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Psychosocial Job Factors and Return-to-Work After Compensated Low Back Injury: A Disability Phase-Specific Analysis

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Background *Job characteristics may constitute a barrier to return-to-work (RTW) after compensated disabling low back pain (LBP). This study examines the impact of psychosocial job factors on time to RTW separately during the acute and subacute/chronic disability phases.*

Methods *This is a retrospective cohort study of 433 LBP workers' compensation claimants with 1–4 years of follow-up. The association of psychosocial job factors with duration of work disability was estimated with Cox regression models, adjusting for injury history and severity, physical workload, and demographic and employment factors.*

Results *High physical and psychological job demands and low supervisory support are each associated with about 20% lower RTW rates during all disability phases. High job control, especially control over work and rest periods, is associated with over 30% higher RTW rates, but only during the subacute/chronic disability phase starting 30 days after injury. Job satisfaction and coworker support are unrelated to time to RTW.*

Conclusions *Duration of work disability is associated with psychosocial job factors independent of injury severity and physical workload. The impact of these risk factors changes significantly over the course of disability.* Am. J. Ind. Med. 40:374–392, 2001.

KEY WORDS: back pain; occupational injury; disability; workers' compensation; psychosocial factors; work stress; social support; work organization; rehabilitation

INTRODUCTION

Low back pain (LBP) is the leading cause of disability for people under age 45 [Wilder, 1973] and the second leading cause of industrial absenteeism [Kelsey and Golden, 1988]. Every year about half of the US working population experiences at least one episode of LBP [Pope et al., 1991]. While only a small fraction (about 2–5%) of these episodes is formally reported as work-related [Spengler et al., 1986], back injuries[1] account for about 25% of all compensable work-related injuries [Klein et al., 1984] and about 33% of all workers' compensation costs in the US [Webster and Snook, 1994]. These costs total about $13–20 billion annually [Bernard, 1997]. Including non-compensated LBP,

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[1] Throughout this paper the term "injury" is used to indicate that LBP cases were formally reported as "occupational injury or illness" in the California workers' compensation system. The term "back injury" includes work-related back pain of both sudden or gradual onset and does not imply that the etiology of the problem is an instantaneous or traumatic event.

the total direct and indirect cost of work-related LBP in 1992 has been estimated to be 49.2 billion, accounting for 34% of the societal costs of all work-related injuries in the US [Leigh et al., 1997]. While LBP is a mostly self-limiting condition with an excellent prognosis, even in the absence of medical care, 10% of workers develop long-term disability of 4 weeks or more. These cases account for about 80% of all workers' compensation costs associated with low back injuries [Leavitt et al., 1971; Spengler et al., 1986; Snook, 1988; Franklin and Fulton-Kehoe, 1996; Williams et al., 1998].

Most researchers acknowledge that LBP and its disability-related sequelae need to be understood as multifactorial in origin; physical, medical, psychological, social, economic, and legal factors all may play an important role in the natural history of this disorder [Nachemson, 1992; Krause and Ragland, 1994; Frank et al., 1998; Krause et al., 2001]. Of late, there has been increasing attention placed on the role of psychosocial factors, located either in the individual worker or in the work environment, in determining the duration of LBP [Deyo and Diehl, 1988; Cats-Baril and Frymoyer, 1991; Feuerstein and Thebarge, 1991; Polatin, 1991; Bigos, 1992; Polatin et al., 1993; Coste et al., 1994; Krause and Ragland, 1994; Feuerstein and Beattie, 1995; Hogg-Johnson et al., 1998; Feuerstein et al., 1999]. Most studies to date on psychosocial job factors have focused on the etiology of LBP *symptoms* or work-related spinal *injuries*[1] reported to occupational health services or workers' compensation insurance carriers [Bigos et al., 1991; Bongers et al., 1993; Bernard, 1997; Krause et al., 1997; Krause et al., 1998b]. Little is known about the prognostic impact of psychosocial working conditions on return-to-work (RTW) and the *duration of work disability* [Infante-Rivard and Lortie, 1996; Frank et al., 1996a; Frank et al., 1998].

Some suggestive evidence for the impact of psychosocial work factors on RTW and length of disability comes from the literature on return to modified work. Modified work programs typically not only reduce physical job demands for the injured worker but also increase social support at work, worker control over job conditions, and work schedule flexibility [Fitzler and Berger, 1982; Fitzler and Berger, 1983; Schmidt et al., 1995; Loisel et al., 1997; Bernacki et al., 2000]. In a recent review of workplace interventions, we found that modified work programs improved return to work rates by a factor of two and cut the number of disability days in half [Krause et al., 1998a]. However, given that these programs often combine changes in work organization with ergonomic interventions and medical case management, it is difficult to identify the specific workplace factors influencing disability outcomes. Similarly, previous occupational risk factor studies for LBP have been criticized because biomechanical and psychosocial risk factors occurring together in the work environment have rarely been evaluated adequately and simultaneously [Bongers et al., 1993; Frank et al., 1995; Bernard, 1997]. Results of a recent prospective study of urban transit operators with individual level measurements of both biomechanical and psychosocial factors suggest that both physical workload and psychosocial job factors independently predict the incidence of formally reported work-related spinal injury [Krause et al., 1998b].

Reviews of the literature have also shown that etiologic and prognostic risk factors for clinical LBP are not identical, and therefore need to be distinguished [Polatin, 1991; Frank et al., 1996a; Frank et al., 1996b; Krause et al., 2001]. Etiologic factors relate to the risk of acquiring LBP, while prognostic factors relate to the chance of recovery after its occurrence.

Moreover, work disability and the process leading to RTW need to be conceptualized as a developmental phenomenon that is influenced by a multitude of physical, psychological, and social factors acting at different points in time after the onset of symptoms [Polatin, 1991; Krause, 1993; Krause and Ragland, 1994; Frank et al., 1996a; Frank et al., 1996b; Krause et al., 2001]. Because of these time-dependent influences, the investigation of prognostic risk factors needs to consider several stages or phases in the development of long-term work disability [Spitzer et al., 1987; Polatin, 1991; Krause and Ragland, 1994; Von Korff, 1994; Leboeuf-Yde et al., 1997; Frank et al., 1998; Gluck and Oleinick, 1998; Williams et al., 1998]. Research designs and analytic strategies not accounting for this phenomenon may be unable to detect risk factors which are primarily associated with only one or another phase of the disabling process. In fact, the failure to stratify analyses according to work disability phase may lead to the masking of the effects of specific risk factors [Oleinick et al., 1996a; Leboeuf-Yde et al., 1997]. Some researchers have suggested that suboptimal timing of interventions may be responsible for disappointing results [Sinclair et al., 1997; Frank et al., 1998]. In our own investigation of the impact of physical job factors on RTW after low back injury, we found that severity of injury had a significantly stronger effect during the first 30 days post injury compared to after 30 days post injury, while high physical workload was an important barrier to RTW during all disability phases [Dasinger et al., 2000]. Phase-specific information on psychosocial risk factors for disabling LBP is currently not available to people charged with the development of workplace programs to prevent spinal injury and disability. It is anticipated that such information will be helpful in setting priorities for planning, resource allocation, and optimal timing of different elements in comprehensive disability prevention efforts.

This study is based on a 3-year cohort of 433 California workers' compensation LBP claimants who received at least one day of temporary disability (TD) benefits, i.e., experienced at least 4 days of work disability (accounting for a

3-day waiting period in California). The primary objective of this study is to determine the possible impact of psychosocial job factors on the time to RTW after a disabling low back injury taking demographic factors, injury severity, and physical workload into account. The secondary objective is to determine if any associations between psychosocial job factors and duration of work disability are disability phase-specific.

Psychosocial job factors are studied using the ''Job Strain Model'' developed by Karasek and Theorell to measure job stress [Karasek and Theorell, 1990] and using a measure of work schedule flexibility called ''Taylorism'' [Kristensen, 1991]. In the Job Strain Model, job demands, job control, and social support (from supervisors and coworkers) constitute the three key dimensions that contribute to job stress. People in high strain jobs, characterized by low job control and high job demands, are hypothesized to be at highest risk for developing disease. Strong empirical evidence for this model has accumulated for cardiovascular diseases [Karasek et al., 1981; Schnall et al., 1994], and there is increasing, though inconclusive, evidence for musculoskeletal diseases [Bongers et al., 1993; Bernard, 1997; Krause et al., 1997], including neck and back injury [Krause et al., 1998b]. We further postulate that people in high strain jobs, once work-disabled, also have more difficulty returning to work, indicated by longer durations of work disability. The concept of Taylorism is named after the work management principles of F. W. Taylor, who, in the early 1900s, sought to streamline work (and thereby increase profits) by creating jobs that were strictly time-regimented and devoid of decision-making [Taylor, 1914]. The Taylorism scale, introduced by Kristensen [Kristensen, 1991], measures the degree of worker control over time management on the job, or ''work schedule flexibility.'' Low work schedule flexibility (high Taylorism), which Kristensen equated with fewer possibilities for coping with sickness on the job, has been shown to predict the duration of sickness absence in slaughterhouse workers [Kristensen, 1991]. A similar scale, called ''personal schedule freedom,'' has been shown to predict cardiovascular disease in an early prospective population-based study [Karasek et al., 1981]. We hypothesize that work flexibility facilitates RTW especially for those workers who have overcome their acute severe LBP but still experience residual pain at levels compatible with modified work until they recover fully. The Job Content Questionnaire (JCQ) and the Taylor scale are conceptually related in that both measure a dimension of worker control over the job. The former uses more general questions, the latter more specific questions to assess job control in terms of scheduling freedom (see Appendices A and B). The questions of the Taylor scale have the advantage of being less prone to recall error due to their specificity and in indicating specific work modifications, the JCQ questions are important because they represent risk dimensions of the psychosocial work environment spanning several health conditions including cardiovascular diseases [Schnall et al., 2000] and pre-disability stages of LBP [Krause et al., 1997; Krause et al., 1998b].

The phase-specificity of risk factors is studied according to a phase model of occupational disability due to LBP developed by Krause and Ragland [Krause, 1993; Krause and Ragland, 1994]. This model describes eight stages or phases in the course of disabling occupational LBP, including two pre-disability phases (the occurrence of LBP symptoms and the formal reporting of work-related LBP) and six disability phases defined by duration of work disability. The model posits that risk factors occurring during all or only specific phases in the disability/RTW process have a differential impact on duration of work disability depending on the length of time the LBP patient has already been unable to work. In this study, we hypothesize that the strength of the association of psychosocial job factors with the duration of work disability varies with progressing phases of disability. Because of sample size limitations, this study collapses the original six disabilty phases into two, the ''acute'' (the first 30 days of disability) and the ''subacute/chronic'' (>30 days of disibility) disability phase, following a convention proposed by Frank and colleagues for duration of LBP symptoms [Frank et al., 1998].

METHODS

Subjects

Study population. A complete 3-year cohort of 850 compensated low back injury cases was drawn from all workers' compensation claims administered at three district offices of a large workers' compensation insurance carrier in California covering both urban and rural areas in Northern California. The insurer has a client base exceeding 230,000 employers, or about 45% of California's insured employers. The 850 cases were extracted by computer algorithms according to the case criteria (see below) using information contained in three relational databases linked by case claim number: (1) a Master Claims file, containing information on age, sex, date of injury, nature of accident, nature of injury, and dollar amounts of benefits paid to date on each claim; (2) an externally reviewed Medical Payment file, containing individual records of all payments for medical services made on a claim, including date of service, physician diagnosis (ICD-9 or *International Classification of Diseases*, ninth revised clinical modification) codes (up to four per bill), and clinical procedure and treatment (CPT) codes; and (3) a Payment History file, containing individual records of all workers' compensation TD, permanent disability, and vocational rehabilitation payments to the worker as well as

medical and legal payments. A fourth database containing Employer Policy information was used to obtain information about employer size, but was not used in the selection of cases.

Case definition. Cases consisted of those matching the following administrative and diagnostic criteria: (1) a date of injury between January 1, 1994 and December 31, 1996; (2) at least one day of TD within 14 days after the date of injury; (3) an ICD-9 code indicating a non-traumatic injury relating to the lumbar or sacral region of the spine, according to a list of codes compiled by Cherkin and coworkers [Cherkin et al., 1992]. This list contains codes indicative of both ''possible'' and ''definite'' spinal injuries in the low back area. While the former include unspecified sites of the spine and ambiguously defined sites (e.g., ''lumbar or thoracic''), the latter codes pertain explicitly and exclusively to the lumbar or sacral region. ICD-9 codes were used over ANSI injury codes as it has been shown that the latter may result in misclassification in identifying low back injuries [Oleinick et al., 1996b].

Eligible cases had the following time- and diagnosis-dependent criteria: (1) an ICD-9 code indicative of a definite LBP diagnosis on any medical bill record of the first physician visit or on any bill record of a physician visit within 14 days after the date of injury; or (2) an ICD-9 code indicative of a possible LBP diagnosis on any medical bill record for the first physician visit or on any bill record of a physician visit within 14 days after the first physician visit, and a definite low back ICD-9 code on a bill of a physician visit within 90 days after the date of injury. For these purposes, a physician was defined as a medical doctor (MD), an osteopathic physician (DO), or a chiropractic (DC).

Case exclusion criteria were: (1) an ICD-9 code indicating a vertebral fracture, neoplasm, infection, or inflammatory disease at any point in the life of the claim, and (2) a nature of accident or nature of injury code indicative of a burn, open wound, or fracture. In other words, this study excludes LBP caused by an acute trauma visibly disrupting the integrity of skin or bones. In fact, most of the cases (75%) in this study represent so-called ''non-specific'' or ''mechanical'' LBP. Only about 3% of cases in this study have received the specific diagnosis of ''herniated lumbar discs with myelopathy'' or ''spinal stenosis'' [for a detailed breakdown of diagnostic groups see Krause et al., 1999].

Case selection process. A complete 3-year set of claims files was available from two of the district offices, while for the third office, only the 1994 and 1995 files were available at the time of data collection. Case selection began with the Medical Payment files by extracting all claims that had at least one ICD-9 code indicative of a definite or possible low back diagnosis at any time in the life of the claim. The resulting claim numbers were then matched to claim numbers in the current Master Claims files at each of the three district offices. This resulted in 12,632 unique claim numbers. The order of application of inclusion and exclusion criteria to this set of 12,632 claims and the number of cases remaining after each step are as follows: (1) date of injury on or after 1/1/1994: 6,828; (2) at least one day of TD within 14 days after date of injury: 3,166; (3) ICD-9 inclusion criteria: 1,076; (4) ICD-9 exclusions: 1,044; (5) nature of accident/injury exclusions: 850. The distribution of sociodemographic and administrative case characteristics, injury characteristics, and medical diagnoses has been reported elsewhere [Krause et al., 1999]. Time on temporary disability benefits showed the following distribution: less than 7 days (21%), 7–30 days (32%), and more than 30 days (47%).

Follow-up interviews. Out of the 850 LBP claims, 721 claimants were selected for a follow-up telephone interview between July and December 1997. The 129 excluded cases: (1) had missing information about their primary treating physician(s) ($n = 26$), (2) had been selected for participation in a pilot test of the telephone survey instrument, based on an early date of injury (<4/1/94) or late (>12/31/96) final temporary disability payment date ($n = 94$), (3) had more than one back injury claim between 1994 and 1996 ($n = 4$), (4) were known to be dead, or living outside the country ($n = 2$), or (5) had been misclassified with respect to injury or temporary disability status ($n = 3$). Of the 721 claimants in telephone follow-up, 433 (60%) were interviewed using a survey instrument developed especially for the project. In addition to the workplace variables used in this analysis, the interview collected self-reported information on RTW outcomes, perception of medical care received for the injury [Dasinger et al., 2001], current health and functional disability, and worker demographics. Subjects were interviewed at least 6 months after their last temporary disability payment and up to 3.7 years post injury.

Of the 288 claimants not interviewed, 214 could not be located, 31 refused to participate, 14 had a language difficulty, 11 could not complete the interview despite several contacts, eight did not have a telephone, seven had died, and three denied having had a back injury. An analysis of survey responders ($n = 433$) vs. non-responders ($n = 288$) is reported elsewhere [Dasinger et al., 1999]. Responders were more often female, older, in professional or machine trades occupations, and had worked longer at the pre-injury job. Median time to the end of disability benefits was slightly lower for responders than non-responders, but differences between the survival curves for duration of disability were not statistically significant. Since responders and non-responders do not differ significantly in terms of administrative outcome measures, and differences in predictor variables across the groups are controlled for by

including these variables in multivariate analyses, we do not expect any important responder bias in our results.

Measurement of Predictor Variables

All characteristics of the time-of-injury job were measured by retrospective self-report during telephone interviews conducted 1–3.7 years after the date of injury.

Psychosocial work variables. Organizational and psychosocial working conditions were measured by 18 questions. We used a 10-item version of the full 49-item Job Content Questionnaire (JCQ) [Karasek et al., 1998] which yields individual scores for job demands, job control, and supervisor support. Appendix A lists each item and shows data on internal consistency. Cronbach's alpha values for most subscales are lower than in studies using the full JCQ questionnaire but still of comparable size, suggesting that our abbreviated version of the JCQ has sufficient internal consistency even with the non-customary administration over the phone [for comparison see Karasek et al., 1998]. Low and high categories were created for each of these constructs based on the median split. High job strain was defined as the combination of high job demands (= above median of job demands scale) and low decision latitude (= below median of job control scale). We also used a 6-item version of the 7-item Taylor scale (see Appendix B Kristensen, 1991]. A low score on the Taylor scale indicates low Taylorization (greater scheduling freedom/flexibility or coping possibilities) and a high score, high Taylorization (less scheduling freedom or fewer coping possibilities). Low and high categories were created based on the median split of this index. Two additional non-scale items measured coworker support (''Were you able to get help from coworkers if you needed it?'') and job satisfaction (''Before your back injury, how satisfied or dissatisfied were you with your job?'').

Assessment of physical workload. Seven survey questions asked the worker to rate on a 6-point scale the amount of time spent at work in various physical activities and postures identified in the literature as risk factors for LBP: lifting heavy objects, pushing or pulling heavy objects, bending, sitting, standing, driving, and working on vibrating surfaces [Bernard, 1997]. Questions about static postures involving the whole body (sitting, standing, driving), activities involving high muscular effort, and exposure to vibration have all been shown to offer fair to high reliability and validity in self-reported contexts [Rossignol and Baetz, 1987; Wiktorin et al., 1993; Viikari-Juntura et al., 1996; Wiktorin et al., 1996]. Exposure was quantified as the percentage of time spent engaged in each activity, following the format of the Edholm Scale [Edholm, 1966; Ilmarinen et al., 1979], a well-established physical activity scale. Categories were ''almost all the time,'' ''about 3/4 of the time,'' ''about 1/2 the time,'' ''about 1/4 of the time,'' ''a little or about 1/10 of the time,'' and ''not at all.'' Based on these questions and a principal component analysis reported elsewhere [Dasinger et al., 2000], three dimensions of physical workload were measured: (1) heavy physical work characterized by bending, lifting, pushing, and pulling heavy objects (heavy work index); (2) whole body vibration from working on vibrating platforms or driving motor vehicles (vibration index); and (3) prolonged standing or sitting work postures (posture index). The latter index was created as ''time sitting minus time standing'' to transform an observed u-shaped relationship of each posture with disability duration into a monotonic function [Dasinger et al., 2000].

Other variables. Additional variables previously identified as prognostic factors for duration of disability and included in the analysis were: age, sex, injury severity, previous back injury with lost work time, union membership, length of pre-injury employment (<1 year, ≥ 1 year), and employer size. Previous back injury and union membership were ascertained during the telephone interview. The source of all other demographic, clinical, and employer variables was the workers' compensation insurance electronic files. Heavy work, vibration, and posture indexes and age were treated as continuous variables. Employer size was a 4-level categorical variable based on approximate quartile divisions of employer total yearly payroll amount. All other variables were binary.

For injury severity, we categorized workers into three groups based on the most severe medical diagnosis received during the life of the claim. Workers with ICD-9 codes indicating probable degenerative changes or non-specific backache were categorized as least severe cases (79% of the total sample of 850). Cases with sciatica, possible instability, or herniated lumbar disc without myelopathy were of middle severity (17%). Cases with postlaminectomy syndrome, spinal stenosis, or herniated lumbar disc with myelopathy were most severe (4%). However, due to the similarity in the survival curves of the two higher severity groups and the small number of cases ($n = 16$) in the most severe group of responders, we combined the two most severe injury groups into one for our analyses.

Measurement of Outcome Variables

The outcome measure for this study is duration of work disability. This was operationalized as the total number of compensated workdays calculated from workers' compensation indemnity benefit information in the insurer's electronic administrative files. A proxy for lost work time, it equals the sum of all wage replacement benefits paid to date (temporary disability, permanent disability, and mainte-

nance allowance during participation in a vocational rehabilitation program), divided by the daily temporary disability (TD) rate. This gives an estimate of the number of lost workdays effectively compensated during the entire life of a workers' compensation claim or up to censoring date. The daily TD rate is used as the unit for measuring lost workdays (as opposed to the daily permanent disability rate or vocational rehabilitation rate) because it reflects the implicit value the workers' compensation system attaches to a full lost workday. We believe that including vocational rehabilitation and permanent disability benefits in the determination of total workdays lost provides a better estimate of actual workdays lost than measures based on TD alone. In earlier papers, we presented this outcome as the best estimate of the number of lost workdays that is derivable from administrative workers' compensation insurance data [Dasinger et al., 1999; Krause et al., 1999]. We use this administrative measure instead of a comparable self-reported measure collected in our telephone survey in order to avoid common method bias, i.e., the tendency for self-reported measures of both predictor and outcome variables to be biased in the same direction. In the rest of this paper, we refer to the end of compensation as a return to work (RTW), although we acknowledge that these two outcomes are not necessarily coincident [Dasinger et al., 1999].

Analyses

A disability phase-specific approach in the examination of the duration of work disability can be performed in the form of a transition analysis, which would answer questions such as, ''Which risk factors predict the transition of a case from the acute into the subacute disability phase?'' This type of analysis could be performed with logistic regression using dichotomous outcomes (transition yes/no) but it would not be able to explain the wide variation in duration of disability, especially after the acute phase. Therefore, an alternative disability phase-specific approach was chosen, one that is able to predict the duration of disability within each disability phase. This approach answers the question, ''Given the worker has entered a specific disability phase, which factors predict the duration of disability within this phase?'' Cox proportional hazards regression analysis, a survival analysis technique, was used to model the effect of each independent variable on duration of disability until return to work [Cox, 1972].

''Survival'' analysis has more commonly been used to model undesirable outcomes such as time to death or disease. The term relative ''hazard'' aptly applies in these contexts to mean the instantaneous risk of death or disease onset at any point in time, given the individual has survived until that time, relative to a baseline reference group. Since we are modeling a positive outcome, time to ''return to work,'' we use the term ''relative return to work rate'' instead of ''hazard ratio'' in reporting our results. In this context, relative RTW rates greater than one reflect shorter durations of disability relative to the reference group.

It is noteworthy that we use a time-to-event outcome which, strictly speaking, is based on an estimate of cumulative days off work, rather than calendar time elapsed since the date of injury, to take into account any interspersed work periods. During the first 30 days after the injury, the correspondence between cumulative number of days on disability and calendar time from date of injury to the end of disability was high. Thirty-eight percent of all interviewed cases had no disability gaps at all, and another 48% of interviewed cases had disability gaps of a week or less during this time. The remaining 14% of cases accrued more than 1 week of work disability after 30 days post injury, indicating some divergence of cumulative and calender-time definitions of work disability in these cases. If these gaps were substantially longer one could speak of ''recurrent'' cases. However, to take the duration and frequency of gaps into account would require a stratified analysis of gap patterns. Given the few cases with longer gaps and the huge variation in gap patterns among them, such analyses would require much larger sample sizes to gain enough statistical power.

The analytic approach used in this study takes into account risk factor phase-specificity by conducting analyses for different phases of disability, as defined in a phase-model of occupational disability adapted from Krause and Ragland [Krause, 1993; Krause and Ragland, 1994]. Specifically, we evaluate outcomes during the acute disability phase (up to 30 lost work days) and the subacute/chronic phase (more than 30 lost work days), applying a cutpoint of 30 days to differentiate ''acute'' from ''subacute'' [Frank et al., 1998]. Again, the goal of this phase-specific analysis is not to determine risk factors for the transition from the acute into the subacute/chronic disability phase, but rather to determine the phase-specific impact of risk factors given an individual has reached the respective disability phase. In other words, the goal was to determine which set of risk factors is associated with more disability days in each given phase.

As a first step in the analysis, the effect of each psychosocial job factor on return to work was studied one at a time in univariate analysis, for the acute phase, the subacute/chronic phase, and the phases combined. For the acute phase, the disability experience of all 433 workers was included in the analysis. Workers who had more than 30 compensated days were censored at 30 days so as not to include their post-acute phase experience when determining the influence of the variable during the acute phase. Only the subset of 214 workers whose disability exceeded 30 days was included in risk factor models of the subacute/chronic phase.

As a second step, we tested the difference between the acute and subacute/chronic phase relative RTW rates of each variable by entering each variable and its time-depend-

ent covariate (variable* phase) into the same Cox model, where phase equals 0 for the acute phase and 1 for the subacute/chronic phase. This allows the effect of the predictor variable to change over the follow-up period. A significant value for the time-dependent covariate indicates that the phase-specific relative RTW ratios significantly differ from each other. This also provides a test of the Cox proportionality assumption, in which the ratio of hazard functions is required to be constant over time for each level of the covariate relative to the baseline, i.e., when the covariate equals zero.

The third step was to incrementally enter covariates into separate multivariate Cox models for each psychosocial job factor. We adjusted incrementally for (1) age and sex, (2) injury severity and history of previous injury, (3) physical workload (heavy work index, vibration index, and posture index), and (4) other employment factors (unionization, employer size, and length of pre-injury employment). For covariates showing phase-specific effects in the univariate analyses, we included their phase-specific terms. This also addresses any violation of the proportional hazards assumption of the Cox proportional hazard model.

In a fourth step, we created two alternative comprehensive models of psychosocial workplace factors with adjustment for physical workload and other possible confounders. Both models included social support at work (with separate variables for supervisory and coworker support) based on the hypothesis that social support may buffer job stress [Cohen and Wills, 1985]. The ''Job Strain Model'' [Karasek and Theorell, 1990] included job strain as the main psychosocial job variable. The alternative ''Taylorism Model'' [Kristensen, 1991] included the ''Taylor index,'' which we call ''work schedule flexibility'' scale, in place of the job strain variable in the multivariate model. In addition, both models controlled for three dimensions of physical workload and for other factors which were found to be significant predictors of RTW in previous studies including injury severity, injury history, and employment variables [Cheadle et al., 1994; Dasinger et al., 2000].

In a final step, we put both job strain and work schedule flexibility in one multivariate model together with the covariates used in the models of step 4. Originally, we did not plan to do this due to the conceptual overlap between job strain and work schedule flexibility in terms of the ''job control'' dimension. The job control concept is measured in the job strain model by more general questions (JCQ), and, in the Taylorism model, by more specific questions relating to control over the work and rest schedule. In fact, we observed relatively strong associations between work schedule flexibility and both job control (0.60) and job strain (0.51). These observations suggested that collinearity is not a major issue, and also that both scales are measuring related but different aspects of the psychosocial work environment justifying a simultaneous regression modeling.

All standard errors and confidence intervals were constructed using the robust method of calculating the variance-covariance matrix [Lin and Wei, 1989]. Analyses were conducted using STATA version 5.0 [Stata Corp, 1997].

RESULTS

Table I gives the distribution of workplace, injury, demographic, and employment factors for workers experiencing acute disability (full sample) and for those additionally experiencing subacute or chronic disability. The table shows no noteworthy differences between the acute and subacute/chronic subjects, except for injury severity and job demands. The subacute/chronic group has a larger percentage of more severely injured workers than the acute group (33.2 vs. 20.8%) and a larger percentage of workers with high job demands (66.7 vs. 60.3%), which is in accord with expectations. Overall, the sample is disproportionately male with an average age of about 38 years. About a third of workers had experienced a previous back injury with lost work time. About a third of jobs were classified as high strain jobs, based on the composite measure of high job demands and low job control. About 40% of claimants reported having low control over their work schedule and the pace of their work based on the Taylorism scale (alias work schedule flexibility scale). Low ratings for social support were given by about 36% of workers for their supervisors and by 13% for their coworkers. The majority of workers reported high job satisfaction regardless of disability phase.

Table II gives the results of the univariate Cox regression models for each of the psychosocial job factors, at both disability phases and for the phases combined. For workers reporting high job demands at the pre-injury job, relative RTW rates were lower than for workers reporting low job demands, during both the acute and subacute/chronic disability phases (relative RTW rates 0.67 and 0.75, respectively). These results were statistically significant during the acute phase and, probably due to smaller sample size, marginally significant during the subacute/chronic phase. Differences between the phases were not significant. Therefore, the relative RTW rate for the combined phases (0.71) is the appropriate effect measure for high job demands, indicating a 29% reduction in the RTW rate. Both low job control and high job strain significantly lowered RTW rates by a factor of about two during the subacute/chronic phase (relative RTW rates 0.53 and 0.54, respectively) but not during the acute phase (relative RTW rates 0.97 and 0.86, respectively). The differences between the phase-specific relative RTW rates for these two variables were statistically significant. A similar pattern was found for the Taylor index, with low work schedule flexibility being associated with a relative RTW rate of 0.55 in the subacute/

TABLE I. Job, Injury, and Demographic Characteristics of the Study Sample, by Work Disability Phase. 1994–1996 California Low Back Pain Claimant Cohort, n = 433

Variable	Acute phase (n = 433) Mean (SD) or %	Subacute/chronic phase (n = 214) Mean (SD) or %
Psychosocial job factors		
Job demands[1]		
High	60.3	66.7
Low	39.7	33.3
Job control[1]		
High	50.7	50.5
Low	49.3	49.5
Job strain[2]		
High	32.7	34.6
Low	67.3	65.4
Supervisor support[1]		
High	63.9	60.5
Low	36.1	39.5
Coworker support[3]		
High	86.6	85.1
Low	13.4	15.0
Work flexibility (Taylorism)[1]		
High	61.2	59.7
Low	38.8	40.3
Job satisfaction[4]		
High	92.8	92.0
Low	7.2	8.0
Physical workload		
Heavy work Index[5]	1.85 (.88)	1.98 (.85)
Vibration Index[6]	0.30 (.42)	0.32 (.43)
Posture index[7]	−.50 (.56)	−.51 (.57)
Injury factors		
Severity of injury		
Less	79.2	66.8
More	20.8	33.2
Previous lost-time back Injury		
No	67.2	65.0
Yes	32.3	34.1
Demographic factors		
Age (years)	37.3 (10.5)	38.6 (9.8)
Sex		
Female	30.0	32.2
Male	70.0	67.8
Employment factors		
Union membership		
No	82.2	81.8
Yes	16.9	16.8
Pre-injury employment		
≤1 year	44.6	46.7
>1 year	55.4	53.3
Employer size (yearly payroll)		
<$150,000	26.3	27.6
$150,000–500,000	21.7	17.8
$500,000–2,000,000	26.8	27.6
>$2,000,000	22.4	24.8
Unknown	2.8	2.3

[1]The high/low scoring of job demands, job control, supervisor support, and work flexibility is based on the median split.
[2]Job strain is defined as high job demands combined with low job control.
[3]High = I always or sometimes was able to get help from coworkers if I needed it; low = no, I couldn't get help from coworkers, or, I don't have coworkers.
[4]High = very satisfied, somewhat satisfied, or somewhat dissatisfied with my job; low = very dissatisfied.
[5]Measures the amount of time spent bending, lifting, and pushing or pulling heavy objects at work. A score of 0 signifies no time spent in these activities, and a score of 3 signifies 100% time spent in all three activities. See Dasinger et al. [2000] for details.
[6]Measures time spent driving at work or working on vibrating surfaces. A score of 0 means no time in these activities, and a score of 2 means 100% time in both activities. See Dasinger et al. [2000] for details.
[7]Measures time spent sitting vs. standing at work. A score of −1 means 100% time standing, +1 100% time sitting, and 0 equal time spent in both positions. See Dasinger et al. [2000] for details.

chronic phase. Low supervisory support tended to be associated with a reduction of the RTW rate by 18% across phases (combined relative RTW rate 0.82, 95% CI 0.67–1.01, $P = .06$). Coworker support showed similar effect sizes, but results were not statistically significant. Job satisfaction was not related to RTW.

Table III gives the relative RTW rates separately for each psychosocial job factor with incremental adjustment for groups of related covariates: (1) demographic factors, (2) injury-related factors, (3) physical workload, and (4) other employment-related factors. Psychosocial job factors and covariates which differed significantly across phases in the univariate analyses were entered as phase-specific covariates into each model. As the results show, adjustment for any subset of covariates or all covariates did not substantially change the effect size estimates obtained in the univariate analyses presented in Table II. In contrast to the univariate analysis, low supervisory support now appears as a statistically significant predictor of lower RTW rates after additional adjustment for physical workload in Models 3 and 4 (relative RTW rate 0.79, 95% CI 0.63–0.99, $P = 0.04$).

Table IV gives the relative RTW rates for psychosocial job factors combined into two alternative comprehensive models of workplace factors, the Job Strain Model

TABLE II. Univariate Relative Return to Work (RTW) Rates and 95% Confidence Intervals (CIs) for Psychosocial Job Factors, by Work Disability Phase. 1994–1996 California Low Back Pain Claimant Cohort, n = 433

	Acute phase (≤30 days compensation) n = 433			Subacute/chronic phase (> 30 days compensation) n = 214			Phase difference[1]	Phases combined n = 433		
Psychosocial job factor	**Relative RTW rate**	**95% CI**	***P*-value**	**Relative RTW Rate**	**95% CI**	***P*-value**	***P*-value**	**Relative RTW Rate**	**95% CI**	***P*-value**
Job demands										
low	1.00			1.00				1.00		
high	0.67	0.52–0.88	.00	0.75	0.55–1.03	.08	.59	0.71	0.58–0.87	.00
Job control										
High	1.00			1.00				1.00		
Low	0.97	0.75–1.26	.83	0.53	0.40–0.72	.00	.00	0.74	0.61–0.90	.00
Job strain										
Low	1.00			1.00				1.00		
High	0.86	0.65–1.13	.28	0.54	0.40–0.73	.00	.03	0.69	0.56–0.85	.00
Supervisor support										
High	1.00			1.00				1.00		
Low	0.80	0.60–1.06	.12	0.85	0.63–1.15	.29	.76	0.82	0.67–1.01	.06
Coworker support										
High	1.00			1.00				1.00		
Low	0.80	0.54–1.18	.26	0.86	0.57–1.31	.49	.79	0.83	0.63–1.10	.20
Work flexibility										
High	1.00			1.00				1.00		
Low	0.89	0.68–1.17	.40	0.55	0.40–0.75	.00	.02	0.71	0.58–0.87	.00
Job satisfaction										
High	1.00			1.00				1.00		
Low	0.81	0.18–1.36	.43	1.31	0.78–2.18	.30	.20	1.02	0.72–1.44	.93

[1]The difference between the acute and subacute/chronic phase relative RTW rates was tested for each psychosocial job factor by entering each factor and its time-dependent covariate (variable* phase) into the same model.

TABLE III. Relative Return to Work (RTW) Rates and 95% Confidence Intervals (CIs) for Psychosocial Job Factors, by Incremental Adjustments for Demographic, Injury, Physical Workload, and Employment Factors.[1] 1994–1996 California Low Back Pain Claimant Cohort, n = 433

	Model 1 (Adjusted for age, sex)		Model 2 (Model 1 + adjusted for injury factors[2])		Model 3 (Model 2 + adjusted for physical workload[3])		Model 4 (Model 3 + adjusted for employment factors[4])	
Psychosocial job factor	**Relative RTW rate (95% CI)**	***P*-value**	**Relative RTW rate (95% CI)**	***P*-value**	**Relative RTW rate (95% CI)**	***P*-value**	**Relative RTW rate (95% CI)**	***P*-value**
High job demands	0.70 (0.57–0.86)	.00	0.69 (0.57–0.85)	.00	0.74 (0.60–0.92)	.01	0.74 (0.60–0.92)	.01
Low job control								
Acute phase	0.95 (0.73–1.23)	.69	1.00 (0.77–1.30)	.99	1.08 (0.82–1.40)	.59	1.12 (0.85–1.48)	.40
Subacute/chronic phase	0.53 (0.40–0.72)	.00	0.53 (0.40–0.72)	.00	0.58 (0.43–0.79)	.00	0.59 (0.43–0.80)	.00
Low supervisor support	0.81 (0.66–1.00)	.05	0.81 (0.66–1.01)	.06	0.79 (0.64–0.99)	.04	0.79 (0.63–0.99)	.04
Low coworker support	0.83 (0.62–1.11)	.21	0.84 (0.61–1.15)	.28	0.87 (0.64–1.20)	.40	0.89 (0.65–1.22)	.47
High job strain								
Acute phase	0.85 (0.65–1.13)	.27	0.92 (0.70–1.22)	.58	1.01 (0.76–1.34)	.95	1.04 (0.77–1.41)	.79
Subacute/chronic phase	0.55 (0.40–0.75)	.00	0.51 (0.37–0.70)	.00	0.54 (0.39–0.75)	.00	0.56 (0.40–0.78)	.00
Low work flexibility								
Acute phase	0.88 (0.67–1.15)	.35	0.94 (0.71–1.23)	.63	1.01 (0.77–1.32)	.96	1.04 (0.78–1.39)	.77
Subacute/chronic phase	0.54 (0.39–0.74)	.00	0.56 (0.40–0.78)	.00	0.58 (0.42–0.81)	.00	0.55 (0.40–0.76)	.00
Low job satisfaction	1.04 (0.73–1.48)	.81	1.04 (0.73–1.49)	.81	1.14 (0.76–1.70)	.52	1.25 (0.80–1.93)	.33

[1]Each psychosocial job factor is evaluated in a separate model, one at a time.
[2]Injury factors include injury severity (less/more) and previous lost-time back injury (yes/no).
[3]Physical workload factors include three physical workload indices: heavy work, posture, and vibration [Dasinger et al., 2000].
[4]Employment factors include union membership (yes/no), length of pre-injury employment ($\leq$1 year/$>$1 year), and employer size (four categories).

(including the job strain and social support variables) and the Taylorism Model (including the work schedule flexibility and social support variables). Each model is also adjusted for age and sex, and the injury, physical workload, and employment variables which were found to significantly predict RTW rates (data not shown). The two models in Table IV yield very similar results. Both Karasek and Theorell's high job strain and Kristensen's low work schedule flexibility variables are associated with significantly reduced RTW rates during the subacute/chronic disability phase (relative RTW rates 0.58 and 0.56, respectively). The effects are phase-specific and not seen during the acute phase. Low supervisory support may result in 16% lower RTW rates, but results are not statistically significant. Coworker support shows no effects. Workers with jobs requiring more lifting, bending, or pushing and pulling show significantly lower RTW rates in both models than workers performing less heavy work (relative RTW rates of heavy work index in job strain model and Taylorism model are 0.77 and 0.76, respectively, data not shown). These effects are independent of disability phase, psychosocial job factors, and other covariates. Other indicators of physical workload, the vibration and posture indexes, show a similar trend but do not reach statistical significance in either model.

Table V shows the results of the 'final' multivariate model, which includes both job strain and work schedule flexibility simultaneously. Again, the model also includes the variables supervisory support, coworker support, and is adjusted for demographic factors, injury factors, physical workload, and employment factors. Both Karasek and Theorell's high job strain and Kristensen's low work schedule flexibility are associated with significantly reduced RTW rates during the subacute/chronic disability phase (33 and 35%, respectively). The effects are phase-specific and not seen during the acute phase. Supervisor support and coworker support show no significant effects in this model.

Workers with jobs requiring more lifting, bending, or pushing and pulling show a 33% lower RTW rate than workers performing one index unit less heavy work (heavy work index relative RTW rate 0.77, 95% CI 0.67–0.89). These effects are independent of disability phase, psychosocial job factors, and all other covariates. Whole body vibration (vibration index) and prolonged sitting or standing (posture index), independently reduce RTW rates by 16% each per index unit change; however, these effects are not statistical significant.

More severe injuries are associated with a 5-fold lower relative RTW rate than less severe injuries in the acute phase, and about a 2-fold lower relative RTW rate during the subacute/chronic phase, indicating a strong but lessening influence of injury severity over time. Unexpectedly, workers with a previous lost-time back injury are 72% more likely to RTW at any day after one month of work disability than claimants with a first-time injury. Increasing age significantly reduces the probability of RTW by 19% for each 10 year increment. Gender is not related to duration of work disability. Union membership has no influence on relative RTW rates, but seniority on the job of more than 1 year improves relative RTW rates by 32%. Unexpectedly, workers employed by smaller employers with a payroll totalling $150,000–500,000 have about a 30% higher relative RTW rate than workers employed by very small or larger employers.

DISCUSSION

Summary of Results

The results of this study suggest several new occupational risk factors for prolonged work disability after an occupational low back injury: heavy physical work, high psychological job demands, low job control, high job strain, low supervisory support, and low work schedule flexibility were all found to be significantly associated with reduced RTW rates. These findings persisted even after adjustment for several groups of potential confounders, including age and gender, injury severity and history of previous lost time back injury, physical workload, length of pre-injury employment, union membership, and employer size. High psychological job demands were associated with a 26% reduction in the RTW rate, independent of a 22% reduction in the RTW rate associated with heavy physical work (calculated from models 3 and 4 in Table III). High job strain and low work schedule flexibility independently reduced the instantaneous rate of RTW by a third during the subacute/chronic disability phase when examined in one multivariate model adjusting for social support at work, physical workload, demographic, injury, and employment factors (from Table V).

The results on work flexibility and job control are consistent with the Canadian treatment inception cohort study by Infante-Rivard and Lortie in which workers' ability to take unscheduled rest breaks predicted a 45% increase in the relative RTW rate after adjustment for covariates [Infante-Rivard and Lortie, 1996]. Our results are further supported indirectly by evidence of the beneficial effects of modified work programs on duration of disability [Fitzler and Berger, 1982; Fitzler and Berger, 1983; Schmidt et al., 1995; Loisel et al., 1997; Krause et al., 1998a] and by studies on absenteeism which identified low work schedule flexibility as a predictor of time absent from work [Kristensen, 1991; Theorell et al., 1991].

Disability Phase-Specific Results

Our phase-specific analyses suggest that: (1) injury severity based on medical diagnosis is a more important risk

TABLE IV. Multivariate Relative Return to Work (RTW) Rates and 95% Confidence Intervals (CIs) for Job Strain and Taylorism Models Including Social Support at Work,[1] and Adjusted for Demographic,[2] Injury,[3] Physical Workload,[4] and Employment[5] Factors. 1994–1996 California Low Back Pain Claimant Cohort, N = 433.

	Job Strain Model			Taylorism Model		
Variable	**Relative RTW rate**	**95% CI**	***P*-value**	**Relative RTW rate**	**95% CI**	***P*-value**
Psychosocial job factors						
Job strain						
Acute phase						
Low	1.00					
High	1.11	0.81–1.51	.52	—	—	—
Subacute/chronic phase						
Low	1.00					
High	0.58	0.41–0.81	.00	—	—	—
Work schedule flexibility						
Acute phase						
High	—	—	—	1.00		
Low	—	—	—	1.11	0.82–1.50	.50
Subacute/chronic phase						
High	—	—	—	1.00		
Low	—	—	—	0.56	0.40–0.78	.00
Supervisor support						
High	1.00			1.00		
Low	0.84	0.66–1.06	.14	0.84	0.67–1.06	.15
Coworker support						
High	1.00			1.00		
Low	0.96	0.70–1.33	.82	0.95	0.68–1.31	.75

[1]The two multivariate models combine either job strain or work schedule flexibility with supervisor and coworker support, and are adjusted for demographic, injury, physical workload, and employment factors.
[2]Demographic factors include age and sex.
[3]Injury factors include injury severity (less/more) and previous lost-time back injury (yes/no).
[4]Physical workload factors include three physical workload indices: heavy work, posture, and vibration.
[5]Employment factors include union membership (yes/no), length of pre-injury employment ($<=$ 1 year/ $>$ 1 year), and employer size (4 categories).

factor for work disability during the acute than the subacute/chronic disability phase. During the acute phase, RTW rates are five times higher for workers with less severe injuries, but during the subacute/chronic phase the relative RTW rate is close to two for workers with less severe injuries; (2) physical and psychological job demands are significant workplace determinants of RTW rates across all phases. Low supervisory support reduces RTW rates by 13–21% in this study depending on the set of covariates. Confirming previous analyses reported elsewhere [Dasinger et al., 2000], heavy physical work showed a statistically significant reduction of RTW rates by 23% across all phases, even after taking all psychosocial job factors and other covariates into account; (3) job control, job strain, work schedule flexibility, and history of a previous back injury are determinants of RTW during the subacute/chronic disability phase but not during the acute phase. Low job control, high job strain, and low work schedule flexibility are each associated with a nearly 2-fold reduction in RTW rates during the subacute/chronic disability phases (relative RTW rates between 0.53 and 0.67 in all univariate and multivariate analyses, Tables II, III, IV, and V).

Unexpectedly, and only during the subacute/chronic phase, a previous lost-time back injury is associated with a 72% improved RTW rate relative to claimants experiencing their first lost-time back injury. This finding may be the result of a 'survivor' selection effect or could indicate that workers and employers can learn how to better deal with a back injury on the job and find better ways of coping and accommodating during recurrent disabling back injuries. Prior experience of a successful RTW may also reduce the fear of re-injury which contributes to avoidance of physical

TABLE V. Multivariate Relative Return to Work (RTW) Rates and 95% Confidence Intervals (CIs) for Psychosocial Job Factors Analyzed Simultaneously in One Multivariate Cox Regression Model with Adjustment for Demographic, Injury, Physical Workload and Employment Factors. 1994–1996 California Low Back Pain Claimant Cohort, N = 433

Variable	Relative RTW rate	95% CI	*P*-value
Psychosocial job factors			
job strain			
acute phase			
low	1.00		
high	1.07	0.77–1.47	0.694
subacute/chronic phase			
low	1.00		
high	0.67	0.46–0.96	0.031
work schedule flexibility			
acute phase			
high	1.00		
low	1.06	0.78–1.45	0.690
subacute/chronic phase			
high	1.00		
low	0.65	0.45–0.93	0.019
supervisor support			
high	1.00		
low	0.87	0.69–1.09	0.232
coworker support			
high	1.00		
low	0.96	0.69–1.32	0.787
Physical workload			
heavy work index	0.77	0.67–0.89	0.000
vibration index	0.84	0.64–1.11	0.225
posture index	0.84	0.66–1.06	0.138
Injury factors			
severity of injury			
acute phase			
less severe	1.00		
more severe	0.20	0.11–0.36	0.000
subacute/chronic phase			
less severe	1.00		
more severe	0.52	0.38–0.71	0.000
previous lost-time back injury			
acute phase			
no	1.00		
yes	1.03	0.75–1.41	0.876
subacute /chronic phase			
no	1.00		
yes	1.72	1.21–2.44	0.002
Demographic factors			
age (10 years)	0.81	0.72–0.91	0.000
sex			
female	1.00		
male	1.09	0.86–1.38	0.454
Employment factors			
union membership			
no	1.00		
yes	0.96	0.72–1.27	0.771
pre-injury employment			
<= 1 year	1.00		
> 1 year	1.32	1.07–1.64	0.010
employer size (yearly payroll)			
< $150,000	1.00		
$150,000–$500,000	1.32	0.98–1.79	0.068
$500,000–$2,000,000	1.05	0.78–1.40	0.748
> $2,000,000	1.00	0.72–1.39	0.990

activity/work [Waddell et al., 1993]; (4) finally, coworker support and job dissatisfaction are not related to time to RTW in either phase.

Other researchers, using slightly different cut points between phases, also reported phase-specific effects for determinants of work disability [Oleinick et al., 1996a; Frank et al., 1998]. For example, Oleinick and coworkers found the following factors predict first RTW during the first 8 weeks post injury: female gender, older age, higher number of dependents, industry, occupation, and accident type. After 8 weeks a different set of factors were predictive: older age, smaller employer size, and higher wage compensation rate [Oleinick et al., 1996a]. Recently, researchers also found it to be of value to use a phase-specific approach for the study of indemnity and health care costs associated with disabling LBP [Williams et al., 1998].

Plausibility of Results

It makes sense that job control in general, and control over one's work schedule specifically, may enable workers to avoid overuse and injury, or if already injured, will allow them to better cope with residual back pain on the job, and that this will facilitate an earlier return to work. Less obvious is why psychological job demands increase the risk for LBP and disability in the first place. Theorell and coworkers found high psychological demands to be associated with increased muscle tension, which in turn was associated with back, neck, and shoulder pain in workers sampled from six different occupations, suggesting a possible mechanism for the effects of these risk factors on the musculoskeletal system [Theorell et al., 1991].

Supervisory support may be essential for securing help from coworkers for physically demanding tasks, for

appropriate work assignments, and for other work accommodations. Supervisory support may also reduce anxiety and job stress, thereby preventing additional muscle tension. Anxiety has been shown to be an important factor in LBP chronicity [Polatin, 1991]. Although the exact mechanisms by which psychosocial job factors influence LBP or work disability have not yet been studied in much detail, our study results appear to be compatible with current biomedical and psychosocial knowledge [Sauter and Swanson, 1996; Bernard, 1997]. In our analyses, we specifically tested Karasek and Theorell's job strain model, a well-established approach in determining the role of job stress on cardiovascular and, to a lesser extent, musculoskeletal disease outcomes [Karasek and Theorell, 1990; Bongers et al., 1993; Schnall et al., 1994; Bernard, 1997; Krause et al., 1998b]. Our results suggest that this model of psychosocial determinants of worker health, especially the concepts of job strain and job control, may also be a promising approach to understanding the etiology and duration of work disability after work-related injury. For our research question, the Taylor Scale had the advantage of measuring job control specifically in terms of worker control over the work and rest schedule, a flexibility that is at the heart of modified work programs that have been shown to facilitate RTW for injured workers [Krause et al., 1998a]. This scale has also been predictive of the duration of sickness absence, a related outcome [Kristensen, 1991]. Therefore, this study, in showing detrimental effects of both high job strain and low work schedule flexibility, supports the view that worker control over the job, especially over work and rest schedules, facilitates RTW after disabling back injury.

Unexpectedly, coworker support was not associated with the duration of work disability due to LBP, although the statistically non-significant effect estimates were in the expected direction. We found a similar pattern in studies of urban transit operators where non-disabling LBP and the incidence of reported spinal injury were associated with supervisory but not coworker support [Krause et al., 1997; Krause et al., 1998b]. Coworker support may be less influential than supervisory support when the job setting is supervised but does not allow for much contact with coworkers. British researchers found a trend for greater effects of coworker support in women than in men [Papageorgiou et al., 1997]. These observations suggest that coworker support may operate only in subgroups of employees which may prevent the detection of effects in highly diverse populations.

Job dissatisfaction is another factor which has been related in previous studies to non-disabling LBP [Krause et al., 1997; Papageorgiou et al., 1997] and reported spinal injury [Bigos et al., 1991; Krause et al., 1998b] but is not related to duration of work disability in this study. It may be that job dissatisfaction is related to disease etiology or a tendency to report work-related injuries but does not affect workers' decisions on whether or when they return to work after an injury. This decision may be more influenced by practical considerations such as injury severity, the necessity to earn a living, the levels of physical and psychological job demands and control over one's work, or the availability of modified work [Krause et al., 1998a]. A recent retrospective cohort study of compensated back injuries in Michigan found that certain physically demanding blue collar occupations exhibit a higher risk for low back injury but a better RTW rate compared to sedentary white collar jobs, providing another example where occupational risk factors for LBP incidence do not operate as barriers to RTW [Gluck and Oleinick, 1998].

Significance of Phase-Specificity

Regardless of possible alternative interpretations of these findings, the fact that identical job factors have a differential impact on the occurrence of non-disabling LBP, formally reported low back injury, and different phases of work disability after low back injury lends empirical support to Krause and Ragland's proposed classification of occupational LBP as (1) non-disabling, (2) formally reported, and (3) several phases of disabling LBP defined by duration of work disability [Krause and Ragland, 1994]. The differentiation of psychosocial workplace characteristics which play a causal role in the development of LBP alone from those which also impact on the duration of any subsequent work disability has important implications for the development of prevention programs. Injury prevention programs need to be informed by risk factors for injury incidence, whereas disability prevention programs need to be informed by risk factors for prolonged disability. However, intervention programs designed to address job factors that are risk factors for both injury incidence and work disability would be most efficient because they could simultaneously address primary and tertiary prevention goals.

Based on the results in this cohort of workers, it appears that jobs characterized by high psychological demands, high physical workload and/or low supervisor support may be prime targets for primary as well as tertiary prevention programs, the latter in the form of RTW or modified work programs. These factors are associated with longer duration of work disability in this study, and they have been reported in the literature as main risk factors for non-disabling LBP as well [Bernard, 1997; Krause et al., 1997] and formally reported injury[Krause et al., 1998b]. Further, the study confirms that risk factors may differ for short- and long-term LBP disability. This is consistent with the finding that risk factors differ for different types of LBP defined by duration of symptoms [Leboeuf-Yde et al., 1997]. Reducing job strain and increasing worker control over the work environment, especially over rest and work schedules, appears to be a promising approach for preventing

prolonged work disability during the subacute and chronic disability phases.

Limitations

In this study, work conditions were assessed retrospectively and by self-report. These reports are thus subject to recall error and may also have been influenced by outcome, which may have led to differential misclassification of job conditions [Koster et al., 1999]. Although respondents were specifically interviewed about work conditions at their pre-injury job, a coloring of their response by their RTW experience cannot be ruled out based on the study design. However, regarding the main psychosocial workplace factor of interest, job control, we find it reassuring that two different measurement instruments, Karasek's JCQ and Kristensen's alternative measure of job control, work schedule flexibility, yielded similar effect sizes. We believe that the two instruments measuring the concept of job control differ in their vulnerability to recall and misclassification bias. The job control questions of the Karasek scale contain rather general statements, while the job flexibility questions are about very specific job conditions. We would expect that the possibilities of bias are greater for the questions that are of a more general nature. However, both instruments yielded very similar results, and we think that this is an argument for the validity of the observed results. In fact, several researchers have suggested using different instruments to measure job stress in order to reduce the possibility of error inherent in self-report measures [Landsbergis et al., 2000].

The fact that we controlled for possible confounders further supports the validity of the study results. Moreover, analyses give no indication that measurement errors regarding physical workload could have led to substantial uncontrolled confounding because none of the potential confounders (including physical workload) substantially changed the effect sizes of the psychosocial job factors in multivariate analyses compared to univariate analyses.

Finally, in order to prevent the possibility of common method bias, which may occur when predictor and outcome variables are based on self-report, we deliberately used an administrative rather than a self-reported outcome measure in this study. The outcome measure used in this study was based on the total number of effectively compensated workdays lost calculated from workers' compensation records. We have shown elsewhere that measuring work disability based on workers' compensation wage replacement benefits consistently and substantially underestimates the absolute duration of work disability [Dasinger et al., 1999]. However, since this study reports only relative RTW rates, differences in the absolute total number of work days lost should not influence the outcome, assuming no differences in outcome measures for subgroups under study.

The subjection of our outcome measure to Cox proportional hazard models is innovative in the sense that our outcome is a cumulative time outcome measure rather than a calendar-time-to-event outcome measure conventionally used in survival analyses [Krause et al., 1999]. This approach was chosen to address the right-censored nature of the time to RTW data and to simultaneously account for gaps in work disability during the course of a claim. An alternative approach, i.e., stratifying analyses by specific disability gap patterns, was not feasible because it would require a substantial larger population to gain comparable statistical power.

Because of sample size considerations, this study was also not able to provide separate analyses for the subacute (4–12 weeks) and chronic (>3 months) disability phases. Future studies should oversample subacute and chronic cases to allow for an even more refined analysis in terms of the phase-specificity of risk factors.

Conclusions

This study links psychosocial job characteristics with the duration of compensated work disability following work-related low back injury. High physical workload, high psychological job demands, and low supervisory support are each associated with about 20% lower RTW rates across disability phases. This analysis took into account possible confounders such as injury severity and physical job demands, which are independently associated with duration of disability in this cohort of claimants. The finding that physical workload, a known predictor of LBP symptoms [Bernard, 1997] and reported spinal injury [Krause et al., 1998c], appears simultaneously to be an independent barrier to RTW throughout all phases of disability [Dasinger et al., 2000] suggests that ergonomic interventions need to be considered an important element of both primary and tertiary prevention. An increasing number of intervention studies shows that modified work programs effectively reduce work disability [Krause et al., 1998a; Bernacki et al., 2000; Crook et al., 1998; Høgelund, 2000; Block and Prins, 2001], our study provides an explanation why such programs can be as effective as they appear to be.

The disability phase-specific analyses show low job control, and, specifically, low control over work and rest periods, to be both associated independently with an over 30% decrease in the relative RTW rate after 30 days of work disability. These factors may therefore be responsible for a large proportion of the total costs associated with disabling LBP. The results suggest that effective tertiary prevention programs, aimed at the reduction of cost-driving chronic work disability, may need to include new organizational job redesign measures which will enable workers to exert more control over their jobs and their work and rest schedules. Additional benefits can be expected from a reduction of

physical workloads and psychological demands and from improved supervisory support. Since several of these psychosocial job factors have been shown to predict precursors of back-related disability as well, tertiary prevention of work disability in the form of organizational job redesign can be expected to have significant ''spill over'' benefits for the primary prevention of non-disabling LBP and the report of work-related back injuries, especially if job redesign efforts are not limited to the returning injured worker. A large body of evidence on Karasek and Theorell's job strain model suggests that such interventions could also help to prevent other musculoskeletal disorders and cardiovascular diseases including hypertension and coronary heart disease [Bernard, 1997; Schnall et al., 2000]. This potential synergy in benefits can make such interventions highly efficient and may inspire the collaboration across disciplines needed to meet the challenges of designing and implementing interventions that address the multifactorial origins of work disability. The study also shows that work scheduling flexibility is an important dimension of work organization that warrants independent assessment in future studies of occupational disability and the psychosocial work environment.

Appendix A

TABLE A. 1. Scoring and Distribution of Responses to 10 JCQ Items.[1,2] 1994–1996 California Low Back Pain Claimant Cohort, n = 433

		Strongly agree % (n)	Agree % (n)	Disagree % (n)	Strongly disagree % (n)
1	My job required me to be creative	24 (104)	50 (217)	21 (92)	4 (18)
2	My job required a high level of skill	34 (146)	47 (204)	18 (78)	1 (4)
3	I had very little freedom to decide how I did my work on my job	6 (27)	31 (136)	43 (186)	19 (84)
4	I had a lot of say about what happened on my job	16 (71)	40 (172)	34 (148)	9 (41)
5	My job required working very hard	44 (189)	44 (191)	11 (47)	1 (4)
6	I was not asked to do an excessive amount of work	6 (25)	43 (188)	38 (163)	13 (57)
7	My supervisor was concerned about the welfare of those under him/her	16 (67)	49 (204)	22 (92)	13 (54)
8	My supervisor paid attention to what I was saying	16 (68)	54 (225)	22 (93)	7 (31)
9	My supervisor was helpful in getting the job done	15 (63)	56 (233)	21 (89)	7 (31)
10	My supervisor was successful in getting people to work together	12 (51)	54 (226)	24 (99)	9 (39)

[1]Response categories were scored as follows: strongly agree = 1, agree = 2, disagree = 3, strongly disagree = 4. Psychological job demands = items 5 + 6 (reverse coded), score range 2–8; job control = skill discretion (items 1 and 2) + decision authority (items 3 and 4) = items 1 +2 + 3 (reverse coded) + 4, score range 4–16; supervisor support = items 7 + 8 + 9 + 10, range 4–16.
[2]Scale reliability Cronbach's alpha for psychological job demands = 0.48, skill discretion = 0.60, decision authority = 0.75, supervisor support = 0.88.

Appendix B

TABLE B.1. Scoring and Distribution of Responses to 6 Work Schedule Flexibility (Taylorism) Scale Items.[1,2] 1994–1996 California Low Back Pain Claimant Cohort, n = 433

		Scoring	%	n
1	Who controlled your work pace?			
	'line' or machine	2	0	2
	Work group	2	3	13
	Management/boss/supervisor	2	42	184

TABLE B.1. (*Continued*)

		Scoring	%	N
	Self	0	41	177
	Someone else	0	13	57
2	How big an influence did you normally have on the organization of you work?			
	Big influence	0	32	138
	Some	0	33	142
	Very little	1	24	104
	No influence	2	11	48
	'Missing'		0	1
3	Were you able to receive a private visitor at you workplace, for example, for 10 min?			
	Yes always	0	33	142
	Somethimes	1	31	132
	No	1	36	157
	'Missing'		0	1
4	Were you able to decide when to take a break while working?			
	Yes always	0	40	172
	Sometimes	0	26	113
	No	1	34	148
5	Was the management very strict about the time you had to be at work?			
	Yes always	1	68	295
	Sometimes	1	14	60
	No	0	18	76
	'Missing'		0	1
6	If you needed to go on a personal errand, were you able to leave the workplace for a half hour to do so without obtaining special permission?			
	Yes always	0	22	94
	Sometimes	0	17	74
	No	1	61	264

[1]Work schedule flexibility score $= 1 + 2 + 3 + 4 + 5 + 6$, range $= 0-8$.
[2]Scale reliability Cronbach's alpha $= 0.66$.

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