderate-severe disability; and 55% were unemployed. Pretz and associates[15-18] have utilized Individual Growth Curve Analysis to examine individual trajectories of the TBIMS cohort and develop interactive tools to allow prediction of the recovery trajectory for individuals and subgroups with specified characteristics on the selected covariates. Using this methodology to look at global outcome (GOS–E and DRS) trajectories after TBI among those who died versus those who survived,[17] worse functional status correlated with earlier demise and a steeper rate of decline over time as measured by both instruments. In this cohort, it has been found that the probability of returning to productivity increased over the first five years post-injury with associated factors including age of injury, race, level of education and occupational category at time of injury, preinjury substance abuse status, DRS at rehabilitation hospital discharge, and rehabilitation length of stay.[18]

Studies of functional change beyond 5 years post-injury in large, well-characterized samples are scant. With greater understanding of long-term outcome trajectories (including both improvement and decline), we can identify potential opportunities for intervention to facilitate the best outcomes. Examining epoch-to-epoch change via cross-sectional analysis of the TBIMS cohort, Corrigan and Hammond[2] reported approximately one-quarter to one-third of individuals with TBI showed evidence of functional decline at some point in the first 15 years following TBI with a roughly equivalent proportion showing evidence of functional improvement, while 40-50% appeared stable over time. Given the cross-sectional nature of these analyses, the longitudinal trajectory of function in the large TBIMS cohort after 5 years for the same individuals remains unclear. The current study aimed to further increase knowledge of outcome trajectories after 5 years by utilizing the TBIMS cohort to assess the maintenance of independence between years 5 and 15 post-injury and risk factors for decline over that timeframe. While studying the characteristics of those who improve over time is as important as studying those who decline, this study focuses only on decline due to the high ceiling effect of functional outcome measures, with most independent at 5 years.

METHODS

Study Participants

Participants were consecutive inpatient rehabilitation admissions who were prospectively enrolled in the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) funded TBIMS multi-site longitudinal database who completed follow-up assessment at years 5 or 10 and 15 post-injury. They were included in this study if date of injury was between January 1, 1989 through December 31, 2002. TBI was defined by the presence of one or more of the following: GCS score <13 on emergency department admission, loss of consciousness >30 minutes, posttraumatic amnesia >24 hours, or trauma-related intracranial abnormality on neuroimaging. TBIMS inclusion also require: age at the time of injury 16 years or older, medical care received in TBIMS-affiliated trauma center within 72 hours of injury with direct transfer to a TBIMS-affiliated inpatient TBI rehabilitation program, and informed consent provided by legal proxy or participant. In order to be included in the analysis, a subject must have had 15-year outcomes available and either 5-year or 10-year outcomes for all FIM and DRS subscales. All participating sites received local institutional review board approval.

Measures

Functional Independence Measure (FIM). The FIM[19] measures functional independence or burden of care with 18 items that assess Self-care (6 items), Mobility (7 items), and Cognition (5 items). Items are scored 1 through 7 with 1 representing complete dependence and 7 indicating complete independence. For ambulation, primary mobility mode (walking versus wheelchair) was utilized. The total FIM Self-care, Mobility and Cognition index scores were calculated as the sums of the respective item scores. In cases of missing FIM items within a subscale, the subscale data were omitted for that individual. As in our prior work,[20] based on the mean scores for Self-care, Mobility and Cognition, each participant was classified at each time point as Totally Independent (mean score > 5.5), Some Assistance needed (1.5 ≤ mean score ≤ 5.5), or Totally Dependent (mean score < 1.5). If both the 5 year and 15-year FIM data were available, "decline" was determined based on these values. When 5-year data were unavailable, decline was determined from the 10-year and 15-year data. Participants were classified as having declined (yes or no) from 5 to 15 years if they decreased in independence (from Independent to Some Assistance, or Independent or Some Assistance to Dependent) on FIM Self-care, Mobility, Cognition, or any of the three FIM indices. Definition of "decline" is illustrated in Table 1. Improvement was defined similarly based on categorical improvements over time.

Disability Rating Scale (DRS). The 8-item DRS assesses cognitive ability to manage daily living activities, level of assistance or supervision with function, and employability.[21] DRS scores range from 0 (no disability) to 29 (extreme vegetative state). For this study we only used the Level of Functioning and Employability Item scores. DRS Level of Functioning assesses all aspects of function and takes into account if one requires special equipment, supervision, or assistance. DRS Employability assesses employment potential as a worker, student or homemaker (such as, abilities to plan, initiate, carry out tasks, handle social situations, get around using transportation systems, deal with number concepts, handling cash transactions, and managing schedule) rather than actual employment, and categorizes employability as: not restricted, selected competitive jobs, non-competitive (sheltered), and not employable. "Decline" on DRS was determined comparing the 5-year and 15-year DRS data. When 5-year data were unavailable, decline was determined from the 10-year and 15-year data. Decline in DRS was defined in two ways: 1) as at least a 1 unit increase in the ordinal value of the variable, as each unit increase may represent a clinically meaningful decline; and 2) as more than a 1 unit increase in the value of the variable, per our prior work.[12] See Table 1 for illustration. Improvement was defined similarity based on 1 unit (or more than one unit) increases over time.

Procedures

Participants or family/significant others were interviewed for the collection of demographic information (e.g.: date of birth, education, and premorbid functioning). Data regarding injury severity [Glasgow Coma Scale (GCS) score, time to follow commands, and duration of posttraumatic amnesia] and medical course were obtained by trained research assistants from review of hospital and emergency medical service records consistent with TBIMS database protocols. Time to follow commands is the interval in days from the date of injury until the first of two consecutive reports of command-following within a 24-hour period. Posttraumatic amnesia duration is the days from the date of injury until the first of two consecutive reports of orientation within a 72-hour period in which the participant was fully oriented (> 76 on the Galveston Orientation and Amnesia Test,[22] or > 25 on the Orientation Log,[23,24] or two days with consistent orientation documented in the acute medical record within a three-day period with no intervening days at less than full orientation). For those remaining in PTA at rehabilitation discharge, the sum of acute care and rehabilitation length of stay plus one day was used to represent PTA duration consistent with prior work.[25,26] The DRS and FIM were administered at the time of rehabilitation admission. Follow up data were collected using a standardized telephone follow-up assessment protocol at post-injury years 5, 10, and 15.[27] Data were collected from family or care providers familiar with the participant when participants were unable to communicate or provide reliable information.

Data analysis

Data were analyzed using statistical software SAS Version 9.4 (Cary, NC).[28] Descriptive statistics were expressed as quartiles (1st/median/3rd) for continuous variables and count (percent) for categorical variables. Subjects used in statistical analyses were compared to those who were not using chi-square tests for categorical variables and Wilcoxon Rank Sum test for numerical variables. Univariate and multivariable logistics models were fit with pre-specified predictor variables. Firth's penalized likelihood approach was used to fit the models due to the low frequencies of decline for FIM subscales and DRS employability decline > 1 which could cause biased estimates for the multivariable models when using standard maximum likelihood methods. The age range for those included in the statistical analyses was 16 to 78 years; thus, we assessed the assumption of linearity for age of injury in the multivariable models, both with a formal test, the Box-Tidwell Test, and graphically by plotting the relationships between age of injury and the values of the linear predictor (logit) from the logistic model under the assumption of linearity. Results are displayed in Supplemental Figures 1 (for FIM) and 2 (for DRS). Though the Box-Tidwell Test was not always significant, the plots consistently indicated less or no linear relationship ≤ 25 years of age at injury, with a linear relationship after age at injury of 25. Thus, our final multivariable models included separate linear effects for age at injury ≤25 vs. > 25.

RESULTS

Participant Characteristics

A final sample of 1381 met study criteria. Figure 1 summarizes the number excluded from analyses by reason. Among TBIMS national database participants, 2,456 were alive at year 5 and eligible for year 15 follow-up by a participating center. Of those, 692 were excluded due to missing 15-year data or having 15-year data but missing both 5-year and 10-year data (n=692), and 383 were excluded due to death between Year 5 and 15 post-injury. Table 2 summarizes the characteristics of the overall sample analyzed, those excluded due to missing follow-up, and those who died within the 5 to 15-year window. For demographic and clinical characteristics, comparisons of the sample who were analyzed to those excluded due to missing follow-up revealed statistically significant differences for gender (27.0% vs 21.0% female), race (62.3% vs 47.8% white), education (35.6% vs 25.0% with > high school diploma), moderate to severe GCS (57.4% vs 62.1% yes), days to follow commands (median 2 vs 3 day), posttraumatic amnesia days (median 23 vs 24 days); there were no differences for age of injury, cause of injury, length of stay (LOS) in acute stay, or rehabilitation LOS (RLOS). Compared to those who died, those who were analyzed were different based on age (median 30 vs 51 years), gender (27.0% vs 21.7% female), race (62.3% vs 68.7% white), cause of injury (46.8% vs 31.9% motor vehicle), moderate to severe GCS category (57.4% vs 42.4% yes), posttraumatic amnesia days (median 23 vs 29 days), and RLOS (median 21 vs 23 days). The two groups were not different based on education, days to follow commands, and LOS in acute stay. For outcomes, those that were analyzed had significantly better scores on both the FIM Cognitive and Mobility subscores and DRS subscales at Year 5 than those who died. For DRS subscales at Year 5, scores indicated less disability in the sample than those excluded due to missing follow-up. Note that for those included in the analysis, the Q1 scores for the FIM subscales and Q3 for the DRS subscales indicate high levels of functioning for the majority (75% or more) of the participants.

Functional Changes Between Years 5 and 15

Table 3 shows the percentage of participants who declined, stayed the same, or improved over time for all FIM and DRS subscales. The majority of participants had no changes, with the exception of change in "Any DRS ($\geq$ 1)" category, where there were a large percentage of improvements in both employability and/or functioning (25.3%; driven mostly by improvements in Employability) and larger declines (46.7%; driven mostly by declines in Level of Function). For FIM, only 4.4% showed decline in Self-Care, 4.9% declined in Mobility, and 5.9% declined in Cognition. Overall, 10.4% showed decline in one or more FIM subscales. For the DRS change $\geq$ 1, 15.9% showed decline in Employability, 42.3% in Level of Functioning, and 46.7% in either. For the DRS change > 1, 6.3% showed decline in Employability, 24.4% in Level of Functioning, and 26.5% in either. Percentages of those who improved were lower than those who declined in all cases except for FIM Cognition (7.5% improved vs 5.9% declined, and DRS Employability (change $\geq$ 1, 22.2% improved, 15.9% declined; change > 1, 9.4% improved, 6.3% declined).

Predictors of Decline

<u>FIM</u>: Univariate predictors of FIM decline included older age at injury, male gender, injury not being caused by a motor vehicle accident, greater number of days to follow commands, duration of posttraumatic amnesia, and LOS in both acute stay and rehabilitation (Supplemental Table 1). In multivariable models (Table 4), independent predictors for decline in Self-care were older age

at injury if > 25 years (OR=2.16, 95% CI = 1.68,2.80, p < .001) and male gender (OR=2.10, 95% CI = 1.10,3.94, p = .02). Having less than or equal to a high school education or other, which was not significant in any univariate FIM model, was also an independent predictor of Self-care decline (OR=2.50, 95% CI = 1.25,5.35, p = 0.01). Independent predictors of decline in Mobility were older age at injury if > 25 years (OR=1.95, 95% CI = 1.55,2.46, p < .001), male gender (OR=1.87, 95% CI = 1.04,3.34, p = 0.03), and RLOS (OR=1.19, 95% CI = 1.08,1.30, p < .001). Independent predictors of Cognition decline were older age if age at injury > 25 (OR=1.59, 95% CI = 1.27,1.97, p < .001), having less than a high school education or other (OR=1.94, 95% CI = 1.12,3.48, p = 0.02), and greater RLOS (OR=1.12, 95% CI = 1.01,1.24, p = 0.02). Results for any FIM decline were similar to Cognition.

<u>DRS</u>: Univariate predictors of decline by one or more units based on the DRS included older age at injury if > 25, male gender, being black, and having less than or equal to a high school education or other. Gender, cause of injury, days to follow commands, days in posttraumatic amnesia, LOS, and RLOS were not significant predictors in any univariate model (Supplemental Table 2). In multivariable models (Table 5), older age at injury if > 25 (ORs = 1.29, all p < 0.005) and having less than high school education or other (ORs ranging from 1.32 to 1.67, p = 0.03 or less) were independent predictors of all three DRS decline ≥1 outcomes. Results for decline on DRS of > 1 unit were similar (Table 5 and Supplemental Table 3). Exceptions were that male gender and black race were no longer significant in any univariate model, and having less than high school education was significant for Level of Functioning instead of Employability in the univariate models and no longer significant for Employability in the multivariable model.

DISCUSSION

This prospective longitudinal cohort study examined the frequency of, and risk factors for, functional decline during years 5 through 15 following moderate-severe TBI using follow-up assessments at 5 or 10, and 15 years post-TBI. These results suggest that the course of recovery in these later years post-injury may be more nuanced than that observed in the first 5 years. At 15 years post-injury, participants were most likely to have remained unchanged from their earlier level of functioning. When change occurred, decline in status was more likely than improvement for the DRS, but more equivalent on the FIM subscales. Whether using a conservative or liberal criterion for change on the DRS, decline in Level of Functioning was substantially more likely than improvement. In contrast, for Employability on the DRS, improvement was more likely than decline regardless the criterion for change that was used. Perhaps the most general conclusion that can be drawn is that some stability is attained in the time preceding 15 years post-injury (at least for this cohort) and that higher level cognitive and social behaviors (i.e., FIM Cognition, DRS Employability) may be less susceptible to decline while functions that subserve physical and instrumental independence (FIM Self-Care, FIM Mobility, DRS Level of Functioning) are more susceptible. There are obvious parallels between which abilities were more susceptible to change and what is observed in normal aging. Indeed, older age was the most consistent predictor of decline. Lower education was the next most consistent predictor of decline. Again, a protective effect of education is also consistent with age-related change in the general population. The lower education relationship may also be a proxy for socioeconomic status. Remarkably, indices of injury severity did not contribute significantly to predicting decline—the modest exception being Rehabilitation LOS which was predictive of decline in FIM Mobility and Cognition. If replicated in other samples, these findings would suggest that severity of the original injury will not be a primary driver of long-term needs but the exigencies of aging will be.

It appears that, depending on age, somewhere between year 5 and 15 years after TBI, the process of aging becomes a major contributor to the dynamics of change. Other investigators using this dataset have identified distinct clinical profiles associated with outcome trajectories that are consistent with the age-effect found in our analysis.[16,17] The effects of age on the trajectory of recovery over time has also been found in other longitudinal datasets in which participants were followed up to 30 years after TBI. While normal aging appears to have a more substantial effect than injury severity, we are not able to attribute the changes observed to one or the other without either a matched comparison group who had no TBI or normative longitudinal data for the DRS and/or FIM. Further, we are unable to determine what contribution covariates not considered or available in the dataset (such as socioeconomic status or medical comorbidities) make to the changes we observed.

The generalizability of these findings depends to a large part on how representative this cohort is of all people who are 15 years post-moderate or severe TBI. First, it is likely that those who survive to 15 years post-injury differ systematically from all persons with moderate to severe injury. Previous studies have established that nationally 1 in 5 people treated in rehabilitation for a primary diagnosis of TBI will have died by 5 years post.[8] In this study, another 16% of those alive at 5 years had deceased in the next 10 years. The approximately two-thirds still alive at 15 years are certainly unique—between 5 and 15 years those still alive were younger at injury and more likely white, female and more educated. However, while these differences reflect on who survives, they do not detract from the generalizability of the findings. One-in-four of persons who could have been studied at 15 years were lost to follow-up.

Compared to those lost, the sample was more frequently male, white and had more education. These differences are consistent with previous studies of systematic bias due to loss to follow-up in TBI longitudinal studies.[29-31] This source of difference does undermine the potential generalizability of the findings.

Study Limitations

We have described the possible effect of both selection and survival biases when compared to all individuals who receive acute inpatient rehabilitation for a primary diagnosis of TBI. Further, there are individuals with comparable injury severity who are not admitted to acute inpatient rehabilitation due to factors unrelated to the injury (e.g., insurance-type, resources available geographically, family or personal preference). Among those studied, subjective ratings, measurement artifact, and ceiling effects may influence the FIM and DRS findings. Given the long period of time over which data were collected, historical bias is possible due to changes in demographics and etiology of TBI, health policies, technologies, and clinical care practices. The reader should bear in mind that DRS Employability measures one's ability to be employed and not actual employment. Finally, causes for and degree of decline were not studied; and treatment received over the period of study were not available.

Clinical and Research Implications

This study expands upon existing knowledge about long-term outcome after moderate-severe TBI and has direct implications for clinical care. First, findings support that many individuals do not demonstrate decreased function between 5 and 15 years post-injury. To help prevent premature decline before and after 15 years post-injury, healthcare professionals should empower all chronic TBI survivors, in collaboration with their families and other caregivers, to maintain a healthy lifestyle (e.g., healthy eating, cognitive and physical exercise, socialization) using such strategies as education, positive feedback, and collaborative goal setting.[32-33] Extending the concept of 'brain' or 'cognitive' reserve to 'health' or 'functional' reserve or resilience, ongoing engagement in these types of evidence-supported practices may prolong length of stable function and, perhaps, in some, improve it.[34]

Second, for chronic TBI survivors who are older than 25 years of age at time of injury and whose highest level of education did not exceed high school or the equivalent, study findings support the need for more than ongoing healthy lifestyle empowerment. For these individuals and others with risk factors that were not studied here, application of a chronic disease management approach appears justified. Such an approach would include ongoing medical monitoring for early identification and management of new onset co-morbidities whether or not they are directly related to the TBI.[2,35-37] Periodic therapy for motor and/or cognitive reconditioning, especially in the absence of reserve that is associated with higher levels of education, may further reduce the heightened risk of functional decline over time.[2,38]

This longitudinal study only looked at decline in functional independence between 5 and 15 years post-TBI. Given the relatively small number of participants whose independence declined in this study and given previous cross-sectional study findings that significant proportions of individuals have both stable and positive 15-year trajectories of function post-injury,[2] future longitudinal studies should examine individuals whose functional independence is maintained and whose functional independence improves between 5 and 15 years post-TBI. Further research is also needed regarding the effectiveness of interventions to prevent—or at least slow—predicted declines in function.

Conclusion

Chronic TBI is a lifelong condition that has been characterized as more dynamic than static. This study found that the nature of change from 5 to 15 years post-injury may differ from the first 5 years. At least among those still alive, stability of functional abilities is more common, and some abilities appear more susceptible to decline than others, particularly self-care, mobility and instrumental skills necessary for independence. Aging and cognitive reserve appear to be more important drivers of loss of function than original severity of the injury. More research is needed to understand the generalizability of these findings, the role of co-variates not considered here, as well as whether improvement is simply the mirror image of decline or if it has unique determinants.

Conflicts of Interests

The authors have no conflicts of interests to disclose.

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Figure 1: Participant flow diagram.

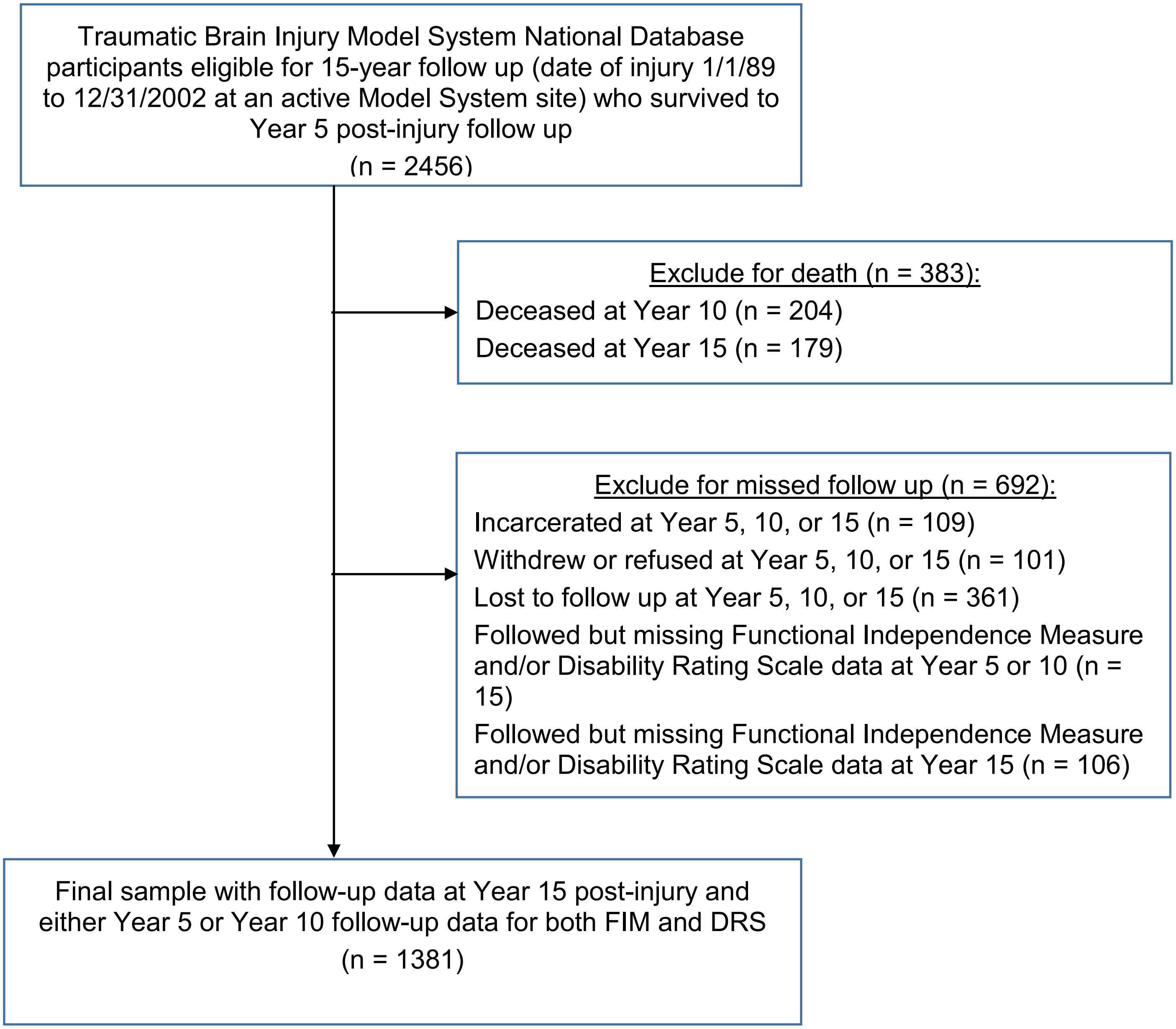


Table 1: Summary Illustrations of Decline Across Indices

	≥ 1 Decline **At a minimum, decline by one level**	**>1 Decline** **At a minimum, decline by two levels**
FIM Levels (In Any Category of Self Care, Mobility, and Cognition)		
Totally Independent		
Some Assistance Needed		
Totally Dependent		
DRS Level of Functioning		
Completely Independent *(Able to live as he/she wishes with no restrictions in independent living)*		
Independent in Special Environment *(Capable of functioning independently when needed requirements are met such as mechanical aids)*		
Mildly Dependent *(Able to care for most of own needs but requires limited assistance thus needs non-residential helper in the home)*		
Moderately Dependent *(Able to care for self partially but needs another person at all times in the home)*		
Markedly Dependent *(Needs help with all major activities and the assistance of another person at all times)*		
Totally Dependent *(Not able to assist in own care and requires 24-hour nursing care)*		
DRS Employability Levels		
Unrestricted Competitive Employment *(Can compete in the open market for a wide range of jobs)*		
Selected Competitive Employment *(Can compete in limited job market for a narrow range of jobs due to limitations)*		
Non-Competitive Employment, Sheltered Workshop *(Cannot compete in successfully in a job market due to limitations)*		
Not Employable *(Completely unemployable/unable to carryout school assignments due to limitations)*		

Footnote: FIM = Functional Independence Measure; DRS = Disability Rating Scale

Table 2: Characteristics of the Study Sample (N=2456)

Parameter	Excluded: Not Missing at Random (n=692)		Excluded: Death Between Years 5-15 (n=383)		Included in Analyses (n=1381)	
	n	Med (Q1,Q3) or % (n)	n	Med (Q1,Q3) or % (n)	n	Med (Q1,Q3) or % (n)
Age at injury (years), Median (Q1, Q3)	692	29 (21,39)	383	51 (38,67)	1381	30 (21,41)[1]
Gender, % (n)	692		383		1381	
Female		21.0% (145)		21.7% (83)		27.0% (373)[2]
Male		79.0% (547)		78.3% (300)		73.0% (1008)
Race, % (n)	692		383		1381	
White		47.8% (331)		68.7% (263)		62.3% (861)[2]
Black		35.6% (246)		24.8% (95)		26.2% (362)
Hispanic		10.5% (73)		3.9% (15)		6.2% (85)
Other		6.1% (42)		2.6% (10)		5.3% (73)
Education, % (n)	661		365		1357	
<= High school diploma or other[4]		75.0% (496)		69.9% (255)		64.4% (874)[3]
> High school diploma		25.0% (165)		30.1% (110)		35.6% (483)
Cause of Injury, % (n)	692		383		1381	
Motor Vehicle		46.5% (322)		31.9% (122)		46.8% (646)[1]
Other/Unknown		53.5% (370)		68.1% (261)		53.2% (735)
GCS Category, % (n)	691		380		1367	
Severe		43.7% (302)		28.7% (109)		43.5% (595)[2]
Moderate		18.4% (127)		13.7% (52)		13.9% (190)
Mild		21.3% (147)		44.5% (169)		23.5% (321)
Chemically Sedated or Paralyzed		16.2% (112)		12.9% (49)		19.1% (261)
Intubated		0.4% (3)		0.3% (1)		0.0% (0)
TFC (days), Median (Q1, Q3)	675	3 (1,11)	374	1 (0.5,9)	1355	2 (0.5,9)[3]
PTA (days), Median (Q1, Q3)	642	24 (14,45)	362	29 (16,52)	1291	23 (11,42)[2]
Acute Stay LOS (days), Median (Q1, Q3)	692	16 (9,25)	383	15 (8,30)	1381	15 (9,24)
Rehabilitation LOS (days), Median (Q1, Q3)	692	21 (13,35)	383	23 (15,39)	1381	21 (13,35)[1]
FIM Self-Care at Year 5, Median (Q1, Q3)	314	42 (40,42)	287	42 (34,42)	1218	42 (41,42)[1]
FIM Mobility at Year 5, Median (Q1, Q3)	306	49 (47,49)	278	46 (39,49)	1212	49 (47,49)[1]
FIM Cognition at Year 5, Median (Q1, Q3)	312	32 (29.5,34)	286	30 (25,34)	1213	33 (30,35)[1]

DRS Employability at Year 5, Median (Q1,Q3)	323	1 (0,2)	288	2 (1,3)	1218	0.5 (0,1.5)[2]
DRS Functioning at Year 5, Median (Q1, Q3)	323	0.5 (0,1)	288	1(0,3)	1219	0 (0,1)[2]

[1]Included significantly different from death;[2]Included significantly different from NMR and death; [3]Included significantly different from NMR; [4]other education = 5 refusals
Abbreviations: GCS = Glasgow Coma Scale score; TFC = time to follow commands; PTA = posttraumatic amnesia; LOS = length of stay; NMR = Not Missing at Random

Table 3: Changes in Functioning From Year 5 or 10 to Year 15 (n=1381)

	% Declined (n)	% Did not Change (n)	% Improved (n)
FIM Change			
Self-care	4.4 % (61)	93.1 % (1286)	2.5 % (34)
Mobility	4.9% (68)	93.1% (1285)	2.0 % (28)
Cognition	5.9% (82)	86.5 % (1195)	7.5 % (104)
Any FIM[a]	10.4% (144)	79.9 % (1103)	10.1 % (139)
DRS (≥ 1) Change			
Employability	15.9% (219)	61.9% (855)	22.2 % (307)
Functioning	42.3% (584)	50.5% (697)	7.2 % (100)
Any DRS[b]	46.7% (645)	35.6% (491)	25.3 % (349)
DRS (> 1) Change			
Employability	6.3% (87)	84.3% (1164)	9.4 % (130)
Functioning	24.4% (337)	72.3% (999)	3.3 % (45)
Any DRS[c]	26.5% (366)	63.9% (883)	11.3 % (156)

[a]Percentages sum to > 100% since 5 subjects both declined and improved in some area (4 declined on Mobility but improved on Self-care or Cognition, 1 declined on Self-care but improved on Cognition)
[b]Percentages sum to > 100% since 104 subjects both declined and improved in some area (101 declined on functioning but improved on employability, 3 declined on employability but improved on functioning)
[c]Percentages sum to > 100% since 24 subjects declined on functioning but improved on employability

Table 4: Predictors of FIM Decline in Multivariable Logistic Regression Models (n=1249)

	Self-Care Decline No. of Events = 49			Mobility Decline No. of Events = 61			Cognition Decline No. of Events = 72			Any FIM Decline No. of Events = 124		
Predictors	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**
Age at Injury if ≤25[1]	0.81(0.38,1.86)	0.31(1)	0.5789	1.19(0.58,2.73)	0.21(1)	0.6444	0.86(0.5,1.54)	0.27(1)	0.6022	1.06(0.67,1.7)	0.06(1)	0.8134
Age at Injury if >25[2]	**2.16(1.68,2.80)**	**36.36(1)**	**<0.0001**	**1.95(1.55,2.46)**	**33.03(1)**	**<0.0001**	**1.59(1.27,1.97)**	**17.25(1)**	**<0.0001**	**1.62(1.35,1.93)**	**28.27(1)**	**<0.0001**
Male (1=Yes;0=No)	**2.10(1.1,3.94)**	**5.52(1)**	**0.0188**	**1.87(1.04,3.34)**	**4.59(1)**	**0.0321**	0.85(0.46,1.48)	0.33(1)	0.5682	1.14(0.73,1.76)	0.36(1)	0.5469
Race		1.45(3)	0.6948		6.52(3)	0.0888		3.18(3)	0.3648		3.47(3)	0.3242
Black vs Hispanic	0.78(0.27,2.71)			0.46(0.19,1.21)			0.5(0.2,1.34)			0.54(0.27,1.15)		
Black vs Other	0.79(0.25,2.95)			1.23(0.38,5.1)			1.37(0.39,7.17)			1.04(0.43,2.86)		
Black vs White	1.27(0.63,2.5)			1.41(0.74,2.65)			0.72(0.38,1.29)			1.02(0.63,1.6)		
Hispanic vs Other	1.01(0.22,4.63)			2.65(0.7,12.21)			2.71(0.67,15.31)			1.91(0.69,5.8)		
Hispanic vs White	1.63(0.49,4.47)			3.05(1.22,7.06)			1.42(0.58,3.11)			1.87(0.93,3.57)		
Other vs White	1.61(0.45,4.69)			1.15(0.29,3.45)			0.52(0.1,1.63)			0.98(0.37,2.22)		
High School (1= ≤ High School or Other[3]; 0= > High School)	**2.5(1.25,5.35)**	**6.56(1)**	**0.0104**	1.41(0.78,2.61)	1.29(1)	0.2564	**1.94(1.12,3.48)**	**5.45(1)**	**0.0195**	**1.87(1.21,2.96)**	**7.69(1)**	**0.0056**
Cause of Injury (1=Motor Vehicle;0= Other/Unknown)	0.66(0.34,1.24)	1.7(1)	0.1929	0.57(0.31,1.02)	3.5(1)	0.0613	0.73(0.43,1.23)	1.44(1)	0.2306	0.75(0.49,1.13)	1.9(1)	0.1677
Days to Follow Commands[4]	1.02(1,1.03)	3.28(1)	0.0702	1.01(0.99,1.03)	1.83(1)	0.1764	1.01(0.98,1.02)	0.49(1)	0.4844	1.01(0.99,1.02)	1.51(1)	0.2193
Days in Posttraumatic Amnesia[4]	1.03(0.91,1.17)	0.19(1)	0.6596	0.96(0.88,1.06)	0.63(1)	0.4269	0.99(0.9,1.1)	0.01(1)	0.9099	0.99(0.92,1.07)	0.04(1)	0.8411
Acute Length of Stay[4]	0.98(0.8,1.16)	0.03(1)	0.8648	1.14(0.99,1.29)	3.79(1)	0.0514	0.94(0.78,1.1)	0.47(1)	0.4931	1.03(0.92,1.15)	0.36(1)	0.5484
Length of Stay in Rehab[4]	1.11(0.98,1.25)	3.26(1)	0.0709	**1.19(1.08,1.3)**	**12.54(1)**	**0.0004**	**1.12(1.01,1.24)**	**5.48(1)**	**0.0192**	**1.15(1.06,1.24)**	**12.61(1)**	**0.0004**

[1]units=5 years; [2]units=10 years; [3]other education = 5 refusals; [4]units=7 days

Table 5: Predictors of DRS Decline (≥ 1) in Multivariable Logistic Regression Models (n=1249)

	Employability Decline No. of Events = 188			Functioning Decline No. of Events = 513			Any DRS Decline No. of Events = 566		
Predictors	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**
Age at Injury if ≤25[1]	0.99(0.7,1.41)	0(1)	0.9616	0.84(0.66,1.06)	2.09(1)	0.1481	0.87(0.69,1.11)	1.24(1)	0.2652
Age at Injury if >25[2]	**1.29(1.10,1.50)**	**9.97(1)**	**0.0016**	**1.29(1.14,1.46)**	**16.51(1)**	**<0.0001**	**1.29(1.14,1.45)**	**16.23(1)**	**<0.0001**
Male (1=Yes;0=No)	0.90(0.62,1.30)	0.30(1)	0.5849	1.28(0.99,1.66)	3.54(1)	0.0597	1.24(0.96,1.61)	2.75(1)	0.0975
Race		7.69(3)	0.0530		0.96(3)	0.8102		0.6(3)	0.8965
Black vs Hispanic	1.61(0.81,3.44)			0.86(0.52,1.44)			1.09(0.66,1.82)		
Black vs Other	4.24(1.57,15.87)			0.9(0.52,1.55)			1.17(0.68,2.01)		
Black vs White	1.26(0.88,1.8)			0.87(0.66,1.15)			0.98(0.75,1.29)		
Hispanic vs Other	2.64(0.81,10.93)			1.04(0.53,2.02)			1.07(0.55,2.07)		
Hispanic vs White	0.79(0.38,1.51)			1.01(0.62,1.62)			0.9(0.55,1.44)		
Other vs White	0.3(0.08,0.78)			0.97(0.59,1.6)			0.84(0.51,1.38)		
High School (1= ≤ High School or Other[3]; 0= > High School)	**1.67(1.17,2.42)**	**7.86(1)**	**0.0050**	**1.32(1.03,1.7)**	**4.75(1)**	**0.0293**	**1.34(1.05,1.72)**	**5.47(1)**	**0.0194**
Cause of Injury (1=Motor Vehicle;0= Other/Unknown)	0.99(0.71,1.38)	0(1)	0.9579	1.16(0.91,1.48)	1.42(1)	0.2329	1.09(0.86,1.38)	0.49(1)	0.4853
Days to Follow Commands[4]	1(0.98,1.01)	0.2(1)	0.6560	1(0.99,1.01)	0.12(1)	0.7255	1(0.99,1.01)	0.16(1)	0.6924
Days in Posttraumatic Amnesia[4]	0.99(0.92,1.07)	0.09(1)	0.7630	1(0.94,1.06)	0(1)	0.9447	1(0.95,1.06)	0.01(1)	0.9327
Acute Length of Stay[4]	1.06(0.96,1.18)	1.38(1)	0.2398	1.02(0.94,1.1)	0.15(1)	0.6997	1.02(0.94,1.11)	0.24(1)	0.6224
Length of Stay in Rehab[4]	1.01(0.94,1.09)	0.12(1)	0.7306	1.01(0.95,1.06)	0.09(1)	0.7652	1.01(0.95,1.06)	0.06(1)	0.7999

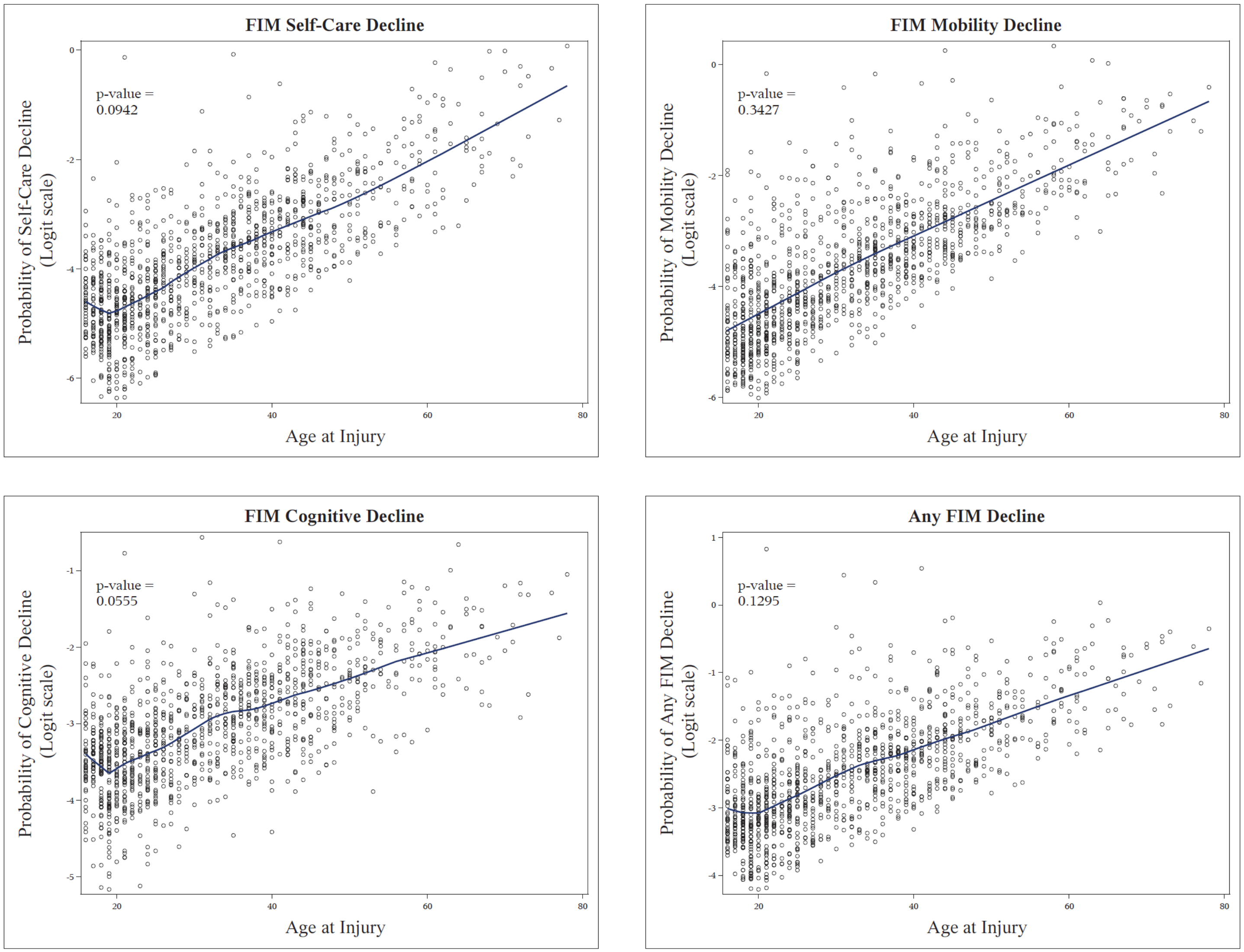
[1]units=5 years; [2]units=10 years; [3]other education = 5 refusals; [4]units=7 days

Table 6: Predictors of DRS Decline (> 1) in Multivariable Logistic Regression Models (n=1249)

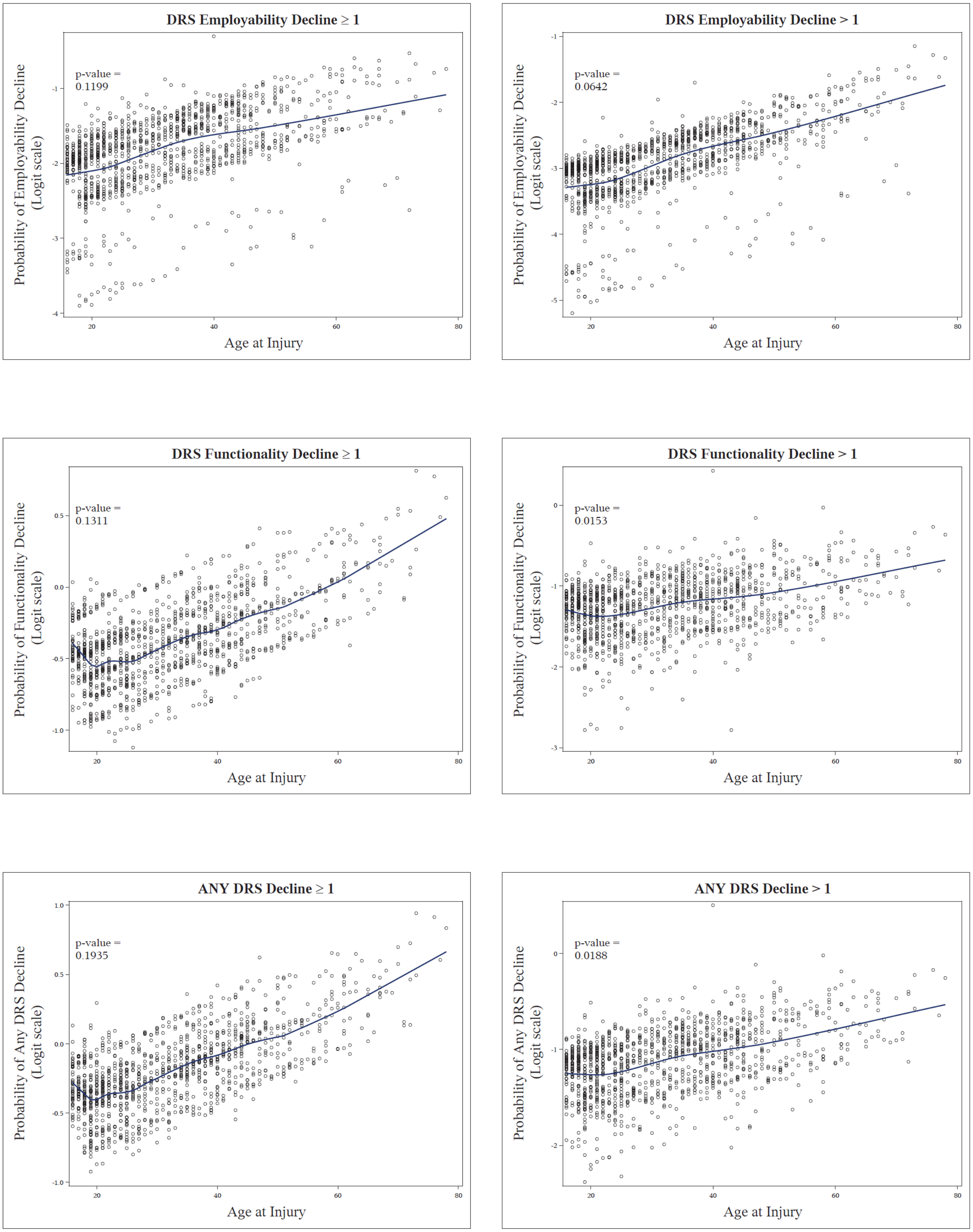
	Employability Decline No. of Events = 73			Functioning Decline No. of Events = 288			Any DRS Decline No. of Events = 315		
Predictors	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**
Age at Injury if ≤25[1]	0.78(0.47,1.34)	0.88(1)	0.3469	0.87(0.66,1.16)	0.93(1)	0.3357	0.9(0.68,1.19)	0.56(1)	0.4553
Age at Injury if >25[2]	**1.49(1.19,1.85)**	**13.04(1)**	**0.0003**	**1.23(1.07,1.40)**	**8.45(1)**	**0.0037**	**1.23(1.08,1.40)**	**9.58(1)**	**0.0020**
Male (1=Yes;0=No)	1.04(0.6,1.75)	0.02(1)	0.8817	1.11(0.82,1.5)	0.49(1)	0.4829	1.03(0.76,1.37)	0.03(1)	0.8630
Race		2.86(3)	0.4142		1.63(3)	0.6536		2.64(3)	0.4511
Black vs Hispanic	1.59(0.56,6.14)			0.87(0.5,1.56)			0.95(0.55,1.68)		
Black vs Other	3.65(0.9,33.49)			1.45(0.76,2.97)			1.71(0.9,3.49)		
Black vs White	1.08(0.61,1.83)			1.04(0.75,1.42)			1.07(0.79,1.46)		
Hispanic vs Other	2.29(0.36,24.28)			1.67(0.76,3.8)			1.81(0.83,4.09)		
Hispanic vs White	0.68(0.18,1.82)			1.19(0.69,2)			1.13(0.66,1.89)		
Other vs White	0.29(0.03,1.13)			0.71(0.36,1.31)			0.63(0.32,1.15)		
High School (1= ≤ High School or Other[3]; 0= > High School)	1.49(0.88,2.59)	2.19(1)	0.1390	**1.57(1.17,2.13)**	**8.63(1)**	**0.0033**	**1.5(1.12,2.01)**	**7.45(1)**	**0.0063**
Cause of Injury (1=Motor Vehicle;0= Other/Unknown)	1.07(0.65,1.77)	0.08(1)	0.7816	1.16(0.88,1.54)	1.11(1)	0.2924	1.15(0.88,1.52)	1.06(1)	0.3043
Days to Follow Commands[4]	1.01(0.99,1.03)	1.5(1)	0.2206	0.99(0.97,1.01)	1.07(1)	0.3009	1(0.98,1.01)	0.35(1)	0.5539
Days in Posttraumatic Amnesia[3]	0.96(0.86,1.08)	0.47(1)	0.4930	1.02(0.96,1.09)	0.38(1)	0.5375	1.01(0.95,1.08)	0.19(1)	0.6655
Acute Length of Stay[4]	1.04(0.88,1.21)	0.32(1)	0.5738	1.05(0.95,1.15)	1.02(1)	0.3124	1.05(0.96,1.15)	1.1(1)	0.2949
Length of Stay in Rehab[4]	1.02(0.9,1.13)	0.09(1)	0.7657	0.95(0.88,1.01)	2.59(1)	0.1073	0.95(0.89,1.01)	2.33(1)	0.1266

[1]units=5 years; [2]units=10 years; [3]other education = 5 refusals; [4]units=7 days

Supplemental Figure 1: Linearity Plot for Age at Injury for FIM subscales with LOESS curve (P-value is for Box-Tidwell Test of Linearity)



Supplemental Figure 2: Linearity Plots for Age at Injury for DRS subscales with LOESS curve (P-value is for Box-Tidwell Test of Linearity)



Supplemental Table 1: Univariate Results for FIM Decline

		Self-Care Decline			Mobility Decline			Cognition Decline			Any FIM Decline		
n	**Predictors**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**
1381	Age at Injury[1]	**1.84(1.55,2.2)**	**46.57(1)**	**<.0001**	**1.81(1.54,2.15)**	**48.97(1)**	**<.0001**	**1.40(1.2,1.63)**	**18.62(1)**	**<.0001**	**1.46(1.29,1.65)**	**37.25(1)**	**<.0001**
1381	Male (1=Yes;0=No)	**2.09(1.24,3.5)**	**7.78(1)**	**0.0053**	**1.85(1.11,3.03)**	**5.87(1)**	**0.0154**	0.82(0.47,1.35)	0.56(1)	0.4540	1.09(0.74,1.59)	0.2(1)	0.6516
1381	Race		1.63(3)	0.6524		5.07(3)	0.1667		6.05(3)	0.1090		5.35(3)	0.1477
	Black vs Hispanic	1.03(0.39,3.36)	--	--	0.55(0.24,1.33)	--	--	0.38(0.17,0.92)	--	--	0.52(0.28,1.02)	--	--
	Black vs Other	0.88(0.33,2.87)	--	--	1.21(0.42,4.63)	--	--	1.36(0.41,6.96)	--	--	1.2(0.53,3.13)	--	--
	Black vs White	1.36(0.76,2.38)	--	--	1.32(0.74,2.26)	--	--	0.69(0.38,1.19)	--	--	1.03(0.68,1.54)	--	--
	Hispanic vs Other	0.85(0.21,3.42)	--	--	2.21(0.65,9.25)	--	--	3.55(0.97,19.05)	--	--	2.28(0.89,6.47)	--	--
	Hispanic vs White	1.32(0.42,3.3)	--	--	2.41(1.04,5.04)	--	--	1.8(0.82,3.58)	--	--	1.97(1.06,3.48)	--	--
	Other vs White	1.55(0.49,3.89)	--	--	1.09(0.29,2.95)	--	--	0.51(0.1,1.53)	--	--	0.86(0.34,1.85)	--	--
1357	High School (1= ≤ High School or Other[2]; 0= > High School)	1.66(0.94,3.08)	2.84(1)	0.0919	1.15(0.7,1.96)	0.29(1)	0.5931	1.47(0.9,2.47)	2.28(1)	0.1314	1.44(0.99,2.13)	3.44(1)	0.0636
1381	Cause of Injury (1=Motor Vehicle;0= Other/Unknown)	0.64(0.37,1.07)	2.82(1)	0.0929	**0.57(0.34,0.94)**	**4.61(1)**	**0.0318**	0.72(0.45,1.12)	2.04(1)	0.1529	0.72(0.51,1.02)	3.28(1)	0.0702
1355	Days to Follow Commands[3]	**1.01(1,1.02)**	**4.07(1)**	**0.0436**	**1.01(1,1.02)**	**4.03(1)**	**0.0447**	1(0.99,1.02)	0.38(1)	0.5392	1.01(1,1.02)	3.13(1)	0.0768
1291	Days in Posttraumatic Amnesia[3]	**1.07(1.01,1.12)**	**7.28(1)**	**0.0070**	**1.08(1.04,1.13)**	**13.85(1)**	**0.0002**	1.04(0.99,1.09)	3.23(1)	0.0725	**1.08(1.04,1.11)**	**19.05(1)**	**<.0001**
1381	Acute Length of Stay[3]	1.06(0.96,1.16)	1.78(1)	0.1816	**1.11(1.03,1.2)**	**7.29(1)**	**0.0069**	1.03(0.93,1.12)	0.39(1)	0.5300	**1.1(1.03,1.17)**	**9.2(1)**	**0.0024**
1381	Length of Stay in Rehab[3]	**1.11(1.04,1.18)**	**12.02(1)**	**0.0005**	**1.14(1.07,1.2)**	**20.66(1)**	**<.0001**	**1.1(1.04,1.16)**	**12.75(1)**	**0.0004**	**1.14(1.09,1.19)**	**35.84(1)**	**<.0001**

[1]units=10 years; [2]other education = 5 refusals ; [3]units=7 days

Supplemental Table 2: Univariate Results for DRS Decline (≥ 1)

		Employability Decline			Functioning Decline			Any DRS Decline		
n	Predictors	OR (95% CI)	χ^2(df)	p-value	OR (95% CI)	χ^2(df)	p-value	OR (95% CI)	χ^2(df)	p-value
1381	Age at Injury[1]	**1.21(1.09,1.34)**	**12.48(1)**	**0.0004**	**1.16(1.07,1.26)**	**12.5(1)**	**0.0004**	**1.17(1.08,1.27)**	**14.01(1)**	**0.0002**
1381	Male (1=Yes;0=No)	0.87(0.62,1.2)	0.68(1)	0.4093	**1.31(1.03,1.67)**	**5(1)**	**0.0253**	1.24(0.98,1.58)	3.21(1)	0.0730
1381	Race		**12.41(3)**	**0.0061**		1.01(3)	0.7978		0.81(3)	0.8481
	Black vs Hispanic	1.86(0.96,3.91)	--	--	0.9(0.55,1.51)	--	--	1.13(0.71,1.82)	--	--
.	Black vs Other	**5.2(1.98,19.19)**	--	--	0.88(0.69,1.13)	--	--	1.24(0.75,2.06)	--	--
.	Black vs White	**1.42(1.03,1.94)**	--	--	1.04(0.56,1.96)	--	--	1.04(0.81,1.33)	--	--
.	Hispanic vs Other	2.8(0.87,11.46)	--	--	1.02(0.65,1.59)	--	--	1.09(0.58,2.05)	--	--
.	Hispanic vs White	0.77(0.37,1.44)	--	--	0.98(0.6,1.58)	--	--	0.92(0.59,1.44)	--	--
.	Other vs White	0.27(0.07,0.71)	--	--	0.9(0.55,1.51)	--	--	0.84(0.52,1.36)	--	--
1357	High School (1= ≤ High School or Other[2]; 0= > High School)	**1.7(1.23,2.39)**	**9.93(1)**	**0.0016**	1.21(0.97,1.52)	2.74(1)	0.0977	**1.27(1.01,1.58)**	**4.24(1)**	**0.0394**
1381	Cause of Injury (1=Motor Vehicle;0= Other/Unknown)	0.89(0.66,1.19)	0.64(1)	0.4249	1.16(0.94,1.44)	1.95(1)	0.1623	1.08(0.87,1.33)	0.46(1)	0.4968
1355	Days to Follow Commands[3]	1(0.98,1.01)	0.33(1)	0.5649	1(0.99,1.01)	0.61(1)	0.4344	1(0.99,1.01)	0.51(1)	0.4739
1291	Days in Posttraumatic Amnesia[3]	1.01(0.98,1.05)	0.79(1)	0.3746	1(0.98,1.03)	0(1)	0.9629	1.01(0.98,1.03)	0.32(1)	0.5706
1381	Acute Length of Stay[3]	1.05(0.99,1.11)	2.51(1)	0.1128	1.01(0.96,1.06)	0.23(1)	0.6281	1.03(0.98,1.08)	1.06(1)	0.3036
1381	Length of Stay in Rehab[3]	1.01(0.96,1.05)	0.18(1)	0.6679	1.01(0.98,1.05)	0.55(1)	0.4564	1.02(0.98,1.05)	0.87(1)	0.3502

[1]units=10 years; [2]other education = 5 refusals; [3]units=7 days

Supplemental Table 3: Univariate Results for DRS Decline (> 1)

		Employability Decline			Functioning Decline			Any DRS Decline		
n	**Predictors**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**	**OR (95% CI)**	**χ^2(df)**	**p-value**
1381	Age at Injury[1]	**1.32(1.13,1.53)**	**13.11(1)**	**0.0003**	**1.15(1.04,1.25)**	**8.46(1)**	**0.0036**	**1.16(1.06,1.27)**	**10.6(1)**	**0.0011**
1381	Male (1=Yes;0=No)	1.11(0.68,1.76)	0.18(1)	0.6733	1.19(0.91,1.56)	1.64(1)	0.2009	1.1(0.84,1.44)	0.52(1)	0.4719
1381	Race									
	Black vs Hispanic	1.78(0.64,6.75)	3.2(3)	0.3611	0.92(0.55,1.59)	2.93(3)	0.4020	1(0.6,1.71)	4.27(3)	0.2340
.	Black vs Other	3.65(0.93,33.04)	.(.)	.	1.71(0.92,3.41)	.(.)	.	1.96(1.06,3.91)	.(.)	.
.	Black vs White	1.04(0.63,1.66)	.(.)	.	1.08(0.81,1.43)	.(.)	.	1.11(0.84,1.46)	.(.)	.
.	Hispanic vs Other	2.05(0.33,21.51)	.(.)	.	1.85(0.87,4.1)	.(.)	.	1.96(0.92,4.33)	.(.)	.
.	Hispanic vs White	0.58(0.16,1.53)	.(.)	.	1.17(0.7,1.9)	.(.)	.	1.11(0.67,1.8)	.(.)	.
.	Other vs White	0.28(0.03,1.07)	.(.)	.	0.63(0.32,1.15)	.(.)	.	0.57(0.29,1.03)	.(.)	.
1357	High School (1= ≤ High School or Other[2]; 0= > High School)	1.48(0.92,2.46)	2.47(1)	0.1157	**1.48(1.14,1.95)**	**8.14(1)**	**0.0043**	**1.43(1.11,1.87)**	**7.22(1)**	**0.0072**
1381	Cause of Injury (1=Motor Vehicle;0= Other/Unknown)	0.97(0.63,1.49)	0.02(1)	0.8827	1.14(0.89,1.46)	1.1(1)	0.2941	1.09(0.86,1.38)	0.5(1)	0.4787
1355	Days to Follow Commands[3]	1(0.98,1.02)	0.21(1)	0.6482	0.99(0.98,1)	0.97(1)	0.3254	1(0.98,1.01)	0.39(1)	0.5305
1291	Days in Posttraumatic Amnesia[3]	0.99(0.94,1.04)	0.08(1)	0.7831	1(0.97,1.03)	0.03(1)	0.8673	1(0.97,1.03)	0.05(1)	0.8314
1381	Acute Length of Stay[3]	1.01(0.91,1.1)	0.08(1)	0.7739	1.02(0.97,1.08)	0.8(1)	0.3718	1.03(0.97,1.08)	0.88(1)	0.3490
1381	Length of Stay in Rehab[3]	1(0.93,1.06)	0.01(1)	0.9053	0.98(0.94,1.02)	0.91(1)	0.3401	0.98(0.94,1.02)	0.87(1)	0.3510

[1]units=10 years; [2]other education = 5 refusals ; [3]units=7 days