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Factors predicting depression among persons with spinal cord injury 1 to 5 years post injury

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Abstract

Objectives—Estimate changes in prevalence of Major Depressive Disorder (MDD) 1 to 5 years post spinal cord injury (SCI); Identify demographic, injury, and discharge factors associated with MDD at 1 and 5 years post-injury; Identify modifiers of changes in MDD.

Design—Retrospective. Setting: Model Spinal Cord Injury System. Participants: 2,256 adult participants enrolled in the National Spinal Cord Injury Statistical Center between 1999 and 2004. Main Outcome Measure: MDD as determined by the Patient Health Questionnaire-9 (PHQ-9).

Results—Prevalence of MDD was 11.9% at 1 year and 9.7% at 5 years post SCI. Odds of MDD decreased significantly 1 to 5 years post-injury (odds ratio = 1.26, 95% confidence interval = 1.02, 1.56). At 1 year post-injury, the odds of MDD was greater for persons 35–55 years old at injury, unemployed, having an indwelling catheter or voiding bladder management at discharge, and higher scores on ASIA motor index. At 5 years post-injury, the odds of MDD were greater for females, persons 35–55 years old at injury, those with a high school education or less, those having an indwelling catheter, voiding, and no bladder management at discharge, and higher scores on ASIA motor index. Sex was the only significant modifier.

Conclusions—MDD occurs commonly 1 to 5 years post SCI. Sociodemographic, injury, and discharge factors are associated with the development and changes in depression. Future research should expand upon current findings in order to identify, prevent, and reduce the prevalence of MDD after SCI.

Keywords

SCI; depression

1. Introduction

Spinal cord injury (SCI) is a devastating condition causing profound life changes for millions of people around the world [49]. In the United States alone, an estimated 262,000 individuals are living with SCI [41]. Over 80% of these are male, with an average age at

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injury of about 40 years [41] and most frequent causes of injuries include motor vehicle accidents, violence, falls, and recreational accidents [38]. SCI typically causes paralysis and permanent disability, and over $7 billion is spent in the US each year on management of disabilities and treatment for secondary medical complications [3,38]. Despite costly and aggressive rehabilitative options, injuries to the spinal cord remain permanent and create lifelong challenges for survivors [38].

SCI results in diminished mobility, greatly reduced functional independence, and difficulties with socialization and employment [8]. Many individuals with SCI will also experience serious secondary medical complications including pressure ulcers, pneumonia, deep venous thrombosis, kidney and/or ureter calculi, spasticity, and pain [22,39]. Many survivors also experience serious psychological, psychosocial, and neurobehavioral issues and are at increased risk of developing anxiety disorders, substance abuse problems, feelings of helplessness, poor coping skills, low self-esteem, and depression [8,20,21]. Depression is the most common psychological issue associated with SCI [8], reportedly affecting approximately 30% of patients, and is generally characterized by depressed mood and diminished pleasure over a two-week span accompanied by issues including energy loss, concentration difficulties, and sleep or appetite disturbances [1].

Although it was once believed that virtually all SCI patients experience some level of depression as part of the adjustment process [17], depression has more recently been recognized as a secondary complication that is itself linked to a variety of problems [9,14]. Negative outcomes associated with depression among persons with SCI include diminished quality of life, poor social integration, and increased secondary medical complications [13]. Depression levels may change over time since injury [25], and depression has also been correlated with prolonged rehabilitation and fewer functional gains [36].

Because the presence or absence of depression can be a critical factor in the recovery process, researchers have sought to identify risk factors and predictors of depression among individuals with SCI. Factors found to predict or place individuals at risk for depression include greater severity of handicap [27,28,47], lack of autonomy, presence of severe complications [46], fewer years of education [29,46], greater number of hours spent in bed, degree of self-perceived handicap, younger age, being unmarried [47], pre-injury psychiatric or psychological issues such as substance abuse [22,27], inadequate coping abilities [43], pain [5, 7], lower activity patterns, frequent alcohol use post-injury, insufficient personal assistance [29], somatic symptoms [4], divorce, unemployment [23], pressure sores, low self-rated adjustment to disability [10], and neurological deficits [11].

Researchers have also identified several factors related to positive changes in post-injury levels of depression including adequate social support [27] and negative changes in post-injury depression including changes in level of pain [28]. Treatment modalities such as cognitive-behavioral therapy [6], social skills training [12], assertiveness training [19], and participation in sports activities [18] have also been correlated with positive changes in levels of depression among persons with SCI.

However, to our knowledge, there is a scarcity of research specifically investigating predictors of depression and factors that influence depression over time among individuals with SCI. Although previous studies have identified factors predictive of depression at various years post-injury, they have not used large, multicenter samples or investigated factors predicting changes in depression over time in the first five years post-injury. In 2000, items of the Patient Health Questionnaire (PHQ-9) were incorporated into the National Spinal Cord Injury Statistical Center (NSCISC) database, providing an optimal opportunity to analyze changes in depression over time within a large sample of individuals with SCI.

The item content of the PHQ-9 exactly parallels DSM-IV criteria, and has been found to have excellent internal consistency among populations with SCI [24]. Therefore, the goals of the present study were to (1) estimate the prevalence of depression 1 and 5 years post SCI and estimate the change in the prevalence of Major Depressive Disorder (MDD) 1 to 5 years post-SCI; (2) identify demographic, injury, and discharge characteristics associated with the prevalence of MDD at 1 and 5 years post SCI; and (3) identify demographic, injury, and discharge characteristics (factors) that modify the change in the prevalence of MDD 1 to 5 years post SCI. Such information could assist rehabilitation professionals to put early supports in place to prevent depression among vulnerable patients, and provide direction for future research into the effect on depression diagnoses when such factors are modified.

2. Methods

2.1. Participants

All participants in the database are model system SCI patients enrolled in the NSCISC database who were interviewed during their scheduled one-year post-injury, and had follow-up evaluation between 1975 and 2010; data was collected retrospectively for participants with injuries occurring between 1973 and 1975. The database stores the records of patient rehabilitation and follow-up information from 26 designated model systems nationwide, although eligibility criteria have been revised several times since the database's creation in 1973. Currently, all participants must (1) receive SCI model system inpatient care, (2) be treated at a model system within one year of injury, (3) have a clinically discernible degree of neurologic impairment following a traumatic event, (4) have given informed consent, and (5) reside in the geographic catchment area of the model system at the time of injury.

A sample of 2,830 participants was selected from the entire NSCISC database in 2010 for a retrospective analysis based on the following criteria: (1) older than 18 years of age at injury, (2) not classified at rehabilitation discharge as normal on the American Spinal Injury Association (ASIA) impairment scale or on the neurological impairment scale, and (3) injury occurred between October 30, 1999 and October 30, 2004. Depression variables were added to the database in October 2000, and required in March 2001. By selecting these inclusion dates we know the participants had the opportunity to respond to the depression questions, and those that were eligible for the one-year follow-up were also eligible for the five-year follow-up by the time the database was queried in October 2009. To be included in the analysis, the subject must have data for either the one or five year follow-up PHQ-9 questionnaire. Of the initial sample, 574 (20.3%) were missing both 1 and 5 year follow up on the PHQ-9 and could not be included in this analysis, leaving data from 2,256 participants available for analysis.

2.2. Dependent variable

The dependent variable was a categorical variable indicating whether or not a participant has "probable" major depressive disorder (MDD), calculated by NSCISC software as a function of questions one through nine of the Patient Health Questionnaire (PHQ-9), which are consistent with DSM-IV criteria [32], at the one and five year follow-up interview. In the present study, a diagnosis of MDD was rendered by first determining whether a patient reported at least 1 of the 2 essential criteria (depressed mood or anhedonia) on more than half of the last 14 days. The remaining items were then reviewed to determine if a total of 5 or more symptoms were present more than half the days in the past 2 weeks, with the exception of one regarding thoughts of death or suicide which was counted if reported at all [32].

The variable was dichotomized for analysis purposes as major depressive syndrome and no major depressive syndrome (including no depressive syndrome, other depressive syndrome).

Coded as missing values were subjects whose depression status was unknown or the interview was not done.

2.3. Independent variables

A variety of demographic, injury, and discharge characteristics were considered as independent variables in this analysis. Demographics included age at injury (in years), race (categorized from the two race and ethnicity variables as Non-Hispanic White, Non-Hispanic Black, Non-Hispanic other and Hispanic), sex, marital status at injury (married or not married (single, divorced, separated, widowed, and other/unclassified)), education level at injury (trichotomized as less than high school (less than grade 12), high school/GED, or more than high school (Associate's degree, Bachelor's degree, Master's degree, or Doctoral degree), employment level at injury (employed and not employed (unemployed, homemaker, on-the-job training, sheltered workshop, student, and other/unclassified)), and cause of injury (categorized as vehicular, sports/recreation/pedestrian, falls/flying objects, and other (including violence, medical/surgical complications, lightning, kicked by an animal, and machinery accidents)).

Discharge characteristics included place of residence at discharge (categorized as private residence, hospital/nursing home, or other (group living situation, correctional institution, hotel/motel, deceased, homeless, or other)), method of bladder management at discharge (categorized as none, catheter-free, voiding, intermittent catheterization program (ICP), and indwelling catheter), category of neuro-impairment at discharge (tetraplegic or paraplegic), ASIA impairment scale at discharge (complete vs. incomplete), and use of mechanical ventilation at discharge (yes or no). Additionally, rehabilitation length of stay (measured in days), a Functional Independence Measure (FIM) total score, measuring severity of disability by summing the 13 motor items comprising FIM, and an ASIA motor index score documenting motor functioning by summing individual scores for each of 20 key muscle groups were considered.

2.4. Statistical analyses

All analysis was performed in SAS v.9.2 [45]. Continuous variables were summarized using means and standard deviations (SD) for normally distributed and using median and range for skewed variables. Categorical variables were summarized using frequency counts and percentages.

Depression as measured by the PHQ-9 was missing at the one and five year follow-up visits for 574 participants. In order to assess for potential bias that may have resulted from excluding them from analysis, these subjects were compared to the remaining 2,256 participants with respect to demographic, injury, and discharge characteristics using chi-square tests, *t*-tests, and Wilcoxon rank-sum tests for categorical, continuous, and non-normally distributed continuous variables, respectively.

Generalized linear mixed effects models (GLMM) were used to model the probability of MDD 1 to 5 years post SCI. The model assumed a logit link and a binary distribution for the response variable. For Aim 1, the model included a fixed effect for post injury year (1 or 5) and a random subject effect. Models were extended for each factor to include a fixed effect for the covariate of interest and the covariate by follow-up year interaction to address Aims 2 and 3. Contrast statements were used to test for the associations between the factor of interest and the probability of MDD at each follow-up year (Aim 2) and the interaction effect was used to test for significant modifiers of the changes in MDD (Aim 3). A significance level of 5% was assumed for all tests and a Satterthwaite approximation was used to approximate the denominator degrees of freedom. Linearity of continuous factors was assessed and variables were categorized if the assumption did not hold.

3. Results

3.1. Description of the sample

The demographic, injury, and rehabilitation characteristics of the sample of 2,256 SCI participants available for analysis are summarized in the left columns of Table 1. The sample was primarily male (78%), non-Hispanic Caucasian (65%), not married (61%), had at least a high school level of education (63%), and were employed (68%) at injury. The mean age at injury was 37.7 years old (standard deviation (SD) = 15.0) and injuries were predominantly due to vehicular accidents (51%). The median number of days spent in rehabilitation was 48 days (interquartile range (IQR) = 30 to 77). At discharge from rehabilitation, the mean FIM and ASIA motor scores were 53.7 (SD =21.7) and 50.8 (SD = 25.6), respectively. Participants primarily were discharged to private residences (90%), were managing their bladder using ICP (62%), required no mechanical ventilation support (97%). Approximately half of the injuries had a neurological classification of tetraplegia (55%) or as incomplete on the ASIA impairment scale (54%).

3.2. Included versus excluded samples

The excluded sample missing PHQ-9 data for both 1 and 5 years follow-up is summarized in the right columns of Table 1. The groups were not different in terms of age at injury, sex, rehabilitation length of stay, or ASIA impairment at rehabilitation discharge (all p's > 0.05). The excluded sample has significantly more non-Hispanic Blacks (28.6% vs. 20.8%) and fewer non-Hispanic Caucasians (54.8% vs. 64.9%) than the analysis sample ($p < 0.0001$). The excluded sample was less likely to be married at injury (32.6% vs. 38.8%; $p = 0.0065$), more likely to have less than a high school education at injury (28.2% vs. 19.6%; $p < 0.0001$), less likely to be employed at injury (60.7% vs. 68.4%; $p < 0.0001$), and less likely to receive injuries from motor vehicle accidents (42.0% vs. 51.0%) and more likely to receive them from other sources (22.5% vs. 15.2%) than the analysis sample ($p < 0.0001$). Additionally, at rehabilitation discharge the excluded sample was more likely to reside in the hospital (17.8% vs. 8.2%) and less likely to reside in private residence (80.8% vs. 90.3%; $p < 0.0001$), more likely to have an indwelling catheter (24.3% vs. 15.7%) and less likely use intermittent catheterization (55.6% vs. 62.3%; $p = 0.0001$), more likely to require mechanical ventilation (5.1% vs. 3.0%; $p = 0.0137$), less likely to be classified as paraplegic (40.2% vs. 45.2%; $p = 0.0339$), and had lower mean FIM motor scores (48.3 vs. 53.7; $p < 0.0001$) and ASIA motor scores (48.1 vs. 50.8; $p = 0.0346$).

3.3. Estimated prevalence and changes in prevalence 1 to 5 years post SCI

The prevalence of MDD was estimated using a GLMM to be 11.9% (95% CI = 10.5%, 13.4%) at 1 year post injury and 9.7% (95% CI = 8.2%, 11.4%) at 5 years post injury. There was a significant decrease in probability of MDD from year 1 to year 5 ($F(1,1706) = 4.53$, $p = 0.0335$), with the odds of MDD being 26% larger at follow-up year 1 than at follow-up year 5 (OR = 1.26, 95% CI = 1.02, 1.56).

3.4. Predictors of major depressive disorder at 1 year post SCI

The mean FIM motor, mean ASIA motor, and median rehabilitation LOS are summarized for cases with and without MDD at 1 and 5 years post SCI in Table 2. In addition, the prevalence of MDD within each level of the demographic, injury, and rehabilitation characteristics are summarized in Table 3.

The GLMMs indicates that age at injury (p = 0.0005), employment status at injury (p = 0.0117), bladder management at discharge (p = 0.0458), and ASIA motor index scores at discharge (p = 0.0266) were the only factors significantly associated with the probability of MDD at year 1 post SCI. In general, the odds of MDD were greater for persons 35–55 years old at injury as compared to those 18–35 or 55–70, for those unemployed at injury as compared to those employed or other, having an indwelling catheter or voiding bladder management at rehabilitation discharge as compared to ICP, and with higher scores on the ASIA motor index. The overall effect for residence at discharge was not significant at 1 year post SCI (p = 0.0934), however the odds of MDD were significantly greater for persons discharged to hospitals/nursing homes as compared to those discharged to private residences (OR =0.61, 95% CI = 0.39, 0.96). The odds ratios for all comparisons are summarized in Table 4.

3.5. Predictors of major depressive disorder at year 5

The GLMMs further indicated that sex (p =0.0001), age at injury (p = 0.0365), level of education at injury (p = 0.0342), bladder management at discharge (p = 0.0013), ASIA motor index (p = 0.0092), and ASIA impairment scale (p = 0.0394) were the only characteristics significantly associated with the probability of MDD at 5 years post SCI. In general, the odds of MDD were greater for females as compared to males, persons 35–55 years old at injury as compared to those 18–35 years, for those with a high school level of education or less as compared to those with greater than a high school level, for those with an indwelling catheter, voiding, and no bladder management at rehabilitation discharge as compared to ICP, those with no bladder management as compared to catheter-free, and for those with higher scores on the ASIA motor index. While the overall effect of cause of injury was not significant at 5 years post SCI (p = 0.0524), persons with sports-related/recreational vehicle/pedestrian injuries were significantly less likely to have MDD than all other etiology groups. The odds ratios for all comparisons are summarized in Table 4.

3.6. Modifiers of the changes in depression over time

Comparisons of the odds of MDD from 1 to 5 years post SCI for each level of the demographic, injury, and discharge characteristics are summarized in Table 5; ORs > than 1 indicate decreases in the odds of MDD over time while ORs < 1 indicate increases in the odds over time. Non-Hispanic Black races/ethnicities, injury ages of 35–55 years, greater than high school levels of education, being unemployed at injury, sports related/recreational vehicles/pedestrian etiologies, ICP methods of bladder management, and completeness of injury were all significantly associated with decreases in the odds of MDD 1 to 5 years post SCI. No factors were significantly associated with increases in the odds of MDD 1 to 5 years post-injury, however Hispanic races/ethnicities, injury ages of 55–70 years, “other” employment classifications at injury, etiologies due to violence/medical surgical complications/other, and no bladder management issues were nominally associated with increases in the odds of MDD 1 to 5 years post SCI. Interaction effects between year post SCI and each covariate were examined to determine if the changes in the probability of MDD were significantly different among the levels of each of the demographic, injury, and discharge characteristics. Sex was the only significant modifying effect (p = 0.0165); the odds of MDD significantly decreased 1 to 5 years post SCI for males and nominally increased 1 to 5 years for females.

4. Discussion

The present study had three aims. The first was to estimate the prevalence of MDD 1 and 5 years post SCI and determine the change in prevalence of MDD from 1 to 5 years post SCI. Results showed that the prevalence of MDD was 11.9% at 1 year and 9.7% at 5 years post

SCI. The odds of MDD decreased significantly 1 to 5 years post-injury (odds ratio = 1.26, 95% confidence interval = 1.02, 1.56).

The estimated prevalence of MDD at 1 and 5 years post SCI in the present study is consistent with prior findings. Bombardier [4] reported that 11.4% of individuals met criteria for MDD at 1-year post SCI (N=849) using the PHQ-9. More recently, Krause et al. [31] found that 10.7% of individuals less than 1-year post SCI ($N = 727$) met diagnostic criteria for MDD. It should be noted that studies conducted prior to the inclusion of the PHQ-9 in the SCI Model System National Database generally provided much higher estimated prevalence of MDD, but were often difficult to interpret because of varying depression scales used across studies. The availability of the PHQ-9 in the database appears to be providing consistent prevalence estimates across studies. Likewise, previous research has reported decreased risk of MDD over the post SCI trajectory [2,31,40]. However, a significant reduction in the odds of MDD from 1 to 5 years post injury has not been previously reported in the literature and was an important finding in the present study.

The second aim was to examine which demographic, injury, and discharge characteristics were associated with the prevalence of MDD at 1 and 5 years post SCI. At 1 year post-injury, the odds of MDD were greater for persons 35–55 years old at injury versus 18–35 or 55–70, for those unemployed at injury versus employed or other, for indwelling catheter or voiding bladder management at discharge versus ICP, and for higher scores on ASIA motor index. At 5 years post-injury, the odds of MDD were greater for females versus males, persons 35–55 years old at injury versus 18–35, for those with a high school education or less versus those with greater than a high school level, for indwelling catheter, voiding, and no bladder management at discharge versus ICP, and for no bladder management versus catheter free, and for higher scores on ASIA motor index.

While many of the above factors associated with MDD in persons with SCI have been previously reported [23,27,28,46,47], the present analysis revealed several novel findings. First, age between 35–55 years was associated with the prevalence of MDD at 1 and 5 years post SCI. Second, characteristics of bladder management influenced MDD prevalence at 1 and 5 years, such that individuals with an indwelling catheter, voiding bladder management or no bladder management had a significantly increased risk of MDD.

To our knowledge, age has not been previously identified as a significant predictor of MDD post SCI, with several studies reporting a lack of association between demographic variables and MDD [2,4,11]. Also intriguing is the new finding of bladder management characteristics as a significant predictor of MDD prevalence post SCI. Individuals who used voiding bladder management (which includes the use of external collection devices, condom catheters, or reflex stimulation techniques), no bladder management, or an indwelling catheter were at higher risk for MDD compared to persons who used ICP. While there is a paucity of research on the influence of bladder management on MDD, therapeutic approaches that increase autonomy, and which provide a greater level of convenience and ability to engage socially are thought to enhance psychosocial outcomes [16]. While this study was not designed to make any inferences about the reasons for increased risk of MDD when individuals use bladder management strategies that are more reliant on caregiver management, it does bring forth interesting relationships that may deserve further consideration in future research.

Of note, a recent cross-sectional study by Oh et al. [42] found that persons with neurogenic bladder secondary to SCI ($N = 102$) who were unable to perform catheterization independently had a 4.6-fold higher risk (OR 4.62; 95% CI 1.67–12.81, $P = 0.003$) of depression than those who were able to perform self-catheterization. In their study sample, the level of injury (cervical vs noncervical), deficits (tetraplegic vs paraplegic), duration of injury, educational level, and income level, were not significantly associated with MDD. Multivariate modeling revealed that female patients had a 3.8 fold higher risk of MDD than male patients, however, the type of catheterization (caregiver vs self) had a more significant impact on the risk of MDD than sex. In the present study, we were unable to differentiate persons who were performing self-ICP vs caregiver-ICP. However, it remains questionable whether the ability to perform self-ICP reflects functional performance rather than a unique category of bladder management. Further research on clinical outcomes between individuals who use self- vs caregiver-ICP will assist in understanding potential differences.

The third aim was to determine which demographic, injury, and discharge characteristics modify changes in the prevalence of depression 1 to 5 years post SCI. Sex was the only significant modifier; the odds of MDD significantly decreased 1 to 5 years post-injury for males and nominally increased for females.

In contrast with previous research findings on the factors associated with MDD post SCI, marital status [47], educational [46], income level [30], prior history of psychiatric disorder [11,28,40], overall health [4,29, 46], social support [29], substance abuse [11,29] and injury characteristics [2,17] did not influence changes in MDD over time. While previous studies have demonstrated that women are at a substantially higher risk for depressive symptoms [26,30], these research approaches were not designed to explore the factors that modify the changes in prevalence of MDD from 1 to 5 years. Thus, the present finding provides a deeper understanding of the relationships among sex and MDD in individuals post SCI, which may help to guide future research and clinical practice.

Several important practice and future research implications can be gleaned from these findings. Perhaps most importantly, the study provides evidence that MDD is not a necessary response to injury or rehabilitation, but occurs in a minority (11.9%) of persons with SCI at 1-year post injury. The results of the present study indicate that the prevalence of MDD decreases from 1 to 5 years post injury [31,44]. While these findings inform practitioners that most individuals with SCI will not experience MDD during the first five years post injury, they do not discount the importance of identifying and providing treatment for individuals who develop clinically significant depressive symptoms.

Using the factors that were significantly associated with the prevalence of MDD at 1 and 5-years post SCI may help to improve identification of individuals at-risk of MDD, or focus more intensive screening programs or resources to improve MDD diagnosis and treatment. Prospective research is needed to identify whether the identified factors can help to improve clinical practice for screening and diagnosis of MDD. One such approach could involve using these criteria (along with PHQ-9 results) to determine need for consultation with a clinical psychologist, who is typically a scarce but highly valued resource in most health care facilities. When considering the human suffering and cost of undiagnosed MDD on clinical outcomes, such an approach may ultimately lead to better clinical outcomes, fewer complications, and cost-savings in the long-term.

The implication of bladder management on MDD is less clear. Although ICP is regarded as the most ideal and safest method for regular, complete bladder evacuation, there are other important factors to consider before initiating ICP, including the individual's preference, financial concerns, access to resources including a care provider who can perform the procedure throughout the day, and desire to engage in sexual activity. Factors such as urological complications and rehospitalization could also potentially influence or explain the association between bladder management and MDD. Besides the benefits of ICP on reducing alterations in perceived body image and enhanced sexual adjustment after SCI [16] the results of this study indicate that it is associated with a reduced prevalence of MDD. Findings should alert practitioners to this potential relationship and allow them to consider these facets of care within the individual's health situation. Further research on ICP and MDD may help to determine which persons with SCI would benefit most and guide resource allocation, particularly in consideration of the personnel and time required for individuals who are unable to perform self-ICP.

There are several important limitations that must be considered when interpreting the findings of the present study. First, there were many instances of missing data points for MDD – both the 1- and 5-year measurement was missing for 574 participants. However, participants with complete missing data were compared to the remaining 2,256 participants with respect to demographic, injury, and discharge characteristics. Differences between the groups were noted for race, marital status at injury, level of education at injury, employment status at injury, cause of injury, discharge disposition, bladder management, mechanical ventilation, category of neurological impairment, FIM motor scores at rehabilitation discharge, and ASIA motor scores. The loss of two model systems in October 2000 (Detroit and Milwaukee) might explain some of the differences in the demographic characteristics between the groups. Second, while we did observe a significant decrease in the probability of MDD from 1 year post injury to 5 years post injury, there was not information available regarding treatment the participants may have received. Thus, the decrease in MDD could be attributed to these participants receiving varying levels of treatment for depression. Furthermore, the study may also be criticized for relying on a measure of MDD that has not been validated in the SCI population [24]. However, extrapolating from studies that have reported on the psychometrics of the PHQ-9 (internal consistency was excellent, 0.872 and 0.8654) and research on persons in primary care settings [33,35,37], with traumatic brain injury [15], and with other acute conditions [34,48], it appears that the PHQ-9 is an adequate instrument for both screening and outcome measures in SCI [24].

5. Conclusions

Depression is associated with diminished quality of life, poor social integration, prolonged rehabilitation, fewer functional gains and increased secondary medical complications in persons with SCI [13,25,36]. Understanding the predictors of MDD in individuals post SCI may help to begin development of therapeutic approaches to prevent depression among vulnerable patients, and provide direction for future research into the effect on depression diagnoses when such factors are modified.

The present study found several predictors of MDD at 1 and 5 years post SCI that may be used to help guide screening practices and resource allocation, such as more frequent screening for MDD in persons between the ages of 35–55, females, persons with a high school education or less, or individuals who are using non-ICP bladder management. The results may also be used to further research by testing the implementation of clinical approaches focused on reducing the prevalence of MDD over the first 5 years post injury. Considering the human suffering and limitations on clinical recovery that MDD can cause in persons with SCI, clinical approaches to reduce the prevalence of MDD may ultimately lead to better outcomes, and potentially improved quality of life in this patient population.

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Table 1

Demographic, injury, and rehabilitation discharge characteristics of the analysis sample (N = 2,256) and excluded sample (N = 574)

	Analysis		Excluded	
	Mean	**SD**	**Mean**	**SD**
FIM Motor††	53.74	21.67	48.28	22.86
ASIA Motor††	50.78	25.64	48.08	25.64
Rehab Length of Stay(days)‡	48	30 to 77	61	29 to 77
	Count	Percent	Count	Percent
Sex				
Male	1762	78.10	454	79.09
Female	494	21.90	120	21.90
Race				
Caucasian	1463	64.91	314	54.80
Black	468	20.76	164	28.62
Hispanic	277	12.29	73	12.74
Other	46	2.04	22	3.84
Age†				
18–35 years old	984	45.39	277	49.91
35–55 years old	858	39.58	178	32.07
55–70 years old	255	11.76	73	13.15
70+	71	3.27	27	4.86
Marital Status†				
Married	873	38.75	186	32.57
Not Married	1380	61.25	385	67.43
Education†				
Less than HS	422	19.63	143	28.15
HS/GED	1345	62.56	294	57.87
More than HS	383	17.81	71	13.98
Employment†				
Employed	1509	68.37	336	60.65
Unemployed	308	13.96	118	21.30
Other	390	17.67	100	18.05
Cause of Injury				
Vehicular	1149	50.98	241	41.99
Falls/Flying or Falling Objects	544	24.13	159	27.70
Sports/Recreational Vehicles/Pedestrians	218	9.67	45	7.84
Violence/Medical Surgical/Other	343	15.22	129	22.47
Place of Residence††				
Private	2033	90.28	459	80.81
Hospital/Nursing Home	184	8.17	101	17.78

	Analysis		Excluded	
	Mean	SD	Mean	SD
Other	35	1.55	8	1.41
Bladder Management††				
Indwelling Catheter	348	15.70	135	24.28
ICP	1380	62.27	309	55.58
Voiding	333	15.03	78	14.03
Catheter-Free	65	2.93	13	2.34
None	90	4.06	21	3.78
Mechanical Ventilation††				
Yes (Any)	67	3.01	29	5.12
No	2159	96.99	537	94.88
ASIA Impairment††				
Complete	994	45.83	247	46.00
Incomplete	1175	54.17	290	54.00
Neurological Impairment††				
Tetraplegia	1192	54.78	322	59.85
Paraplegia	984	45.22	216	40.15

† indicates pre-injury,

†† indicates rehabilitation discharge,

‡ indicates variable described by median and interquartile range.

Table 2

Summary of continuous rehabilitation discharge characteristics by MDD at 1 and 5 years post SCI

	1 year post SCI				**5 years post SCI**			
	No MDD (*N* = 1720)		**MDD (*N* = 232)**		**No MDD (*N* = 1242)**		**MDD (*N* = 132)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
FIM Motor††	54.29	21.60	54.61	22.15	52.93	21.45	54.22	21.53
ASIA Motor††	50.74	25.59	54.81	26.55	48.57	24.91	54.85	25.16
Rehab Length of Stay (days)‡	48	30 to 73	45	28 to 76	50	31 to 85	50	31 to 79

††indicates rehabilitation discharge,

‡indicates variable described by median and interquartile range, SD = standard deviation.

Table 3

Prevalence of MDD by demographic, injury, and discharge characteristics at 1 and 5 years post SCI

	1 year post SCI				5 years post SCI			
	No MDD (N = 1720)		MDD (N = 232)		No MDD (N = 1242)		MDD (N = 132)	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Sex								
Male	1340	88.57	173	11.43	968	92.19	82	7.81
Female	380	86.56	59	13.44	274	84.57	50	15.43
Race								
Caucasian	1112	87.77	155	12.23	871	90.07	96	9.93
Black	355	88.53	46	11.47	236	93.65	16	6.35
Hispanic	220	90.53	23	9.47	109	86.51	17	13.49
Other	33	84.62	6	15.38	24	88.89	3	11.11
Age†								
18–35 years old	758	89.92	85	10.08	557	92.83	43	7.17
35–55 years old	629	84.09	119	15.91	465	87.74	65	12.26
55–70 years old	207	91.59	19	8.41	140	90.32	15	9.68
70+	57	91.94	5	8.06	37	94.87	2	5.13
Marital Status†								
Married	680	87.74	95	12.26	493	89.96	55	10.04
Not Married	1038	88.42	136	11.58	748	90.67	77	9.33
Education†								
Less than HS	314	88.20	42	11.80	214	88.43	28	11.57
HS/GED	1030	88.11	139	11.89	738	90.00	82	10.00
More than HS	305	89.44	36	10.56	241	94.88	13	5.12
Employment†								
Employed	1168	88.48	152	11.52	853	90.46	90	9.54
Unemployed	210	82.35	45	17.65	151	89.35	18	10.65
Other	303	90.18	33	9.82	207	90.00	23	10.00
Cause of Injury								
Vehicular	884	88.22	118	11.78	645	89.83	73	10.17

	1 year post SCI				5 years post SCI			
	No MDD (N = 1720)		MDD (N = 232)		No MDD (N = 1242)		MDD (N = 132)	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Falls/Flying or Falling Objects	415	87.18	61	12.82	286	90.51	30	9.49
Sports/Recreational Vehicles/Pedestrians	161	89.44	19	10.56	142	96.60	5	3.40
Violence/Medical Surgical/Other	259	88.70	33	11.30	167	87.43	24	12.57
Place of Residence††								
Private	1573	88.67	201	11.33	1120	90.69	115	9.31
Hospital/Nursing Home	122	82.43	26	17.57	99	86.09	16	13.91
Other	23	85.19	4	14.81	21	95.45	1	4.55
Bladder Management††								
Indwelling Catheter	243	84.67	44	15.33	184	85.98	30	14.02
ICP	1076	89.52	126	10.48	811	92.47	66	7.53
Voiding	256	85.33	44	14.67	149	86.13	24	13.87
Catheter-Free	51	94.44	3	5.56	47	95.92	2	4.08
None	65	86.67	10	13.33	37	82.22	8	17.78
Mechanical Ventilation††								
Yes (Any)	49	81.67	11	18.33	34	87.18	5	12.82
No	1655	88.50	215	11.50	1192	90.44	126	9.56
ASIA Impairment††								
Complete	744	88.36	98	11.64	591	92.06	51	7.94
Incomplete	916	88.25	122	11.75	616	88.76	78	11.24
Neurological Impairment††								
Tetraplegia	904	87.68	127	12.32	663	91.32	63	8.68
Paraplegia	759	89.08	93	10.92	549	89.27	66	10.73

† indicates pre-injury,

†† indicates rehabilitation discharge.

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Table 4

Comparison within demographic, injury, and discharge characteristics of the odds of MDD versus no MDD at 1 and 5 year post SCI

		Year 1		Year 5	
Predictor	**Comparison**	**OR**	**95% CI**	**OR**	**95% CI**
Sex	Female vs. Male	1.18	(0.86, 1.62)	2.08	(1.43, 3.03)*
Race	White vs. Black	1.06	(0.75, 1.49)	1.59	(0.93, 2.73)
	White vs. Hispanic	1.33	(0.84, 2.11)	0.78	(0.44, 1.37)
	White vs. Other	0.79	(0.32, 1.92)	0.89	(0.27, 2.99)
	Black vs. Hispanic	1.26	(0.75, 2.14)	0.49	(0.24, 1.01)
	Black vs. Other	0.75	(0.30, 1.88)	0.56	(0.15, 2.04)
	Hispanic vs. Other	0.59	(0.22, 1.56)	1.14	(0.31, 4.21)
Age†	18–35 vs. 35–55	0.59	(0.44, 0.79)*	0.56	(0.38, 0.84)*
	18–35 vs. 55–70	1.24	(0.74, 2.09)	0.76	(0.41, 1.41)
	18–35 vs. 70+	1.25	(0.49, 3.18)	1.24	(0.32, 4.82)
	35–55 vs. 55–70	2.11	(1.27, 3.51)*	1.35	(0.74, 2.45)
	35–55 vs. 70+	2.13	(0.85, 5.38)	2.20	(0.57, 8.46)
	55–70 vs. 70+	1.01	(0.37, 2.80)	1.63	(0.39, 6.79)
Marital Status†	Married vs. Not Married	1.05	(0.80, 1.39)	1.09	(0.76, 1.56)
Education Level†	< HS vs. HS/GED	0.98	(0.68, 1.42)	1.17	(0.75, 1.84)
	< HS vs. > HS	1.11	(0.69, 1.78)	2.37	(1.21, 4.64)*
	HS/GED vs. > HS	1.13	(0.77, 1.67)	2.02	(1.12, 3.65)*
Employment Status†	Unemployed vs. Employed	1.63	(1.13, 2.34)*	1.10	(0.65, 1.89)
	Unemployed vs. Other	1.94	(1.20, 3.13)*	1.01	(0.53, 1.93)
	Employed vs. Other	1.19	(0.80, 1.77)	0.92	(0.57, 1.47)
Cause of Injury	Vehicular vs. Falls/Flys	0.91	(0.65, 1.26)	1.06	(0.68, 1.64)
	Vehicular vs. Sports	1.14	(0.68, 1.91)	3.02	(1.24, 7.38)*
	Vehicular vs. Other	1.05	(0.70, 1.59)	0.78	(0.48, 1.27)
	Falls/Flys vs. Sports	1.26	(0.73, 2.18)	2.86	(1.12, 7.29)*
	Falls/Flys vs. Other	1.16	(0.74, 1.83)	0.74	(0.42, 1.29)

Predictor	Comparison	Year 1		Year 5	
		OR	95% CI	OR	95% CI
	Sports vs. Other	0.92	(0.51, 1.68)	0.26	(0.10, 0.67)*
Rehab LOS	Stay of 77 days vs. 30 days	1.03	(0.89, 1.18)	0.94	(0.81, 1.10)
Place of Residence††	Private vs. Hospital	0.61	(0.39, 0.96)*	0.61	(0.35, 1.06)
	Private vs. Other	0.76	(0.26, 2.24)	2.14	(0.29, 15.78)
	Hospital vs. Other	1.24	(0.39, 3.92)	3.50	(0.45, 27.31)
Bladder Management††	Indwelling vs. ICP	1.54	(1.06, 2.23)*	2.01	(1.27, 3.19)*
	Indwelling vs. Voiding	1.05	(0.67, 1.66)	1.00	(0.56, 1.78)
	Indwelling vs. Cath-Free	3.15	(0.93, 10.64)	4.09	(0.90, 18.47)
	Indwelling vs. None	1.17	(0.56, 2.44)	0.74	(0.32, 1.74)
	ICP vs. Voiding	0.68	(0.47, 0.99)*	0.50	(0.30, 0.81)*
	ICP vs. Cath-Free	2.05	(0.62, 6.72)	2.03	(0.46, 8.91)
	ICP vs. None	0.76	(0.38, 1.51)	0.37	(0.17, 0.82)*
	Voiding vs. Cath-Free	2.99	(0.89, 10.09)	4.08	(0.89, 18.65)
	Voiding vs. None	1.11	(0.53, 2.32)	0.74	(0.31, 1.77)
	Cath-Free vs. None	0.37	(0.10, 1.43)	0.18	(0.04, 0.94)*
Mechanical Ventilation††	Yes vs. No	1.69	(0.86, 3.31)	1.38	(0.53, 3.57)
FIM Motor††	Score of 73 vs. 34	1.04	(0.81, 1.34)	1.11	(0.79, 1.55)
ASIA Motor††	Score of 70 vs. 33	1.27	(1.03, 1.56)*	1.46	(1.10, 1.94)*
ASIA Impairment††	Complete vs. Incomplete	0.99	(0.75, 1.32)	0.68	(0.47, 0.98)*
Neuro-Impairment††	Tetraplegia vs. Paraplegia	1.13	(0.85, 1.50)	0.80	(0.56, 1.15)

*indicates $p < 0.05$,

†indicates pre-injury,

††indicates rehabilitation discharge; OR = Odds Ratio; CI = Confidence Interval.

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Table 5

Odds of MDD 1 year versus 5 year post SCI within levels of the demographic, injury, and discharge characteristics

Predictor	Year 1 vs. year 5	OR	95% CI
Sex	Female	0.86	(0.58, 1.25)
	Male	1.51	(1.16, 1.95) *
Race	White	1.24	(0.96, 1.60)
	Black	1.87	(1.07, 3.27) *
	Hispanic	0.72	(0.38, 1.38)
	Other	1.40	(0.34, 5.74)
Age †	18–35	1.42	(0.99, 2.03)
	35–55	1.36	(1.00, 1.85) *
	55–70	0.87	(0.44, 1.71)
	70+	1.40	(0.31, 6.44)
Marital Status †	Married	1.23	(0.88, 1.71)
	Not Married	1.27	(0.96, 1.68)
Education †	< High School	1.01	(0.62, 1.64)
	High School/GED	1.21	(0.92, 1.59)
	>High School	2.16	(1.17, 3.99) *
Employment †	Employed	1.23	(0.95, 1.60)
	Unemployed	1.82	(1.04, 3.19) *
	Other	0.95	(0.56, 1.61)
Cause of Injury	Vehicular	1.18	(0.88, 1.59)
	Falls/Flys	1.38	(0.89, 2.14)
	Sports/Peds	3.14	(1.22, 8.05) *
	Other	0.88	(0.52, 1.50)
Rehab LOS	Median Stay of 48 Days	1.20	(0.96, 1.51)
Place of Residence ††	Private	1.24	(0.99, 1.56)
	Hospital/Nursing Home	1.24	(0.66, 2.35)
	Other	3.51	(0.40, 30.75)
Bladder Management ††	Indwelling Catheter	1.10	(0.68, 1.78)
	ICP	1.44	(1.07, 1.94) *
	Voiding	1.05	(0.63, 1.74)
	Catheter-Free	1.43	(0.24, 8.41)
	None	0.70	(0.26, 1.84)
Mechanical Ventilation ††	Yes	1.50	(0.51, 4.44)
	No	1.22	(0.98, 1.52)
FIM Motor ††	Mean Score of 54	1.24	(1.00, 1.55)
ASIA Motor ††	Mean Score of 51	1.25	(1.00, 1.57)

Predictor	Year 1 vs. year 5	OR	95% CI
ASIA Impairment[††]	Complete	1.53	(1.09, 2.14)[*]
	Incomplete	1.04	(0.79, 1.39)
Neuro-Impairment[††]	Tetraplegia	1.45	(1.08, 1.96)[*]
	Paraplegia	1.03	(0.75, 1.41)

[*] indicates $p < 0.05$,

[†] indicates pre-injury,

[††] indicates rehabilitation discharge; OR = Odds Ratio; CI = Confidence Interval.