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A threshold regression model to predict return to work after traumatic limb injury

Wen-Hsuan Hou [a,b,c], Hung-Yi Chuang [d,e,*], Mei-Ling Ting Lee [f,g]

[a] Master Program in Long-Term Care, College of Nursing, Taipei Medical University, Taipei, Taiwan
[b] School of Gerontology Health Management, College of Nursing, Taipei Medical University, Taipei, Taiwan
[c] Department of Physical Medicine and Rehabilitation, Taipei Medical University Hospital, Taipei, Taiwan
[d] Department of Public Health, College of Health Sciences, Kaohsiung Medical University, Kaohsiung, Taiwan
[e] Department of Occupational and Environmental Medicine, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan
[f] Department of Epidemiology and Biostatistics, School of Public Health, University of Maryland, College Park, MD, USA
[g] Institute of Epidemiology and Preventive Medicine, National Taiwan University, Taipei, Taiwan

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ABSTRACT

Objective: The study aims to examine the severity of initial impairment and recovery rate of return-to-work (RTW) predictors among workers with traumatic limb injury.
Methods: This 2-year prospective cohort study recruited 1124 workers with traumatic limb injury during the first 2 weeks of hospital admission. Baseline data were obtained by questionnaire and chart review. Patient follow-up occurred at 1, 3, 6, 12, 18, and 24 months post injury. The primary outcome was the time of first RTW. The impact of potential predictors on initial impairment and rate of recovery towards RTW was estimated by threshold regression (TR).
Results: A total of 846 (75.27%) participants returned to work during the follow-up period. Our model revealed that the initial impairment level in elderly workers and lower limb injuries were 33% and 35% greater than their counterparts, respectively. Workers with >12 years of education, part-time job, and moderate and higher self-efficacy were less impaired at initial injury compared with their counterparts. In terms of the rate of recovery leading to RTW, workers with older age, part-time jobs, lower limbs, or combined injuries had a significantly slower recovery rate, while workers with 9–12 years of education and >12 years of education had a significantly faster recovery rate.
Conclusions: Our study provides researchers and clinicians with evidence to understand the baseline impairment and rate of recovery towards RTW by explaining the predictors of RTW among workers with traumatic limb injuries.

Introduction

Traumatic limb injury is the leading cause of work disability [1]. The upper and lower extremities are the most commonly injured sites in motor vehicle accidents and occupational accidents [2–4]. In the US, the number of lost working days associated with these injuries is estimated to be about 60 million, and lost productivity is estimated to cost over $7.5 billion annually [2]. After returning to their former jobs, however, many survivors of severe injuries are able to regain a quality of life (QOL) comparable with the normal population [5]. Given that return-to-work (RTW) predictor is one of the major goals for the rehabilitation of workers following traumatic limb injury, it is important to identify early predictors associated with RTW in order to lessen the personal, social, and financial burden of traumatic limb injuries [6].

In order to facilitate the likelihood of injured workers' RTW, factors that could delay or prevent such an outcome need to be identified. A previous systematic review has documented the complex nature of biopsychosocial predictors associated with RTW outcome in workers with traumatic limb injury using various statistical methods [6]. Among these studies, Cox proportional hazard (PH) model has been used to analyze the RTW differences between subgroups of RTW predictors [7]. However, the Kaplan–Meier distribution curves published for RTW have often shown that the data violated the statistical assumption of PHs with respect to subgroups of RTW predictors. Therefore, this study

* Corresponding author at: Department of Public Health, College of Health Sciences, Kaohsiung Medical University, 100, Shih-Chuan 1st Road, Kaohsiung 80708, Taiwan. Tel.: +886 7 3121101x2141 25.
E-mail address: hychuang@gmail.com (H.-Y. Chuang).

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aimed to use an alternative model to examine whether injury conditions and physical, mental, activity, participation, personal, and environmental characteristics at baseline may predict the RTW after traumatic limb injuries.

Material and methods

Participants

This study used data of our previously published 2-year cohort study investigating RTW after traumatic limb injury [8–12]. Workers diagnosed with traumatic limb injuries and hospitalized in the orthopaedic and plastic surgery wards in a teaching hospital of Southern Taiwan were recruited for the study. The inclusion criteria were >20 years of age and hospitalization within 14 days of injury. The workers who were unable to read or answer the questionnaires, foreign workers, and those with coexisting injuries to the central nervous system (i.e., traumatic brain injury or spinal cord injury) or internal organs were excluded. Consecutive cases were collected from January to December 2009 in wards and followed prospectively for 24 months. The study was approved by the ethics committee of the participating hospital; all participants gave their informed consent prior to study enrollment.

Procedure

Participants answered a baseline questionnaire during hospitalization regarding personal data (age, gender, marital status, and educational level), insurance coverage, and occupational history (job titles and seniority). Medical charts were reviewed for the following information: diagnosis, injury dates, date of admission and discharge, and causes or mechanisms of injuries. Each patient's injury history, self-efficacy of RTW, participation in daily life, QOL, and psychological symptoms were administrated within 2 weeks of the injuries. Two trained personnel conducted the follow-up survey of RTW status of all participants at 1, 3, 6, 12, 18, and 24 months after the injury by telephone, mail, or face-to-face interview at the outpatient clinics. The RTW status was the primary endpoint. The number of days between the subject's injury and first RTW event was the time scale for the primary outcome in this study.

Measures

The current study examined the following factors that influence RTW:

RTW

Three levels of self-report RTW status were collected by trained interviewers: (i) RTW at the same job and the same workplace; (ii) RTW at a different job but at the same workplace; (iii) RTW at a different workplace [13]. In this study, we include all of these three levels as RTW. Hence, the RTW variable used in the regression model was a dichotomous variable recorded as either "without RTW" or "RTW."

Occupations

There were three occupation categories. The category of "white-collar workers" used as the reference group in this study includes managers, professionals, technical personnel, salespersons, administrators, and service personnel. "blue-collar workers" included people who worked in the farming, forestry, fishing industries, in repairs, or as operators/labourers [14]. The category of "other workers" refers to students or persons who worked fewer hours (usually <35 h) per week than a full-time job [15], and housewives, students, nuns, or monks. A previous study showed that these hierarchical job classes were associated with a significant trend in risks of adverse health outcomes [16].

Insurance status

Taiwan launched the National Health Insurance (NHI) system in March 1995. This universal health programme covered 98.4% of Taiwan's population since 2007 [17]. In addition, there is a national work compensation system in Taiwan which has insured 8.8–9.4 million workers (i.e., 55–57% of workers) [18]. This system provides no-fault compensation and temporary partial income replacement if workers are unable to earn wages because of their sick leaves due to occupational injuries or disease [7]. People can also purchase private health insurance to receive supplemental compensation during injury episodes. In this study, we have grouped the insurance status condition into two categories, namely those with NHI only and those with additional insurance (e.g., work compensation, private insurance, etc.).

Injury energy and injury part

We classified injury energy into two categories: high energy (traffic accident, fall from height, or struck by falling object) or low energy (cutting, crashing, or crushing by machines). Previous studies specified that the high-energy category (e.g., vehicular trauma or fall from a height) usually results in complicated destructive bony injury, while the low-energy category rarely does [19]. According to the presence of musculoskeletal involvement, the injury parts were grouped into "upper limb," "lower limb," and "limb and other body parts." These two categorical variables have been validated in previous studies as among the significant determinants for RTW.

Self-efficacy of RTW

The question adapted to measure the self-efficacy of RTW was, "What is the likelihood of your returning to work within one month?" The respondents gave their estimates from 1 (no chance) to 5 (very high). Previous studies have demonstrated that self-efficacy plays an important role in the RTW process, presumably because it is a consequence of the interplay of the employment situation, the medical care process, and the individual worker's health and personal characteristics [20]. It is noted that self-efficacy is likely to be influenced by physician's estimated ability to resume employment. It encapsulates a broad and stable sense of personal competence to deal effectively with a variety of stressful situations [21].

Statistical analysis

In this study, we consider the following predictors for RTW identified in the literature [6–10,22]: age, sex, education, marital status, injury parts, injury energy, insurance status, occupation, and self-efficacy. Descriptive statistics were presented as means, SD (standard deviation), and percentages as applicable. The RTW and non-RTW groups of traumatic limb injuries were compared by χ^2-test for categorical variables and t-test for continuous variables. Table 1 defines the demographic information for workers with traumatic limb injury in the study and presents descriptive statistics for their predictive indicator variables.

As mentioned earlier, the Cox PH model has been used in Ref. [7] to analyze the differences between subgroups of RTW predictors. Kaplan–Meier RTW curves for these subgroups suggest, however, that the PH assumption does not hold. Therefore, here we reexamine the same dataset with a different conceptual framework for time to RTW. Our modelling perspective involves an alternative time-to-event methodology called threshold regression (TR). Without assuming PHs, the TR model [23,24] is based on the conception that health events occur when the latent process