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ORIGINAL RESEARCH

Return to Driving After Moderate-to-Severe Traumatic Brain Injury: A Traumatic Brain Injury Model System Study

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Abstract

Objective: Describe who is able to return to driving (RTD) after moderate-to-severe traumatic brain injury (TBI), when this occurs, who maintains that activity, and the association with outcome.

Design: Cross-sectional descriptive study.

Setting: Eight follow-up sites of the TBI Model Systems (TBIMS) program.

Participants: 618 participants enrolled in the TBIMS and 88 caregivers (N=706).

Interventions: Not applicable.

Main Outcome Measures: A survey was completed from 1-30 years postinjury focusing on RTD. Descriptors included demographic information, injury severity, and current employment status. Outcome was assessed at the time of the interview, including depression, quality of life, functional status, and community participation.

Results: Of 706 respondents, 78% (N = 552) RTD, but 14% (N = 77) of these did not maintain that activity. Of those who RTD, 43% (N = 192) did so within 6 months of the injury and 92% did so within 24 months postinjury. The percentage of people driving after TBI did not differ significantly based on age at time of injury or follow-up. There were significant differences between drivers and nondrivers with respect to severity of injury, seizures, race, education, employment, rural vs urban setting, marital status, and family income. We performed a multivariate logistic regression to examine the association between driving status and demographic variables, adjusting for other variables in the model. The strongest associations were with current employment, family income, race, seizures, and severity of injury. Driving was associated with greater community participation, better functional outcomes, fewer symptoms of depression, and greater life satisfaction.

Conclusions: Over a span of 30 years, three-quarters of people experiencing moderate-to-severe TBI return to driving a personal vehicle, although not everyone maintains this activity. Employment, race, family income, and seizures are strongly associated with RTD.

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Return to driving (RTD) a personal vehicle is a goal for most people experiencing moderate-to-severe traumatic brain injury (TBI) in the United States and internationally because driving is associated with greater community participation,[1,2] employment,[3] and higher life satisfaction.[2,4] Existing literature from the United States and elsewhere suggests that 40%-70% of people experiencing TBI return to drive[2,4-6] depending on timing of the survey. However, there is sparse information about when the return takes place. Lower education, unemployment, and being Black are associated with not driving in US studies,[2-4] as well as severity of injury[2,7,8] and presence of physical and cognitive deficits in the United States and elsewhere.[8-12] In the United States, the date post-TBI that a person drives may also be influenced by state guidelines. A third of states require reporting of recurrent episodes of altered mental status, but the phrasing of such statutes is problematic with regard to TBI.[13] Of the sites participating in this study, only 1 requires reporting of a TBI to a state licensing bureau (Pennsylvania), and statutes in most states do not specifically mention loss of consciousness or TBI but do mention neurologic events as a reason to restrict driving. Reevaluation is required in only 1 state (Minnesota), and the duration of time that driving is restricted varies from 3-13 months. Surprisingly, the potential influence of age on driving after TBI has not been addressed.

The present study examines RTD after moderate-to-severe TBI using a follow-up protocol established by the TBI Model Systems (TBIMS) program with the aims of confirming existing information and adding new findings regarding the timing of RTD, effects of age, and comparison with noninjured drivers. This study provides the benefit of a large sample collected at multiple locations within the United States, allowing a breakdown of who returns to driving after TBI by multiple variables. The following hypotheses were generated: (1) of those who drive after injury, 50% will do so within 2 years of injury; (2) there will be significant associations among driving, injury severity, and demographic characteristics, such as education, race, and financial resources; and (3) those not driving will exhibit lower life satisfaction, greater emotional distress, and diminished community participation compared with those driving at the time of follow-up. There are also additional, unique hypotheses: (4) the percentage of people driving after TBI will diminish with age and (5) relative to national statistics the percentage of those driving after TBI will be diminished. Such information is integral to our understanding of outcome after moderate-to-severe TBI and advising those experiencing TBI and family members. This information can also lead to rehabilitation programs emphasizing RTD as a primary goal in recovery that directs allocation of staff and other resources.

List of abbreviations:

GOS-E	**Glasgow Outcome Scale-Extended**
IRF	**inpatient rehabilitation facility**
PART-O	**Participation Assessment with Recombined Tools-Objective Scale**
PHQ-9	**Patient Health Questionnaire-9**
RTD	**return to driving**
SWLS	**Satisfaction With Life Scale**
TBI	**traumatic brain injury**
TBIMS	**TBI Model Systems**
TFC	**time to follow commands**

Methods

Participants

The TBIMS has been funded by the National Institute on Rehabilitation, Independent Living and Rehabilitation Research for over 30 years to maintain a longitudinal database focusing on recovery after TBI. There are presently 16 funded centers. Based on the TBIMS definition, participants had a history of moderate-to-severe TBI for which they were admitted to an inpatient rehabilitation facility (IRF). Diagnosis was based on the Glasgow Coma Scale score, duration of posttraumatic amnesia, presence of abnormalities on neuroimaging consistent with trauma, and/or evident neurologic disorder reflective of TBI. Participants in the TBIMS have a minimum age of 16. Consent for participation in the TBIMS is obtained from the injured person or a legally authorized representative during acute rehabilitation.

Procedures

Telephone follow-up interviews focusing on recovery occur at 1, 2, and 5 years after injury and every 5 years thereafter. After completion of the standard follow-up interview, participants were given the option of completing the driving survey and consent was obtained. The survey took 15-20 minutes and participants were paid for their involvement. After obtaining telephone consent, 2 centers elected to mail the survey to consenting respondents with follow-up calls as necessary. Eight TBIMS centers collected data after obtaining institutional review board approval for the interview. Any participant eligible for a follow-up call from May 1, 2018-May 31, 2019 was asked to complete the driving survey, regardless of the time since injury, resulting in completion of 738 driving surveys. Because of concerns about validity, based on vague and/or inconsistent responses, we removed 12 of the surveys from the analysis sample. Participants who were not driving before the injury and had not been driving at all after the injury (20 cases) were also removed, leaving 706 surveys for analysis. To maintain a comprehensive study of RTD, information collected from caregivers was included. The sample represented by caregivers was less likely to be driving and was more severely injured. Interviewing caregivers regarding driving practices after TBI is an accepted method of data collection,[14] and information collected from both caregivers and those with TBI is highly correlated based on the only study to examine this issue.[15]

During the time of data collection, 1261 TBIMS participants were eligible for a follow-up call based on time of enrollment. The 706 participants in the study represent 56% of the eligible sample. Forty-nine percent (n=273) of nonresponders were lost to follow-up, 30% (n=168) had died, 8% (n=45) were incarcerated, and 5% (n=29) withdrew from the study. Only 7% (n=40) of nonresponders refused to do the survey.

Measures

The driving survey was developed based on examination of existing surveys.[1,2,15-19] A copy of the survey is provided as a supplement (supplemental appendix S1, available online only at http://www.archives-pmr.org/). The present study examines only a few components of the survey, leaving other areas (eg, barriers to driving, driving patterns, safety) for future examination. The current

study focused on whether the person RTD, when they RTD, and outcomes related to driving.

To address consistency of responses to the survey, a sample of 50 individuals completed the driving survey again 6 months later. When asked about RTD there was 98% agreement in responses across the 2 time points. One individual interviewed 15 years after his TBI initially denied driving after the TBI, but 6 months later he reported that he had driven short distances at times. There was 71% agreement about when RTD occurred (r=.99, P<.0001). Discrepancies were most evident for those interviewed 5 or more years after injury, with discrepancies ranging from 2-12 months (in 1 case).

In addition to the driving survey, we analyzed information derived from the standard TBIMS follow-up interview, including age at time of injury and interview, sex, employment at the time of follow-up (competitively employed, student, unemployed/retired/disabled), marital status (single-never married, married, divorced/widowed/other), education (less than high school, high school diploma, some college, college degree or more), residence (rural, urban, suburban derived from ZIP code), and annual family income (in thousands, <25, 25-49.9, 50-99.9, 100+). Race of the participants was predominantly White (68.3%) and Black (26.9%), with few participants identifying as Asian/Pacific Islander (0.8%), Native American (0.4%), and Hispanic (2.8%). Characteristics related to the TBI were also examined, including time since injury, injury severity (as measured by time to follow commands [TFC], in days), and seizures in the year prior to the interview (yes/no). The use of TFC as a measure of injury severity was generated by a desire to avoid imputation of data necessitated by missing values for the Glasgow Coma Scale and duration of posttraumatic amnesia. Duration of unconsciousness, as measured by TFC, is associated with functional outcome after TBI.[20] Variables related to status at the time of data collection included depression (Patient Health Questionnaire-9 [PHQ-9] total score[21]), life satisfaction (Satisfaction With Life Scale [SWLS] total score[22]), functional status (Glasgow Outcome Scale-Extended [GOS-E] total score[23]), and community participation (Participation Assessment with Recombined Tools-Objective Scale [PART-O] total score and subscales of Productivity, Social Activity, and Out and About[24]).

Finally, in the absence of a control sample in the TBIMS, statistics for US drivers were reviewed.[25] The study sample and national sample are vastly different in terms of size (706 vs hundreds of thousands) and survey method (verbal survey vs written diary documentation), but the comparison was still considered potentially informative, although admittedly tentative.

Statistical analysis

The study sample was described using means and SDs for continuous variables and frequencies (percentages) for categorical variables. Differences between groups were analyzed using independent samples t tests for continuous variables and Pearson chi-square tests for categorical variables. Estimation of the probability that a participant would RTD was derived by Kaplan-Meier survival analysis.[26] Those who reported not driving or stopped driving were treated as censored.

Multivariate logistic regression analysis was performed to examine the association between driving status and demographic variables adjusting for other variables in the model. Multiple imputation via the method of chained equations provided estimates incorporating incomplete or missing data.[27] Odds ratios and 95% confidence intervals were generated from the logistic regression models. Pooled results from 20 iterations (10 multiple imputations each) were reported.

We estimated the associations between driving status and outcome variables using linear regression analysis adjusting for age. Results were considered statistically significant at P<.05.

Statistical analyses were performed using version 3.5.1 of the R programming environment.[28,a] Survival analyses were performed using version 2.44-1.1 of the *survival* package for R.[29,30,b] Multiple imputation analyses were performed using version 3.3.0 of the *mice* package for R.[31,c]

Results

Distribution of surveys was relatively even for years 1, 2, 5, 10 and 15 after injury, ranging from 16.4%-20.3% (n=651) of the total sample. Those interviewed at 20, 25, and 30 years after injury were a smaller proportion (7.8% [n=55] of the entire sample). Demographic, injury, and outcome information for the sample is presented in Table 1. This sample is relatively young and predominantly male, single, and White and with a range of education, as is common in studies focusing on TBI. Severe injuries predominated based on a TFC of 8 days and it is noteworthy that 10.7% (n=75) reported having experienced a seizure in the year before the interview. Of the 706 surveys completed, 552 (78.2%) participants had RTD, although 77 (14.0% of those who had RTD) had stopped driving by the time of the interview.

Figure 1 provides results of a survival analysis employing the entire sample (drivers and nondrivers) predicting the percentage of individuals (and 95% confidence intervals) who had RTD at points up to 30 years after TBI. Rate of RTD is estimated to accelerate for 2 years after injury, reaching 61.8% (n=436) of the entire sample at 24 months, followed by slow, but steady, increases subsequently, reaching 78.2% (n=623) by 30 years after TBI.

Examining only active drivers at the time of interview, the estimated median time to RTD was 11 months. However, 42.7% (n=192) of active drivers who could recall when they resumed driving (456 of 475 active drivers) reported resumption of driving earlier than 6 months after injury and 92.8% (n=423) had RTD within 2 years after injury. Compared with those who RTD at 6 months or later, those who RTD earlier than 6 months after injury were older (40.8 vs 34.4y, P<.001) and had less severe TBI based on TFC (5.14 vs 8.00d, P=.002).

Of those who resumed driving and then discontinued, the average time to resume driving was significantly longer than for active drivers (18.2 vs 11.0mo, P=.018). The average duration of driving prior to stopping was 46 months, with a modal value of 1 month and a median of 12 months.

Age at time of injury and at follow-up did not differ significantly for active drivers, those who drove and stopped, and those who did not drive after TBI (table 1). There were no sex differences and location (urban/suburban/rural) did not significantly differentiate the groups. However, active drivers were significantly more educated and Black participants were significantly less likely to RTD or maintain driving. Those employed at the time of interview were more likely to be driving, as were those with higher family income. Nondrivers were significantly more likely to have experienced a seizure in the year prior to interview. Finally, TFC did not differ between active and stopped drivers, but these groups exhibited shorter TFC (indicating less severe injury) than those who had not returned to driving.

Table 1 Demographic, injury-related, and functional descriptors of participants

Characteristics	Overall	Driving Status			*P* Value	n
		No Attempt n = 154	Driving/Stopped n = 77	Driving Now n = 475		
Age at time of injury (y)	37.2±15.9	38.7±16.2	34.1±15.2	37.2±15.9	.120	706
Age at follow-up (y)	45.3±15.7	44.9±16.4	44.1±15.9	45.7±15.5	.659	703
Sex (male), n (%)	509 (72.1)	116 (75.3)	52 (67.5)	341 (71.8)	.445	706
Race, n (%)					<.001	706
White	482 (68.3)	84 (54.5)	40 (51.9)	358 (75.4)		
Black	190 (26.9)	63 (40.9)	33 (42.9)	94 (19.8)		
Asian/Pacific Islander	6 (0.9)	1 (0.7)	0 (0.0)	5 (1.0)		
Native American	3 (0.4)	0 (0.0)	1 (1.3)	2 (0.4)		
Hispanic origin	20 (2.8)	4 (2.6)	2 (2.6)	14 (3.0)		
Other	5 (0.7)	2 (1.3)	1 (1.3)	2 (0.4)		
Marital status at time of injury, n (%)					.003	705
Single (never married)	347 (49.2)	82 (53.2)	45 (58.4)	220 (46.4)		
Married	230 (32.6)	38 (24.7)	15 (19.5)	177 (37.3)		
Others	128 (18.2)	34 (22.1)	17 (22.1)	77 (16.2)		
Education at time of injury, n (%)					<.001	656
Bachelor's degree or higher	96 (14.6)	15 (10.1)	3 (4.55)	78 (17.7)		
Some college	185 (28.2)	29 (19.5)	17 (25.8)	139 (31.5)		
HS diploma	192 (29.3)	45 (30.2)	16 (24.2)	131 (29.7)		
Less than HS	183 (27.9)	60 (40.3)	30 (45.5)	93 (21.1)		
Employment at time of follow-up, n (%)					<.001	703
Not employed	420 (59.7)	135 (87.7)	66 (86.8)	219 (46.3)		
Students	13 (1.85)	2 (1.30)	3 (3.95)	8 (1.69)		
Employed	270 (38.4)	17 (11.0)	7 (9.21)	246 (52.0)		
Total family income over the past year, n (%):					<.001	654
<$25,000	278 (42.5)	90 (63.8)	52 (73.2)	136 (30.8)		
$25,000-$49,999	137 (20.9)	25 (17.7)	15 (21.1)	97 (21.9)		
$50,000-$99,999	133 (20.3)	18 (12.8)	4 (5.63)	111 (25.1)		
≥$100,000	106 (16.2)	8 (5.67)	0 (0.00)	98 (22.2)		
Location at time of follow-up (urban), n (%)	164 (25.2)	38 (25.7)	24 (36.4)	102 (23.3)	.075	651
TFC (d)	8.07±13.0	13.1±18.8	7.09±11.4	6.69±10.5	<.001	690
Seizures in past year (yes), n (%)	75 (10.7)	31 (20.1)	20 (26.3)	24 (5.1)	<.001	702
SWLS	21.4±8.18	19.2±8.07	16.5±8.09	22.7±7.83	<.001	622
PHQ-9	5.52±5.90	6.07±6.05	8.70±6.86	4.87±5.52	<.001	613
Out/about	1.63±0.76	1.25±0.76	1.37±0.68	1.80±0.71	<.001	702
Productivity	1.40±1.01	0.73±0.77	0.97±0.75	1.68±0.99	<.001	702
Social	2.46±1.07	1.86±1.02	1.97±1.06	2.74±0.98	<.001	702
Total	1.83±0.75	1.28±0.65	1.44±0.59	2.07±0.67	<.001	702
GOS-E	5.95±1.65	4.62±1.60	5.21±1.49	6.49±1.39	<.001	692

NOTE. Values are mean ± SD or as otherwise indicated.
Abbreviation: HS, high school.

Logistic regression was performed with imputation of missing data, which did not exceed 8% for any variable. Analysis using nonimputed data did not alter the findings substantially. After adjusting for other participant characteristics, the odds of RTD were 5 times higher for employed respondents (table 2) compared with those who did not have a job, including students. The odds of RTD for those in the highest income bracket were over 4 times higher than for those in the lowest income bracket. Having a seizure in the past year diminished the odds of driving by 66%. Black participants were half as likely to be driving as White participants, which was also true of those residing in urban compared with rural areas. Severity of injury had a modest but still significant effect. With each day increase in TFC, the odds of driving were decreased by 3%.

Based on linear regression, active drivers were significantly different from nondrivers in terms of all PART-O measures, SWLS, PHQ-9, and GOS-E (table 3). Even controlling for age, the driving group performed better than the nondriving group with respect to community participation, expressed higher life satisfaction, and reported fewer symptoms of depression. Age alone statistically affected 2 PART-O scores and the PHQ-9 score, although the effect appears to be of minimal clinical value, particularly when compared with the effect of driving. There was an interaction between age and driving for PART-O Out and About, as well as Productivity, but the clinical significance of the finding appears to be marginal.

As a percentage of respondents, driving among those with TBI was less than anticipated when compared with similar age

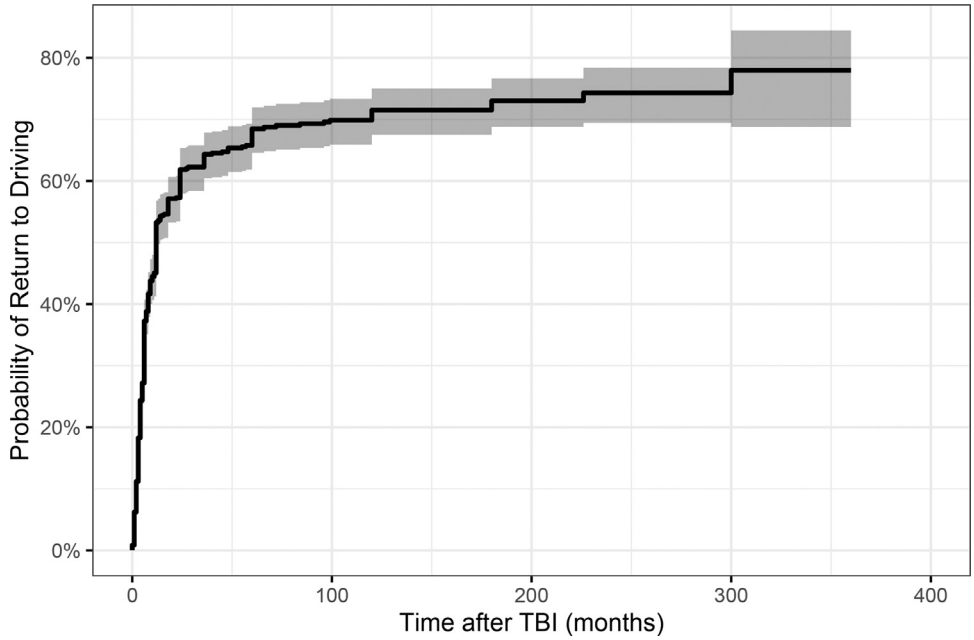

Fig 1 Kaplan-Meier survival analysis of return to driving with gray area denoting the 95% confidence intervals.

groupings in a national survey[25] (table 4). The differences were significant for each age group, with the exception of the age group greater than 70 years.

Discussion

This study confirms, but also extends and partly contradicts, findings from other studies examining RTD after moderate-to-severe TBI. Of note, this study examined a larger and more geographically diverse US sample compared with prior studies. The finding that 78% of respondents had returned to driving exceeded what is typically reported,[4-6] but this finding included individuals who had stopped driving. Excluding those individuals, the observation of 67% of active drivers is consistent with other reports. This study is unique in accounting separately for individuals who had RTD but stopped driving (11%). The association of employment and race with RTD has been noted in other studies,[3,4] but no other studies have also examined family income, which has a strong association with RTD. The effect on driving of having a seizure in the year prior to interview is not surprising; the presence of seizure activity is often a focus of state guidelines limiting driving. Consistent with other studies,[3,4,32] severity of injury was associated with RTD, but the association was considerably weaker than other characteristics. Consistent with prior studies,[3,8] the influence of education and marital status dissipated after accounting for other potentially explanatory characteristics.[3,8] Comparison of this TBI sample to national survey results is tentative given the difference in sample sizes and the manner in which information was obtained, but such a comparison does indicate that moderate-to-severe TBI is associated with fewer drivers at all ages levels examined except those above age 70.

Hypotheses were confirmed regarding time to RTD, association with injury severity, and some demographic characteristics, as well as association with life satisfaction, symptoms of depression, and community participation. For those who RTD, 9 in 10 do so within 2 years of injury. The specific barriers for RTD after that time frame and for those who were driving and stopped remain largely unknown. Seizure activity represents 1 barrier observed in our study that bears more detailed exploration in future research. The frequency of driving early after injury (42% of active drivers reported RTD earlier than 6 months after injury) was surprising and raises questions about adherence to state guidelines. This concern is somewhat ameliorated, perhaps, by the finding that early returners tended to be older (presumably more experienced drivers) and less severely injured.

Table 2 Logistic regression of active drivers on demographic and injury variables

	OR (95% CI)*
Age at time of follow-up	1.01 (0.99, 1.02)
Follow-up period	1.08 (1.04, 1.12)†
Sex-Female	0.76 (0.49, 1.18)
Race-Black	0.50 (0.31, 0.78)†
Race-Other	1.32 (0.50, 3.50)
Education-Some college	1.42 (0.65, 3.09)
Education-HS diploma	0.94 (0.43, 2.06)
Education-Less than HS	0.56 (0.25, 1.27)
Marriage-Married	1.11 (0.61, 2.02)
Marriage-Others	0.94 (0.52, 1.71)
TFC days	0.97 (0.95, 0.99)†
Employment-Student	1.98 (0.51, 7.58)
Employment-Employed	5.85 (3.38, 10.13)†
Income $25,000-$49,999	1.47 (0.84, 2.56)
Income $50,000-$99,999	2.30 (1.17, 4.49)†
Income ≥$100,000	4.58 (1.82, 11.54)†
Location of discharge-Urban	0.53 (0.30, 0.93)†
Location of discharge-Suburban	0.94 (0.59, 1.51)
Seizures in past year	0.34 (0.18, 0.62)†
N	706

Abbreviations: CI, confidence interval; HS, high school; OR, odds ratio.
* Pooled result from 10 multiple imputations (20 iterations).
† 1 outside the confidence interval

Table 3 Linear multiple regression: driving status as predictor for functional outcomes

	SWL	PHQ-9	GOS-E	Out and About†	Social	Productivity‡	Summary
Intercept	17.26***	8.24***	5.07***	1.57***	1.95***	0.95***	1.60***
Age‡	0.02	−0.03*	−0.01	−0.01*	−0.00	−0.00	−0.01***
Drive now§	4.53***	−2.24***	1.67***	0.22	0.84***	1.65***	0.74***
Age*driving				0.01*		−0.02***	
n	622	613	692	702	702	702	702

* $P<.05$ ** $P<.01$
*** $P<.001$.
† Model includes the interaction between age and driving status. Out and About, Social, and Productivity are subscales of the PART-O. Summary represents the summary score of PART-O.
‡ Indicates the change in scores with each year of increase in age, adjusting for the effect of driving status.
§ Indicates the difference in scores between drivers and nondrivers, adjusting for the effect of age.

The present study benefited from a sufficient sample size to allow consideration of multiple demographic and injury-related characteristics. Individually, expected associations were observed between RTD and injury severity, racial identity, education, marital status, employment, and family income. However, in the context of multiple predictors, the most unique information about who returns to driving was observed for employment, family income, racial identity, seizure activity, and residence location as the primary associations with RTD. Severity of injury still had an effect on RTD but a modest effect compared with other factors. It is possible that another measure of injury severity, such as duration of posttraumatic amnesia, may have had a stronger association with driving than TFC, but the impact of any severity measure likely decreases over a span of time, which in the case of this study extends to 30 years after injury. These findings suggest that RTD over the long term is influenced by social and demographic characteristics more than injury severity, a conclusion also reached by Rapport et al.[2] It makes sense that those living in urban areas may have transportation opportunities other than driving that are not available to those living in other circumstances. Also, driving is an expensive endeavor, so those with a higher family income are more likely to drive. The association of employment with driving is not surprising; to be employed, driving to and from work is often a necessity. The recent article by Erler et al[3] speaks to this issue as well. The effects of race on RTD, reported by others as well,[3,4] may reflect relatively limited access to driving assessment, training, and vehicles.

The association of RTD with life satisfaction, emotional status, and community participation has been reported in numerous studies.[1,2,4] In the United States and many other countries, driving opens doors to opportunities that otherwise might not be available after TBI. This study does not establish a causal relationship between RTD and these outcomes, but the association is clear. It is reasonable to assume that this is a bidirectional relationship. This observation underscores the need to address RTD with patients and their family members and lessen or remove barriers to driving whenever possible.

The hypothesis that the percentage of people driving after moderate-to-severe TBI would diminish with age at a rate consistent with the able-bodied population was not supported. In general, at each age level, the percentage of drivers in the TBI group was stable, although considerably less than reported for drivers in a recent national survey,[25] except for those above age 70. Among those in the 71-80 age range at the time of interview, 70% reported RTD. Also, there was generally little indication that increasing age was associated with lower life satisfaction or diminished community participation. In fact, reported depressive symptoms decreased slightly with age.

Table 4 Incidence of driving after TBI relative to a national survey*

Age at Follow-Up (y)	n	Driving, n (%)	National (%)	*P* Value
≤30	127	81 (63.8)	75.50	.003
31-40	191	126 (66.0)	92.10	<.001
41-50	122	83 (68.0)	93.20	<.001
51-60	130	84 (64.6)	90.70	<.001
61-70	93	71 (76.3)	89.40	<.001
≥71	40	28 (70.0)	77.60	.336
Total	703	473 (67.3)	85.80	<.001

* Based on comparison with the *Summary of Travel Trends: 2017 National Household Travel Survey*,[25] which is tentative given sample differences.

Study limitations

First, the sample focused solely on RTD among individuals with a moderate-to-severe TBI admitted to an IRF in the United States. Persons admitted to an IRF represent 7% of all persons hospitalized with moderate-to-severe TBI in the United States and are less likely to be a member of an ethnic minority and more likely to have health insurance compared with those hospitalized with moderate-to-severe TBI who are not admitted to an IRF.[33] This limits generalization of these findings to individuals with less severe injury, persons not admitted to an IRF, and individuals with TBI living outside the United States. In addition, the study included only individuals contacted during a scheduled follow-up. It has been demonstrated[34] that individuals lost to follow-up in the TBIMS database tend to be of lower education and from racial/ethnic minority backgrounds, which are 2 characteristics associated with not returning to driving. Consequently, the finding that 78% of those followed had returned to driving is likely an overestimate if the entire TBIMS enrollment sample is considered. Another limitation of this study is that the data collection involved self-report vs observation, although there is a basis for assuming adequate response accuracy. Additionally, given the severity of the TBI and effect on neurocognitive functioning, there may be limitations in terms of accuracy of details concerning when RTD occurred, a lack of awareness about details, and/or fears of reporting related to continued driving. The reliability sample addresses this issue to some extent but does not remove all concerns. Related to this issue, the sample included caregivers who served as surrogates for those who were too impaired to participate or not

available. However, based on existing literature there was adequate basis to include reports from caregivers, and removal of those cases did not alter the findings of the study. Although the sample size is robust, the numbers diminish precipitously for ages ≥60 and for those ≥20 years postinjury. Lastly, this study did not examine circumstances unique to individuals that may have transpired over many years, the impact of state statutes related to driving, and access to driver assessment and training.

Conclusions

The majority of people experiencing moderate-to-severe TBI return to driving, usually within 2 years postinjury. A substantial number of these RTD within 6 months of injury. Factors potentially limiting driving include being a student or unemployed, having a lower family income, being Black, living in an urban setting, and (to a lesser extent) having a more severe TBI. Age, sex, education, and marital status were unrelated to RTD in the context of those predictors of RTD. Driving is associated with higher life satisfaction, fewer depressive symptoms, and greater community participation, underscoring the importance of driving for individuals with TBI. Ensuring timely access to driver assessment/training regardless of income, employment status, and racial identity is an important goal. Access to a vehicle, which was not addressed in this study, needs to be explored. When advising patients and their family members, practitioners need to be aware of state guidelines regarding RTD after TBI. If those guidelines are unclear, RTD may need to be addressed at the state level.

Suppliers

a. R, version 3.5.1; Comprehensive R Archive Network.
b. Survival package for R, version 2.44-1.1; Comprehensive R Archive Network.
c. Mice package for R, version 3.3.0; Comprehensive R Archive Network.

Keywords

Automobile driving; Brain injuries; Brain injuries, traumatic; Rehabilitation

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