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Clinical Study

Psychological morbidity and chronic disease among adults with nontraumatic spinal cord injuries: a cohort study of privately insured beneficiaries

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Abstract

BACKGROUND: Individuals living with a spinal cord injury (SCI) are at heightened risk for a number of chronic health conditions such as secondary comorbidities that may develop or be influenced by the injury, the presence of impairment, and/or the process of aging. However, very little is known about the development of secondary comorbidities among individuals living with nontraumatic SCIs (NTSCIs).

PURPOSE: The objective of this study was to compare the prevalence of psychological morbidities and chronic diseases among adults with and without NTSCIs.

DESIGN: Cross-sectional cohort from a nationwide insurance claims database.

METHODS: Privately insured beneficiaries were included if they had an ICD-9-CM diagnostic code for a NTSCI and accompanying diagnosis of paraplegia, tetraplegia, quadriplegia, or unspecified paralysis (n=10,006). Adults without SCIs were also included (n=779,545). Prevalence estimates of common psychological morbidities, chronic diseases, and multimorbidity (≥2 conditions) were compared.

RESULTS: Adults with NTSCIs had a higher prevalence of adjustment reaction (11.4% vs 5.1%), anxiety disorders (23.7% vs 14.5%), depressive disorders (31.6% vs 9.6%), drug dependence (3.4% vs 0.8%), episodic mood disorders (15.9% vs 5.4%), central pain syndrome (1% vs 0%), psychogenic pain (1.9% vs 0.2%), dementia (5.2% vs 1.5%), and psychological multimorbidity (29.3% vs 11.6%), as compared to adults without SCIs. The adjusted odds of psychological multimorbidity were 1.86 (95% confidence interval: 1.76–2.00). Adults with NTSCIs also had a significantly higher prevalence of all chronic diseases and chronic disease multimorbidity (73.5% vs 18%), except HIV/AIDS. After propensity matching for age, education, race, sex, and the chronic diseases (n=7,419 matched pairs), there was still a higher prevalence of adjustment reaction (9.2% vs 5.4%), depressive symptoms (23.5% vs 16.0%), central pain syndrome (1% vs 0%), psychogenic pain (1.5% vs 0.3%), and psychological multimorbidity (20.2% vs 17.4%) among adults with NTSCIs.

CONCLUSIONS: Adults with NTSCIs have a significantly increased prevalence of psychological morbidities, chronic disease, and multimorbidity, as compared to adults without SCIs. Efforts are needed to facilitate the development of improved clinical screening algorithms and early

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interventions to reduce risk of disease onset/progression in this higher risk population.

Keywords: Anxiety; Depression; Epidemiology; Multimorbidity; Psychological health; Spinal cord injury

Introduction

Persons with physical disabilities, such as spinal cord injury (SCI), are at heightened risk for a number of acute and chronic health conditions such as secondary comorbidities that may develop or be influenced by the presence of impairment and/or the process of aging [1]. Specifically, having a SCI may increase the risk of developing a health condition that is directly linked to the impairment (eg, neurogenic bladder, etc.), or occurs as an indirect consequence of the impairment itself (eg, increases in sedentary behaviors that contribute to the development of obesity-related conditions such as diabetes). Through these pathways, living with a SCI places individuals at risk of experiencing an accelerated development of age-related chronic health conditions or comorbidities [1].

Much of the research to date has focused on studying physical outcomes following traumatic SCI (TSCI) (eg, functional deficit, musculoskeletal atrophy, etc.), with little to no attention on the psychological factors (eg, depression, anxiety, drug and substance dependency, post-traumatic stress disorders, etc.) co-occurring or associated with these chronic health conditions. Similarly, and in spite of the growing prevalence of nontraumatic SCIs (NTSCIs), particularly in the older adult population [2], there is a paucity of research to describe the trajectories of chronic disease, psychological morbidity, and mortality in this subpopulation. Instead, the current literature focuses solely on understanding the burden of disease among the TSCI population, or includes only small samples of patients with NTSCIs [3–6]. Etiologies of NTSCIs include spinal stenosis, cervical spondylotic myelopathy, extrinsic neoplastic or developmental tumors, infection, ischemic injury, inflammatory disorders, transverse myelitis, multiple sclerosis, syringomyelia, and metabolic disorders [7–13].

Both TSCIs and NTSCIs represent significant lifetime disabilities for individuals, their families, and caregivers and are associated with decreased health and well-being, and a shortened life expectancy [4,14,15]. Psychological morbidity is particularly burdensome with chronic TSCI [16–19], and the prevalence of major depressive disorders among patients residing in the community is approximately 30% [16]. Depression and anxiety commonly co-occur after TSCI and are implicated in significantly poorer health, diminished function, and higher rates of early mortality [20]. Depression and anxiety have also been consistently linked with other psychological problems after SCI, such as lower quality of life and higher perceived stress [21].

In a 15-year follow-up study of patients with TSCI, Krause et al. found that life satisfaction and adjustment were the best predictors of survival status [20]. There are no studies that have examined this issue with the NTSCI population; however, it is plausible that NTSCI patients with advance stages of cancer or cardiovascular disease are likely to exhibit high levels of depression and anxiety. A systematic review of studies on psychological morbidity and SCI revealed that clarification is needed concerning the interactive nature of these factors and their consequences to those aging with a SCI [16], particularly those associated with psychological morbidity. Thus, future research is needed to clarify the extent and nature of psychological morbidity and mental health in relation to physical comorbidities, and particularly of chronic disease and psychological multimorbidity within a large cohort of adults with NTSCIs. Information pertaining to these health outcomes among patients with NTSCIs would serve to improve clinical screening for this population, and also to inform targeted, early interventions (eg, behavioral interventions, education, counseling, etc.) to reduce the risk of disease progression and multimorbidity. The objective of this study was therefore to determine the prevalence of diagnosed psychological morbidities and mental health disorders, as well as chronic diseases and multimorbidity among adults with NTSCIs, as compared to adults without SCIs.

Methods

Data source

The Clinformatics Data Mart Database (OptumInsight, Eden Prairie, MN) is a de-identified nationwide claims database of all beneficiaries from a single private payer. This database comprises all enrollees who had medical and pharmacy insurance coverage at any time between January 1, 2001, and December 31, 2017—a total of 79 million unique patients. Data are organized by a specific patient identification number, which ensures longitudinal follow-up even if there were changes in plan details or gaps in insurance coverage, as previously described [22]. The data set includes information on medical claims for all conditions for the enrollees as well as demographic information. This database has been previously used to investigate other conditions and their complications, including other neurologic [22,23], urologic [24], and metabolic [25] conditions. Since the data are de-identified, the University of Michigan Institutional Review Board approved this as a nonregulated study.

Sample selection

We obtained access to data for all enrollees with NTSCIs and without SCIs (controls), aged≥18 years, during the period from 2002 to 2017. Enrollees were deemed to have an NTSCIs if they had an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code for a NTSCI diagnosis *and* if they had a diagnosis of paraplegia, tetraplegia, quadriplegia, or unspecified paralysis (all ICD-9-CM codes for NTSCIs are provided in Supplemental Table 1). Individuals with pre-existing psychological morbidities (≥1 diagnosis of psychological morbidity in the 3 months preceding the index diagnosis of NTSCI) were excluded, as were those younger than 18 years of age at the time of index NTSCI diagnosis. For individuals without SCIs (controls), we included individuals who did not have a diagnosis of TSCI, NTSCI, paraplegia, tetraplegia, quadriplegia, or unspecified paralysis. Similar to the NTSCI cohort, individuals without SCIs (controls) with pre-existing psychological morbidities (≥1 diagnosis of psychological morbidity in the 3 months preceding) were excluded, as were those younger than 18 years of age at the time of enrollment. In total, a cohort of n=10,006 adults with NTSCIs and n=779,545 without SCIs were included in the primary analyses (Table 1).

Outcomes

The study outcomes were diagnoses of any of the following 12 primary psychological morbidities or mental health disorder categories, using ICD-9-CM codes (all ICD-9-CM codes for psychological morbidities are provided in Supplemental Table 1), after the NTSCI diagnosis/index date: (1) adjustment reaction, (2) anxiety disorders, (3) depressive disorders, (4) personality disorders, (5) alcohol dependence, (6) drug dependence, (7) episodic mood disorders, (8) post-traumatic stress syndrome, (9) central pain syndrome, (10) psychogenic pain, (11) insomnia, and (12) dementia. Psychological multimorbidity was defined as the presence of having at least two of the aforementioned psychological morbidities.

Chronic diseases/conditions were chosen and included on the basis of a modified Elixhauser Comorbidity Index, in which we included the following conditions: (1) congestive heart failure, (2) cardiac dysrhythmia, (3) valvular disease, (4) pulmonary circulation disorders, (5) peripheral vascular disorders, (6) hypertension (uncomplicated and complicated), (7) chronic pulmonary disease, (8) type II diabetes (uncomplicated and complicated), (9) hypothyroidism, (10) renal failure, (11) liver disease, (12) peptic ulcer disease (excluding bleeding), (13) HIV/AIDS, (14) lymphoma, (15) metastatic cancer, (16) solid tumor without metastasis, (17) rheumatoid arthritis, (18) coagulopathy, (19) unintended weight loss, (20) fluid and electrolyte disorders, (21) blood loss anemia, and (22) deficiency anemia. Multimorbidity was defined as the presence of having at least two of the aforementioned chronic diseases/conditions. These conditions were selected in accordance with guidance from the literature pertaining to chronic diseases in adults and adults with and without disabilities [26,27] and the availability of the diagnosis within the claims data 1 year prior to the NTSCI diagnosis.

Table 1
Descriptive characteristics among adults with and without NTSCI

	NTSCI	Without NTSCI
Sample size, n	10,006	779,545
Age, mean (SD)	59.2 (14.4)	48.8 (17.1)
Gender, %		
Female	48.5	51.6
Male	51.5	48.4
Ethnicity, %		
White	67.7	68.3
Black	13.7	8.6
Hispanic	6.8	9.9
Asian	2.2	4.4
Unknown/missing	9.6	8.8
Education, %		
Less than high school	1.0	0.8
High school diploma	29.8	25.9
More than high school	62.6	67.9
Unknown/missing	6.6	5.4

Statistical analysis

All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). Enrollee characteristics were summarized using means (SDs) for continuous variables and frequencies and percentages for categorical variables. Bivariate analysis was conducted using chi-square tests or Fisher's exact test in the case of small sample size for categorical variables, or an analysis of variance or nonparametric tests for continuous variables. The analysis of variance assumptions required us to check continuous variables based on quantile-quantile plots, assessing the degrees of skew and kurtosis, and evaluating if normally distributed errors were evident. We also reviewed the histogram of the distribution for visual inspection for any strong departures from normality.

The primary analyses were carried out to compare the unadjusted prevalence estimates of each of the 12 primary psychological or mental health morbidities, and chronic diseases between adults with NTSCIs, as compared to adults with no SCIs. Standardized mean differences (SMD=[(M_1-M_2)/Pooled SD]) via Cohen's d were used in conjunction with formal p value determination of significance to better understand a clinically meaningful effect size, with SMD≥0.2 determined to be a clinically meaningful difference. Multivariable logistic regression was used to determine the adjusted odds for psychological multimorbidity for individuals with NTSCIs, after adjusting for age, sex, race, and education.

Secondary analyses were carried out to compare prevalence estimates of the primary psychological or mental health

morbidities between adults with NTSCIs vs those without a SCI, after propensity score matching. The estimated propensity score, (ê(X)), for SCI was obtained from the fit of a multivariable logistic regression model for which we considered the following clinically relevant variables: age, education, race, sex, and each of the chronic conditions from the Elixhauser Comorbidity Index. We matched patients who did not have an index diagnosis of NTSCI to those with an index diagnosis of NTSCI based on a caliper size of 0.05 without replacement. We originally chose a caliper size of 0.05 because it is commonly used [28], provides reasonable balance of the included covariates, and does not lose many treated individuals as unmatchable. We also examined a tighter caliper (±0.01) to verify if results are meaningfully different and decided to use this in the final matching of participants. To match participants, we used an automated matching procedure in the SAS software that randomly selects a patient with NTSCI and a control (comparator) from the pool of potential comparators, to determine whether he or she fulfilled the matching criterion. In the event that the selected comparator was eligible, he or she was matched to the patient with NTSCI, and the pair will be removed. This procedure was repeated until all patients with NTSCI were matched to one comparator or until no further comparators fulfill the matching criteria (n=7,419 matched pairs).

Results

Adults with NTSCIs had a higher prevalence of adjustment reaction (11.4% vs 5.1%), anxiety disorders (23.7% vs 14.5%), depressive disorders (31.6% vs 9.6%), drug dependence (3.4% vs 0.8%), episodic mood disorders (15.9% vs 5.4%), central pain syndrome (1% vs 0%), psychogenic pain (1.9% vs 0.2%), dementia (5.2% vs 1.5%), and psychological multimorbidity (29.3% vs 11.6%), as compared to adults with no SCIs (all p<.001 and SMD≥0.2; Table 2). Additionally, the adjusted odds ratios (OR) and 95% confidence intervals (CIs) of psychological multimorbidity (OR: 1.86; 95% CI: 1.76–1.96) were higher among the adults with NTSCIs, even after adjusting for age, sex, race, and education.

Adults with NTSCIs also had a significantly higher prevalence of *all* chronic diseases, except for HIV/AIDS, compared to adults without SCIs (all p<.001 and SMD≥0.2), as well as chronic disease multimorbidity (Table 2).

After propensity matching for age, education, race, sex, and diseases from the Elixhauser Comorbidity Index (n=7,419 matched pairs), there was still a higher prevalence of adjustment reaction, depressive symptoms, central pain syndrome, and psychogenic pain among adults with NTSCIs, as compared to adults with no SCIs (all p<.001 and SMD≥0.2; Table 3).

Table 2
Unadjusted prevalence estimates (%) of chronic diseases and psychological morbidities among adults with and without NTSCI

	NTSCI n=10,006	Without NTSCI n=779,545
Chronic diseases (%)		
Congestive heart failure	11.3*	1.6
Cardiac arrhythmia	20.8*	3.8
Valvular disease	10.5*	2.5
Pulmonary circulation disorders	4.8*	0.4
Peripheral vascular disorders	15.3*	2.1
Hypertension uncomplicated	50.6*	20.8
Hypertension complicated	8.5*	1.8
Other neurologic disorders	46.7*	0.9
Chronic pulmonary disease	19.5*	6.5
Diabetes uncomplicated	22.4*	7.8
Diabetes complicated	9.7*	1.8
Hypothyroidism	13.6*	6.4
Renal failure	9.7*	1.2
Liver disease	6.4*	1.4
Peptic ulcer disease excluding bleeding	1.4*	0.3
AIDS/HIV	0.3	0.1
Lymphoma	2.6*	0.2
Metastatic cancer	8.0*	0.2
Solid tumor without metastasis	13.5*	2.8
Rheumatoid arthritis	7.1*	1.6
Coagulopathy	6.1*	0.6
Weight loss	8.7*	0.7
Fluid and electrolyte disorders	23.0*	1.9
Blood loss anemia	2.0*	0.3
Deficiency anemia	8.3*	1.6
Multimorbidity	73.5*	18.0
Psychological morbidities (%)		
Adjustment reaction	11.4*	5.1
Anxiety disorders	23.7*	14.5
Depressive disorders	31.6*	9.6
Personality disorders	1.0	0.3
Alcohol dependence	1.7	1.0
Drug dependence	3.4*	0.8
Episodic mood disorders	15.9*	5.4
Post-traumatic stress disorders	1.1	0.4
Central pain syndrome	1.0	0.0
Psychogenic pain	1.9*	0.2
Insomnia	10.9*	7.4
Dementia	5.2*	1.5
Psychological multimorbidity	29.3*	11.6

* p<.001 *and* standard mean difference (SMD)≥0.2.

Discussion

We compared the prevalence estimates and odds of psychological and mental health morbidities, as well as chronic diseases in a large sample of adults with and without NTSCIs. The principal findings were that adults with NTSCIs had significantly higher estimates of psychological and mental health morbidities and multimorbidity. Specifically, we determined that the prevalence of adjustment reaction, anxiety disorders, depressive disorders, drug dependence, episodic mood disorders, central pain syndrome, psychogenic pain, dementia, and psychological multimorbidity were significantly higher in adults with NTSCIs as compared to adults without SCIs, and to an extent that was clinically meaningful. Moreover, the adjusted odds psychological multimorbidity was 186% higher among adults with NTSCIs.

Table 3
Propensity-matched estimates of psychological morbidities among adults with and without NTSCIs (n=7,419 pairs)

	NTSCI	Without NTSCI
Psychological morbidities (%)		
Adjustment reaction	9.2*	5.4
Anxiety disorders	16.7	17.9
Depressive disorders	23.5*	16.0
Personality disorders	0.6	0.8
Alcohol dependence	1.2	1.5
Drug dependence	2.3	1.1
Episodic mood disorders	9.9	7.8
Post-traumatic stress disorders	0.6	0.4
Central pain syndrome	0.9*	0.0
Psychogenic pain	1.5*	0.3
Insomnia	8.9	9.4
Dementia	3.5	6.3*
Psychological multimorbidity	20.2*	17.4

* p<.001 *and* standard mean difference (SMD)≥0.2.

These findings corroborate the current state of the literature pertaining to psychological morbidity in TSCI. Specifically, a systematic review of studies on psychological morbidity and TSCI revealed that clarification is needed concerning the interactive nature of these factors and their consequences to those aging with a TSCI [16]. The review concluded that individuals with TSCI are at increased risk of sustaining high levels of psychological morbidity. Thus, future research is needed to clarify the extent and natural history of psychological morbidity in relation to physical comorbidities, and particularly the longitudinal trajectories of chronic disease and psychological multimorbidity within heterogeneous samples of patients with TSCIs *and* NTSCIs.

Of relevance to both, psychological issues arise as part of the emotional adaptation to losses of physical function and social participation. Stress and anxiety symptoms are critical to consider when studying their role in chronic disease, morbidity, and mortality. Secondary complications such as pressure ulcers, pain, persistent bladder infections resulting in frequent rehospitalizations, and even premature death relate to both personality and behavior, including the extent to which persons take responsibility for their own health, and the degree of self-destructive behaviors they exhibit [20]. Importantly, these behaviors in nondisabled individuals are often also associated with depression, anxiety, and high levels of stress and are found in combination with other risk factors, such as the presence of chronic cardiometabolic and musculoskeletal diseases (eg, cardiovascular disease, deep vein thrombosis/pulmonary emboli, fractures, diabetes, and others). These interactions have yet to be studied in persons with NTSCI, and therefore, determining how these conditions accumulate longitudinally is critical to our understanding of aging trajectories for those with NTSCIs.

Of relevance, we also found that prevalence estimates of chronic diseases were much higher among adults with NTSCIs as compared to adults without SCIs. Notably, adults with NTSCIs had a 4- to 10-fold higher prevalence of many chronic, noncommunicable diseases and multimorbidity, including congestive heart failure, cardiac dysrhythmia, pulmonary circulation disorders, peripheral vascular disorders, hypertension, type 2 diabetes, liver disease, fluid and electrolyte disorders, and anemia. These findings raise critical questions about preventable health complications in adults with NTSCIs; however, this is the first ever study to examine chronic diseases among adults with NTSCIs, and thus future work is needed to explicate the underlying risk factors or mechanisms for these secondary complications. Based on these findings and those of other recent reports showing increased risk of prevalent chronic cardiometabolic conditions and other noncommunicable diseases among adults with TSCIs [29–35], future surveillance efforts are needed not only to better understand the healthcare burden associated with these conditions among individuals with NTSCIs, but more importantly to facilitate the development of appropriate clinical screening algorithms and design of early behavioral interventions to reduce the risk of preventable disease onset/progression in this subpopulation.

Strengths/limitations

As with all studies, there are several important limitations to this study. First, we were unable to determine if other competing risks or unmeasured confounding (ie, other risk factors [eg, smoking], protective factors [eg, physical activity], personal factors [eg, geographic, family support, etc.] or other existing but undiagnosed diseases [eg, mild cognitive impairments]) may have influenced the observed estimates. Second, we were unable to disentangle the cause-effect relationship between exposures and outcomes. Whether having an NTSCI "causes" an elevated risk for many chronic diseases, or if comorbid abnormalities (eg, diabetes, pulmonary disorders, cancer, etc.) themselves cause neurologic deficits (ie, reverse causality), is an interesting and complex topic. Last, our sample included adults with and without NTSCIs from a nationwide claims database of all beneficiaries from a single *private* payer. Future studies are certainly needed to examine the extent to which disparities exist across federal health care covered vs privately insured individuals with SCIs. Despite these limitations, this study has various strengths. Most notably, this is the first study to examine estimates of psychological morbidity and chronic disease outcomes in a very large sample of adults in the United States with NTSCIs. This is particularly important since the older adult population is growing rapidly and thus the rate of NTSCI—a population with unique and poorly understood clinical and preventive healthcare needs—is likely to increase. Moreover, and in spite of the fact that this is a cross-sectional study, we were able to exclude individuals with pre-existing psychological morbidity, and thus examine the onset of psychological morbidity and multimorbidity after the index NTSCI diagnosis. Last, by using a stringent propensity matching

approach, we demonstrated that much of the increased prevalence of psychological morbidity seen among the adults with NTSCI may have been driven by comorbid chronic disease in those individuals. This is important, as many of these are noncommunicable diseases and are preventable or treatable with aggressive clinical screening and targeted interventions.

Conclusions

Adults with NTSCIs had a higher prevalence of many psychological morbidities, including adjustment reaction, anxiety disorders, depressive disorders, drug dependence, episodic mood disorders, central pain syndrome, psychogenic pain, dementia, and multimorbidity, as compared to adults without a SCI. Moreover, adults with NTSCIs had a substantially higher prevalence of preventable, noncommunicable diseases, and chronic disease multimorbidity. Based on these findings, future efforts are needed not only to better understand the healthcare burden associated with these conditions in this SCI subpopulation, but, just as critical, also to facilitate the development of appropriate clinical screening algorithms and design of early behavioral interventions to reduce the risk of disease onset/progression in this higher risk population.

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Supplementary materials

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