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Depression trajectories during the first year after spinal cord injury

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Abstract

Objective—To determine the number and type of longitudinal depression trajectories during the first year after spinal cord injury (SCI) and to identify baseline predictors of these trajectories.

Design—Cohort study

Setting—Rehabilitation and postacute community settings.

Participants—Of 168 consecutive admissions to inpatient rehabilitation for acute SCI, 141 (115 males and 26 females) patients were enrolled in a randomized controlled trial (RCT) telephone follow-up intervention, which showed no outcome differences, and completed assessments on at least 2 of the 4 follow-up occasions (3, 6, 9, and 12 months after SCI). Participants were on average 41 years old, most were non-Hispanic (96%) and white (86%), and 61.7% had tetraplegia.

Intervention(s)—Data were drawn from the ineffective randomized controlled trial.

Main Outcome Measure(s)—Patient Health Questionnaire-9 (PHQ-9).

Results—Unconditional linear latent class growth analysis models of PHQ-9 total scores revealed an optimal 3-class solution: *stable low depression* (63.8%), *mild to moderate depression* (29.1%), and *persistent moderate to severe depression* (7.1%). Preinjury mental health history and baseline pain, quality of life, and grief predicted class membership.

Conclusions—The modal response to SCI was stable low depression, whereas persistent moderate to severe depression primarily represented a continuation or relapse of preinjury depression. This line of research has the potential to improve identification of subgroups destined for poor outcomes and to inform early intervention studies.

Keywords

spinal cord injury; depression; trajectories; resilience

Introduction

The prevalence of depression after spinal cord injury (SCI) has been studied extensively.¹ We know that approximately 20-38% of individuals with new SCI will exhibit significant depressive symptomatology during inpatient rehabilitation and 11-31% surveyed in the community will have a depressive episode. However, group averages captured at one point in time actually convey little clinically relevant information for the individual patient. We do not know how many people are never depressed, how many become depressed, how many remain depressed and how many recover from depression. For purposes of prognosis and treatment planning, we need to know what is a given person's likely *course* of depression.

There is surprisingly little research on the course of depression in SCI. Two studies on course of depression through inpatient rehabilitation found 54-62% were never depressed, 18-25%, 20-21% were persistently depressed, and 18-25% recovered from depression.^{2,3} There is new onset major depression, depression recovery and persistent depression 3-6 months after SCI.^{4,4} Approximately 30% of people who are depressed and anxious after SCI remain so 1-2 years after SCI.⁵ One longitudinal study depression 1-5 years after SCI found that 8.7% of the sample had persistent or recurrent depression, while 25% demonstrated improved depression, and 20% reported worsening depression.⁶

Newer statistical methods are able to detect subgroups with similar longitudinal trajectories within samples that have heterogeneous outcomes.⁷ A seminal European study detected four depression trajectories during the first two years after SCI.⁸ The trajectories were: (1) stable low depression (50.8%), (2) depression improvement (23.9%), (3) delayed depression (12.8%) and (4) persistent moderate to severe depression (12.5%). However, it is unclear whether these trajectories will be the same for those with SCI in the United States where mental health treatment may be different and initial rehabilitation stays are shorter.

Depression after SCI is currently under-treated in the context of usual care.⁹ Describing and ultimately being able to predict depression trajectories using demographic, injury, and clinical characteristics (e.g., past psychiatric history, pain, alcohol use, grief, quality of life) has potential not only for enhanced understanding of post-SCI depression, but also for improved targeting and tailoring of prevention and treatment efforts. Numerous studies have provided specialized treatment indiscriminately to people with SCI in an effort to improve overall adjustment.¹⁰⁻¹⁴ Trajectory research holds promise for identifying those at risk of persistent depression and designing specific interventions that target them.

Therefore, we examined trajectories of depression in a sample of individuals with new SCI who were followed for one year after injury. We hypothesized that the four depression trajectories found in the European study would characterize our sample.⁸ Based on research in SCI and other populations, we also examined potential demographic, injury, and clinical predictors of trajectory membership. We predicted that younger age and single or divorced marital status,¹⁵ female gender and non-White race,¹⁶ pre-injury history of depression or substance abuse,¹⁷ and pain,^{2,18} would predict higher depression trajectories.

Methods

Participants

The study sample was drawn from consecutive admissions to inpatient rehabilitation units at the University of Washington Medical Center and Harborview Medical Center (Seattle, WA) between 2007 and 2010 for acute SCI. Participants were excluded if they were less than 18 years old, not fluent in English, did not complete inpatient rehabilitation, had severe speech, cognitive, or psychotic disorders that would prevent reliable responding, or if they had no telephone access after discharge from the hospital. Eighty percent of eligible patients who were admitted agreed to participate. 168 persons were consented and enrolled into a randomized controlled trial (RCT) of a telephone follow up intervention. The RCT tested the efficacy of telephone counseling to reduce rehospitalizations and emergency healthcare visits, and to improve adjustment after inpatient rehabilitation. The treatment group received up to 11 calls over one year from one of two care managers supported by a multidisciplinary team of SCI experts. The counseling was comprised of eliciting participant concerns, facilitated problem solving, and providing education, resources or referrals. The control condition received usual care.

Outcomes of the trial were equivalent in the treatment and control groups.¹⁹ Therefore, data from both groups were combined to form this cohort study. Thirty-five additional persons were excluded from the cohort study because they completed fewer than two of the follow-up assessments (at 3, 6, 9, and 12 months post injury). The final sample consisted of 141 people (115 males, 26 females). Those excluded did not differ from the final sample on initial depression scores, $t(174)=1.36$, $p=0.18$. Excluded participants were more likely to be non-white ($\chi^2(1)=11.09$, $p<.001$) and less educated ($\chi^2(2)=8.84$, $p=.01$) than those included. No other differences were found on any variables of interest.

Procedure

Trained research assistants screened all admissions for basic eligibility. Eligible persons underwent informed consent procedures. Individuals who consented completed a structured in-person interview at baseline that included all the variables described below. Depression was assessed at baseline as well as via telephone at 3, 6, 9 and 12 months after injury by trained research assistants blinded to treatment assignment. The University of Washington Institutional Review Board approved all study procedures.

Measures

Demographic information, including age, race, sex, education, marital status, and insurance status was obtained from medical records and self-report.

Injury characteristics and treatment information, including length of hospital stay, neurologic level, discharge FIM™ scores, and use of antidepressant medications were collected from participants' inpatient medical records.

Psychological characteristics were assessed at baseline via self-report, and included:

Preinjury depression history was measured (yes/no) by an item that asked whether the participant had ever been diagnosed with depression prior to injury.

Other preinjury mental health history was comprised of items (yes/no) that asked whether the participant had ever been diagnosed with bipolar disorder, panic, generalized anxiety, PTSD, obsessive-compulsive disorder, phobias, or schizophrenia) prior to injury. Endorsement of any condition was coded as a positive history of other mental health disorder.

Hazardous drinking was assessed using the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C), a three-item measure that captures typical quantity and frequency of alcohol use and binge drinking on a 0-4 scale.²⁰ The cutoff for hazardous drinking is a score of three or more for women and four or more for men.

Quality of Life was measured with the Life-1.²¹ Subjects indicated how they felt about their overall quality of life since their SCI on a scale from 1 (terrible) to 7 (delighted). The Life-1 is a valid measure of well-being and not significantly influenced by social desirability.^{21,22}

Health-related Quality of Life was measured with the European Quality of Life (EuroQoL) Health State thermometer.²³ The thermometer was changed to a numerical scale in order to be given verbally. Responses range from 0 (worst imaginable health state) to 100 (best imaginable health state).

Pain was assessed using a single numerical rating scale item, "In the past 24 hours, how intense was your WORST pain?" with responses ranging from 0 "no pain" to 10 "pain as bad as could be."

Grief symptoms were assessed using a 12-item structured clinical interview developed by Prigerson and colleagues²⁴ and modified for SCI. It measures frequency or intensity of common grief symptoms and captures psychological distress that is distinct from depression in people with SCI.²⁵ All items were summed, with higher scores indicating greater grief. The grief interview has good internal consistency ($\alpha = .90$) and test-retest reliability ($r = .80$).²⁴ In the present study, the grief scale demonstrated good internal consistency ($\alpha = .88$).

Post-Traumatic Growth was assessed using a 5-item short form of the Post-Traumatic Growth Inventory (PTGI).^{26,27} The PTGI measures perceived positive changes after a traumatic event on a scale from 0 (I did not experience this change) to 5 (I experienced this change to a very great degree). The shortened PTGI scale demonstrated adequate internal consistency in this sample ($\alpha = .72$).

Depression was assessed using the nine item Patient Health Questionnaire (PHQ-9)²⁸ which parallels the DSM-IV major depression criteria.²⁹ Each item is scored from (0 = not at all to 3 = nearly every day). Scores can range from 0 to 27, with higher scores indicating greater depression severity. The PHQ-9 is reliable and valid screener for major depressive disorder in people with recent SCI.³⁰ The following depression severity categories are used: 0-4 minimal or low; 5-9 mild, 10-14 moderate; 15-19 moderately severe, and 20-27 severe.²⁸

Cronbach's alpha for the PHQ-9 total score ranged from 0.82 to 0.87 across the four time points in this study.

Statistical Analysis

To examine patterns of depression over the course of participants' first year with SCI, we used Mplus Version 7 to conduct a latent class growth analysis (LCGA) on PHQ-9 total scores.³¹ We examined unconditional models (no covariates) with increasing numbers of classes (starting with a single-class growth model). The optimal number of classes was determined using the Bayesian (BIC) and Akaike information criteria (AIC), entropy values, the Lo-Mendell-Rubin likelihood test (LMR-LRT), the bootstrap likelihood ratio fit indices (BLRT), and average latent class probabilities of class membership.³² We sought a model with lower values for information criteria indices, higher entropy (0.80) and latent class probability values (0.90), and *p* values .05 for both the LRT and the BLRT. We also considered interpretability of trajectories when determining the optimal number of classes. To avoid problems with local solutions, models were estimated using 500 different starting values.

We examined baseline characteristics of the classes by conducting ANOVA and chi-square tests that compared the various trajectories on demographic variables, injury characteristics, and psychological characteristics, using participants' most-likely class membership assignments. To identify specific differences between trajectories, Games-Howell tests were used for post hoc analyses because they do not assume equal sample size or variance.

Results

Sample characteristics

Participants were between 18 and 79 years old ($M = 41$, $SD = 16$ years) (see Table 1). The final sample was predominantly white (86%) and of non-Hispanic origin (96%); 81.6% were male and 61.7% had tetraplegia. Participant retention was good at all time points: (3-month: $n=127$, 90.1%; 6-month: $n=131$, 92.9%; 9-month: $n=134$, 95.0%; 12-month: $n=136$, 96.5%).

Trajectory Identification

A single class quadratic model was compared to a single class linear model. The linear model was retained due to closer fit. To determine the correct number of linear trajectories, models ranging from one- to five-class solutions were estimated. Model fit improved as the number of classes increased from one to four, as evidenced by AIC, BIC, and entropy values (see Table 2). Although AIC, BIC, and entropy values suggested that a four-class solution was optimal, the BLRT was unreliable due to non-convergence of the model and the LRT value suggested that a three-class solution better fit the data. As a result, we selected the three-class solution as optimal. Group assignment accuracy was assessed using class membership probability scores; the 3-class solution probabilities ranged from 0.93 to 0.97, suggesting accurate assignment (see Table 3).

The 3-class solution identified three trajectories of depressive symptoms across the first year following SCI (see Figure 1). The majority of participants were within a *stable low*

depression class (63.8%) with PHQ-9 scores in the minimally depressed range at each time point (4.04, $SD = 3.00$; 3.46, $SD = 2.81$; 3.98, $SD = 3.38$; 3.56, $SD = 3.14$; and 3.52, $SD = 3.18$, respectively). The second most populous class (29.1%), was characterized by average PHQ-9 scores in the *mild-moderate depression* ranges at each time point (11.88, $SD = 4.99$; 10.95, $SD = 3.97$; 8.81, $SD = 4.49$; 9.74, $SD = 4.87$; and 10.23, $SD = 4.59$, respectively). A third class (7.1%) was made up of persons with average PHQ-9 scores persistently in the *moderately severe to severe depression* ranges at each time point (19.10, $SD = 6.42$; 16.33, $SD = 6.76$; 16.20, $SD = 6.78$; 21.44, $SD = 3.69$; and 20.50, $SD = 3.98$, respectively).

Predictors of Class Membership

We conducted separate ANOVAs for continuous variables and chi-square tests for categorical variables to identify baseline differences between the three trajectories with regard to demographic, injury, and psychological characteristics (see Table 4). None of the trajectories varied by demographic or injury-related characteristics.

As depression severity increased across the three trajectories, the prevalence of a history of depression in each class also increased, with individuals in the *stable low depression* group having the lowest prevalence of a history of depression (18%), *mild-moderate depression* group having an intermediate prevalence of a history of depression (41%), and the *persistent moderate to severe depression* group (89%) having the highest prevalence of a history of depression. There was a higher prevalence of having a psychiatric diagnosis other than depression (e.g., anxiety disorders) within both the *mild-moderate depression* (27%) and *persistent moderate to severe depression* (40%) trajectories trajectory relative to the *stable low depression* (9%) trajectory. Games-Howell post hoc tests revealed that members of the *persistent moderate to severe depression* trajectory rated their baseline quality of life as significantly lower than both the *mild-moderate* and *stable low depression* trajectories. Individuals in the *persistent moderate to severe depression* trajectory also reported significantly more pain than those in the *persistent low depression* group, and a trend ($p = .06$) towards more intense pain than the *mild-moderate depression* group. All trajectories differed from each other with regard to levels of grief, with the *stable low depression* trajectory reporting less grief than the *mild-moderate depression* and *persistent moderate to severe depression* trajectories. Overall, 49.3% were prescribed antidepressants at baseline. There was a non-significant trend for higher rates of antidepressant use among trajectory groups with higher depression scores.

Discussion

The identification of depression trajectories following SCI has potential to improve identification of subgroups at risk for poor outcomes and to inform early intervention studies. Results of this study are similar to previous research in that the modal response to SCI was the absence of significant depressive symptoms. This group, comprising 63.8% of the sample, had average PHQ-9 scores in the 1-4 range at all time points. In comparison, 66.1% of people with SCI studied by Bonanno and colleagues were not depressed.³¹ Longitudinal studies of people with SCI show that 54-62% are not depressed.^{2,3} Similarly, between 35-65% of people who are exposed to other forms of psychological trauma,

physical trauma, or loss have a non-depressed trajectory, often referred to as resilient.³³ Persons with low depression were less likely to have a preinjury history of depression or other mental illness, less severe pain, less grief, and better initial ratings of quality of life compared to the group with persistent moderate to severe depression. Future research should examine other predictors of low depression after SCI, especially how people appraise and cope with injury. Catalano and colleagues, through structural equation modeling, reported that resilience may 'buffer' the perceptions of stress resulting from SCI on depressive symptoms.³⁴ Bonanno and colleagues⁸ reported that those with stable low depression appraised SCI as a challenge rather than a threat and coped more through acceptance and fighting spirit while using less social reliance and behavioral disengagement compared to those with chronic depression. Research that combines mental health history with post-injury appraisal and coping as predictors of depression trajectories may be especially informative.

A small fraction (7.1%) of the sample experienced persistent moderate to severe depression. This proportion is similar to the persistent moderate to severe depression class in the European study (10.7%)⁸ and among trauma-exposed persons generally (5-30%).³³ Other research has emphasized that depression after SCI can become chronic.^{5,6,35} Research is needed on the reasons for persistent moderate to severe depression after SCI and effective interventions for this group. One reason may be that people with SCI are under-treated for depression. Independent research shows they are unlikely to receive pharmacological and psychological treatment for depression and when they do receive treatment the dose and or duration tend to be inadequate.⁹ In this study, receipt of antidepressant treatment during inpatient rehabilitation by persons in the depressed trajectories (60.97-66.67%) was greater than in a large outpatient cohort (29%). Even so, there is room to improve and we do not have information on whether participants received an adequate dose or duration of antidepressants. Also, while venlafaxine XR was recently shown to be an effective treatment for core symptoms of depression in people with SCI,³⁶ the addition of cognitive-behavioral therapy,³⁵ or other adjunctive treatments targeting resilience,³⁷ appraisal and coping,¹³ or physical activity³⁸ may be needed to improve outcomes.

The third trajectory group, 29.1% of our sample, experienced persistent mild-to-moderate depression throughout the first year. In contrast, two intermediate trajectory groups were found in the European sample: 13.3% experienced depression recovery and 9.8% had delayed depression.³¹ Among those exposed to trauma or loss more generally, 15-25% demonstrate a depression recovery pattern and 0-15% demonstrate a delayed depression course.³³ The fact that we did not detect recovery or delayed depression trajectories may be due to our relatively small sample size or to actual differences in the course of depressive symptomatology at our site. Research should investigate whether under-recognition and under-treatment of depression is particularly prevalent in this group with less severe symptoms.

Our second hypothesis had to do with predictors of trajectory classification. Since all three trajectories had horizontal trends, the initial depression score is likely to be a strong predictor of later depression. No demographic or injury characteristics predicted trajectory class. Pre-injury history of depression and other mental health diagnosis was predictive of

post-SCI depression. Indeed, 89% of those with persistent moderate to severe post-SCI depression had a pre-injury depression diagnosis suggesting this trajectory is often a continuation or recurrence of a pre-injury depressive disorder rather than a new condition caused by SCI.

Greater grief symptoms, high pain intensity, and poorer initial subjective quality of life also predicted membership in depression trajectory classes. Early grief symptoms are psychometrically distinct from depression in individuals with SCI²⁵ and may represent an important, conceptually independent risk factor for persistent mild to severe depression. This study corroborates prior research in which greater pain severity^{2,18} and lower initial perceptions of quality of life⁸ were found to predict greater depression or distress. Future research should examine whether recent advances in treating grief³⁹ and SCI-related pain⁴⁰ also can help alleviate depression following SCI. Other potentially modifiable depression risk factors such as loss of rewarding activities and low self-efficacy to manage SCI-related impairments,⁴¹ as well as low physical activity⁴² should be examined as potential predictors in future trajectory research. Ultimately, treating persistent depression after SCI may require a multi-modal approach that addresses multiple risk factors.

Notably, a history of excessive alcohol use was not associated with post-SCI depression. Other studies in SCI^{17,43,44} and traumatic brain injury⁴⁵ have found a relationship between a history of alcohol related problems and post-injury outcomes. Future research should examine the independent contributions of preinjury alcohol use versus preinjury alcohol related life problems in predicting post injury depression.

Study Limitations

This was a single site study with a modest sample size and little gender or racial and ethnic diversity. These study characteristics limit the generalizability of the findings. This study had a narrow focus on depressive symptoms. Mental health conditions tend to co-occur after SCI⁴⁶ and future trajectory research should examine other disorders such as post-traumatic stress disorder, generalized anxiety disorder, and substance use disorders. The study data were drawn from a randomized controlled telephone counseling trial that was ineffective. However, the intervention may have had an undetected effect on depression trajectories that could lessen the reproducibility of the findings. The study lacks information on outpatient depression treatments that may have influenced the course of depressive symptoms. The period over which participants were studied was limited to the period from inpatient rehabilitation to one year after SCI. Future research should capture symptoms and treatments received prior to injury, during acute care, during rehabilitation, during the post-acute phase, and beyond one year after SCI. Ultimately it would be important to create and test predictive models that clinicians could use to assign people to likely trajectories. In this study we lacked some promising predictors of depression such as comorbid TBI^{45,47} and family or other social support.^{2,4,48} Unfortunately the overall study sample and especially certain subgroups in the current sample are too small to do predictive modeling.

Although depression trajectory research is in its infancy, we can speculate regarding some potential clinical and research implications. First, finding a limited number of clinically meaningful depression trajectories should facilitate patient education and treatment planning

regarding this aspect of adjustment to SCI. Second, by combining information on mental health history with post injury depression, pain, quality of life, grief symptoms and other variables eventually we may be able to develop trajectory prediction models accurate enough for clinical use. If so, early trajectory classification could inform follow-up and treatment planning. It may also spur development of depression treatment programs tailored to the specific needs of homogenous subgroups, allow early identification of those needing treatment beyond usual care, and exclude people on resilient trajectories who do not require mental health treatment.

Conclusions

This study found three distinct, clinically meaningful depression trajectory classes after SCI. Results highlight the prominence of low depression as the modal response. Depression scores and other data obtained during inpatient rehabilitation, such as psychiatric history, grief symptoms, pain and poor quality of life predicted membership in persistently depressed trajectory groups. Trajectory groups and predictors can inform patient education as well as depression monitoring, treatment, and targeted research efforts. These results are preliminary and merit replication in larger more diverse US samples.

ABBREVIATIONS

PHQ-9	Patient Health Questionnaire-9
SCI	Spinal Cord Injury
LCGA	Latent Class Growth Analysis
RCT	Randomized Controlled Trial

References

1. Craig A, Tran Y, Middleton J. Psychological morbidity and spinal cord injury: A systematic review. *Spinal Cord*. Feb; 2009 47(2):108–114. [PubMed: 18779835]
2. Quale AJ, Schanke AK. Resilience in the face of coping with a severe physical injury: A study of trajectories of adjustment in a rehabilitation setting. *Rehabilitation psychology*. Feb; 2010 55(1):12–22. [PubMed: 20175630]
3. Judd FK, Stone J, Webber JE, Brown DJ, Burrows GD. Depression following spinal cord injury. A prospective in-patient study. *Br J Psychiatry*. May; 1989 154:668–671. [PubMed: 2597860]
4. Kishi Y, Robinson RG, Forrester AW. Prospective longitudinal study of depression following spinal cord injury. *J Neuropsychiatry Clin Neurosci*. 1994; 6(3):237–244. Summer. [PubMed: 7950345]
5. Craig AR, Hancock KM, Dickson HG. A longitudinal investigation into anxiety and depression in the first 2 years following a spinal cord injury. *Paraplegia*. 1994; 32(10):675–679. [PubMed: 7831074]
6. Hoffman JM, Bombardier CH, Graves DE, Kalpakjian CZ, Krause JS. A longitudinal study of depression from 1 to 5 years after spinal cord injury. *Arch Phys Med Rehab*. Mar; 2011 92(3):411–418.
7. Muthen B, Muthen LK. Integrating person-centered and variable-centered analyses: Growth mixture modeling with latent trajectory classes. *Alcohol Clin Exp Res*. Jun; 2000 24(6):882–891. [PubMed: 10888079]
8. Bonanno G, Kennedy P, Galatzer-Levy I, Lude P, Elfström M. Trajectories of resilience, depression, and anxiety following spinal cord injury. *Rehabil Psychol*. 2012; 57:236–247. [PubMed: 22946611]

9. Fann JR, Bombardier CH, Richards JS, Tate DG, Wilson CS, Temkin N. Depression after spinal cord injury: Comorbidities, mental health service use, and adequacy of treatment. *Arch Phys Med Rehabil.* Mar; 2011 92(3):352–360.
10. Craig AR, Hancock K, Dickson H, Chang E. Long-term psychological outcomes in spinal cord injured persons: Results of a controlled trial using cognitive behavior therapy. *Arch Phys Med Rehabil.* 1997; 78(1):33–38. [PubMed: 9014954]
11. Dorstyn D, Mathias J, Denson L, Robertson M. Effectiveness of telephone counseling in managing psychological outcomes after spinal cord injury: A preliminary study. *Arch Phys Med Rehabil.* Nov; 2012 93(11):2100–2108. [PubMed: 22705237]
12. Duchnick JJ, Letsch EA, Curtiss G. Coping effectiveness training during acute rehabilitation of spinal cord injury/dysfunction: A randomized clinical trial. *Rehabilitation Psychology.* May; 2009 54(2):123–132. [PubMed: 19469601]
13. Kennedy P, Duff J, Evans M, Beedie A. Coping effectiveness training reduces depression and anxiety following traumatic spinal cord injuries. *Br J Clin Psychol.* Mar; 2003 42(Pt 1):41–52. [PubMed: 12675978]
14. King C, Kennedy P. Coping effectiveness training for people with spinal cord injury: Preliminary results of a controlled trial. *Br J Clin Psychol.* 1999; 38(Pt 1):5–14. [PubMed: 10212733]
15. Bombardier CH, Richards JS, Krause JS, Tulsy D, Tate DG. Symptoms of major depression in people with spinal cord injury: Implications for screening. *Arch Phys Med Rehabil.* Nov; 2004 85(11):1749–1756. [PubMed: 15520969]
16. Krause J, Kemp B, Coker J. Depression after spinal cord injury: Relation to gender, ethnicity, aging, and socioeconomic indicators. *Arch Phys Med Rehab.* 2000; 81(8):1099–1109.
17. Dryden DM, Saunders LD, Rowe BH, et al. Depression following traumatic spinal cord injury. *Neuroepidemiology.* 2005; 25(2):55–61. [PubMed: 15947491]
18. Cairns DM, Adkins RH, Scott MD. Pain and depression in acute traumatic spinal cord injury: Origins of chronic problematic pain? *Arch Phys Med Rehab.* Apr; 1996 77(4):329–335.
19. Hoffman, JM.; Bombardier, CH.; Burns, SP. Scheduled telephone follow-up to improve outcomes after spinal cord injury rehabilitation.. American Spinal Injury Association Annual Meeting; Chicago, IL. 2013;
20. Bradley KA, DeBenedetti AF, Volk RJ, Williams EC, Frank D, Kivlahan DR. Audit-c as a brief screen for alcohol misuse in primary care. *Alcoholism, clinical and experimental research.* Jul; 2007 31(7):1208–1217.
21. Andrews, FM.; Withey, SB. Social indicators of well-being. Plenum Press; New York: 1976.
22. McCrae RR. Well-being scales do not measure social desirability. *J Gerontol.* May; 1986 41(3): 390–392. [PubMed: 3700990]
23. The EuroQol Group. Euroqol--a new facility for the measurement of health-related quality of life. *Health policy.* Dec; 1990 16(3):199–208. [PubMed: 10109801]
24. Prigerson HG, Horowitz MJ, Jacobs SC, et al. Prolonged grief disorder: Psychometric validation of criteria proposed for dsm-v and icd-11. *PLoS Med.* Aug.2009 6(8):e1000121. [PubMed: 19652695]
25. Klyce DW, Bombardier CH, Davis TJ, et al. Distinguishing grief from depression during acute recovery from spinal cord injury. *Arch Phys Med Rehabil.* Mar 3.2015
26. Kalpakjian CZ, McCullumsmith CB, Fann JR, et al. Post-traumatic growth following spinal cord injury. *J Spinal Cord Med.* Mar; 2014 37(2):218–225. [PubMed: 24559420]
27. Tedeschi RG, Calhoun LG. The posttraumatic growth inventory: Measuring the positive legacy of trauma. *J Trauma Stress.* Jul; 1996 9(3):455–471. [PubMed: 8827649]
28. Kroenke K, Spitzer RL, Williams JB. The phq-9: Validity of a brief depression severity measure. *J Gen Int Med.* Sep; 2001 16(9):606–613.
29. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed. Text Revision ed.. American Psychiatric Association; Washington DC: 2000.
30. Bombardier CH, Kalpakjian CZ, Graves DE, Dyer JR, Tate DG, Fann JR. Validity of the patient health questionnaire-9 in assessing major depressive disorder during inpatient spinal cord injury rehabilitation. *Arch Phys Med Rehabil.* Oct; 2012 93(10):1838–1845. [PubMed: 22555007]

31. *Mplus version 7.11* [computer program].. 2012.
32. Jung T, Wickrama K. An introduction to latent class growth analysis and growth mixture modelling. *Soc Personal Psychol Compass*. 2008; 2:302–317.
33. Bonanno GA, Westphal M, Mancini AD. Resilience to loss and potential trauma. *Ann Rev Clin Psychol*. 2011; 7:511–535. [PubMed: 21091190]
34. Catalano D, Chan F, Wilson L, Chiu CY, Muller VR. The buffering effect of resilience on depression among individuals with spinal cord injury: A structural equation model. *Rehabilitation Psychology*. Aug; 2011 56(3):200–211. [PubMed: 21843016]
35. Kemp BJ, Kahan JS, Krause JS, Adkins RH, Nava G. Treatment of major depression in individuals with spinal cord injury. *Journal of Spinal Cord Medicine*. 2004; 27(1):22–28. [PubMed: 15156933]
36. Fann JR, Bombardier CH, Richards JS, et al. Venlafaxine extended-release for depression following spinal cord injury: A randomized clinical trial. *JAMA Psychiatry*. Mar 1; 2015 72(3): 247–258. [PubMed: 25607727]
37. Monden KR, Trost Z, Catalano D, et al. Resilience following spinal cord injury: A phenomenological view. *Spinal Cord*. Mar; 2014 52(3):197–201. [PubMed: 24418959]
38. Adamson BC, Ensari I, Motl RW. Effect of exercise on depressive symptoms in adults with neurologic disorders: A systematic review and meta-analysis. *Arch Phys Med Rehabil*. Jul; 2015 96(7):1329–1338. [PubMed: 25596001]
39. Shear MK, Wang Y, Skritskaya N, Duan N, Mauro C, Ghesquiere A. Treatment of complicated grief in elderly persons: A randomized clinical trial. *JAMA Psychiatry*. Nov; 2014 71(11):1287–1295. [PubMed: 25250737]
40. Cardenas DD, Nieshoff EC, Suda K, et al. A randomized trial of pregabalin in patients with neuropathic pain due to spinal cord injury. *Neurology*. Feb 5; 2013 80(6):533–539. [PubMed: 23345639]
41. Bombardier CH, Fann JR, Tate DG, et al. An exploration of modifiable risk factors for depression after spinal cord injury: Which factors should we target? *Arch Phys Med Rehabil*. May; 2012 93(5):775–781. [PubMed: 22440484]
42. Martin Ginis KA, Jetha A, Mack DE, Hetz S. Physical activity and subjective well-being among people with spinal cord injury: A meta-analysis. *Spinal Cord*. Jan; 2010 48(1):65–72. [PubMed: 19581918]
43. Tate DG, Forchheimer MB, Krause JS, Meade MA, Bombardier CH. Patterns of alcohol and substance use and abuse in persons with spinal cord injury: Risk factors and correlates. *Arch Phys Med Rehabil*. Nov; 2004 85(11):1837–1847. [PubMed: 15520979]
44. Bombardier CH, Stroud MW, Esselman PC, Rimmele CT. Do preinjury alcohol problems predict poorer rehabilitation progress in persons with spinal cord injury? *Arch Phys Med Rehabil*. Sep; 2004 85(9):1488–1492. [PubMed: 15375822]
45. Bombardier CH, Fann JR, Temkin NR, Esselman PC, Barber J, Dikmen SS. Rates of major depressive disorder and clinical outcomes following traumatic brain injury. *JAMA*. May 19; 2010 303(19):1938–1945. [PubMed: 20483970]
46. Banerjea R, Findley PA, Smith B, Findley T, Sambamoorthi U. Co-occurring medical and mental illness and substance use disorders among veteran clinic users with spinal cord injury patients with complexities. *Spinal Cord*. 2009; 47(11):789–795. [PubMed: 19417763]
47. Macciocchi S, Seel RT, Thompson N, Byams R, Bowman B. Spinal cord injury and cooccurring traumatic brain injury: Assessment and incidence. *Arch Phys Med Rehabil*. Jul; 2008 89(7):1350–1357. [PubMed: 18586138]
48. Elliott TR, Herrick S, Witty T. Social support and depression following spinal cord injury. *Rehabilitation Psychology*. 1992; 37:37–48.

Table 1

Descriptive Information for Sample

	N	Range	Mean (SD) / Percentage (N)
Participant Characteristics			
Age	141	18-79	41 (16)
Race	140		White 86.4% (121) Non-white 13.6% (19)
Gender	141		Men 81.6% (115) Women 18.4% (26)
Educational Attainment	139		Less than High School 8.6% (12) High School Graduate 61.2% (85) More than High School 30.2% (42)
Marital Status	141		Married 35.5% (50) Unmarried 64.5% (91)
Insurance Status	140		Medicaid 43.6% (61) Private/Medicare 56.4% (79)
Injury Characteristics			
Length of Inpatient Rehabilitation (d)	141	7-199	42.8 (27.6)
Neurologic Level at discharge	141		Incomplete Paraplegia 22.0% (31) Complete Paraplegia 16.3% (23) Incomplete Tetraplegia 44.7% (63)
FIM score at Discharge	141	13-91	53.9 (23.1)
Psychological Characteristics			
Depression (PHQ-9)			
Baseline	141	0-27	7.4 (6.2)
3-months	127	0-27	6.5 (5.6)
6-months	131	0-27	6.3 (5.4)
9-months	134	0-26	6.7 (6.3)
12-months	136	0-26	6.7 (6.1)
Depression History	138		Yes 29.0% (40) No 71.0% (98)
Other Psychiatric History	141		Yes 16.31% (23) No 83.69% (118)
Hazardous Drinking	138		Yes 65.2% (90) No 34.8% (48)
Quality of Life	140	1-7	4.1 (1.3)
Health-Related Quality of Life	141	0-100	61.4 (24.9)
Pain	140	0-10	6.1 (2.8)
Grief	105	12-51	25.5 (9.8)
Post-Traumatic Growth	106	0-25	11.2 (6.2)

Note. Other psychiatric history excludes depression diagnosis.

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Table 2

Fit Indices for One- to Five-Class Growth Mixture Models for Depression (Unconditional)

Fit Index	Growth Mixture Model				
	1 class	2 classes	3 classes	4 classes	5 classes
AIC	4285.78	4029.90	3936.72	3919.70	3918.43
BIC	4306.42	4059.39	3975.05	3966.88	3974.46
Entropy	--	.90	.90	.92	.92
LRT <i>p</i> value	--	.10	.01	.15	.23
BLRT <i>p</i> value	--	<.001	<.01	<.001 *	<.001 *

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; LRT = Lo-Mendell-Rubin test; BLRT = bootstrap likelihood ratio test.

* Model did not converge during bootstrap draws, suggesting that the BLRT *p* value may be untrustworthy.

Table 3

Parameter Estimates for Each Class in Each Analysis

Class	Proportion (%)	Intercept		Slope	
		Est. (SE)	<i>p</i>	Est. (SE)	<i>p</i>
Low depression	63.8	3.93(0.36)	.001	−0.04 (0.05)	.45
Moderate-severe depression	7.1	16.98 (1.55)	.001	0.31 (0.15)	.04
Mild-moderate depression	29.1	11.02 (0.99)	.001	−0.12 (0.11)	.29

Table 4

Bivariate relationships between trajectories and baseline characteristics

Variables		Low depression N = 90			Mild-moderate depression N = 41			Moderate-severe depression N = 10			p-value
Demographic Characteristics											
Age		38.93 (16.14)		42.27 (14.60)		49.80 (9.95)				.08	
Race										.62	
White (%)		84.30		90.20		90.00					
Non-white (%)		15.70		9.80		10.00					
Gender										.30	
Male (%)		80.00		80.50		100.00					
Female (%)		20.00		19.50		0.00					
Educational Attainment										.57	
Below High School (%)		7.95		7.30		20.00					
High School (%)		59.10		68.30		50.00					
Above High School (%)		32.95		24.40		30.00					
Marital Status											
Married (%)		35.60		36.60		30.00				.93	
Unmarried (%)		64.40		63.40		70.00					
Insurance Type										.55	
Medicaid (%)		42.70		41.50		60.00					
Medicare/Private (%)		57.30		58.50		40.00					
Injury Characteristics											
Length of Hospitalization		44.69 (29.37)		38.59 (24.42)		43.50 (23.02)				.50	
Neurologic Level of Injury										.27	
Incomplete Paraplegia (%)		17.80		31.70		20.00					
Complete Paraplegia (%)		21.10		9.80		0.00					
Incomplete Tetraplegia (%)		45.60		39.00		60.00					
Complete Tetraplegia (%)		15.60		19.50		20.00					

Variables	Low depression N = 90	Mild-moderate depression N = 41	Moderate-severe depression N = 10	p-value
FIM Score	52.03 (21.65)	59.49 (24.41)	47.30 (28.41)	.15
Psychological Characteristics				
Antidepressant Use at Baseline				.08
Yes (%)	42.22	60.97	66.67	
No (%)	57.78	39.03	33.33	
Depression History				<.001
Yes (%)	17.80 _a	41.00 _b	88.90 _c	
No (%)	82.20	59.00	11.10	
Other Mental Health History				.004
Yes (%)	8.89 _a	26.83 _b	40.00 _b	
No (%)	91.11	73.17	60.00	
Hazardous Drinking				.82
Yes (%)	65.91	65.85	55.56	
No (%)	34.09	34.15	44.44	
Quality of Life	4.36 (1.20) _a	3.98 (1.31) _a	2.40 (0.70) _b	<.001
Health-Related Quality of Life	65.34 (22.62)	54.39 (26.15)	54.30 (33.49)	.05
Pain	5.62 (2.83) _a	6.46 (2.67) _{ab}	8.78 (0.97) _b	.003
Grief	22.62 (8.50) _a	29.32 (9.28) _b	39.17 (9.99) _c	<.001
Post-Traumatic Growth	10.97 (6.25)	11.44 (6.43)	11.71 (4.92)	.91

Note. Data are shown as mean (SD) or percentile. *p*-values are from ANOVA for continuous variables and Chi-square for categorical variables. Values that do not share the same symbol differ by *p* < .05 according to Games-Howell post hoc tests and follow-up chi-square tests.