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Workers' risk of unemployment after traumatic brain injury: A normed comparison

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Abstract

We examined, among those persons working preinjury, the risk of unemployment 1 year after traumatic brain injury (TBI) relative to expected risk of unemployment for the sample under a validated risk-adjusted econometric model of employment in the U.S. population. Results indicate that 42% of TBI cases were unemployed *versus* 9% expected, relative risk (RR) = 4.5, 95% confidence interval (CI) (4.12, 4.95). The relative risk for unemployment was higher among males, those with higher education, persons with more severe injuries, and more impaired early neuropsychological or functional status. Difference in unemployment rates gave similar results for gender, severity of injury, and early neuropsychological and functional status. However, for education, the excess was smaller among those more highly educated, but the unemployment rate in the more highly educated in the general population was sufficiently small to yield a larger relative risk. In conclusion, after accounting for underlying risk of unemployment in the general population, unemployment is substantially higher after TBI for people who were employed when they were injured. The differential employment status varies depending on demographics, severity of brain injury, early functional outcome, and neurobehavioral indicators. For characteristics such as education, associated with rates of unemployment in the general population, different methods used to compare the rates may yield different results. (*JINS*, 2005, *11*, 747–752.)

Keywords: Closed head injuries, Employment, Unemployment, Vocational rehabilitation, Risk factors, Neuropsychology.

INTRODUCTION

Most studies of vocational outcome after traumatic brain injury (TBI) have evaluated the contribution of different predictors to postinjury status using regression analysis within the injured group (Cattelani et al., 2002; Cifu et al., 1997; Felmingham et al., 2001; Keyser-Marcus et al., 2002; Ruff et al., 1993; Kraft et al., 1993; Sherer et al., 2002; Wagner et al., 2002). Dikmen et al. (1994) studied prediction of work return in the first two years postinjury using survival curve methodology, and Temkin et al. (1995) used Classification and Regression Trees (CART). These studies have indicated that TBI carries a high risk for unemployment based on pre–post injury comparisons and comparisons with control groups.

However, unemployment risk is highly sensitive to demographic factors (e.g., age, gender, education), as well as to previous employment history. Women of child-rearing age are less likely to be employed than men of the same age. Elderly persons are more likely to be out of the workforce than persons of middle age. None of these studies have taken this into account. In other words, to our knowledge there are no studies that have examined risk of unemployment after head injury controlling for demographic factors

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closely associated with employment and irrespective of TBI. In addition, there have been no studies modeling the risk of unemployment after TBI for those working at the time of the injury as compared to those working in the general population.

Employment history over the last year is a good predictor of current employment status. For example, using the Current Population Survey (CPS), Millimet et al. (2003) found that among men age 30 years with less than a high school education, the probability of being employed at age 31 was around 0.90, provided they were employed at age 30, and only about 0.06 if they were not employed at age 30. Their model allows for calculation of an individual's risk of unemployment, year to year, based on a number of demographic factors and last year's employment status. Comparison based on a large representative group such as this may provide more accurate and stable results than have been previously reported.

The fact that demographic factors and prior work history account for so much variance in employment makes the contribution of TBI, as a cause of unemployment, difficult to determine in selected samples. For example, if a large proportion of persons with a TBI are no longer working after their injury and this proportion is largely composed of persons that never completed high school, then it becomes unclear whether unemployment is a result of the TBI-related impairments and disabilities interfering with job finding, job performance, and job retention skills, or, if persons never completing high school simply have a high rate of unemployment because of preinjury factors and fewer job opportunities? A similar problem with interpretation of findings occurs when a vocational intervention program reports high rates of reemployment when their sample consists of persons with high education or stable preinjury employment.

Nevertheless, the question of how much the risk of unemployment increases after a TBI remains an important one. One way to address this question is to evaluate TBI unemployment risk against a *normed comparison* (i.e., general population) risk. We propose to address this research question using the following strategy:

1. Calculate the risks of unemployment in the general population *as a function of* demographic factors and prior year work status using a validated econometric model for employment (Millimet et al., 2003).

2. Assign a general population risk of unemployment to each TBI study participant as given by the individual demographic profile and prior year work status.

3. Observe unemployment rates a year following a traumatic brain injury *as a function of* demographic factors and prior year work status variables.

4. Compare general population risk to observed risk of unemployment.

In our analysis, employment rates in the general population are comparable to post-WWII (1947–2000) average employment rates (Millimet et al., 2003, p. 91). In addition, care was taken with the general population data to insure that estimates are not sensitive to the particular economic conditions that existed each year the data were collected (Millimet et al., 2003, p. 84). Also, because of restrictions in the similarity of questions within the two data sources, comparisons between our data set and the national one are limited to persons working before the injury. The first hypothesis is that TBI is a risk factor for unemployment. If TBI has no effect on employment, then observed unemployment should be close to expected unemployment as given by the econometric model. The study's second hypothesis is that particular background variables place individuals at differential risk for unemployment after a TBI. We examine demographics, severity of brain injury, early functional outcome, and neurobehavioral indicators in predicting future employment status among those working before injury.

METHODS

In this study, the focus is on persons with traumatic brain injury who were working at the time of injury and the effect of the injury on employment status a year later. To measure this effect, the unemployment rate for these persons 1 year postinjury is first established. We compare this rate with the average of each subjects' general population unemployment risk. The general population unemployment risk is calculated from transition probabilities, given by Millimet et al. (2003), that indicate the probability of transition between labor states year to year in the labor force. Millimet et al. (2003) derived these estimates from the Current Population Survey (CPS) (Bureau of Labor Statistics, 2002). In our analysis, persons with a TBI who were working just prior to the injury are each assigned a general population transition probability that indicates the general population risk for unemployment the following year given their demographic profile. This risk of unemployment considers each subject's age, gender, and education level in its calculation. To assess the effect of TBI on unemployment, the sample's general unemployment risk, based on CPS data, is compared to the observed unemployment rate in the TBI sample, the year following their injury. This approach is analogous to the indirect method of age adjustment and the standardized mortality ratio used in epidemiology (Armitage, 1971).

Research Participants

The sample consists of 418 people who were working prior to sustaining a mild to severe traumatic brain injury and who survived and were followed prospectively until 1 year postinjury. Participants of this study were in one of four prospective longitudinal investigations. Participants were enrolled from 1980 to 1994. The selection criteria varied across the studies, but all subjects met the following mini-

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mum entrance criteria: positive evidence of TBI (e.g., any period of loss of consciousness, posttraumatic amnesia of at least 1 hour, or computed tomography (CT) evidence of a brain lesion), brain injury serious enough to require hospitalization, and survival for at least 1 month. Two of the four studies were pharmacologic in nature, one evaluated the effects of phenyton prophylaxis of posttraumatic seizures (Dikmen et al., 1991), the other evaluated the neuropsychological effects of valproate in traumatic brain injury (Dikmen et al., 2000). Although many of the subjects were involved in experimental treatment protocols, treatment was not considered either because it had already been determined to have no effect on 1-year outcome (Dikmen et al., 1991) or because the treatment had terminated at least 6 months prior to the outcomes studied here. For more details on selection criteria see our prior publications (Dikmen et al., 1991; Dikmen et al., 2000; Temkin et al., 1990; Temkin et al., 1999).

Design

The design is a longitudinal inception cohort design. Data for persons who sustained a traumatic brain injury were examined from four prospective longitudinal data sets of consecutive cases at a level-1 trauma center.

Measures

Employment questions asked in the general population were part of the current population survey (CPS) (Bureau of Labor Statistics, 2002). The CPS is collected by the U.S. Census Bureau using a scientifically selected sample of approximately 56,000 occupied households. Details on the survey design and sampling methods can be found at the U.S. Census Bureau's main page for CPS on-line at: http://www.bls.census.gov/cps/cpsmain.htm. Employment status for the sample of subjects with traumatic brain injury was determined by a structured interview at 1 month and 1 year postinjury. At 1 month postinjury, subjects were questioned about their employment status prior to the injury and were classified as working if they had worked the day of or within seven days of the injury. Subjects were questioned again at 1 year postinjury to determine if they were currently working or had worked within seven days of the interview.

Traumatic brain injury severity was evaluated with the Glasgow Coma Scale score obtained in the emergency department (Teasdale & Jennett, 1974). The Glasgow Coma Scale is a measure of coma depth, which evaluates best response in eye opening, verbalization, and motor domains. Scores range from 3 (no verbal, motor, or eye-opening response) to 15 (oriented). Neuropsychological outcome at 1 month postinjury was evaluated by the Wechsler Adult Intelligence Scale's (WAIS) Performance Intelligence Quotient (PIQ) and Digit Symbol Subtest (Wechsler, 1955) and the Trail Making Test Part B (Army Individual Test Battery, 1944). These neuropsychological measures appear to be more sensitive to employment outcome than other neuropsychological measures (Dikmen & Morgan, 1980, Fraser et al., 1986). Glasgow Outcome Scale (GOS) was used as an index of functional status at 1-month. The GOS (Jennett & Bond, 1975) is an overall measure of outcome based on degree of dependence on others and ability to participate in normal life. Outcome is rated on a five-point scale: death, persistent vegetative state, severe disability, moderate disability, and good recovery.

Data Analysis

We conducted a normed analysis of unemployment using the following steps:

1. Compute the fraction not working 1 year after injury given they were working before TBI, P_{TBI}.
2. Using the Current Population Survey data, assign a risk score (e.g., general population transition probability or chance of unemployment 1 year later) to each person, i, in the sample of size N of persons who were working before they sustained a TBI, P_i.
3. Let $P_{\text{GP}} = \Sigma P_i/N$, represent the general population average risk of unemployment in the sample of persons who sustained a TBI.
4. Compute the relative risk (RR) or risk ratio via the formula: $\text{RR} = P_{\text{TBI}}/P_{\text{GP}}$ and the excess percentage unemployed (or risk difference or absolute risk) by $P_{\text{TBI}} - P_{\text{GP}}$.

In addition, confidence intervals around unemployment rates among persons with TBI are computed based on the binomial distribution. Finally, 95% confidence limits for the relative risk and excess percentage unemployed are computed from this assuming P_{GP} was known without error. Although this is an approximation, the large size of the general population sample makes the variability in P_{GP} very small compared to that of P_{TBI}.

RESULTS

Of the original 418 subjects, 44 were lost to follow-up at 1-year. Statistical comparisons between those persons with and without follow-up on variables at Time 1 (age, sex, Glasgow Coma Scale, preinjury work stability, and work-status at 1-month) revealed no significant differences between groups. Table 1 shows the frequencies, percent actually unemployed, percent expected unemployed, relative risk, and excess risk for subgroups based on demographic variables. As is clear from the table, being male, age 25 to 39 years, and having at least a high school education were associated with greater relative risk of unemployment.

For age and gender, relative risk and excess percentage unemployed give similar conclusions. However, for education, those with less education have higher excess unemployment after TBI than college graduates (i.e., 54.0% − 14.3% = 39.7% excess for those with less than high school education

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Table 1. Relative and excess risk values as a function of demographic characteristics

	N	Actual unemployed (%)	Expected unemployed (%)	Excess risk (95% CI)	Relative risk (95% CI)
Gender					
Male	334	43.1%	8.5%	34.6% (29.2, 40.1)	5.05 (4.42, 5.69)
Female	84	35.7%	12.1%	23.6% (13.4, 34.8)	2.95 (2.11, 3.87)
Age group					
Below 25	133	45.1%	14.0%	31.1% (22.4, 39.9)	3.22 (2.60, 3.85)
25 to 39	200	42%	6.8%	35.2% (28.2, 42.3)	6.15 (5.14, 7.20)
40 to 49	51	23.5%	5.4%	18.1% (7.3, 32.0)	4.36 (2.37, 6.95)
50 and over	34	52.9%	10.8%	42.1% (24.3, 59.4)	4.9 (3.25, 6.50)
Education					
Less than HS	111	54.0%	14.3%	39.7% (30.0, 49.2)	3.77 (3.09, 4.43)
High school	254	40.6%	8.1%	32.5% (26.3, 38.7)	5.02 (4.26, 5.80)
College	53	20.7%	4.3%	16.5% (6.5, 29.8)	4.87 (2.54, 8.00)

compared to 20.7% − 4.3% = 16.5% excess for college graduates).

In spite of this, the risk ratio is higher for college graduates, owing to their low unemployment rates in the general population (i.e., RR = 54.0%/14.3% = 3.77 for those who never graduated from high school *vs.* RR = 20.7%/4.3% = 4.87 for college graduates). Thus, if one looks at the excess unemployment, one sees that a much larger burden of unemployment after TBI falls on the poorly educated, while the relative risk suggests the burden is lowest for that group.

Table 2 shows similar results for subgroups defined by Glasgow Coma Scale (GCS) and the Glasgow Outcome Scale (GOS) at 1-month. This table shows that there is a clear increase in relative risk of unemployment and excess percentage unemployed both with worse initial neurological severity and 1-month functional outcome.

Although not shown in Table 2, for those persons with mild injuries, as determined by the GCS of 13 to 15, relative risk of unemployment was greater for those with CT abnormalities [Relative Risk (confidence interval) = 4.04 (3.13, 5.03)] as compared to those without CT abnormalities [Relative Risk = 2.85 (1.78, 4.16)]; similar results held for excess risk estimates as well.

Table 3 shows similar results for subgroups defined by several neuropsychological measures (i.e., Trails B, PIQ, and Digit Symbol). These measures were given at 1-month. Overall, greater risk for unemployment was associated with worse performance on these measures. As might be expected, those with severe enough injuries to be untestable at 1-month uniformly had the greatest risk for unemployment. Essentially, all subgroups had an elevated risk of unemployment 1 year after TBI. The effect of neuropsychological subgroup is more variable than the medical severity indices. The wider confidence intervals are likely a reflection of the reduced sample size (since neuropsych has more missing values) rather than any inherent added variability.

DISCUSSION

The results of this study suggest that traumatic brain injury puts persons at substantial risk for unemployment even when demographic factors and prior year employment sta-

Table 2. Relative and excess risk values as a function of Glasgow Coma and Outcome scores

	N	Actual unemployed (%)	Expected unemployed (%)	Excess risk (95% CI)	Relative risk (95% CI)
Glasgow Coma score					
13 to 15	228	31.1%	8.8%	22.3% (16.3, 28.7)	3.46 (2.87, 4.28)
9 to 12	84	46.4%	9.6%	36.8% (25.8, 48.0)	4.85 (3.71, 6.02)
3 to 8	87	62.1%	10.4%	51.7% (40.6, 61.8)	5.98 (4.92, 6.96)
Pharmacologically paralyzed*	19	52.6%	8.5%	44.1% (20.3, 67.0)	6.21 (3.41, 8.92)
Glasgow Outcome score (at 1 month)					
Good	109	15.6%	8.5%	7.1% (0.8, 15.2)	1.83 (1.10, 2.79)
Moderate	93	39.8%	8.3%	31.5% (21.4, 42.1)	4.81 (3.60, 6.10)
Severe	129	66.7%	9.8%	56.8% (48.0, 64.9)	6.79 (5.89, 7.61)

*Unable to assess GSC due to paralytic agents.

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Table 3. Relative and excess risk values as a function of neurobehavioral indicators*

	N	Actual unemployed (%)	Expected unemployed (%)	Excess risk (95% CI)	Relative risk (95% CI)
Trails B at 1-month					
45 & below	30	20.0%	6.6%	13.4% (1.1, 31.9)	3.01 (1.16, 5.81)
46 to 60	18	22.8%	9.2%	13.6% (4.8, 24.3)	2.47 (1.53, 3.64)
61 to 90	106	30.2%	8.7%	21.5% (12.9, 31.1)	3.47 (2.49, 4.58)
Over 90	109	46.8%	9.4%	37.4% (27.7, 47.1)	4.97 (3.94, 6.01)
Untestable	57	87.7%	10.9%	76.8% (65.4, 84.0)	8.01 (6.97, 8.67)
PIQ at 1-month					
110 and over	80	18.7%	6.8%	11.9% (4.0, 22.2)	2.76 (1.60, 4.28)
100 to 109	72	18.1%	8.7%	9.4% (1.2, 20.1)	2.08 (1.15, 3.33)
90 to 99	85	41.2%	9.9%	31.2% (20.7, 42.4)	4.14 (3.08, 5.27)
80 to 89	44	38.6%	8.7%	29.9% (15.6, 45.8)	4.44 (2.80, 6.26)
Below 80	44	61.4%	11.0%	50.3% (34.4, 64.6)	5.57 (4.13, 6.86)
Untestable	56	85.7%	10.9%	74.8% (62.8, 82.7)	7.83 (6.74, 8.55)
Digit Symbol at 1-month					
10 and over	111	12.6%	8.2%	4.4% (1.2, 12.0)	1.54 (0.86, 2.47)
6 to 9	161	41.6%	9.2%	32.4% (24.7, 40.4)	4.51 (3.68, 5.38)
0 to 5	52	50.0%	9.2%	40.8% (26.6, 54.9)	5.42 (3.88, 6.95)
Untestable	55	87.3%	10.8%	76.4% (64.7, 83.9)	8.05 (6.97, 8.74)

*Trails B is reported in seconds, PIQ is reported as standard scores (mean = 100, standard deviation = 15), and Digit Symbol is reported as scaled scores (mean = 10 and standard deviation = 3).

tus are controlled. To our knowledge, this is the first study to address the problem of unemployment for persons working at the time of injury after adjusting for general population risk. Because the results from this study help us understand the risk of unemployment as it relates to economic models of unemployment in the general population, they may shed some light on the economic effect of TBI on the workforce. They may also be particularly useful to healthcare providers advising injured workers and their family members in their effort to make financial and household work plans. For example, neuropsychologists conducting assessments in the context of vocational rehabilitation planning may wish to consider that diminished performance on Trails B, PIQ, and Digit Symbol tests are each predicitive of greater risk of unemployment after a traumatic brain injury.

The findings should also help in both the design and interpretation of intervention studies aiming to improve employment outcomes. For example, stratifying or otherwise controlling for educational level, gender, and employment history would be important. The methodology used here should also be able to help in evaluating an intervention when a randomized control group has not been included. Often, the most highly educated seek out and are able to afford the best treatments. Without correction for the demographics of the group, a highly touted new intervention may look more effective than it truly is. Conversely, a program serving a poorly educated group may look less effective than it really is among a broader group of persons with TBI. This methodology should also help clinicians and clinical program evaluators in estimating the degree to which they have improved the outcome of their clients after correcting for powerful predictors of outcome.

As expected and consistent with prior reports, severity of brain injury (as assessed by GCS), associated functional status limitations (as assessed by GOS), and neuropsychological impairments examined at 1 month after injury have systematic and important effects on the risk of unemployment at 1-year (Dikmen et al., 1994; Sherer et al., 2002; Temkin et al., 1995). The confidence bands around risk of unemployment estimates for neuropsychological measures were wider than those for neurological severity indicators and demographic variables. These latter indicators appear to provide more precise estimates of unemployment risk.

Interestingly, the framework used to summarize the findings gives different answers about what education group is most impacted by TBI. The relative risk was higher, but actual excess percentage unemployed was smaller, among those more highly educated as compared to those with less than high school education. The discrepancy between relative risk and excess percentage unemployed for groups based on educational level can be attributed to the rate of unemployment in the general population for the different educational groupings. Among the highly educated, this rate was sufficiently small to yield a higher relative risk even though the excess percent unemployed is lower than it is for those without a high school diploma. Thus, if one looks at the excess unemployment, one sees that a much larger burden of unemployment after TBI falls on the poorly educated, however, relative risk suggests the burden is lowest for that group.

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There are several limitations to this study that need to be mentioned. First, we note that questions asked of the two samples (i.e., the general population and the TBI sample), while functionally equivalent, differed in exact wording. Second, the TBI sample and the normed comparison sample overlapped only partially (1992–1994). The general population data used to generate transition probabilities were collected between 1992 and 2000, whereas the neuropsychological data were collected between 1980 and 1994. However, we note that Millimet et al. 2003 found that general population unemployment rates between 1992 and 2000 were highly representative of unemployment rates for more than half a century after World War II (see p. 93). Finally, most persons that suffered a TBI in our study were from a five state catchment area in the Pacific Northwest of the United States, whereas the general population data represent national employment data.

This study reveals that TBI has a significant effect on the future employment of workers after accounting for underlying risk of unemployment in the general population. Moreover, it highlights the importance of demographics, severity of brain injury, early functional outcome and neurobehavioral indicators in predicting future employment status among workers. We hope that these results help those patients working at the time of injury, family members, and providers seeking to better understand the chance of employment after TBI.

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