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Unemployment in the United States After Traumatic Brain Injury for Working-Age Individuals: Prevalence and Associated Factors 2 Years Postinjury

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Abstract

Objective—To estimate the prevalence of unemployment and part-time employment in the United States for working-age individuals completing rehabilitation for a primary diagnosis of traumatic brain injury (TBI) between 2001 and 2010.

Design—Secondary data analysis.

Setting—Acute inpatient rehabilitation facilities.

Participants—Patients aged 16 to 60 years at injury who completed inpatient rehabilitation for TBI between 2001 and 2010.

Main Outcome Measures—Unemployment; Part-time employment.

Results—The prevalence of unemployment for persons in the selected cohort was 60.4% at 2-year postinjury. Prevalence of unemployment at 2-year postinjury was significantly associated with the majority of categories of age group, race, gender, marital status, primary inpatient rehabilitation payment source, education, preinjury vocational status, length of stay, and Disability Rating Scale. The direction of association for the majority of these variables complement previous research in this area, with only Hispanic ethnicity and the FIM Cognitive subscale demonstrating disparate findings. For those employed at 2-year postinjury, the prevalence of part-time employment was 35.0%. The model of prevalence for part-time employment at 2-year postinjury was less robust, with significant relationships with some categorical components of age group, gender, marital status, primary payment source, preinjury vocational status, and Disability Rating Scale.

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The authors declare no conflicts of interest.

Conclusions—The prevalence of unemployment for patients completing inpatient rehabilitation for TBI was substantial (60.4%). The majority of factors found to associate with 2 years' unemployment were complementary of previously published research; however, these were often smaller in magnitude than previous reports. The prevalence of part-time employment was also an issue for this cohort and included 35.0% of all employed individuals. In regard to the determination of factors associated with part-time employment, additional analyses that include more fine-grained factors associated with employment, including physical and psychosocial functioning, are recommended.

Keywords

injury outcomes; prevalence; TBI; traumatic brain injury; unemployment

Traumatic brain injury (TBI) is a national public health concern in the United States. The Centers for Disease Control and Prevention estimates that in 2009 there were approximately 2.4 million emergency department visits, hospitalizations, and deaths that included a TBI diagnosis; furthermore, from 2007 to 2009, there was an average of almost 1.2 million visits each year to outpatient clinics or physician offices that included a TBI diagnosis.[1] Approximately 300 000 of these injuries will result in a hospital admission,[2] 90% of which will involve those 16 years and older.[3] A subpopulation (~20 000 annually) of this late-teen and adult group will be discharged to inpatient rehabilitation for continued care following hospitalization.[4] People with injuries severe enough to require admission to inpatient rehabilitation have been shown to have an increased likelihood of physical, cognitive, emotional, behavioral, social, and functional problems after injury.[5,6]

The adverse outcomes associated with TBI can have a substantial impact on a person's ability to assume gainful employment after injury. Not only does this reduce an individual's ability to earn an income, but it also has the potential to negatively influence postinjury psychosocial adjustment,[7] life satisfaction,[8] and quality of life.[9] The impact of TBI on employment after injury is so profound that the National Institutes on Disability Rehabilitation and Research has consistently prioritized the study of skills, policy, and health system practices that result in unequal opportunities for and interventions aimed to enhance postinjury employment for this population.[10,11]

A substantial body of literature exists regarding employment and unemployment after TBI, with numerous investigations of variables that may influence employment. Variables previously demonstrated to be associated with employment or unemployment after TBI include the preinjury variables of age,[12–16] gender,[12,13,17] race,[12–14] occupational type (eg, professional, skilled, manual),[12–14,18,19] marital status,[12,13] alcohol use,[20] and injury severity,[12–15,17–19,21–23] as well as postinjury variables, including pain[24] and coping strategies.[17,21,23–25] Despite the breadth of information regarding employment after TBI requiring inpatient rehabilitation, no current literature exists regarding national level population estimates and predictors of unemployment after TBI in the United States, as previous research has used small sample cohorts or nongeneralizable archival data sets.

Recent works by Corrigan et al[26] and Cuthbert et al[4] have demonstrated the ability to evaluate population estimates for adults receiving inpatient rehabilitation for a primary

diagnosis of TBI using the Traumatic Brain Injury Model Systems National Database (TBIMS-NDB) by comparing specific years of this data set with the 2 data repositories (the Uniform Data System for Medical Rehabilitation[27] and the American Medical Rehabilitation Providers Association, eRehabdata[28]). These data repositories serve as intermediaries between inpatient rehabilitation facilities (IRFs) and the Centers for Medicare & Medicaid services and require submission of a core data set for all patients admitted to an IRF, regardless of payment source. Using combined data from these intermediaries, the authors were able to discern population characteristics of all patients receiving inpatient rehabilitation with a primary diagnosis of TBI in the United States for 7- and 10-year samples.[4,26] It was estimated that at least 92% of all civilian IRFs submitted data to these 2 repositories, and because these included the largest IRFs in the United States, the data sets approached 100% of all IRF admissions for TBI.[26]

The purpose of this study was to use the 10-year nationally weighted TBIMS-NDB data set to assess the prevalence of unemployment 2 years postinjury for late teens and adults who completed inpatient rehabilitation for a primary diagnosis of TBI in the United States, as well as the factors associated with an increased prevalence of unemployment. The 2-year postinjury time period was selected, as this would allow people with particularly complex injuries requiring extensive acute care and inpatient rehabilitation ample time to be discharged from their medical care and possibly resume day-to-day activities. The prevalence of part-time employment among those who return to paid employment was evaluated as an addendum to this study, with an accompanying investigation of factors associated with an increased prevalence for this type of employment.

METHODS

Settings and subjects

Since 1987, the US Department of Education, National Institute on Disability and Rehabilitation Research has funded the TBIMS program, with one of the primary objectives being to maintain a standardized, longitudinal database for studies of TBI treatment and outcomes.[29] The TBIMS-NDB contains patients treated at 20 TBIMS centers located in varied locations throughout the United States, which have been funded between 1988 and 2013.[29] For the purposes of the TBIMS-NDB, TBI has been operationalized as damage to brain tissue caused by an external mechanical force evidenced either by medically documented loss of consciousness or posttraumatic amnesia (PTA) due to brain trauma or by objective neurological findings that can be reasonably attributed to TBI. Patients enrolled in this data set must (1) have at least one of the following indicators of moderate or severe TBI: PTA of more than 24 hours, trauma-related intracranial neuroimaging abnormalities, loss of consciousness of more than 30 minutes, or a Glasgow Coma Scale score in the emergency department of less than 13 (unless due to intubation, sedation, or intoxication); (2) be at least 16 years of age at the time of injury; (3) present to an acute care hospital within 72 hours of injury; (4) receive both acute hospital care and comprehensive rehabilitation in a designated brain injury inpatient unit within the TBIMS; and (5) provide informed consent to participate or have a proxy provide consent.[30] Data are collected during inpatient rehabilitation and subsequently at follow-up interviews at 1, 2, and 5 years postinjury and

every 5 years thereafter. The TBIMS uses a “best source” policy for all follow-up data collection, interviewing a proxy if an enrolled individual is unable to supply valid information.[30] As of June 30, 2013, the TBIMS-NDB contained 11 758 patients and had a follow-up rate of 76% for all follow-up interviews conducted up to 20 years postinjury; 79% for just those at 2 years. Of the missing patients at 2 years, 68% were missing due to lost contact with the participant, 15% were missing due to center defunding, 12% were missing due to participant incarceration at follow-up, and 5% were missing due to withdrawal.

Weighting scheme

To obtain population estimates for patients receiving inpatient rehabilitation who met the patient inclusion criteria for a primary diagnosis of TBI, the TBIMS-NDB was weighted to match the US TBI Rehabilitation population included in the study by Cuthbert et al.[4] To weight the TBIMS-NDB, the data set was limited to patients admitted and discharged between October 1, 2001, and December 31, 2010, resulting in a sample size of 7373. The dates selected for raking were the date at which data reporting to the 2 national data repositories became mandatory (October 1, 2001) and the most recent data from these repositories at the time of the Cuthbert et al publication in 2012 (December 31, 2010).[4] These data were then weighted to represent the US TBI Rehabilitation population of 156 447 using raking. Raking[31] is an iterative proportional weighting procedure that repeats until the distribution of sample characteristics, in this patient the TBIMS-NDB, match the distributions of population characteristics simultaneously, which were the US TBI Rehabilitation population. Sample characteristics of the US TBI Rehabilitation population that were found to be below 5% were combined with additional categories, as to provide reliable weights, the raking procedure requires all population characteristics to be 5% or greater. Variables included in raking and their distributions are presented in Table 1.

Missing data for variables to be used in the raking procedure were rare (<3.0%) within the TBIMS-NDB, with no individual patients missing more than 2 variables. Patients with missing data for any weighting variables had these values imputed using expectation maximization[32] before raking. At the completion of the raking process, extreme weights were assessed using weight trimming, a process used to evaluate the truncation of the largest and smallest weights to less extreme values. The intent of this process is to reduce sample bias, estimated by the mean squared error, for the outcomes of interest. For the present analyses, weight trimming was found to be unnecessary.

To investigate unemployment at 2 years postinjury for working-age individuals, the TBIMS-NDB was limited to participants who were injured between the ages of 16 and 60 years and who had not reported a productive status of retired prior to injury, resulting in a sample of 3121 patients, equivalent to a US TBI Rehabilitation Population sample of 66 224 individuals. Patients 60 years and older at injury were excluded from these analyses, as this cohort would be 62 years or older at the 2-year follow-up interview. Individuals in this age range have a known high likelihood of retirement after injury, particularly due to the ability to apply for early Social Security benefits at 62 years of age.[33] Patients reporting a preinjury status of retired were excluded, as these individuals would not foreseeably seek employment after rehabilitation from their injuries, as the likely focus of their rehabilitation would be to

return them to their preinjury vocational status. Of the selected sample, 95% (n = 2977) had a valid 2-year follow-up interview response, meaning that the participant had completed the interview or expired. To minimize the possible effects of nonresponse bias by evaluating only patients with valid 2-year interviews, propensity scoring was applied to determine the likelihood of each completed patient for having a valid 2-year follow-up interview. The sample with valid outcomes was then reraked using the propensity score as an additional population estimate, which slightly increased the weights of those participants who were less likely to have a valid 2-year follow-up interview and returned the sample size to 3121 patients. All raking, weight-trimming, and nonresponse bias adjustments were completed with SAS/STAT version 9.3 software (SAS Institute Inc, Cary, North Carolina), with raking completed using the IHB raking macro.[31]

Outcomes

Two binary outcomes were selected for this study: unemployment and part-time employment. Unemployment was operationalized as a report of any productive status that did not involve paid legal or illegal employment; employment included paid legal or illegal work. Unemployment included patients that reported the following as their primary productive status: student, family caretaker, retired, volunteer, unemployed, or other. Part-time employment was limited to patients who reported a productive status of being employed for pay. Patients reporting an average of less than 35 hours per week were designated as having part-time employment,[34] whereas the remaining sample was designated as full-time.

Covariates

Independent variables of interest were categorized into 5 blocks: demographic, socioeconomic, injury severity, function, and substance use. Nondynamic independent variables (eg, race, gender, length of stay [LOS]) were obtained at initial data collection. Variables that could have changed between initial data collection and the 2-year follow-up interview (eg, marital status, education, functional measures) were obtained from the 2-year interview and are noted with an asterisk in the following descriptions.

Demographic variables included age group, race/ethnicity, gender, and marital status*. Age group was categorized as follows: 16 to 19, 20 to 29, 30 to 39, 40 to 49, and 50 to 59 years. Race/ethnicity included white non-Hispanic, black non-Hispanic, Hispanic, and other. Gender included male and female. Marital status categories were married, never married, and previously married.

Socioeconomic variables were composed of the primary payment source for inpatient rehabilitation, education*, and preinjury vocational status. Primary payment sources included private insurance, Medicare, Medicaid, workers' compensation, self-pay, or no pay. Education was grouped by advanced degree (meaning a master's degree or higher), bachelor's degree, some college or associate degree, high school graduate or equivalent, and less than high school graduate. Preinjury vocational status included groups of employed, unemployed, and student.

Injury severity variables were inpatient rehabilitation LOS and PTA severity. Inpatient rehabilitation LOS was categorized as 1 to 9, 10 to 19, 20 to 29, 30 to 39, and 40 or more days; PTA was computed as days from hospital admission to the first day that the participant achieved 2 consecutive scores of 76 or greater on the Galveston Orientation and Amnesia Test,[35] 11 or greater on the Galveston Orientation and Amnesia Test–Revised,[36] 25 or greater on the Orientation-Log, or 8 or greater on the nonverbal Orientation-Log.[37] These scores would signify that an individual has emerged from amnesia due to injury and is able to retain and communicate (verbally or nonverbally) new information. Patients remaining in PTA at the time of inpatient rehabilitation discharge had their days of PTA computed as days from rehabilitation admission to rehabilitation discharge. PTA severity was calculated using the established severity rankings of mild (0–1 day), moderate (2–7 days), and severe (>7 days). Severity based upon the Glasgow Coma Scale score was not considered for inclusion due to a high percentage of missing data (44%), primarily due to intubation and sedation at admission. Severity based on days of unconsciousness was not included, as the majority of patients (70.9%) had a rating of severe for this measure.

Function variables included the Motor* and Cognitive* subscores of the FIM instrument (here forward referred to as “FIM”) and the Disability Rating Scale* (DRS). The FIM includes 18 items, each of which is scored on a scale ranging from 1 to 7, with higher scores indicating greater independence in activities of daily living. FIM Motor and FIM Cognitive subscales are useful in describing 2 distinct components of functional status.[38] The FIM Motor subscale score was calculated from 13 items, with scores ranging from 13 to 91; the FIM Cognitive subscale score was calculated from 5 items, with scores ranging from 5 to 35. The DRS total score was calculated from the 8 items included in this outcome assessment, with a range of 0 to 28. Each of these variables was included as a continuous outcome.

Substance use variables included drinking category* and drug use*. Drinking category included abstaining, light, moderate, and heavy alcohol consumption, given one’s age/gender, at the period at the time of interview.[39] Drug use included any reports of either illegal substance use or unwarranted use of prescribed medications in the year prior to interview.

Analyses

Neither primary outcome was found to be rare; thus, multivariate modified Poisson regressions with robust error variances were used to assess the relationship between the covariates and these outcomes. These analyses have well-documented advantages to logistic regression for prevalence-based analyses, in that they produce prevalence ratios (risk ratios) as opposed to odds ratios. Numerous studies have demonstrated that odds ratios produced by logistic regression overestimate associations between covariates and outcomes, particularly for outcomes that are not rare. For extended reading about the differences between these measures of probability for dichotomous outcomes and their appropriate application and examples, the authors suggest reviewing the work of Zhang and Yu[40] or Viera.[41]

Each outcome was analyzed individually and by additive entry of covariate blocks. We considered each model to be complete when the Akaike information criterion value of the overall model failed to reduce by 0.005 points. Once a model was determined to be

complete, 2 interactive terms selected a priori (age by gender; marital status by gender) were added to test for effect modification between these covariates. The same constraint for determining model completion was applied to the inclusion of the interactive terms. All outcome models were computed using STATA 12 SE (Stata Statistical Software: Release 12, 2011; StataCorp LP, College Station, Texas).

Additional data

US population-level employment data for all noninstitutionalized individuals who were 16 years and older between October 2003 and December 2012 were obtained from the Bureau of Labor Statistics (BLS) Labor Force Statistics Web site.[42] These data were queried to obtain unadjusted comparative population prevalence data to ascertain what, if any, influence TBI had on unemployment overall and for specific demographic groups. Comparisons across data sets are provided only for descriptive purposes and should not be considered absolute.

RESULTS

Of all individuals in the United States who were admitted to inpatient rehabilitation for a primary diagnosis of TBI between 2001 and 2010 and who were between the ages of 16 and 60 years and not retired at injury, 3.2% (n = 2,143) had expired by 2 years postinjury. The prevalence of unemployment at 2 years postinjury (2003–2012) for individuals who were alive (n = 64 081) was 60.4% (n = 38 682), whereas the average unemployment rate for the US population during the same period was 9.0%.[42] Descriptive demographic and socioeconomic comparisons (see Table 2) show that persons unemployed at 2 years postinjury were more likely to be younger at injury, female, black, and have lower educational attainment. Those who were employed preinjury were most likely to be employed full-time (81.2%). Comparisons with US population-level unemployment data from October 2003 to December 2012 showed that individuals receiving inpatient rehabilitation for a primary diagnosis of TBI had higher rates of unemployment for males (58.7% TBIMS-NDB; 9.4% BLS), females (64.8% TBIMS-NDB; 8.5% BLS), black race (76.6% TBIMS-NDB; 15.8% BLS), and Hispanic ethnicity (64.7% TBIMS-NDB; 11.4% BLS). Comparisons of other demographic categories were not completed because of differences in categorical definitions (eg, 20–29 for TBIMS-NDB data vs 25–34 for BLS data).

In the creation of predictive models of the prevalence of unemployment at 2 years postinjury, 2 covariate pairs (PTA and LOS; FIM Motor and FIM Cognitive) were found to have substantial confounding. Confounding was identified by a reversal in the predictive direction of a covariate when comparing the univariate and multivariate prevalence models (eg, a variable predicting a significant increase in the prevalence of unemployment univariately predicting a significant decrease in prevalence multivariately). Both covariate pairs were found to be highly correlated (Pearson r = 0.69 and 0.72 for LOS and PTA and FIM Cognitive and FIM Motor, respectively); thus, for outcome prediction, only one variable from each pair was retained (LOS and FIM Cognitive). Length of stay was retained, as it did not require inclusion of any derived values, whereas FIM Cognitive was retained, as it was

considered to provide more insight into the cognitive impact of TBI as opposed to resultant physical disabilities.

The results of the modified Poisson regression analyses using additive covariate blocks predicting unemployment at 2 years postinjury are presented in Table 3. The model was considered complete following the addition of the function covariates, with the substance use variables and interactive terms failing to reduce the overall model Akaike information criterion value by 0.005. After multivariate adjustment, variables from each of the covariate blocks provided significant association of unemployment at 2 years postinjury.

Demographic variables that predicted unemployment included age group, race, gender, and marital status. The prevalence of unemployment demonstrated a significant increase as age group at injury increased (9%–39% increase); however, the prevalence ratio for those aged 20 to 29 years at injury was not significant. Within race, the prevalence ratio for individuals who were black demonstrated a significant increased prevalence of unemployment compared with those who were white whereas the prevalence ratio for individuals reporting an ethnicity of Hispanic as compared with white was not significant. Females were found to be slightly less likely to be employed at postinjury than males, and people who reported being previously married were less likely to be employed than those who were married.

All socioeconomic variables included in the predictive model of unemployment produced significant results. Reimbursement, or lack thereof, for rehabilitation using government payers, workers' compensation, and self-pay or no pay had an increased prevalence of unemployment relative to those with private insurance. As compared with individuals with advanced degrees, the pattern of prevalence of unemployment showed a stepped increase as educational attainment category decreased (from 7% to 48%), with those with only a bachelor's degree not significantly more likely to be unemployed at 2 years. Preinjury vocational status demonstrated the greatest association with 2-year unemployment, with individuals who reported being student at the time of injury being 56% more likely to be unemployed. Those who reported being unemployed preinjury were 40% more likely to be unemployed postinjury than those employed preinjury.

The lone injury severity variable, LOS, an indicator of length of time in inpatient rehabilitation, was found to be significantly associated with unemployment. As compared with an LOS of 1 to 9 days, the prevalence ratios of unemployment demonstrated a stepped increase as LOS categories increased (from 13% to 34%). Of the 2 functional variables, only the DRS was significantly associated with unemployment, with an increased prevalence of 5% for every 1 point increase on the DRS.

Brief demographic and socioeconomic comparisons of patients employed part- and full-time at 2 years postinjury ($n = 8891$, $n = 16\,508$, respectively) show that those employed part-time were younger than 30 years and female (see Table 4). Multivariate prediction of part-time employment status was less robust than prediction of unemployment (see Table 5). Variables found to have substantial association with part-time employment included gender, preinjury vocational status, and DRS, whereas only some components of the variables age group, marital status, primary payment, and education had a significant association with the

dependent variable. After multivariate adjustment, females were found to have a 43% higher prevalence of part-time employment than males; students had a 57% higher prevalence of part-time employment than those employed at preinjury and those unemployed preinjury had a 36% higher prevalence of being part-time employed; each 1 point increase on the DRS was associated with a 41% higher risk of part-time employment.

DISCUSSION

Unemployment

The central aim of this research was to estimate the prevalence of and variables associated with unemployment at 2 years postinjury for individuals who were of working age and not retired at injury and who completed inpatient rehabilitation for a primary diagnosis of TBI between 2001 and 2010. Unemployment for this cohort was found to be substantial, with an overall prevalence of 60.4% (n = 38 682) between 2003 and 2012. This finding provides further credence to the conceptualization of TBI as an injury with both short- and long-term consequences that would benefit from assessment and management during each of these phases.[43] Comparisons of unemployment rates for the US TBI population with the total US population showed extreme differences in rates both overall and across comparable categorical groups. Individuals who attended inpatient rehabilitation for a primary diagnosis of TBI and who were male, female, of black race, or Hispanic ethnicity had unemployment rates more than 50% above the national averages for these groups. In modeling factors that are associated with unemployment, numerous demographic, socioeconomic, injury severity, and function variables demonstrated significant relationships, with several categorical levels demonstrating considerably higher prevalence rates at 2 years postinjury.

The multivariate adjusted prevalence ratios for the selected demographic variables were largely consistent with previous research. The adjusted prevalence ratios of unemployment associated with age demonstrated a stepped pattern of increasing unemployment as age group at the time of injury increased (in reference to the youngest age group), providing further support that TBI exacerbates known age-related employment disparities in noninjured populations. [12–16] Similarly, those of black race were found to have a significantly increased prevalence of unemployment as compared with whites, with known racial disparities between these groups in noninjured populations continuing after injury.[12,13] While small, females were found to have a significantly increased prevalence of unemployment (8%) compared with males, providing further support that gender does influence outcomes after TBI and that women have an increased risk of unemployment following injury compared with men.[12,17] The sole demographic category found to contradict previously reported results was Hispanic ethnicity. In the present analyses, Hispanic ethnicity was not significantly associated with unemployment (P =.60); however, previous investigations of Hispanic ethnicity and unemployment have demonstrated a positive association with unemployment. Differences in the results of these studies may be due to differing definitions of TBI,[44] selection of differing years of TBIMS-NDB data, the use of the weighted TBIMS-NDB population,[45] or differing postinjury year of assessment.[14]

The multivariate adjusted socioeconomic variable prevalence ratios also had findings that were consistent with previously published research regarding unemployment after TBI.[12]

The associations between primary payment source and unemployment show a clear difference between those with private insurance and nonprivate insurance payment sources, with all of those in the latter group having an increased prevalence of unemployment. While it is logical that those with government-based insurance or who were unable to pay for care may be more likely to be unemployed preinjury and thus unemployed postinjury, it was interesting to find that individuals with workers' compensation insurance, the primary goal of which is to return an individual to work after injury, had the highest multivariate adjusted prevalence ratio of 1.22 for unemployment, or 22% greater unemployment for those with workers' compensations as compared with those with private insurance) of all nonprivate insurance sources. Further investigation of this finding is warranted. Finally, preinjury employment status was found to have the greatest influence on 2-year postinjury employment, as evidenced by the large multivariate adjusted prevalence ratios associated with this variable, a finding that has been established in numerous prior investigations.[12–14,18,19]

The multivariate adjusted prevalence ratios for injury severity and function variables were also primarily consistent with previous research.[12–15,19,46] Results with strong similarities included an increased prevalence of unemployment with increased LOS and DRS scores. Of this covariate group, only the results for FIM Cognitive contradicted previous investigations of unemployment after TBI. In the current study, the FIM Cognitive score was not found to significantly associate with unemployment. While we are confident with these FIM Cognitive results, some previous research has demonstrated a significant association between this measure and employment,[18] with lower scores associated with an increased probability of unemployment. These differences may be due to dissimilarities in the timing of the collection of this outcome or by sample selection differences; they may also be due to instability of the FIM, with studies reporting an association[15,18,22] or lack of association with employment[19] with this measure.

Despite the robust prevalence models, the majority of variables associated with an increased prevalence of unemployment were static and no variables included information regarding specific rehabilitative strategies that may reduce the prevalence of unemployment. While this information may be of use to rehabilitation professionals to inform their practice regarding which patients may require extended focus to enhance the ability of employment after injury, future research in this area would be greatly enhanced by the inclusion of dynamic physical and psychosocial functional covariates or rehabilitation-specific strategies. Furthermore, additional research would benefit by utilizing longitudinal measures of employment postinjury, as it is likely that employment itself is a dynamic construct.

Many of the results presented here are similar to previously published research about the variables demonstrating significant associations with unemployment and the direction of those associations; however, the majority of the associations between predictors and unemployment provided here do not demonstrate the magnitude of association between predictors and unemployment reported in previous research. As an illustration, a recent study of unemployment using the TBIMS-NDB by Gary et al[13] found that after multivariable adjustment, those of black race had 2.1 times the odds of being unemployed at 2 years postinjury as compared with whites, whereas in the current study, those of black race

were found to have only a 12% increased prevalence of unemployment. While these differences in magnitude may be partially due to sample differences, they are also likely linked to the selected outcome, prevalence (risk) ratios, which were computed by modified Poisson regressions with robust error variances. Much of the published research regarding employment after TBI has used logistic regressions that produce odds ratios. While odds ratios are valid outcomes for some study designs, this measure of probability is typically reserved for patient-control studies in which the outcome of interest is rare whereas risk ratios and prevalence ratios are the preferred measure for cross-sectional and cohort-based epidemiological research.[40]

Part-time employment

To our knowledge, this study represents one of the first analyses of 2-year part-time employment for persons who were of working age and who acquired a TBI requiring inpatient rehabilitation in the United States. For individuals who are employed at 2 years postinjury, part-time employment prevalence was 35.0% (13.9% of the total population) for the period of 2003–2012. While the percentage of individuals who preferred part-time employment as opposed to those who were employed part-time but were seeking full-time employment within this 35% is unknown, the large percentage of individuals who are working part-time at 2 years postinjury as compared with those working part-time prior to injury (≈19%) suggests that in addition to unemployment, underemployment may be a significant issue for individuals following TBI. Unfortunately, the model result associated with part-time employment was less robust than that of unemployment, with only the gender, preinjury vocational status, and DRS demonstrating consistent significant associations with part-time employment.

With regard to demographic variables, females were shown to have an increased prevalence of part-time employment as compared with males. This result is not unexpected, as in uninjured populations, females are also more likely to be employed part-time. Demographic variables with partial associations to part-time employment included age group and marital status. With regard to age, individuals aged 20 to 29 years and 30 to 39 years at injury were less likely to be employed part-time than individuals aged 16 to 19 years. While the youngest individuals at injury may have an increased prevalence of part-time employment due to dual roles as students and employees, the finding that people who were older at injury (aged 40–49, 50–59 years) are more likely to be employed part-time suggests an age-related disparity in the assumption of full-time work postinjury.

Of the remaining socioeconomic, injury, and functional variables, only 3 variables demonstrated complete or partial significant associations with part-time employment. Individuals with both types of nonemployed preinjury vocation were found to have a higher prevalence of part-time employment postinjury, suggesting that those accustomed to the demands of paid employment preinjury were more prepared to deal with the demands following injury. DRS scores were also predictive of part-time employment, with an increased prevalence of part-time employment as DRS score increased. Given that higher DRS scores represent less severe disability, these results are intuitive and suggest that individuals who demonstrate more disability postinjury are more likely to be employed part-

time. Individuals using both types of government-based insurance had a higher prevalence of part-time employment than individuals who used private insurance as their primary payment for inpatient rehabilitation. This result is not surprising, given that both of these payment sources have restraints on the amount of income that a person is allowed to receive in order to qualify for this type of insurance.

Overall

Given the influence of employment on psychosocial health[7–9] and the high rate of unemployment and part-time employment for individuals of working age who incur moderate to severe TBI in the United States, research and development of interventions to positively influence postinjury work placement for this population are essential to ensure the long-term psychological well-being of this population. Furthermore, additional research on the influence of unpaid productive activities (eg, volunteering) on psychosocial health for this population is strongly recommended, as some individuals with TBI may lack the capacity to adhere the structure, pace, or stress of paid employment, however, could thrive in less rigid unpaid environments. Such unpaid activity could uncouple the link between meaningful work and income, thereby allowing an individual to reap the psychological benefits of being productive while maintaining the earned income contingencies, or lack thereof, required for the receipt of disability-based insurance benefits. Finally, the reconceptualization of TBI as a chronic condition requiring long-term monitoring and treatment, as opposed to an injury with short-term consequences, could greatly influence the structure and availability of employment-centered rehabilitation opportunities for this population. As noted in this study, the consequences of TBI on employment are well marked at 2 years postinjury. Unfortunately, under the current care model, the majority of rehabilitation opportunities for this population have long passed, greatly reducing the ability to improve these outcomes as time moves forward.

LIMITATIONS

The major limitation of this study is the definition of employment as only participants who report gainful work. While this definition is clear, it excludes individuals who report being students or home caregivers, with both of these vocations possibly requiring as much time and energy as paid employment and providing similar benefits such as socialization and productive activity. While this study does provide insight into the prevalence of and factors associated with gainful employment, these results should not be interpreted as true for all productive activity. Gainful employment was selected, as it would provide conservative estimates of a 2 years postinjury positive rehabilitation outcome; however, these estimates fail to capture all successful postrehabilitation outcomes, such as individuals who were students prior to injury (13.1% in the current sample) who subsequently return to scholastic activity (4.5%). In addition, many of the variables available within the TBIMS-NDB were not included in the analyses. In reviewing the data available for analysis, many variables of interest that may have enhanced the multivariate modeling (eg, Satisfaction With Life Scale,[47] 9-item Patient Health Questionnaire[48]) were either not collected throughout the entire 10-year period or not collected because of proxy interview completion. Because of substantial missing data for these variables, they were not selected for inclusion in these

analyses. This study also did not include adjustment for national economic variation, including known fluctuations in the US economy. As the period of study included here covers 2 periods of established uncertainty in the US economy (2002, 2008) during which employment for all Americans was significantly impacted, the report of prevalence of unemployment may be skewed and not relevant to other time periods. Finally, the design of this study is cross-sectional and used prevalence ratios to assess factors associated with unemployment. While these designs are adequate for epidemiologically based research, they are limited in their interpretation in that the results of the analyses cannot be interpreted as causation, only association. To evaluate factors that truly lead to employment or unemployment, longitudinal studies of these outcomes are required.

CONCLUSIONS

This study demonstrates that at 2 years postinjury, unemployment is prevalent for individuals who are of working age and who were admitted to and discharged from rehabilitation between 2001 and 2010 following a primary diagnosis of TBI. Comparisons with US population unemployment data during the same time period showed a vastly inflated rate of unemployment for the total US TBI population and for all comparable demographic categories, indicating that TBI greatly exacerbates preexisting market inequalities. Factors that demonstrated the greatest increases in the prevalence of unemployment included older age group at the time of injury, nonprivate insurance payment sources, nonemployed preinjury vocational status, and longer LOS. Education was shown to have an inverse relationship with the prevalence of unemployment, with lower levels of education having a higher prevalence of unemployment. For those in this cohort who were employed, part-time employment occurred often and at a higher rate than preinjury; however, only gender, preinjury employment status, and DRS were found to have significant associations with this outcome. Further investigation of both of these outcomes (unemployment; part-time employment) using longitudinal methodologies and including dynamic predictors is warranted to help identify the key components to maximize the potential for employment after TBI and reduce the negative consequences associated with unemployment.

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TABLE 1

US TBI Rehabilitation population characteristics used to weight TBIMS-NDB

Variable	%	Variable	%	Variable	%
Age, y		Preinjury living status		Rehabilitation LOS, d	
16–19	6.0	Alone	24.2	1–9	29.1
20–29	12.7	Other	75.8	10–19	40.5
30–39	8.1			20–29	18.5
40–49	10.6	Marital status		30–39	6.0
50–59	10.8	Never married	31.4	40+	5.8
60–69	11.2	Married	41.9		
70–79	17.6	Previously married	26.8	Admission FIM Motor	
≥80	23.1			13	7.4
		Preinjury vocational status		14–23	16.9
Gender		Employed	31.1	24–33	16.9
Male	64.3	Student	5.6	34–43	19.8
Female	35.7	Not working	14.1	44–53	21.1
		Retired—any reason	49.2	54–63	12.7
Race/ethnicity				≥64	5.2
White, non-Hispanic	78.5	Primary payment source			
Black, non-Hispanic	9.0	Private insurance	33.6	Admission FIM Cognitive	
Hispanic	7.2	Medicare	46.3	5	9.4
Other	5.3	Medicaid	8.6	6–15	34.6
		Workers’ compensation and other	6.0	16–25	38.8
		Self-pay or no pay	5.5	26–35	17.2

Abbreviations: LOS, length of stay; TBI, traumatic brain injury; TBIMS-NDB, Traumatic Brain Injury Model Systems National Database.

TABLE 2

Population-weighted demographic comparisons of 2-year postinjury employment and unemployment of individuals who received inpatient rehabilitation for a primary diagnosis of TBI and who were younger than 60 years at injury, alive at 2 years postinjury, and not retired at injury

	Employed		Unemployed		Total	
	n	%	*n*	%	*n*	%
Total	25 399	39.6	38 682	60.4	64 081	100.0
Age group, y						
16–19	3 480	13.7	7 571	19.6	11 051	17.2
20–29	4 414	17.4	8 695	22.5	13 109	20.5
30–39	4 774	18.8	6 808	17.6	11 582	18.1
40–49	8 763	34.5	10 286	26.6	19 048	29.7
50–59	3 968	15.6	5 323	13.8	9 291	14.5
Gender						
Male	19 251	75.8	27 357	70.7	46 608	72.7
Female	6 148	24.2	11 325	29.3	17 473	27.3
Race						
White	20 328	80.0	27 018	69.8	47 345	73.9
Black	1 825	7.2	5 980	15.5	7 806	12.2
Hispanic	1 888	7.4	3 457	8.9	5 345	8.3
Other	1 358	5.3	2 227	5.8	3 585	5.6
Education						
Advanced degree	1 874	7.4	1 262	3.3	3 138	4.9
Bachelor’s degree	4 237	16.7	3 314	8.6	7 557	11.8
Some college or associate degree	9 453	37.2	11 611	30.0	21 069	32.9
High school graduate or equivalent	7 643	30.1	14 369	37.1	22 008	34.3
Less than high school	2 193	8.6	8 126	21.0	10 310	16.1
Employment category						
Full-time	20 624	81.2	0	0.0	20 624	32.2
Part-time	4 775	18.8	0	0.0	4 775	7.4

Abbreviation: TBI, traumatic brain injury.

TABLE 3

Risk of being unemployed as compared with employed at 2 years postinjury

	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
Age group, y												
16–19	reference			reference			reference			reference		
20–29	0.96	0.86–1.06	.42	1.09	0.98–1.21	.12	1.08	0.97–1.21	.15	1.09	0.98–1.22	.12
30–39	1.08	0.96–1.22	.22	1.21	1.07–1.37	.00	1.17	1.04–1.33	.01	1.16	1.03–1.32	.02
40–49	1.22	1.08–1.37	.00	1.37	1.21–1.55	.00	1.33	1.17–1.50	.00	1.26	1.11–1.43	.00
50–59	1.32	1.17–1.49	.00	1.49	1.32–1.69	.00	1.47	1.30–1.67	.00	1.39	1.23–1.58	.00
Race												
White	reference			reference			reference			reference		
Black	1.32	1.23–1.41	.00	1.14	1.07–1.22	.00	1.14	1.07–1.22	.00	1.12	1.05–1.19	.00
Hispanic	1.17	1.04–1.30	.01	1.04	0.94–1.16	.44	1.02	0.92–1.13	.75	0.97	0.87–1.09	.60
Other	1.07	0.89–1.29	.45	1.07	0.89–1.28	.47	1.07	0.90–1.27	.44	1.04	0.88–1.24	.63
Gender												
Male	reference			reference			reference			reference		
Female	1.10	1.03–1.18	.00	1.08	1.02–1.15	.01	1.08	1.02–1.15	.02	1.08	1.01–1.15	.03
Marital status												
Married	reference			reference			reference			reference		
Never married	1.22	1.11–1.34	.00	1.07	0.98–1.17	.16	1.06	0.97–1.16	.21	1.06	0.97–1.16	.19
Previously married	1.27	1.17–1.39	.00	1.11	1.02–1.20	.01	1.11	1.02–1.20	.01	1.12	1.03–1.21	.01
Primary payment												
Private insurance				reference			reference			reference		
Medicare				1.26	1.14–1.39	.00	1.24	1.12–1.38	.00	1.15	1.02–1.30	.02
Medicaid				1.26	1.18–1.34	.00	1.27	1.19–1.35	.00	1.21	1.13–1.29	.00
Workers’ compensation				1.24	1.09–1.43	.00	1.24	1.09–1.41	.00	1.22	1.07–1.39	.00
Self-pay or no pay				1.16	1.07–1.26	.00	1.23	1.13–1.34	.00	1.21	1.11–1.31	.00
Education												
Advanced degree				reference			reference			reference		
Bachelor’s degree				1.06	0.85–1.34	.60	1.07	0.85–1.35	.55	1.07	0.85–1.35	.56
Some college or associate degree				1.31	1.07–1.61	.01	1.31	1.07–1.61	.01	1.30	1.06–1.58	.01

	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
High school graduate or equivalent				1.46	1.19–1.79	.00	1.45	1.18–1.77	.00	1.38	1.14–1.69	.00
Less than high school				1.62	1.32–1.99	.00	1.61	1.31–1.97	.00	1.48	1.21–1.81	.00
Preinjury vocational status												
Employed				reference								
Student				1.59	1.43–1.78	.00	1.57	1.40–1.75	.00	1.56	1.39–1.74	.00
Unemployed				1.50	1.41–1.60	.00	1.48	1.39–1.57	.00	1.40	1.32–1.50	.00
Length of stay, d												
1–9							reference			reference		
10–19							1.14	1.04–1.24	.01	1.13	1.03–1.24	.01
20–29							1.34	1.22–1.46	.00	1.29	1.18–1.42	.00
30–39							1.42	1.29–1.56	.00	1.31	1.19–1.45	.00
≥40							1.63	1.49–1.79	.00	1.34	1.22–1.47	.00
FIM Cognitive										0.99	0.99–1.00	.13
Disability Rating Scale									1.05	1.00	1.04–0.01	

Abbreviations: AIC, Akaike information criteria; CI, confidence interval; PR, prevalence ratio.

TABLE 4

Population-weighted demographic comparisons of 2-year postinjury part- and full-time employment of individuals who received inpatient rehabilitation for a primary diagnosis of TBI and who were younger than 60 years at injury, alive at 2 years postinjury, not retired at injury, and employed at 2 years postinjury

	Full-time		Part-time		Total	
	n	%	*n*	%	*n*	%
Total	16 508	65.0	8 891	35.0	25 399	100.0
Age group, y						
16–19	1 472	8.9	2 496	28.1	3 968	15.6
20–29	6 211	37.6	2 553	28.7	8 764	34.5
30–39	3 522	21.3	1 252	14.1	4 774	18.8
40–49	3 034	18.4	1 379	15.5	4 414	17.4
50–59	2 270	13.8	1 210	13.6	3 480	13.7
Gender						
Male	13 431	81.4	5 821	65.5	19 252	75.8
Female	3 077	18.6	3 071	34.5	6 148	24.2
Race						
White	13 253	80.3	7 075	79.6	20 328	80.0
Black	1 052	6.4	773	8.7	1 824	7.2
Hispanic	1 103	6.7	785	8.8	1 888	7.4
Other	1 103	6.7	255	2.9	1 358	5.3
Education						
Advanced degree	1 235	7.5	638	7.2	1 874	7.4
Bachelor’s degree	3 110	18.8	1 127	12.7	4 237	16.7
Some college or associate degree	5 304	32.1	4 148	46.7	9 452	37.2
High school graduate or equivalent	5 496	33.3	2 148	24.2	7 644	30.1
Less than high school	1 363	8.3	830	9.3	2 193	8.6

TABLE 5

Risk of being employed part-time as compared with full-time at 2 years postinjury

	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
Age group, y												
16–19	reference			reference			reference			reference		
20–29	0.53	0.44–0.65	.00	0.60	0.48–0.74	.00	0.61	0.49–0.75	.00	0.65	0.52–0.81	.00
30–39	0.55	0.41–0.73	.00	0.67	0.50–0.90	.01	0.68	0.50–0.91	.01	0.67	0.50–0.91	.01
40–49	0.72	0.54–0.96	.03	0.88	0.65–1.18	.38	0.88	0.66–1.19	.41	0.79	0.58–1.06	.11
50–59	0.84	0.61–1.14	.26	1.07	0.77–1.50	.68	1.08	0.77–1.51	.67	1.04	0.74–1.46	.82
Race												
White	reference			reference			reference			reference		
Black	1.23	0.96–1.57	.10	1.15	0.92–1.44	.23	1.17	0.93–1.48	.18	1.12	0.90–1.41	.32
Hispanic	1.15	0.89–1.50	.28	1.09	0.85–1.40	.49	1.10	0.85–1.41	.47	1.01	0.77–1.32	.95
Other	0.56	0.29–1.08	.09	0.51	0.26–0.99	.05	0.51	0.27–0.99	.05	0.49	0.26–0.94	.03
Gender												
Male	reference			reference			reference			reference		
Female	1.49	1.27–1.74	.00	1.40	1.20–1.64	.00	1.41	1.20–1.64	.00	1.43	1.22–1.67	.00
Marital status												
Married	reference			reference			reference			reference		
Never married	1.43	1.12–1.83	.00	1.38	1.09–1.75	.01	1.39	1.10–1.75	.01	1.35	1.09–1.68	.01
Previously married	0.98	0.72–1.32	.88	0.93	0.69–1.25	.62	0.93	0.69–1.25	.64	0.98	0.73–1.33	.92
Primary payment												
Private insurance				reference			reference			reference		
Medicare				1.76	1.22–2.54	.00	1.78	1.23–2.57	.00	1.75	1.21–2.53	.00
Medicaid				1.63	1.35–1.96	.00	1.64	1.36–1.97	.00	1.60	1.33–1.93	.00
Workers’ compensation				1.08	0.74–1.57	.70	1.08	0.74–1.57	.69	1.03	0.72–1.49	.86
Self-pay or no pay				0.99	0.75–1.30	.93	1.01	0.77–1.33	.95	1.02	0.77–1.35	.88
Education												
Advanced degree				reference			reference			reference		
Bachelor’s degree				0.73	0.50–1.07	.10	0.73	0.50–1.07	.11	0.70	0.48–1.01	.06
Some college or associate degree				1.02	0.73–1.44	.89	1.06	0.75–1.49	.75	1.01	0.72–1.42	.95

	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
HS Grad or Equivalent				0.68	0.48–0.98	.04	0.69	0.48–0.99	.05	0.61	0.42–0.87	.01
Less than HS Grad				0.89	0.59–1.34	.58	0.93	0.62–1.40	.73	0.74	0.49–1.09	.13
Preinjury vocational status												
Employed				reference								
Student				1.47	1.18–1.83	.00	1.47	1.18–1.83	.00	1.57	1.25–1.99	.00
Unemployed				1.43	1.11–1.85	.01	1.41	1.09–1.82	.01	1.36	1.06–1.73	.01
Length of stay, d												
1–9							reference		reference			
10–19							0.94	0.78–1.14	.54	0.90	0.75–1.08	.25
20–29							1.28	1.04–1.57	.02	1.07	0.87–1.32	.52
30–39							1.49	1.17–1.89	.00	1.19	0.93–1.52	.16
≥40							1.52	1.17–1.98	.00	1.08	0.81–1.43	.61
FIM Cognitive										0.97	0.93–1.01	.15
Disability Rating Scale										1.41	1.29–1.54	.00

Abbreviations: AIC, Akaike information criteria; CI, confidence interval; PR, prevalence ratio.