

Depression After Traumatic Brain Injury: A National Institute on Disability and Rehabilitation Research Model Systems Multicenter Investigation

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ABSTRACT. Seel RT, Kreutzer JS, Rosenthal M, Hammond FM, Corrigan JD, Black K. Depression after traumatic brain injury: a National Institute on Disability and Rehabilitation Research Model Systems multicenter investigation. *Arch Phys Med Rehabil* 2003;84:177-84.

Objective: To identify the frequency and manifestations of depression after traumatic brain injury (TBI) and the factors that contribute to developing this mood disorder.

Design: A prospective, nationwide, multicenter study; 17 centers supplied data from medical records and patient responses on a standardized criterion instrument.

Setting: Traumatic Brain Injury Model Systems programs.

Participants: A demographically diverse sample of 666 outpatients with TBI was evaluated 10 to 126 months after injury.

Interventions: Not applicable.

Main Outcome Measures: Depressive symptoms were characterized with the Neurobehavioral Functioning Inventory by using the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed; DSM-IV) diagnostic framework. Analysis of variance and Pearson correlations were used to identify factors that were significantly related to depression.

Results: Fatigue (29%), distractibility (28%), anger or irritability (28%), and rumination (25%) were the most commonly cited depressive symptoms in the sample. Twenty-seven percent of patients with TBI met the prerequisite number (≥ 5) of criterion A symptoms for a DSM-IV diagnosis of major depressive disorder. Feeling hopeless, feeling worthless, and difficulty enjoying activities were the 3 symptoms that most differentiated depressed from nondepressed patients. Patients who were unemployed at the time of injury and who were impoverished were significantly more likely to report DSM-IV criterion A symptoms than patients who were employed, were students, or were retired due to age. Time after injury, injury

severity, and postinjury marital status were not significantly related to depression.

Conclusions: Patients with TBI are at great risk for developing depressive symptoms. Findings provide empirical support for the inclusion of depression evaluation and treatment protocols in brain injury programs. Unemployment and poverty may be substantial risk factors for the development of depressive symptoms. Future research should develop biopsychosocial predictive models to identify high-risk patients and examine the efficacy of treatment interventions.

Key Words: Brain injuries; Depression; Rehabilitation; Treatment outcome.

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TRAUMATIC BRAIN INJURY (TBI) is a predominant cause of death and disability, particularly for persons age 35 years and younger. Many patients face long-term disability. Research has shown postinjury employment rates ranging from 17% to 80%.¹ With regard to emotional functioning, depression is often a significant clinical concern. Commonly reported symptoms include sadness, irritability, loss of interest, fatigue, sleep disturbance, psychomotor retardation, poor concentration, and memory dysfunction.²⁻⁵ However, brain injury rehabilitation researchers have generated few consistent findings regarding the frequency, distinguishing features, and factors associated with depression after TBI.

Research findings⁶⁻¹⁷ regarding the frequency of post-TBI depression have varied widely, ranging from 6% to 77%. Differential findings have been attributed to differences in assessment methods.¹⁸ Some studies²⁻⁵ of neurobehavioral functioning and depression relied on semistructured interviews and checklists with unknown psychometric properties. Other studies¹⁹⁻²² measured depression with assessment instruments developed for and standardized with psychiatric populations. Empirically based, standardized, and reliable diagnostic systems have been available to the medical community for several decades. More recently, researchers have developed standardized methods for collecting reliable and valid information about brain injury symptoms. With these tools, the rehabilitation community is now positioned to ascertain reliably the frequency of depressive symptoms and depressive disorders after brain injury.

The *Diagnostic and Statistical Manual of Mental Disorders*²³ (DSM) is the predominant diagnostic framework for assessing depression in North America and is used by a vast number of health care providers. The DSM assessment approach, based on reliable and empirically supported diagnostic criteria, has been developed over 5 decades. The most recent version, DSM-IV, reflects a multifactorial framework developed by work groups comprising thousands of specialists and validated through scientific literature reviews, concerted data analyses, and field trials.

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Table 1: Sample Characteristics, Methods, and Findings From Studies Using DSM Criteria to Examine Depression After TBI

Study	Sample Characteristics	Methods	Findings
Alexander ³¹	N=36; 6–60mo postinjury; mild or severe CHI	DSM-III-R psychiatric interview	67% prevalence; no sample-wide symptom rates reported; mildly injured patients (87%) more likely to be depressed than severely injured patients (31%)
Fann et al ⁴⁰	N=50	DSM-III-R; NIMH diagnostic interview	26% prevalence; depressed patients reported more severe postconcussive symptoms than non-depressed patients
Federoff et al ¹³	N=66; 1–2mo postinjury; mild to severe CHI	DSM-III-R; Hamilton Depression Scale; semistructured patient interview	27% prevalence; no symptom rates reported; depression related to premorbid psychiatric history (including substance abuse) and poor social functioning
Jorge et al ^{14,15}	N=66; 1–12mo postinjury; mild to severe CHI	DSM-III-R; Hamilton Depression Scale; semistructured patient interview	42% prevalence; no sample-wide symptom rates reported; depressed mood, lack of energy, suicidal ideation, and feeling worthless consistently differentiated depressed from nondepressed patients over time
Kreutzer et al ⁶	N=722; 3–108mo postinjury; mild to severe injury	DSM-IV; NFI patient ratings	42% prevalence; tired (46%), frustration (41%), and poor concentration (38%) were the most commonly cited manifestations of depression
Varney et al ¹¹	N=120; ≥24mo postinjury; mild to severe CHI	DSM-III; patient interview	77% prevalence; poor concentration/memory (96%), anergia (96%), indifference (90%), irritability (87%), insomnia (87%), and anorexia (77%)

Abbreviations: CHI, closed head injury; NFI, Neurobehavioral Functioning Inventory; NIMH, National Institute of Mental Health.

Despite widespread use of the DSM diagnostic systems in the mental health community, only a few brain injury researchers have used the system to identify the frequency of depression in the brain injury population (table 1). For example, Jorge et al,¹⁵ using a relatively small sample size, measured specific depressed-mood symptoms by using a dichotomous classification system derived from a semistructured psychiatric interview that was based on the DSM-III-R. The median number of DSM-III-R symptoms reported by patients ranged from 3 to 4. Further, 4 symptoms consistently differentiated depressed from nondepressed TBI patients between 3 and 12 months after injury: depressed mood, lack of energy, feelings of worthlessness, and suicidal ideation.

Kreutzer et al⁶ addressed the methodologic limitations of Jorge and other studies using DSM-IV criteria. Using a large and diverse TBI sample, Kreutzer administered the Neurobehavioral Functioning Inventory (NFI) to assess patients' DSM-IV-related symptoms and difficulties. Kreutzer found that 42% of patients reported symptoms consistent with a depressive disorder. Predominant symptoms included fatigue (46%), frustration (41%), poor concentration (38%), and boredom (32%). The investigation was centered in a single institution, and the generalizability of findings to other settings was uncertain. Kreutzer reported primarily on the frequency of depressive symptoms and offered little information about risk factors.

Several studies have examined variables that affect the development of depression after TBI. Preliminary reports suggest that several factors might be linked to depressive symptoms. Several studies^{2,24–27} indicate that marital and family disruptions are related to the development of depressive sequelae. Likewise, unemployment and resulting financial stressors have been related to depression.^{1,2,28,29} Last, some evidence suggests that injury severity^{30–32} and time after injury^{8,10,32} are related to depression.

The present study replicates the central procedures used by Kreutzer⁶ and offers several enhancements to the original research design. First, the study's multicenter sample provides a broad, diverse sampling of the TBI population. Second, this

study extends Kreutzer's analysis by identifying neurobehavioral symptoms that distinguish, within the DSM framework, patients who report high versus low levels of depression. Last, this study examines demographic, temporal, injury, and psychosocial factors that may be related to the development of depressive symptoms.

METHODS

Data Sources

The present study analyzed patient data from the National Institute on Disability and Rehabilitation Research Traumatic Brain Injury Model Systems (TBIMS) programs.^{33,34} Each TBIMS center includes emergency medical services, intensive and acute medical care, inpatient rehabilitation, and a spectrum of outpatient services. A comprehensive program of inpatient rehabilitation, tailored to meet their needs and abilities, was provided to all subjects. Within each center, the following services were provided: nursing, occupational therapy, psychiatry and related medical services, physical therapy, psychologic and neuropsychologic assessment, recreation therapy, and social services.

Participants

The sample consisted of 666 patients with TBI who received follow-up assessments as part of the TBIMS programs. Patient data were derived from 17 TBIMS centers, including the Virginia Commonwealth University TBIMS center. Patient data examined by Kreutzer⁶ were not included in the present study. Patients were included in the sample if they met the following criteria: (1) completion of a TBIMS outpatient follow-up evaluation between 1996 and 2000, (2) availability of demographic data, and (3) completion of the NFI at annual follow-up intervals.

Demographic information, including age at evaluation, time after injury at evaluation, gender, ethnicity, injury etiology, and injury severity, was collected. Patients' mean age \pm standard

deviation at time of evaluation was 38.0 ± 14.5 years (range, 18–76y). Average time after injury for evaluation was 35.3 ± 26.9 months (range, 10–126mo). The sample was 75% male. With regard to ethnicity, 56% were white, 32% black, 8% Hispanic, 3% Asian, and 1% other ethnic backgrounds. Most patients (54%) had been injured in vehicular crashes. Violence, falls, and pedestrian accidents accounted for 22%, 15%, and 7% of injuries, respectively.

With regard to injury severity, several indices were examined. The mean duration of unconsciousness was 9.8 ± 21.2 days, with a median of 3.0 and a mode of 0.5. The mean number of days that patients experienced posttraumatic amnesia (PTA) was 31.7 ± 26.2 days. More than 90% of patients experienced ≥ 7 days of PTA. The mean Glasgow Coma Scale (GCS) score at the time of admission to a TBIMS program was 8.6 ± 4.6 . Almost 54% of patients were admitted with a GCS score of ≤ 8 . The median Rancho Los Amigos (RLA) Scale of Cognitive Functioning admission score was 5. Two thirds of patients were admitted with an RLA score of ≤ 5 . Patients' injuries required an average of 21.2 ± 16.7 days of acute treatment and 33.7 ± 25.6 days of inpatient rehabilitation.

Information on employment, income, and marital status was collected on follow-up evaluation. With regard to employment status, 47% of the sample reported that they were unemployed, 30% reported being employed, 8% were students, 6% were retired due to age, 4% were homemakers, and 5% were of other employment status. With regard to family income, 23% of patients were impoverished, with annual earnings of \$9999 or less. Conversely, 14% of patients reported family earnings of \$50,000 or more per year. With regard to marital status, 47% reported being single, 29% were married, 15% were divorced, 5% were separated, and 3% were widowed.

Data Collection

Per standard TBIMS protocols,^{33,34} data were prospectively collected while patients were observed at hospital admission, in acute medical care and rehabilitation settings, and after discharge. Experienced clinicians at each center collected data from a variety of sources, including medical records, team conferences, physical examinations, and patient and family interviews. Demographic and injury information was obtained, including age, gender, ethnicity, pre- and postmarital status, pre- and postinjury residence, pre- and postinjury employment status, health care insurance provider(s), injury severity, and traumatic etiology. Appropriate members of the interdisciplinary rehabilitation team, using standard protocols, determined scores for injury severity variables and outcome measures.

After discharge from inpatient rehabilitation, subjects were contacted for neurobehavioral follow-up at 12-month intervals. A follow-up data collection packet that included the NFI was mailed to each patient's residence before the follow-up appointment. When patients arrived for evaluation, experienced personnel reviewed their responses for completeness and compliance with instructions. Whenever possible, patients' forms were corrected or missing information was obtained by interviewing the patient in person. Appropriate members of the outpatient rehabilitation follow-up team conducted interviews, administered tests, and derived scores for outcome measures. When a patient had provided information at more than 1 follow-up interval, the most recent protocol was selected for analysis.

Instruments

Information regarding DSM-IV symptoms of major depressive disorder was derived from the NFI.³⁵ The NFI, a standard component of the TBIMS follow-up protocol, is composed of

83 items. Seventy items comprise 6 scales based on principal components and confirmatory factor analytic methods. The 6 scales are depression, somatic complaints, memory/attention difficulties, communication deficits, aggressive behaviors, and motor impairment. Subjects are asked to rate the frequency of the problem occurrence on a 5-point scale: (1) never, (2) rarely, (3) sometimes, (4) often, or (5) always. Research has provided support for criterion-related validity and high internal consistency within NFI scales.³⁶ The Cronbach α for individual scales has ranged from .86 to .95. Furthermore, scores for each NFI scale correlate logically with other measures of neurobehavioral dysfunction, including the Minnesota Multiphasic Personality Inventory. Research has shown high levels of interrater reliability and agreement between patients' and family members' perceptions of difficulties.³⁷

DSM-IV Classification of Depression Using NFI Responses

The DSM-IV diagnostic manual describes 9 symptom domains as essential features of depression; these are earmarked criteria A1 thru A9. For this study, the NFI was used to identify and quantify (criterion A) symptoms of major depressive disorder, as specified in the DSM-IV. To replicate the protocol used by Kreutzer et al.,⁶ a 3-step process was used to identify diagnostically relevant NFI items. First, the 2 lead authors independently reviewed the DSM-IV descriptions of the 9 criterion A symptom domains. Second, each author identified a subset of the 83 NFI items that reflected the content of each symptom domain. Finally, the authors' opinions regarding diagnostically relevant NFI items and corresponding domains were compared, and consensus was reached. Thirty-two items were selected as diagnostically relevant; each item was assigned to only 1 of the 9 depressive domains. The list in table 2 shows the selected NFI items and their corresponding assigned DSM-IV criterion A symptom domains.

To characterize patients' experience of depressive symptoms, NFI item response patterns were examined in detail. The proportion of patients who rated each NFI item as occurring never, rarely, sometimes, often, and always was calculated. NFI items were grouped within the 9 DSM-IV criterion A symptom domains and organized into 3 major categories: (1) mood, (2) somatic, and (3) cognitive. Consistent with DSM-IV criteria requiring symptoms to "persist for most of the day, nearly every day," NFI items were labeled as clinically problematic when they were described as occurring often or always.

RESULTS

Mood Category

Three DSM-IV criterion A symptom domains were included in the mood category: depressed mood, diminished interest or pleasure, and feelings of worthlessness. Patient ratings of NFI items within the 3 mood domains are in table 3. In the depressed mood domain, "easily angered or irritated," reported by 26% of patients, was the most problematic symptom. Similarly, one fourth of the patients reported feeling frustrated. Feeling sad or blue was reported by 18% of the sample; 12% reported feeling hopeless often or all of the time. With regard to angry social interactions, 16% of patients reported arguing as a significant problem. Depressed mood was least likely to be manifested in physical violence; 8% reported that they at least sometimes hit or pushed others.

NFI items that described diminished interest or pleasure were also clinically problematic. Boredom and sitting with nothing to do were the most prevalent descriptors of anhedonia,

Table 2: DSM-IV Symptom Domains and Corresponding NFI Items

DSM-IV Symptom Domain	NFI Item
Mood category	
Depressed mood	Sad, blue Feel hopeless Frustrated Easily angered or irritated Hit or push others Curse at others Scream or yell Argue
Diminished interest or pleasure	Bored Difficulty enjoying activities Sit with nothing to do Lonely Uncomfortable around others Loss of interest in sex
Feelings of worthlessness	Feel worthless No confidence Curse at self
Somatic category	
Weight change	Poor appetite
Sleep disturbance	Trouble falling asleep
Psychomotor agitation or retardation	Restless Talk too fast or slow Move slowly
Decreased energy	Weak Tire easily during physical activity
Cognitive category	
Diminished thinking ability	Cannot get mind off certain thoughts Concentration is poor Easily distracted Forget yesterday's events Forget to do chores or work Forget if I have done things Forget or miss appointments
Recurrent thoughts of death	Threaten to hurt self

with 22% and 19% of patients reporting these difficulties as occurring often or always. Likewise, 19% of patients reported feeling lonely. Sixteen percent of the sample reported clinically significant problems with loss of interest in sex; conversely, 55% reported never having loss of interest in sex.

Symptoms within the feelings of worthlessness domain were somewhat less frequently reported than the previous 2 mood domains. No confidence (14%) was the most common manifestation of feeling worthless. Feeling worthless and cursing at self were reported as problematic by 11% of the sample.

Somatic Category

Four DSM-IV criterion A symptom domains comprised the somatic category: weight change, sleep disturbance, psychomotor agitation or retardation, and decreased energy (table 4). One NFI item addressed the issue of eating pattern changes. Having a poor appetite was endorsed by only 8% of the sample. Another NFI item described sleep disturbance. Trouble falling asleep was a clinically significant problem for 22% of patients with brain injury. NFI items related to psychomotor agitation or retardation were frequently endorsed as problematic. Twenty-four percent of patients reported that they move slowly

Table 3: Proportion of TBI Patients Reporting Criterion A Mood Symptoms

Symptom Domain/NFI Item	Always	Often	Some	Rarely	Never
Depressed mood					
Easily angered or irritated	12	14	24	20	30
Frustrated	9	16	34	20	21
Sad, blue	6	12	31	20	31
Feel hopeless	6	6	21	15	52
Argue	5	11	31	23	30
Curse at others	4	8	22	23	43
Scream or yell	3	6	24	22	45
Hit or push others	1	1	6	10	82
Diminished interest or pleasure					
Bored	8	14	33	18	27
Sit with nothing to do	7	12	25	23	33
Lonely	7	12	26	16	39
Loss of interest in sex	9	7	15	14	55
Difficulty enjoying activities	5	8	25	23	39
Uncomfortable around others	5	8	27	20	40
Feelings of worthlessness					
No confidence	6	8	23	20	42
Feel worthless	5	6	23	16	51
Curse at self	4	7	21	15	53

NOTE. Boldface values represent the presence of clinically significant symptoms. All data are percentages.

often or always. Conversely, 20% of patients reported significant difficulties with being restless. With regard to the decreased energy domain, "tires easily during physical activity" was among the most frequently endorsed NFI items, with 56% of the sample reporting fatigue at least some of the time and 29% reporting being tired often or all of the time.

Cognitive Category

The DSM-IV diagnostic framework characterizes 2 domains of cognitive problems: diminished thinking ability and recurrent thoughts of death (see table 5). Within the domain of diminished thinking ability, problems with concentration and memory were frequently endorsed. Twenty-eight percent of patients reported that they often or always were easily dis-

Table 4: Proportion of TBI Patients Reporting Criterion A Somatic Symptoms

Symptom Domain/NFI Item	Always	Often	Some	Rarely	Never
Weight change					
Poor appetite	3	5	17	15	60
Sleep disturbance					
Trouble falling asleep	12	10	22	18	38
Psychomotor agitation or retardation					
Move slowly	15	9	24	16	36
Restless	8	12	31	17	32
Talk too fast or slow	6	7	29	21	37
Decreased energy					
Tire easily during physical activity	14	15	27	15	29
Weak	7	7	29	18	39

NOTE. Boldface values represent the presence of clinically significant symptoms. All data are percentages.

Table 5: Proportion of TBI Patients Reporting Criterion A Cognitive Symptoms

Symptom Domain/NFI Item	Always	Often	Some	Rarely	Never
Diminished thinking ability					
Easily distracted	13	15	29	19	24
Cannot get mind off certain thoughts	11	14	31	18	26
Concentration is poor	9	10	29	23	29
Forget if I have done things	7	13	34	21	25
Forget yesterday's events	7	12	27	18	36
Forget to do chores or work	4	8	21	22	45
Forget or miss appointments	4	7	22	24	43
Recurrent thoughts of death					
Threaten to hurt self	1	1	5	7	86

NOTE. Boldface values represent the presence of clinically significant symptoms. All data are percentages.

tracted, whereas 25% had difficulties with rumination. About 20% reported each of the following as problematic: poor concentration, forgetting whether they had done things, and forgetting yesterday's events. Less often reported were problems with forgetting to do chores or work (12%) or forgetting appointments (11%). Recurrent thoughts of death was addressed by 1 NFI item. Seven percent reported that they sometimes threatened to hurt themselves, and 2% reported threatening to do so often or always.

Number of Depression Domains Reported

Having problems in ≥ 5 of the 9 criterion A symptom domains is a prerequisite for a major depressive episode diagnosis according to DSM-IV. For each patient, the number of problematic domains was identified. A domain was considered problematic if the patient reported at least 1 symptom within the domain as occurring *often* or *always*. The recurrent thoughts of death domain was considered problematic if the patient reported symptoms as occurring sometimes, often, or always. Information on the number of patients who reported ≥ 5 problematic domains is provided in fig 1. Our analysis showed that 27% of the sample met the criteria for a major depressive episode diagnosis. Less than 10% of the patients reported ≥ 7 problematic domains. Less than 1% of the patients reported clinically significant difficulties in all 9 criterion A

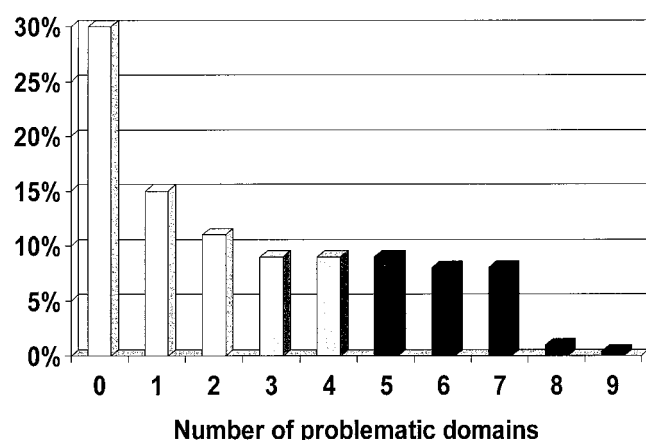


Fig 1. Percentage of patients reporting problems, by number of depressive episode domains.

Table 6: NFI Item Within Each Criterion A Symptom That Most Differentiated Depressed From Nondepressed TBI Patients

Symptom Domain/NFI Item	Depressed	Nondepressed	Difference Ratio
Depressed mood			
Feel hopeless	38%	3%	13:1
Diminished interest or pleasure			
Difficulty enjoying activities	38%	4%	10:1
Feelings of worthlessness			
Feel worthless	37%	2%	19:1
Weight change			
Poor appetite	24%	3%	8:1
Sleep disturbance			
Trouble falling asleep	58%	9%	6:1
Psychomotor			
agitation/retardation			
Restless	55%	7%	8:1
Decreased energy			
Weak	39%	5%	8:1
Diminished thinking ability			
Concentration is poor	56%	6%	9:1
Recurrent thoughts of death			
Threaten to hurt self	19%	3%	6:1

NOTE. Boldface values represent the presence of clinically significant symptoms.

symptom domains. Conversely, nearly 30% of the sample reported that they had no clinically significant problems in any of the 9 symptom domains.

NFI Items That Best Differentiate High and Low Depressive Symptoms

A 4-step process was used to identify the NFI item within each of the 9 criterion A symptom domains that most distinguished patients reporting high and low levels of depressive symptoms. First, the sample was divided into 2 groups. Patients who reported ≥ 5 criterion A symptom domains were identified as depressed. Patients who reported ≤ 4 criterion A symptom domains were identified as nondepressed. Second, the proportion of depressed and nondepressed patients who reported each NFI item as clinically problematic was tabulated. Third, a difference ratio was created for each NFI item in which the proportion of depressed patients reporting clinically significant problems was divided by the proportion of nondepressed patients reporting clinically significant problems. Last, the NFI item within each criterion A symptom domain that showed the largest difference ratio was identified (see table 6).

The analysis indicated that the NFI items "feel worthless" (19:1) and "feel hopeless" (13:1) most differentiated depressed patients from nondepressed patients. Depressed patients were nearly 10 times more likely than nondepressed patients to report difficulty enjoying activities and having poor concentration. With regard to psychomotor agitation, 55% of depressed patients reported restlessness, compared with 7% of nondepressed patients. Likewise, 58% of depressed patients reported difficulty falling asleep; only 9% of nondepressed patients reported clinically significant difficulties falling asleep. Depressed patients were 6 times more likely than nondepressed patients to report that they threatened to hurt themselves sometimes, often, or always. Almost 19% of depressed patients reported clinically significant problems with wanting to harm themselves.

Influences on Depressive Symptoms

Demographic factors. The effect of demographic factors on the self-report of DSM-IV criterion A depression symptom domains was analyzed. Based on Pearson r correlation analyses, neither time after injury nor age at follow-up evaluation was significantly related to depression. One-way analysis of variance (ANOVA) showed a main effect for patients' ethnic affiliation on depression. Tukey post hoc analyses indicated that blacks were significantly more likely to report criterion A depression symptom domains (mean, 3.00) than whites (mean, 2.36). No main effects were found for gender or injury etiology on the self-report of depressive symptoms.

Injury severity. A comprehensive analysis of injury severity variables was undertaken. Pearson r correlation analyses were run on acute-care and acute rehabilitation length of stay, days in coma, and days with PTA to identify their relationship with patients' self-report of criterion A depression symptom domains. Spearman rank-order correlation analyses were run on GCS admission rating, Disability Rating Scale total score on admission and discharge, FIM™ instrument total score on admission and discharge, and RLA rating on admission and discharge to identify their relationship to patients' self-report of criterion A depression symptom domains. The correlation analyses did not indicate that injury severity variables were significantly related to patients' reports of depressive symptoms.

Psychosocial factors. Social functioning and community integration were evaluated for their potential effect on patients' reports of depression. One-way ANOVA showed a main effect for employment category on the number of DSM-IV criterion A depression symptoms reported (fig 2). Tukey post hoc analysis indicated that unemployed patients were significantly more likely to report criterion A depression symptoms (mean, 3.22) than patients who were employed (mean, 1.76), full-time students (mean, 1.50), or retired due to age (mean, 1.87). Similarly, 1-way ANOVA showed a main effect for income category on criterion A depressive symptoms. Tukey post hoc analysis indicated that patients with annual family incomes of \$9999 or less were significantly more likely to report depressive symptoms (mean, 3.58) than all other income categories (mean, 1.54–2.97). Furthermore, individuals with family incomes of \$10,000 to \$19,999 were significantly more likely to report depressive symptoms (mean, 2.97) than individuals making \$50,000 or more (mean, 1.54). One-way ANOVA showed that marital status did not have a significant effect on depression.

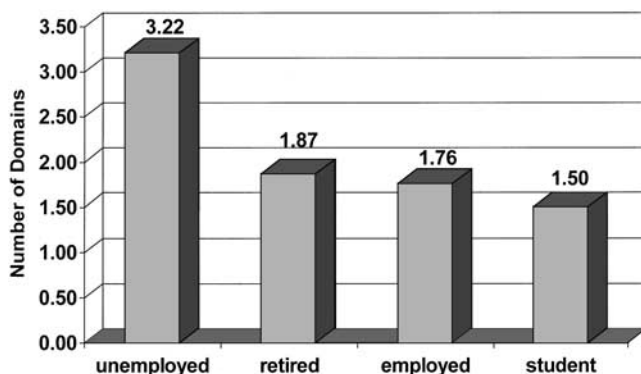


Fig 2. Employment category and number of major depressive episode domains reported.

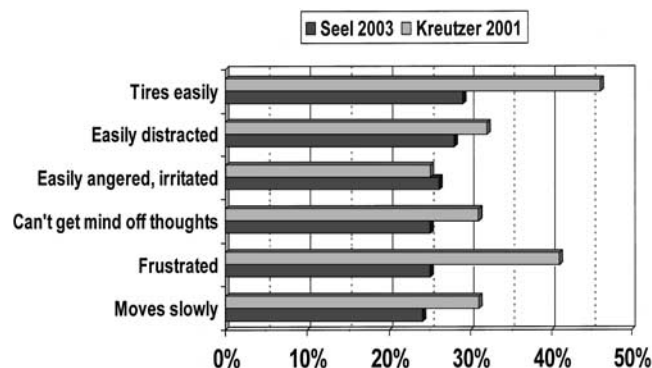


Fig 3. The NFI depression items most frequently reported in the present study, compared with the findings of Kreutzer et al.⁶

DISCUSSION

Symptom Rates

Across depressive episode criterion A domains, the most commonly occurring NFI items were identified. The 6 most frequently endorsed items represented 4 of the 9 symptom domains. Tires easily during physical activity (29%), a symptom associated with the decreased energy domain, was the most frequently reported symptom. Easily distracted (28%) and easily angered or irritated (26%) were also frequently reported as clinically problematic. Cannot get mind off certain thoughts, frustrated, and move slowly were reported often or always by approximately 25% of the sample.

Replicating the procedures of the single-center study by Kreutzer et al⁶ and comparing findings was a primary goal of this investigation (fig 3). The rate of problems with fatigue and frustration was considerably higher in the earlier study, whereas the rate of the remaining problems was comparable. Differences in sample composition offer the best explanation for varying symptoms rates. The present investigation was a multicenter study predominated by moderate and severe injuries. The Kreutzer single-center sample contained many persons whose injuries were mild. Research^{20,38} indicates that people with mild injuries are often acutely aware of their problems, whereas persons with severe injuries are less likely to be aware.

Early research studying common problems after severe brain injury reported similar rates of problems with fatigue, irritability, and slowness. For example, Oddy et al² reported symptom rates for fatigue and irritability as 33% and 29%, respectively. In her classic study of outcome 2 to 5 years after injury, Thomsen³⁹ reported symptoms rates for fatigue, irritability, and slowness as 28%, 38%, and 65%, respectively. The similarities in symptom frequency rates are remarkable, considering that these groundbreaking researchers relied on simple checklists and structured interviews.

Depression Frequency Rates

Using DSM criteria, most brain injury researchers have reported depression rates ranging from 26% to 42%. In the present sample, which consisted of persons with predominantly moderate and severe injuries, 27% reported ≥ 5 DSM-IV criterion A depressive symptoms. Fedoroff et al¹³ (27%) and Fann et al⁴⁰ (26%) reported similar rates. Jorge et al¹⁵ and Kreutzer⁶ both reported depression rates of 42%.

A few researchers have reported depression rates 2 to 3 times higher. For example, Alexander³¹ reported that 2 of every 3

patients were depressed. Varney et al¹¹ noted that 3 of every 4 patients were depressed. Patients in the Varney study had extremely high symptom rates, with nearly 90% of the sample reporting each of the following problems: (1) lack of energy, (2) indifference, (3) irritability, (4) poor concentration, and (5) sleep disturbance. Anorexia was reported by 77% of the Varney sample. Differential findings are most likely attributable to differences in sampling methods. The present investigation incorporated a large sample (N=666) enrolled from 17 geographically separate regions of the country. The Alexander and Varney studies relied on relatively small, single-center samples composed of many patients with mild injuries.

Differentiating Depressed From Nondepressed TBI Patients

Jorge et al¹⁵ found that depressed mood, lack of energy, and feeling worthless differentiated depressed from nondepressed patients at 4 different postinjury time intervals. Replicating their findings was an important aspect of the present investigation. In this investigation, patients who reported ≥ 5 DSM-IV criterion A symptoms for depression were compared with patients who did not. Distinctions similar to Jorge's were identified. Depressed patients were 10 to 19 times more likely to report feelings of hopelessness, difficulty enjoying activities, and feeling worthless.

Trouble falling asleep, restlessness, weakness, and poor concentration are typically attributed to the pathophysiologic consequences of neurotrauma. Some may be surprised that the depressed patients in the present study were 6 to 9 times more likely to report these 4 problems, compared with their nondepressed counterparts. Injury severity did not distinguish depressed from nondepressed patients. The current findings suggest that depression may be the primary contributor to sleep disturbance, restless, weakness, and concentration difficulties after brain injury. More research is needed to delineate the affective and pathophysiologic components of postinjury depressive behavior.

Factors Related to Depressive Symptoms After TBI

The present findings suggest that unemployment, low income, and minority status are risk factors for developing postinjury depressive symptoms. These findings are consistent with previous research^{1,2,28,29} that identified a relationship between unemployment, financial stressors, and depression after TBI. Further research is required to establish a causal link between TBI, mood disorder, vocational outcomes, and economic hardship. In the meantime, clinicians are encouraged to consider risk factors in developing plans for assessment and treatment.

The present study found no statistically significant relationships between depressive symptoms and time after injury, age, gender, marital status, injury etiology, or measures of injury severity. In addition, functional outcomes at the time of inpatient rehabilitation admission and discharge did not correlate significantly with depressive symptoms. With regard to injury severity, one should note that the current sample was predominantly composed of patients with moderate and severe injuries. Previous research suggesting a link between injury severity and depression³⁰⁻³² has focused predominantly on mild brain injury. Future research can help identify the full spectrum of protective and risk factors. Examining patients with a full range of injury severity (eg, mild, moderate, severe) should prove helpful.

Advantages and Limitations of the Present Study

The methods in this study, although imperfect, offer several advantages compared with previous studies of depression after TBI. First, the present study used the DSM-IV diagnostic framework for depression, the protocol endorsed by the American Psychiatric Association and perhaps the protocol most frequently used by mental health professionals. Second, it is among the first in the research literature to examine depression after TBI in a large, national, multicenter sample of patients. Third, it used an assessment instrument, the NFI, that was standardized on a large sample of persons with brain injury and that quantifies a broad range of symptoms related to both TBI and depression. Fourth, it provides a framework for categorizing the NFI according to the DSM-IV criteria in future studies. Last, this study is among relatively few that have compared the symptoms of depressed and nondepressed patients and have examined potential depression risk factors.

The study's limitations should be noted. First, the sample included recipients of inpatient rehabilitation who had predominately moderate and severe injuries. The findings may not be generalizable to persons with mild injuries and those who do not receive inpatient rehabilitation. Second, only persons who were able to provide NFI responses were included. Thus, the neurobehavioral symptoms of persons with TBI who were unable to communicate were not captured. Third, because the TBIMS centers are located primarily in urban medical centers, sample characteristics may not be representative of the general population. Fourth, potential risk factors for depression, such as history of alcohol abuse, psychiatric illness, and other medical problems, were not examined.

The NFI seems to be a valuable tool for identifying depressive symptoms within the TBI population. Conversely, the NFI was not used in this study to make formal diagnoses of major depressive disorders. Researchers and clinicians should note that no self-report depression instrument can reveal the fine distinctions necessary to make a formal diagnosis of a major depressive disorder. In particular, the NFI does not succinctly address symptom duration.

Future Research

Future research should examine the relationships between NFI items and scale scores related to depression, other instruments that measure depression, and formal diagnoses of the full spectrum of depressive disorders. As with all self-report depression instruments, a complementary formal interview would be necessary to fully identify the DSM-IV inclusion and exclusion criteria. Future research might also track patients' depressive symptoms from acute rehabilitation admission to several years after injury. Longitudinal data could be examined to identify rates of persistent and recurrent depression after TBI, as well as to clarify the issue of causality in the relationship between depression and unemployment. Last, future research should develop biopsychosocial predictive models to identify high-risk patients and to examine the efficacy of treatment interventions.

CONCLUSIONS

The present investigation adds to a growing body of evidence that depression is highly prevalent among persons with brain injury. Evidence also indicates that depression can greatly affect daily functioning and exacerbate cognitive impairments arising from brain dysfunction. Screening for depression makes sense as a standard feature of all TBI inpatient and outpatient rehabilitation protocols. Identifying the presence of depressive symptoms and providing appropriate referrals to

mental health professionals can minimize the effect that major depression has on a person's daily functioning and quality of life. Identification may also improve patients' use of rehabilitation and cognitive therapies. Further, the finding of increased depressive symptoms among the unemployed and impoverished may emphasize the importance of prompt vocational assessment and rehabilitation, as well as referral to appropriate community support programs.

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