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A Comparison of Satisfaction with Life and the Glasgow Outcome Scale Extended after Traumatic Brain Injury: An Analysis of the TRACK –TBI Pilot Study

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Abstract

Objective: To evaluate the relationship between satisfaction with life (SWL) and functional outcome after traumatic brain injury (TBI).

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Author Contribution Statement: GTM, NPK, OMA, KH, CJL, and JJR conceived the study. GTM, SSD, and JKY supervised the conduct of the study. KH managed the data. CJL and KH provided statistical advice on study design and analyzed the data. NPK drafted the manuscript, and all authors (GTM, NPK, OMA, KH, CJL, JJR, JKY, and SSD) contributed substantially to its revision. NPK takes responsibility for the paper as a whole.

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DECLARATION OF INTEREST

The authors declare no conflicts of interest.

Setting and Participants: The Transforming Research and Clinical Knowledge in Traumatic Brain Injury Pilot study (TRACK-TBI Pilot) enrolled patients at three U.S. Level I trauma centers within 24hrs of TBI.

Design: Patients were grouped by outcome measure concordance (good-recovery/good-satisfaction, impaired-recovery/impaired-satisfaction) and discordance (good-recovery/impaired-satisfaction, impaired-recovery/good-satisfaction). Logistic regression was utilized to determine predictors of discordance.

Main Measures: Functional outcome: Glasgow Outcome Scale-Extended (GOSE); SWL: Satisfaction with Life Scale (SWLS)

Results: Of the 586 enrolled subjects, 298 had completed both outcome measures at six-month follow-up; the correlation between GOSE and SWLS was 0.380. Patients with impaired-recovery (GOSE<7)/impaired-satisfaction (SWLS<20) were more likely to have mild TBI (83% vs 62%, $p=0.012$), baseline depression (42% vs 15%, $p<0.0001$), and six-month depression (59% vs 21%, $p<0.0001$) when compared with patients with impaired-recovery/good-satisfaction. Patients with good-recovery/impaired-satisfaction were more likely to have baseline depression (31% vs 13%, $p<0.0001$) and six-month depression (33% vs 6%, $p<0.0001$) compared with good-recovery/good-satisfaction.

Conclusion: Correlation between SWL and functional outcome was not strong, and depression may modulate the association. Future research should account for functional, mental health, and patient-centered outcomes when assessing TBI recovery.

Keywords

Traumatic brain injury; satisfaction with life; depression; TBI outcomes

Introduction:

There are 2.5 million emergency department (ED) visits, 282,000 hospitalizations, and 56,000 deaths related to traumatic brain injury (TBI) each year in the United States.¹ TBI results in significant healthcare costs, including those associated with rehabilitation efforts following injury. While the majority of TBI research has focused on functional outcome, satisfaction with life (SWL) is also germane to the patient experience after TBI. The commonly reported global functional outcome measure for TBI, the Glasgow Outcome Scale-Extended (GOSE),¹ does not capture such factors.

Studies in children suggest that patients with mild TBI have a lower quality of life in the months following injury.^{2,3} Adult patients are at risk of low or declining life satisfaction following severe TBI,⁴ which may persist for many years irrespective of scores on the SWL assessment tool.⁵ This relationship is neither linear nor straightforward to understand: the lowest satisfaction is reported among those with moderate functional disability, while those with severe disability report similar satisfaction to those with a good recovery GOSE.⁶ Given that self-reported SWL is a patient-centered outcome rather than a measure of overall functional status, improved understanding of the relationship between these key outcome variables, and factors confounding or moderating this relationship, is important.

We evaluated the correlation between functional outcome and satisfaction with life in a cohort of civilian TBI patients from the Transforming Research and Clinical Knowledge in Traumatic Brain Injury Pilot (TRACK-TBI Pilot) study. We hypothesized that patients with a good functional outcome would be more likely to have good SWL while those with an impaired functional outcome would have impaired SWL. We also investigated whether depression and other demographic, medical history, and clinical management factors affect the relationship between functional outcome and SWL.

Methods:

TRACK-TBI Pilot enrolled patients suffering external force trauma to the head who presented to one of three U.S. Level I trauma centers and received a clinically-indicated head computed tomography (CT) scan within 24 hours of injury. Study details have been previously published.⁷ Patients across the full spectrum of injury severity (Glasgow Coma Scale (GCS) score 3 to 15) were included. Data comprised demographic and medical history, clinical/injury course, imaging findings, and six-month outcomes, which were collected in accordance with National Institutes of Health (NIH)/National Institute of Neurological Disorders and Stroke (NINDS) TBI Common Data Elements (CDEs).⁷ Patients with completed six-month GOSE and Satisfaction with Life Scale (SWLS) were used for the current analysis.

The GOSE is a widely utilized measure of global functional outcome in TBI research (1=death, 2=vegetative state, 3= lower severe disability, 4=upper severe disability, 5=lower moderate disability, 6=upper moderate disability, 7=lower good recovery, 8=upper good recovery).^{8,9} When administered correctly, it has high reliability (kappa scores 0.85 to 0.89) and validity.^{1,10,11} The SWLS is a five-item instrument designed to measure overall life satisfaction, with each item scored on a Likert scale (1=strongly disagree, 4=neither agree nor disagree, 7=strongly agree). The SWLS ranges from 5–35; a higher total score indicates greater SWL. It has high internal consistency, high test-retest reliability, can be used across a wide age range, and has been previously validated for use throughout the spectrum of severity in TBI research.^{12,13} SWLS and GOSE were both dichotomized into “good” and “impaired.” SWLS was considered “good” if the score was 20–35 (e.g., in general satisfied with life), while GOSE was considered “good” if the score was 7–8 (e.g., return to baseline self-care, work, and social activities with minor residual symptoms/problems). Subjects were grouped into concordant recovery/satisfaction (good-recovery/good-satisfaction, impaired-recovery/impaired-satisfaction) and discordant recovery/satisfaction (good-recovery/impaired-satisfaction, impaired-recovery/good-satisfaction).

The Spearman’s correlation coefficient was used to evaluate of the relationship between the SWLS and GOSE at six months. Between-group differences in demographic and medical history, clinical/injury course, imaging findings and depression were evaluated; if these factors differed between concordant and discordant patients it would suggest a role in moderating or confounding the relationship between functional and SWL outcomes. Imaging findings were categorized as “unfavorable” if there was evidence of intracranial hemorrhage/contusion on CT. Prior history of depression was measured using a self-reported history of depression by chart review and patient report at enrollment, and depression at six

months was measured using the Brief Symptom Inventory-18 (BSI-18) Depression scale.¹⁴ Prior history of depression was based either on self-report or medical record review. Self-reported depression included both diagnosed and undiagnosed depression, either currently or in the past. Depression based on medical record review required a past or current diagnosis at the time of ED admission.⁷ The BSI-18 has previously demonstrated good reliability and validity in patients with TBI.¹⁵ Between-group differences were evaluated using analysis of variance (ANOVA) and/or the Kruskal-Wallis test for continuous variables, and Pearson's Chi-square test and/or Fisher's Exact test for categorical variables.

Degree of discordance between GOSE and SWLS was computed as the residual of the linear regression model predicting SWLS from the GOSE at six months. Negative residuals suggest a lower SWLS than would have been predicted by the GOSE, while positive residuals suggest a higher SWLS than would have been predicted by the GOSE. A multiple regression model was then constructed to evaluate independent associations between possible predictors (six-month depression, past history of depression, TBI severity, patient sex) and discordance. Predictors were centered to mitigate collinearity concerns, as described by Kraemer and Blasey.¹⁶ Statistical analyses were computed using the Statistical Package for Social Sciences (SPSS) version 24 (IBM Corporation, Armonk, NY) and R (<https://www.r-project.org/>, version 3.2.4).

Results:

Of 586 patients enrolled, 338 completed a 6 month follow up, and 40/338 were missing at least one data point leaving 298 cases for inclusion in this analysis. For included patients, the mean age was 42 (SD) 18) years and 234 (69%) were male, 27 (8%) were black, 281 (83.6%) were Caucasian, 13 (3.9%) were Asian, and 15 (4.5%) were described as "other" races. At presentation, 279 (83%) had GCS 13–15, 17 (5%) had GCS 9–12, and 40 (12%) had GCS 3–8. Included patients did not differ based on presenting GCS. Included patients were slightly more likely to be better educated and have full-time employment and less likely to be retired, students, or disabled pre-injury when compared with excluded patients (Table 1).

Figure 1 shows the association between GOSE and SWLS. At six months, the correlation between SWLS and the GOSE was 0.380. The correlation between depression measured at six months and SWLS was -0.656 . Overall, the GOSE and SWLS were concordant for 205 (69%) and discordant for 93 (31%) subjects. Concordant and discordant participants are described in Table 2, which shows differences in college education ($p = 0.017$), history of depression ($p < 0.0001$), TBI severity ($p = 0.003$), and BSI depression score ($p < 0.0001$) among groups. To directly compare concordant and discordant subjects, Table 3 quantifies the differences between participants with a low SWLS and a high SWLS within those with a low GOSE (impaired recovery), and within those with a high GOSE.

Among patients with impaired recovery, those with impaired SWL (concordant) were more likely to have mild TBI (83% vs 62%, $p=0.002$) compared to moderate and severe TBI, history of depression (42% vs 15%, $p<0.0001$), and depression at six months as measured by BSI score (59% vs 21%, $p<0.0001$) when compared with patients with good SWLS

(discordant) (Table 2). They were also less likely to be college educated (24% vs 31%, $p=0.017$). Among patients with good recovery, those with impaired SWLS (discordant) were more likely to have a history of depression (31% vs 13%, $p<0.0001$), and depression at six months (33% vs 6%, $p<0.0001$) when compared to patients with good SWLS (concordant). Patients with good recovery and good SWLS at six months were more likely to be college educated (45% vs 33%, $p=0.017$) when compared to those with good recovery but impaired SWLS. We note that regardless of recovery, college educated subjects tended to have a higher SWL, subjects with a severe TBI had a higher SWL, and subjects with a history of depression had a lower SWLS. BSI depression scores were higher in those with low SWL across the spectrum of injury. Table 3 additionally describes the differences in concordant and discordant groups when the cohort is grouped based on recovery at six months.

Using the degree of discordance, (the degree to which SWLS and GOSE were not correlated at six months) as the outcome, we found no demographic factors (age, race, sex, college education) to be significantly predictive of discord when controlling for other variables. History of depression, depression at six months, and TBI severity were each independently associated with discordance (good-recovery/impaired-satisfaction, impaired-recovery/good-satisfaction). As TBI severity worsened, the amount of discordance between SWLS and GOSE decreased. We then constructed a multiple regression model with BSI-18 at six months, past history of depression, sex, TBI severity, and interactions of these variables as predictors of degree of discordance. In this model, males with a past history of depression had the most significant discordance ($p = 0.001$ with partial eta squared of 0.035) of SWLS and GOSE after TBI, meaning highest likelihood of good-recovery and impaired satisfaction, followed by individuals with mild TBI ($p = 0.003$ with partial eta squared of 0.030) (Table 4).

Discussion:

In patients across all severities of TBI, the correlation between the GOSE and SWLS at six months was not strong, suggesting that: 1) the commonly used measure of global functional outcome, the GOSE, insufficiently reflects overall patient satisfaction with life experience after a TBI as measured by SWLS; and, 2) a critical focus in assessing satisfaction with life is needed following TBI. Depression at six months was more strongly correlated with SWLS than functional outcome, even among those without a prior history of depression. Our findings support a growing body of evidence suggesting that treatment of depression is an important target for improving quality of life after TBI,¹⁷ particularly since the risk of depression following TBI is high, with prevalence between 25% and 61% after TBI.^{18–22} Depression is common after TBI with 30% prevalence at one-year post injury,⁶ and thus may have important implications on quality and satisfaction with life. This is higher than the lifetime prevalence of depression in the overall population of the United States, which is estimated at 17%.²³

Depression can be challenging to diagnose after TBI since depressive symptoms can overlap with sequelae that are present following TBI.²⁴ Our study was not designed to provide evidence for the development of new onset depression after TBI as the baseline evaluation includes both current and past depression while the 6-month depression is based on a

validated scale to assess for current depression. However, since inclusion of past depression at baseline likely inflates the proportion with depression at baseline and we did observe a small (from 24% to 27%), increased diagnosis of depression over six months, our results are not inconsistent with prior findings. Our study does highlight the importance of the relationship of life satisfaction and depression following TBI, and future research might consider the relationship between satisfaction with life and onset of new depression.

Our findings are similar to those of Davis et al.,²⁵ who showed that in 444 patients with moderate to severe TBI, pre-injury factors such as education, employment, prior TBI and psychiatric or substance abuse problems contribute significantly to SWLS scores while severity of TBI did not. Similarly, in a cohort of 210 patients with moderate and severe TBI who were followed for three to five years, brain injury severity was associated with functional outcome but not with quality of life or emotional outcomes.²⁶ These results challenge those of Anke et al., who found that a better GOSE score at 12 months was associated with better satisfaction with life in a cohort of 163 adult patients with severe TBI.²⁷ Interestingly, despite enrolling only severe TBI, 63% of the cohort described overall satisfaction with life. The majority of our patients had mild TBIs, which may explain the difference in findings.

Patients with good recovery at six months were more likely to have an impaired SWLS if they reported a history of depression or depression at six months. For example, in patients with mild TBI, the only significant predictor of discordance (good-recovery/impaired-satisfaction) was depression at six months. However, when we evaluated for interactions of variables, we demonstrated that male patients with a history of past depression were at highest risk of discordance (good-recovery/impaired-satisfaction), which is a unique finding in our study.

At six months, approximately half of our subjects with initial severe injuries and poor functional outcomes had a discordant SWLS, meaning impaired recovery with good satisfaction. Potential explanations for this discordance have been described previously. Severely injured TBI patients may have a greater sense of “survivorship” when compared with mild TBI patients, contributing to a higher satisfaction with life.²⁸ One commonly held belief is that patients with severe TBI are simply not able to describe life satisfaction themselves. However, this was refuted by Machamer et al. when 76% (374/491) of eligible testable survivors after severe TBI were able to accurately describe life satisfaction.²⁹ Patients included for this analysis (SWLS at six months) did not differ from those excluded (those without SWLS at six months), so there was no bias in severity of presentation.

Although previous studies have examined the relationship between functional measures, such as GOSE and life satisfaction measures such as SWLS,^{30–32} our study is unique in that we sought to determine the variables driving discordance in the relationship. Moreover, studies to determine predictors of SWLS have almost exclusively been conducted in patients with severe TBI with little effort spent on patients who were well enough to be discharged from the ED.⁶ We found that discordance between functional outcome (measured by GOSE) and satisfaction (SWLS) at 6 months in mild TBI was due in part to depression at six months, as reflected by the BSI-18. When we looked at interactions between independent

predictor variables (six-month depression, past history of depression, TBI severity, patient sex), we found that males with past history of depression were most discordant at six months. Thus, a male with history of depression who has a mild TBI and subsequent high GOSE, may be at highest risk of low SWLS at six months. Untangling the additional factors that may be leading to low life satisfaction in patients who are otherwise expected to have a favorable functional outcome is important in order to better understand patient centered outcomes.

Limitations:

There were differences in patients who did and did not complete the six-month follow-up that may have influenced our overall findings. Two of these differences were education and employment, neither of which were associated with significant discordance between GOSE and SWLS at six months. Patients with more education and who were employed prior to their TBI were more likely to complete follow up, and also had a higher SWLS regardless of TBI severity. It is possible that any difference between those lost to follow up and those included bias our findings to those with a higher SWLS. However, patients who completed the six-month follow-up did not differ from those who did not complete the six-month follow-up with respect to severity of injury at presentation (GCS). This means that patients with the most severe injuries at presentation were as likely to complete a SWLS at six months as those with less severe injuries, making functional severity bias less likely.

Another limitation is that we could not infer causality in the relationship of depression at six months and SWLS score because these data were measured at the same time. Further, we only had variables that were captured in the database, and this relationship could have been mediated by factors that were not captured. We identified available moderators *a priori*, but there are many others that could putatively contribute to the relationship. Examples include chronic pain, sleep disorders, and PTSD, among others. Although depression was a significant predictor of discordance between SWLS and GOSE, especially in patients with mild TBI, there remains a large amount of unexplained variation potentially attributable to unmeasured factors. Additionally, prior history of depression was ascertained by either self-report or medical record review. The combination of approaches was used to maximize the likelihood of identifying depression but does not allow us to differentiate the effects of past or current depression nor does it allow us to differentiate between self-reported feelings of depression and a formal diagnosis.

Our findings are also limited by the low frequency of moderate and severe TBI cases. Although the GOSE, SWLS, and BSI-18 have all been validated in patients with moderate and severe TBI, it is plausible that patients with more severe cognitive deficits after TBI may have responded differently than those with less severe cognitive deficits.

Prior descriptions of this patient population have demonstrated a difference between patients with GOSE of 7 and those with GOSE of 8 with respect to impaired scoring on other outcome measures, calling into question the ability of the GOSE to capture global functional outcome, particularly for individuals with mild disability.³³ The finding that patients who were anticipated to make a good functional recovery had a highly discrepant satisfaction

with life score is a complex problem. This complexity should not deter us from attempting to better understand this relationship so that targets for intervention can improve both SWL and functional outcome.

Conclusions:

Functional status at six months, as measured by GOSE, does not correlate strongly with SWL, suggesting SWL may also be affected by other factors. Depression may be an important contributor to the discordance between functional outcome and life satisfaction after TBI. Future studies should consider both functional and SWL outcomes, along with mental health measures, when assessing TBI recovery, with implications for clinical follow-up and counseling.

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Figure 1.
The Relationship Between Functional Outcome and Satisfaction With Life

Table 1:

Differences between cases who completed the six month follow up with available SWLS score and those who did not complete follow up or did not have a valid SWLS score.

	SWLS Not Available (n=248)		SWLS Available (n=338)	
Age – mean (SD)	45	(20)	42	(18)
Race – n (%)				
Caucasian	211	(86.1)	281	(83.6)
Sex – n (%)				
Male	185	(74.6)	234	(69.2)
Baseline Education – n (%) *				
High School Graduate	139	(59.1)	178	(54.4)
Baseline Employment – n (%) *				
Full-Time	80	(34.2)	141	(43.7)
Baseline Marital Status – n (%)				
Single	114	(48.1)	178	(54.3)
TBI Severity n (%)				
Severe (GCS 3–8)	30	(12.3)	40	(11.9)
Moderate (GCS 9–12)	14	(5.7)	17	(5.1)
Mild (GCS 13–15)	200	(82.0)	279	(83.0)
Baseline History of Depression – n (%)	41	(16.5)	82	(24.3)

* Significant at P<0.05

Table 2.

Patient Characteristics by Group

	Concordant (n=205)				Discordant (n=93)				P Value
	High GOSE High SWLS (n=129)	Low GOSE Low SWLS (n=76)	High GOSE Low SWLS (n=54)	Low GOSE High SWLS (n=39)	High GOSE Low SWLS (n=54)	Low GOSE High SWLS (n=39)	High GOSE Low SWLS (n=54)	Low GOSE High SWLS (n=39)	
Age – mean (SD)	41 (18)	43 (15)	43 (17)	43 (18)	43 (17)	43 (18)	43 (17)	43 (18)	0.857
Black – n (%)	8 (6.2)	9 (11.8)	6 (11.1)	3 (7.7)	6 (11.1)	3 (7.7)	6 (11.1)	3 (7.7)	0.466
Male – n (%)	84 (65.1)	57 (75.0)	41 (75.9)	24 (61.5)	41 (75.9)	24 (61.5)	41 (75.9)	24 (61.5)	0.219
College Education – n (%)	58 (45.0)	18 (23.7)	18 (33.3)	12 (30.8)	18 (33.3)	12 (30.8)	18 (33.3)	12 (30.8)	0.017
Employed – n (%)									
Yes	89 (69.0)	41 (53.9)	30 (55.6)	23 (59.0)	30 (55.6)	23 (59.0)	30 (55.6)	23 (59.0)	
N/A	17 (13.2)	21 (27.6)	16 (29.6)	8 (20.5)	16 (29.6)	8 (20.5)	16 (29.6)	8 (20.5)	0.124
No	23 (17.8)	14 (18.4)	8 (14.8)	8 (20.5)	8 (14.8)	8 (20.5)	8 (14.8)	8 (20.5)	
History of Depression – n (%)	17 (13.2)	32 (42.1)	17 (31.5)	6 (15.4)	17 (31.5)	6 (15.4)	17 (31.5)	6 (15.4)	<0.0001
TBI Severity – n (%)									
Severe (GCS3–8)	10 (7.8)	11 (14.5)	3 (5.6)	12 (30.8)	3 (5.6)	12 (30.8)	3 (5.6)	12 (30.8)	
Moderate (GCS9–12)	8 (6.2)	2 (2.6)	1 (1.9)	3 (7.7)	1 (1.9)	3 (7.7)	1 (1.9)	3 (7.7)	0.003
Mild (GCS13–15)	111 (86.0)	63 (82.9)	50 (92.6)	24 (61.5)	50 (92.6)	24 (61.5)	50 (92.6)	24 (61.5)	
6 Month Outcomes									
Depression* – n (%)	8 (6.2)	45 (59.2)	18 (33.3)	8 (20.5)	18 (33.3)	8 (20.5)	18 (33.3)	8 (20.5)	<0.0001
GOSE – mean (SD)	8 (0)	5 (1)	7 (0)	5 (1)	7 (0)	5 (1)	7 (0)	5 (1)	--
BSI Depression – mean (SD)	46 (7)	63 (10)	58 (10)	53 (10)	58 (10)	53 (10)	58 (10)	53 (10)	<0.0001
SWLS – mean (SD)	28 (4)	13 (4)	14 (4)	25 (4)	14 (4)	25 (4)	14 (4)	25 (4)	--

* BSI Depression Scale 63 or higher

Table 3:

Differences in patient characteristics by group based on recovery

Patient Characteristic	95% CI when comparing Low GOSE/Low SWLS to Low GOSE/High SWLS			P value
	Difference	Lower	Upper	
Mean Age	-0.3%	-6.7	6.1	0.926
Black (%)	-4.1%	-15.2%	6.9%	0.466
Male (%)	-13.5%	-31.6%	4.6%	0.219
College Education (%)	7.1%	-10.3%	24.4%	0.017
History of Depression (%)	-26.7%	-42.6%	-10.9%	<0.0001
TBI Severity (Severe, Moderate, Mild) (%)	--	--	--	0.002
6 Month Outcomes				
Depression * (%)	-38.7%	-55.5%	-21.9%	<0.0001
Mean GOSE	0.0	-0.4	0.3	0.785
Mean BSI Depression	-10.5	-14.3	-6.6	<0.0001
	95% CI when comparing High GOSE/High SWLS to High GOSE/Low SWLS			P value
	Difference	Lower	Upper	
Mean Age	1.7	-4.1	7.5	0.563
Black (%)	4.9%	-4.4%	14.3%	0.466
Male (%)	10.8%	-3.2%	24.9%	0.219
College Education (%)	-11.6%	-26.9%	3.6%	0.017
History of Depression (%)	18.3%	4.6%	32.0%	<0.0001
TBI Severity (Severe, Moderate, Mild) (%)	--	--	--	0.003
6 Month Outcomes				
Depression * (%)	27.1%	13.9%	40.4%	<0.0001
Mean GOSE	-0.3	-0.4	-0.1	0.001
Mean BSI Depression	11.4	8.9	14.0	<0.0001

* BSI Depression Scale 63 or higher

Table 4:

Multiple regression model predicting discordance of SWLS and GOSE with independent variables centered

Parameter	B	Std. Error	t	P Value	95% CI		Partial Eta Squared
					Lower	Upper	
Intercept	2.273	1.111	2.046	0.042	0.086	4.459	0.014
Male	0.652	0.898	0.727	0.468	-1.114	2.419	0.002
Female	0 ^a						
Mild TBI	-2.915	0.975	-2.992	0.003	-4.833	-0.997	0.030
Moderate/Severe TBI	0 ^a						
Past depression	1.402	1.380	1.016	0.311	-1.314	4.118	0.004
No past depression	0 ^a						
BSI	-0.176	0.088	-1.988	0.048	-0.350	-0.002	0.013
Male* Past depression	-5.942	1.821	-3.263	0.001	-9.526	-2.358	0.035
Male * No past depression	0 ^a						
Female * Past depression	0 ^a						
Female * No past depression	0 ^a						
Mild TBI * BSI	-0.207	0.096	-2.156	0.032	-0.396	-0.018	0.016
Moderate/Severe TBI * BSI	0 ^a						
Past depression * BSI	0.216	0.077	2.800	0.005	0.064	0.368	0.026
No past depression * BSI	0 ^a						

^a. This parameter is set to zero because it is redundant.