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WORK, WORKER, AND INJURY FACTORS ASSOCIATED WITH REPORTING AND WORKERS' COMPENSATION CLAIMS FOR LOW-BACK PAIN AMONG AUTOMOBILE MANUFACTURERS

Jonathan Martin Smith

A thesis submitted in conformity with the requirements
for the degree of Master's of Science
Graduate Department of Community Health
University of Toronto

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Master's of Science 2000

Jonathan Martin Smith

Graduate Department of Community Health

University of Toronto

Recent data collection efforts among automotive workers provides an opportunity to investigate factors associated with low-back pain that explicitly involve complex social processing, namely reporting symptoms to the workplace and filing a worker's compensation claim. Risk factors were categorized into 'clusters' representing the worker, the work (psychosocial and biomechanical), and the injury. Workers reporting LBP to nursing stations were compared to a symptomatic control group randomly selected from the working population, while among those reporting, workers' compensation claimants were compared to non-claimants. Results indicate that workers reporting low-back pain to the workplace have more physically demanding jobs and more disabling pain symptoms. Claimants appear to have less control over job tasks, but feel empowered in the workplace against possible negative consequence of filing a claim. These results suggest that while biomechanical demands are important in determining who reports symptoms to the workplace, psychosocial factors are important in filing a claim.

Preface

The Ontario Universities Back Pain Study, or OUBPS, was designed to examine both etiological and prognostic risk factors for low-back pain. The study team, comprised of researchers from the Institute for Work & Health and the University of Waterloo, set out to accomplish a daunting task - to collect biomechanical, psychosocial, and clinical data on each individual in the study. This prospect was not only costly, but would require researchers from medicine, epidemiology, psychology, sociology, and human kinetics to cross discipline boundaries and cultures, working together to design the various data collection instruments.

Data collection took place at the General Motors Autoplex in Oshawa Ontario, a massive assembly operation producing several mid-size car models and extended cab trucks. Between September of 1993 and July 1996, a virtual army of researchers were in the field conducting interviews and making extensive measurements of the biomechanical demands from job tasks on the lumbar spine. Such an effort required a huge amount of collaboration between study teams, and the logistical and management skills of the Study Coordinator, Sue Ferrier, are to be commended for making the entire operation a successful one.

The etiological question for the which the data was collected has been answered by Mickey Kerr, in his doctoral thesis. Several questions raised in the original protocol remain, however, and this thesis utilizes the OUBPS data in an attempt to provide some answers. "Cases" of low-back pain, accrued from first-aid centres in the plants as they reported symptoms, were redefined. Based on WCB data and GM Personnel records, it was possible to determine if those workers had made a compensation claim for their symptoms or not. A sub-group of the randomly selected population controls, those with low-back pain symptoms in the past week, were retained as the comparative group. Thus everyone in this analysis has current low-back pain symptoms, and the research question is not an etiological one. Rather, this thesis is an investigation into the factors that drive the decisions around reporting symptoms to the workplace and to file a worker's compensation claim for low-back pain.

I would like to thank my thesis committee, Claire Bombardier, John Frank, and Sheilah Hogg-Johnson, for their support and overall guidance through the Master's program. Their careful steering of this work from its conception and analysis through to the finished product was crucial. Claire was most helpful in the supervisor role, and taught me not only something about epidemiology, but also the finer points of academic research. I am privileged to have had the opportunity to work with her, and grateful for the dedication she afforded my apprenticeship. John 's eye for detail, analytical mind, and ability to interpret results played a valuable role. I am indebted to the encouragement and support he gave to me, not only as a member of my thesis committee and in my pursuit of the Masters degree, but also during his tenure as Research Director at IWH when I was first involved in the OUBPS study as an interviewer. Sheilah is an invaluable resource for anything statistical. She is without doubt an expert in the art and science of modeling data, and was the first person I turned to as issues arose in the course of the design and analysis of these data. Sheilah supervises my daily work responsibilities at the Institute for Work & Health, and has given me the tools and opportunities to develop through active participation in various projects and assignments.

When I first joined the Institute for Work & Health in March of 1993 during the pilot phase for the OUBPS Study, management and senior staff indicated a commitment to education and developing young researchers. They have certainly produced on this account, and the growing number of Masters' and doctorates that have arisen from the halls (and cubicles!) at the IWH is a testament to their commitment to education and occupational health research. Full credit goes to Terry Sullivan and Sandra Sinclair for creating and maintaining an environment that fosters and promotes continuing education among its ranks of employees. The Institute is a great place to learn.

Thanks to my immediate coworkers, Mike Manno and Selahadin Ibrahim, who were very supportive during this work. Mickey Kerr is as close to the OUBPS data as anyone, and his thoughtful discussions were often enlightening. Bob Norman, Richard Wells, and Patrick Neumann from the University of Waterloo were instrumental in producing the biomechanical variables and providing insight into their meaning.

Jennifer Payne, a SAS whiz, was very patient with a neophyte programmer such as myself and to her I extend a special thank-you. Finally, I wish to acknowledge Sue Ferrier, from whom I have learnt a great deal about the nuts and bolts of epidemiology and data collection. Sue is a conscientious researcher, always thinking about how to get things done, with genuine compassion and interest in study participants.

To my wife Janet and daughter Torianne, I love you both.

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List of Common Acronyms Encountered Throughout the Text

Acronym	Meaning
95%CI	95% Confidence Interval
AGV	Automated Guided Vehicle
CAW	Canadian Auto Workers Union
CPG	Chronic Pain Grade
GM	General Motors
HMO	Health Management Organization
HRR	Hazard Rate Ratio
IWH	Institute for Work & Health
LBP	Low-Back Pain
LT-C	Lost-Time Claim
MSPQ	Modified Somatic Perception Questionnaire
N	Newtons
NLT-C	No Lost-Time Claim
NLT-NC	No Lost-Time No Claim
Nm	Newton•metres
NIOSH	National Institute of Occupational Safety and Health
OR	Odds Ratio
OUBPS	Ontario Universities Back Pain Study
RR	Relative Risk
SAQ	Sleep Assessment Questionnaire
UW	University of Waterloo
WCB	Workers' Compensation Board
WSIB	Workplace Safety and Insurance Board

Chapter 1: Introduction

Background

Disability from low-back pain (LBP) has increased dramatically in the last half of this century in industrialized countries (Waddell, 1992; Frank et al., 1995b) and has only recently shown signs of leveling off (Murphy and Volinn, 1999). The burden of low-back disability on social security systems has the potential to strangle the fabric and economic success of some Scandinavian countries (Shelerud, 1998). This has prompted extensive investigations into the etiological and prognostic factors for the condition by researchers (Burdorf and Sorock, 1998; Shelerud, 1998), government agencies (NIOSH, 1997), and workers' compensation organizations (Frank et al., 1995a).

Modern medicine was founded on the biomedical model of disease in the last half of the nineteenth century, following Pasteur's discovery that disease is caused by infection, the identification of the tuberculosis bacterium by Koch, and the basis of cellular pathology put forward by Virchow (Waddell, 1992). However low-back pain does not fit traditional biomedical models of disease, especially since roughly 95% of cases cannot be given a specific diagnosis by clinicians (Frank et al., 1995b). In addition, epidemiological evidence has established the role of psychosocial and social factors as risk factors (or 'agents') for the condition (Bongers et al., 1993).

Researchers have been challenged to conceptualize low-back pain within frameworks that recognize the psychosocial, social, and medico-legal aspects of the condition (Waddell, 1992; Frank et al., 1995b). Wilson and Cleary (1995) have recently suggested a framework within which to interpret disease, including the transition from the pathological through functional status to the impact on quality of life, mediated by personal and environmental factors. This may be a more successful way to interpret low-back pain rather than the traditional biomedical model. Distinct from the onset of low-back pain is the decision to report symptoms arising from or aggravated by work to the workplace, or indeed, to submit a compensation claim.

These outcomes are not simple clinical definitions of symptom clusters, but involve complex processing on the worker's part about information on risk, symptom severity, and relations in the social environment that may affect the outcome or prognosis.

The effect of compensation in low-back pain has led health care providers to be wary of compensation status among patients (Teasell and White, 1994). Low-back pain patients on compensation have been compared to LBP patients not on compensation and found to have a worse prognosis (i.e., Grenough and Fraser, 1989), respond less favourably to physical therapy (i.e., Tollison et al., 1993), and to have worse surgical outcomes (i.e., Javid, 1988). These findings have led many to conclude that LBP patients on compensation are motivated by secondary financial gain which has adverse affects on outcome, are over-exaggerating symptoms, or are outright malingerers. Studies of compensation and low-back pain have been criticized by Leavitt (1992) for failing to consider physical aspects of work that may contribute not only to the onset and severity of the condition, but also will play a role in the successful return to work of the disabled worker.

Thesis Objective and Purpose

A large study was recently conducted at General Motors Car and Truck assembly complex in Oshawa, Ontario, by researchers from the Institute for Work & Health and the University of Waterloo. The study had two components: an etiological case-control component to assess biomechanical and psychosocial risk factors, and a prognostic component to determine factors associated with low-back disability. These data allow an opportunity to apply an integrated pathological and social conceptualization to low-back pain. Sociological complexity can be explicitly captured in the outcome variable, and pathological, psychological, and social factors examined as risk factors. Symptomatic workers with LBP have three primary options available to them. Workers can report their symptoms to the workplace, or carry that one step further and file claim for compensation to the Workplace Safety and Insurance Board (WSIB). Alternatively, workers

may decide to remain at work and neither report their symptoms to the workplace or file a claim. The purpose of this thesis is to investigate characteristics of the worker, the work, the workplace, and the injury as they are associated with two outcomes, reporting low-back pain symptoms to the workplace, and filing a workers' compensation claim.

Thesis Outline

Chapter 2 contains the literature review, broken down into three main parts. First, the evidence for demographic, biomechanical, and psychosocial risk factors for low-back pain is reviewed. Although the focus of this thesis is not on the etiology of symptoms from a biomedical perspective, these are included since they undoubtedly overlap with the outcomes utilized in this thesis, which are socio-medical markers of disability due to low-back pain symptoms. Three etiological studies which utilize compensation claim as a case definition are discussed in more detail owing to the comparability of outcome with this thesis. Several economic studies are discussed which assess the 'moral hazard' associated with compensation, a term used by economists to refer to changes in behaviour among claimants, workplaces, and others due to changes in indemnification rates (i.e., how does increasing indemnification or benefit rates affect claim frequency). Finally, the literature comparing psychological and therapeutic outcomes for low-back pain patients on compensation to those without claims is examined. Chapter 3 presents the development of a conceptual framework for low-back pain that incorporates clinical, physical, and psychosocial risk factors with the socio-medical outcomes defined above, namely reporting low-back pain symptoms to the workplace and filing a workers' compensation claim.

Chapter 4 describes in detail the study design and accrual strategy. Workers who reported low-back pain symptoms to the first-aid stations at GM were recruited into the study (REPORT), as long as they had not reported symptoms to the workplace in the past three months. These workers were categorized according to whether they had filed a compensation claim (CLAIM), or just required some immediate attention, such

as aspirin or analgesic balm (NO CLAIM). Simultaneous with accrual from the nursing stations, a random sample of population controls was recruited from active plant rosters. Those who responded positively to an initial screen of having low-back pain in the past week at the time of the baseline interview formed the comparison group (NO REPORT). The measures collected included a physical exam, a baseline questionnaire (demographic, clinical, and psychosocial data) and a biomechanical assessment of the job to provide data on hand forces (i.e., 88 kilogram lift), direct spinal loading estimates (for example, disc compression in Newtons) and kinematic data about posture (i.e., flexion velocity in degrees per second). This thesis asks the following questions:

1) What worker, work-related, and clinical factors are associated with reporting low-back pain to the workplace (REPORT versus No REPORT)?; and

2) What worker, work-related, and clinical factors are associated with filing a compensation cliam for low-back pain (CLAIM versus NO CLAIM)?

Chapter 5 sets out the methods used in the thesis. The analytical approach is based on the conceptual framework, and overall utilizes an hierarchical-type method. Potential predictor variables are grouped into 'clusters' according to the conceptual framework. The first cluster are worker characteristics, for example age, marital status, previous injuries at work, comorbidity. These are a mix of demographic and clinical history variables, that define the predetermined risk set that the worker brings to the episode of low-back pain. The second 'cluster' is one variable - a history of previous WCB claim for low-back pain. Previous WCB claim or a LBP history is an established risk factor for future LBP episodes, and for subsequent claim, and is an important factor in the conceptual framework. The third cluster are the work-related factors, and include both biomechanical (i.e., peak reaction shear [Newtons], or cumulative disc compression [Newtons per shift]) and psychosocial (i.e., Job Control, Social Support). The fourth and last cluster are the clinical factors, and include current pain intensity, self-reported functional status, and physical findings (i.e., straight-leg raise). Two analyses were performed: one to explain factors associated with reporting low-back pain,

and a second to explain factors associated with filing a compensation claim.

Because there was a plethora of variables available to choose from, simply running a backwards selection regression is unwise. Therefore, preliminary reduction of the number of variables within each cluster to a 'Candidate Set' was performed based on statistical (i.e., collinearity) and subjective (i.e., established risk factor) basis. The Candidate Set of variables for each cluster was then entered into a backwards selection logistic regression, done separately for each comparative analysis, to form 'Representative Set' of variables for each cluster. Final models for reporting and claims laying were derived by sequentially adding the Representative Sets of variables and removing factors that did not reach a $p \leq 0.10$ level of significance.

Chapter 6 provides the results of accrual. A total of 137 eligible and agreeable participants comprise the REPORT group, of which roughly half had filed for compensation. These make up the CLAIM group (n=76), while the remainder are the NO CLAIM group (n=61). Among the eligible and agreeable random controls (n=179), a third had current LBP symptoms, and comprise the NO REPORT group (n=57).

Descriptive results comparing the groups are found in Chapter 7. The Candidate Sets of variables for each cluster and the justification of for their selection are also provided. Chapter 8 describes the results of the modelling, starting with the backwards selection logistic regression on the Candidate Sets of variables for each cluster, and the subsequent modelling of sequential clusters. Final models for reporting low-back pain and for filing a claim are discussed and interpreted.

Chapter 9 outlines the limitations and strengths of the thesis, from study design, accrual, and analysis. Key findings are discussed in terms of the published literature and the socio-medical basis of the conceptual model. Final conclusions about reporting low-back pain and claims laying are made.

The OUBPS group and Previous Roles and Responsibilities of the Student

The study at General Motors was designed by a collaborative group of researchers at the Institute

for Work & Health (IWH) and the University of Waterloo (UW). It was known in the field at GM as the 'Ontario Universities Back Pain Study', or OUBPS. The IWH study team was primarily responsible for the development of the protocol, the study design, and overall subject accrual. Specifically, the IWH was responsible for the physical exam data, collected by interviewers trained by IWH clinicians. The IWH was also responsible for collecting the baseline questionnaire data, and producing the variables used in analysis, including demographic, clinical and psychosocial measures.

The team of ergonomists from the University of Waterloo was responsible for all aspects of the biomechanical data. This involved creating the instruments and methods, the data collection protocol, data reduction, and variable production. In addition the principle investigators of the biomechanical portion, Dr's Bob Norman and Richard Wells, were consulted for their expertise and knowledge, not only in the discipline of human kinetics, but in the behaviour of specific variables in selecting the biomechanical factors to represent the physical demands in the Candidate Set of the Work-Related Cluster.

The data used in this thesis is thus the result of collaboration by a virtual army of researchers. My involvement in the collection of these data began with the piloting of questionnaires and refining the implementation of the study protocol in the worksite. I was onsite for the duration of the data collection and conducted a significant proportion of the baseline and follow-up interviews with both cases and controls. Having been involved in the field work, talking to subjects and being involved at the shopfloor level, provides a unique perspective. It is worth pointing out, although not recorded in any systematic or qualitative fashion, subjects would often provide rich anecdotal personal histories. This source of information will help guide the analysis and interpretation of these data.

Subsequent to the completion of accrual and follow-up, I conducted a validation check on the baseline questionnaire data by re-creating the data in SAS, comparing the results to those done by Mickey Kerr. A significant proportion of my work responsibilities has been involved in the analysis of the clinical data, especially the physical exam and pain diagram. I designed a duplicate entry method using SAS to

create the physical exam data set, and am conducting an analysis of the inter-rater reliability and construct validity of the pain diagrams using four different scoring methods. In addition, I have been responsible for the creation and maintenance of the data set containing the follow-up data from interviews conducted at 3 and 9 weeks post injury for cases and 26 weeks for the entire cohort of participants, both cases and controls.

Mickey Kerr has been the primary individual responsible for the baseline questionnaire data at IWH, and is the PI associated with the OUBPS study at IWH at present. Mickey has used these data along with the biomechanical to conduct an etiological investigation of low-back pain as a PhD thesis, using all cases and controls. I only use the subset of controls who have low-back pain. Although there is clearly overlap in the data used by Mickey and myself, the thesis contained herein is both conceptually and analytically distinct. I have done all of the work for this thesis, with direction and guidance from Claire Bombardier, Sheilah Hogg-Johnson, and John Frank.

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Chapter 2 : Background Literature: Etiological Risk Factors for Low-Back Pain, Workers' Compensation, and the Effects of Workers' Compensation on Low-Back Pain

Why Study Low-Back Pain?

Low-back pain has been the subject of intense study in the past several decades. Many articles on the subject begin with dire proclamations about the dramatic rise in low-back disability during the last half of this century. For instance, in Britain the number of sickness benefit days for low-back disorders rose six-fold from roughly 10 million / annum in 1955 to about 60 million / annum in 1990 (Waddell, 1992: figure 1 p.523). Nachemson (1994) has estimated that in Sweden, permanent disability due to low-back pain has increased 6000% between 1952-1987, which threatens the social security system of that country. The lifetime prevalence of low-back pain has been estimated at between 60-80% for the general population (Frank et al., 1996). Rowe found that low-back pain ranked second only to upper-respiratory tract infections in accounting for absenteeism over a 10 year follow-up of plant workers (Shelerud, 1998), and in Ontario, low-back pain was found to be the number one cause of activity-restriction in persons less than 45 years old, and second only to arthritis among adults 45-65 years old (Frank et al., 1996).

About 30% of all lost-time compensation claims in Ontario result from LBP, which as a group, generally account for a disproportionately larger amount of total compensation costs (Frank et al., 1996). It has been estimated that roughly 75% of the total compensation costs for LBP (which include both medical benefits and indemnification costs) are paid out to the 5-10% of sufferers who become chronic and are off work for 6 months or more (Abenhaim and Suissa, 1987; Frymoyer and Cats-Baril, 1991).

Compensation claim rates for low-back pain vary by occupation. Data from 1984 in 26 US states indicate that claim rates per 100 workers range from 12.3 for labourers to roughly 3.3 for practical nurses[1]

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1. The crudeness of occupational title is evident in the disparate claim rates for "Miscellaneous Labourers" (12.3/100), "Nonspecific Labourers" (3.4/100), and "Construction Labourers" (2.8/100).

(Shelerud, 1998). The most recent review, however, suggests that the overall incidence of claims for low-back pain submitted to insurance providers in the United States has decreased 34%, from 2.7 claims/100 workers in 1987 to 1.8 claims/100 workers in 1995[2], while the associated annual costs have decreased by 58% (overall, 40% and 65% for medical benefits and indemnification costs respectively). Low-back pain, estimated to account for 36% of national compensation payments in 1987, was estimated to account for only 23% in 1995 (Murphy and Volinn, 1999).

Risk Factors for Low-Back Pain

Because the etiology of low-back pain has been the subject of so much study, several reviews of the literature have been produced. Therefore, rather than conduct a comprehensive review of the literature as part of this thesis, published reviews were utilized to examine the evidence on the etiological risk factors for low-back pain. In particular, reviews by Frank and colleagues (1995a; 1996), Burdorf and Sorock (1997), NIOSH (1997), and Shelerud (1998) were utilized extensively. It is important to point out that although the etiology of low-back pain symptoms is not the focus of this thesis, demographic, biomechanical and psychosocial risk factors are hypothesized to overlap with the socio-medical outcomes under investigation (namely, reporting low-back pain to the workplace and filing a compensation claim). Biological plausibility for both biomechanical and psychosocial risks has been advanced by proponents in each discipline.

Burdorf and Sorock (1997) excluded articles that did not include direct measurement of physical demands. Forty-seven of 140 (34%) articles that used occupation or job title to infer exposure were excluded. Thirty (21%) were excluded due to a lack of appropriate risk information, and 7 were excluded based on methodological grounds. After other exclusions, a total of 35 articles (25% of the original 140) were included in the review (see table 2.1). Frank and colleagues present a critical appraisal of the literature

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2. The figure 1.8/100 refers to the rate of claims *filed* with insurance providers; the estimated rate of paid (accepted) claims was 0.7/100 from the Bureau of Labor Statistics quoted in the same article.

and have graded risk factors into categories based on the apparent strength of association (see table 2.2). Shelerud (1998) included 218 articles in his review, and does not appear to have used any methodological or quality review evaluations.

The NIOSH (1997) literature review was fairly inclusive and included case series. Studies were included that had 'well defined' exposed and referent populations, used well defined, and explicit criteria to establish health outcome and exposure. The etiological evidence was graded as strong, moderate, or insufficient. More weight was given to those studies that had participation rates greater than 70%, included physical findings along with self-reported health outcomes, directly measured exposure (as opposed to self-report), and were of a longitudinal study design. NIOSH included fifty-three studies in the section reviewing physical risk factors for low-back disorders. A separate section in the NIOSH document covered psychosocial factors associated with low-back disorders and reviewed eighteen studies.

The articles discussed below are for the most part those that were included in any of the four reviews referenced above. Many utilize a cross-sectional or case-control design, because of the cost effectiveness or the availability of patients. It is important to point out that this study design can confuse etiologic and prognostic factors if the sample of 'cases' drawn includes subjects at acute, subacute, or chronic stages in their natural history. It is also unclear whether the disease or the risk factor under study came first (Bombardier et al., 1994). Studies of a longitudinal design that follow patients over time do not suffer these limitations, but are more costly to conduct. While a complete discussion of each article referenced is beyond the scope of this thesis, the study design, sample size, and indication of covariate adjustment is provided in Appendix 2.A1. Readers are referred to the four reviews, and NIOSH in particular, for a more comprehensive discussion.

The presentation of risk factors for low-back pain has, by convention, been to group risk factors into three categories - worker (or individual) characteristics, biomechanical (or physical) factors, and psychosocial factors. This convention has been adopted here and results are presented below.

Worker Characteristics

Several studies have indicated an increase in low-back pain risk with increasing age until about age 50, the risk leveling off after that (Saraste et al., 1987; Svensson et al., 1989; Heliovaara et al., 1991; Houtman et al., 1994; Skovron et al., 1994; Liira et al., 1996). Of 30 studies including risk estimates for age, 12 had a positive relationship, 15 were null, and 3 were negative (Burdorf and Sorock, 1997). Female gender has also been positively associated with low-back pain with odds ratios in the order of 1.5 (Houtman et al., 1994; Skovron et al., 1994). Most studies however are unable to assess a gender-effect because they are conducted within single gender dominated occupations, such as nurses or automobile workers (Burdorf and Sorock, 1997). However, men have surgery for LBP as much as three times more often than women and file more workers' compensation claims (Shelerud, 1998).

Heliovaara and colleagues found a 50% increase in risk for sciatica for a 10cm increase in height among middle-aged men, although there was no corresponding risk for non-specific low-back pain with increasing height (Heliovaara et al., 1991). Battie and colleagues (1990) found that taller men and more obese women were at increased risk of reporting low-back pain. Risk of long-term low-back disorders were doubled among obese persons in the Ontario Health Survey (Liira et al., 1996). Such cross-sectional studies however, may confuse cause and effect, since reduced physical activity after LBP can lead to obesity.

Smoking has been suggested as a putative risk factor for low-back pain (Boshuizen, 1993). Burdorf and Sorock reported that 5 of 15 studies found a positive association while the rest (10) were null findings. Of five studies that included marital status, none of them found anything but a null effect (see table 2.1). Risk estimates for low education (grade eight or less) were between 1.4 - 2.5 in several studies (Leigh et al., 1989; Bovenzi and Betta, 1994; Houtman et al., 1994; Liira et al., 1996). Low education is commonly confounded with socioeconomic status and physical demands of the job; however the risk estimates for low education reported by Houtman (1994) and Leigh (1989) were controlled for self-reported physical demands of the job (Burdorf and Sorock, 1997) .

Depression and anxiety can either predict future episodes of low-back pain, or can be part of a psychological reaction to unremitting pain and may signal the onset of chronic pain (Shelerud, 1998). A 10-year prospective study by Leino and Mangi (1993) found that while a history of depression or mental stress were predictive of future low-back disorders, symptoms did not predict changes in depression scores. LBP symptoms did predict higher stress scores over 10 years. An 18-month prospective follow up of 403 "volunteers"[3] (with interviews at 0,6, 12, and 18 months) found that higher combined scores on modified Somatic Perception Questionnaire (MSPQ) and the Zung Depression Scale were moderately, but significantly, predictive of subsequent 'serious' low-back pain events, while the MSPQ independently predicted 'any' subsequent low-back pain (Mannion et al., 1996). However, the strongest baseline predictor of subsequent back pain of any type was the presence of previous back pain, even though those with previous "serious" low-back pain episodes had been excluded from analysis. Comparison of the psychosocial measures by the timing of the first subsequent development of any low-back pain with the previous interview result, indicated that of the five psychosocial constructs analyzed in the study, only the Zung Depression measures were affected by the subsequent development of serious low-back pain (Mannion et al., 1996).

Biomechanical (Physical) Factors

Longitudinal analysis of a cohort followed since 1938 by Bergenudd and Nilsson (1988) found self-reported 'moderate' or 'heavy' work to be a risk factor for subsequent self-reported low-back pain (RR 1.83 [95%CI 1.2-2.7]). In this instance, heavy physical work was defined as work that requires some measure of physical strength and high energy demands, which has been interpreted to translate into compressive spinal forces (NIOSH 1997, p.6-4). Burdorf and Zondervan (1990) studied 33 crane operators, where exposure to self-reported 'heavy' work (n=23/31) was moderately associated with self-reported LBP symptoms in the past year (OR 4.0 [95%CI 0.76-21.2]). Note the wide confidence interval given the small sample size. In

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3. The authors used volunteers since one of the study objectives was to achieve a good follow-up rate; however, this will certainly introduce selection bias into the study and cloud any representativeness of the sample to the study population.

contrast, a prospective study by Bigos and colleagues of aircraft assemblers at Boeing's assembly plant in Seattle, WA failed to find an association between physical workload and subsequent injury reporting (Bigos et al., 1992). The investigators in that study suggest that methodological limitations in assigning physical demands to individual workers was likely in part responsible for the null findings.

The elements of a 'heavy' job and their association with low-back pain have been examined in more detail by several authors. Multivariable analysis of a case-control study among automobile assemblers by Punnett and colleagues (1991) revealed an increased risk of reporting low-back pain to the workplace with increased time in "awkward postures" (OR 8.1 [95%CI 1.4-44]) and for lifting (OR 2.2 [95%CI 1.4-44] for a 10lb load). Exposure was measured as the total percentage of work-cycle time a worker was in mild (> 20°) flexion in the sagittal plane, or in a lateral bend of greater than 20 degrees[4]. Bovenzi and Betta (1994) reported a dose-response relationship between postural load scored 1-4 - self-reported frequency rating of prolonged sitting, twisting, bending forward, and lifting - and lifetime low-back pain among agricultural workers driving tractors, with age-adjusted odds ratios of 1.0, 2.0, 3.2, and 7.5 respectively.

Similarly, a 1984 hospital-based study by Kelsey and colleagues (1984) found lifting and twisting to be independent predictors of prolapsed lumbar disc (NIOSH 1997, p.6-15). Compared to controls matched on age, sex, and medical services, cases with prolapsed lumbar disc were more likely to have a work history that involved lifting objects more than 25lbs (OR 3.8 [95%CI 0.7-20.1]) or twisting (OR 3.0 [95%CI 0.9-1.2]). A combination of both factors resulted in increased risk (OR 3.1 [95%CI 1.3-7.5]). A prospective study by Liles and colleagues (1984) of 453 material handlers found a dose-response relationship between deciles of Job Severity Scores - a measure of physical stress associated with lifting - and injuries to the low back (RR 4.5 [95%CI 1.02-19.9] for 10 vs 1) over a two year period (NIOSH 1997, p.6-15). Among female nurses, Arad and colleagues (1986) found an increasing 1-month prevalence of low-back pain with an

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4. The OR=8.1 reported for this measure refers to the risk of the maximum versus the minimum values in the exposure distribution (i.e., 100% vs 0%).

increasing number of patients lifted per shift (Burdorf and Sorock, 1997).

Using electrogoniometric techniques to measure dynamic trunk motion during lifting, Marras and colleagues examined the relationship between lifting requirements and low-back disorders. Based on records at the medical facilities of 48 plants, jobs were designated as low (3 years of 'exposure' with no injuries) or high risk (12 injuries per 200,00 'exposure' hours) for reporting low-back disorder. Four hundred and three jobs were then assessed to determine trunk velocity, position, and acceleration during lifting tasks. High risk jobs (n=111) averaged 176 lifts per hour, with an average load weight of 85 N (roughly 20 lbs) compared to low risk jobs (n=124) with 120 lifts per hour and 29 N handled. The highest combination of risks produced an odds ratio of 10.7 [95%CI 4.9-23.6) compared to the lowest risk combination (Marras et al., 1993). A longitudinal study by Riihimaki and colleagues (1994) also established an association between trunk flexion and rotation and sciatica among office workers, carpenters, and machine operators, whose work rarely involved lifting, thus confirming the independent risk associated with trunk dynamics, irrespective of lifting requirements or hand load.

The Burdorf and Sorock review (1997) included three studies that investigated repetitive movement as a risk factor (see table 2.1). Two of these studies reported null findings (Leigh et al., 1989; Svensson et al., 1989) while in one study there was a positive association with low-back pain (Saraste and Hultman, 1987).

Biological injury mechanisms for biomechanical or physical demands of the job have been established (Garg, 1992; Adams and Dolan, 1995; McGill 1996; Wells et al., 1997). Clinical biomechanical findings allow the epidemiological findings reported above to be placed in a biologically plausible framework. Peak compressive forces acting on the spine are a function not only of the weight being lifted, but also of the speed with which the load is lifted. Adams and Dolan (1995) show that the peak compressive force due to lifting a 10kg weight of the floor quadruple, from ~100Nm to ~400Nm (measured as muscle moment) during a 'slow' to a 'fast' lift (Adams and Dolan, 1995; figure 7). Biological models of spinal

injury implicate spinal compression acting on the vertebral bodies, perhaps by causing the material in the nucleus pulposus to bulge into adjacent vertebrae. Resistance of compressive force by the bones, muscles and ligaments in the low-back are subject to fairly rapid fatiguing with repetitive movements - compressive strength is reduced by 30% after 10 loading cycles. Rapid and severe spinal compression can cause a burst fracture in the spinal body itself, ejecting bony material into the spinal canal (Adams and Dolan, 1995)

Shear force - the force acting perpendicular to the axis of the vertebral joint - is produced in reaction to being in a forward flexed position, as the upper torso 'slides' over the bottom portion. Shear forces are resisted primarily by the facet joints, the fibrous coating of the annulus fibrosis and spinal ligaments if the lumbar lordosis is lost during a task (Garg, 1992; Potvin, et al., 1991; McGill, 1997). Degeneration of the intervertebral disc can cause increased stress on the facet joints during flexion, resulting in increased pain, as the synovial tissue around the facet joint is richly supplied with nociceptor nerve endings (Garg, 1992). Fracture of the facet joint can occur with a single loading of ~2000 Newtons (Adams and Dolan, 1995).

Damage to ligaments occurs with hyperflexion and with rapid flexion. The viscoelastic properties of the ligaments and the nucleolus pulposus, which provide resistance during flexion and rotation, are increased 12% if the duration of the movement is reduced from 10 seconds to 1 second; however, *sustained flexion* reduces the resistance capacity of the ligaments by 42% in 5 minutes (Adams and Dolan, 1995). Loss of lumbar lordosis during the handling of loads raises estimates of the shear force on the *L4/L5* segment from 200 N to 500 N and from 200 N to more than 700 N when using squat lifts for loads of 6 and 32 kg, respectively. This is an increase in joint shear of 150% and 250%, respectively, because of inactivation of lumbar musculature and a reliance, thus, on ligaments to support the moment (Potvin et al., 1991).

Psychosocial Factors

Increased mental stress has been associated with low-back pain in construction workers (Holmstrom et al., 1993) and nurses (Smedley et al., 1995). Stress was found to be an independent risk factor for medically diagnosed back disorders in the Finnish work force, adjusted for self-reported postural load, age,

gender, body-mass index, and smoking status (Heliovaara et al., 1991). Monotony at work and low job control were associated with low-back pain in four population based surveys, with risk estimates ranging from 1.4 to 2.3 (Saraste and Hultman 1987; Svensson and Andersson, 1983, 1989; Houtman et al., 1994). Riihimaki and colleagues (1994) failed to find a significant effect for monotony at work, work pace, and relations with coworkers and supervisors for sciatic pain in a three year longitudinal follow-up study . However, it may be that three years is too far out to find an effect, since workers in high pace, monotonous jobs with low social support are likely to have moved into better positions of employment, and the study outcome was pain in the past week. An early investigation by Hansen (1982) of monotonous work among slaughterhouse workers failed to find an association with low-back pain complaints (Burdorf and Sorock, 1997).

A 1994 study by Hoekstra and colleagues at the Health Evaluations and Technical Assessments Branch at NIOSH of 108 teleservice workers found an *inverse* relationship (OR = 0.60) between job control and back disorders (that is, lower perceived job control was associated with a greater risk of low-back pain).

A review of psychosocial factors and musculoskeletal disorders by Bongers and colleagues (1993) found that of 12 studies looking at demand and control, four had null findings, two were inconclusive, and six indicated a positive association. Few studies have investigated the role of social support. Of five studies investigating social support, four found a positive association between low social support from coworkers and supervisors, while one study reported a null finding. None of the studies investigated demand-control and support simultaneously (Bongers et al., 1993).

Low job satisfaction was associated with low-back pain in five of seven studies included in the Burdorf review (see Table 2.1) with odds ratios in the order of 1.4 - 2.4 (Burdorf and Sorock, 1997). Bergenudd and Nilsson (1988) reported a positive association between low job satisfaction and low-back pain in a 19-year population-based cohort study of residents in Malmo, Sweden. However, Biering-Sorensen and colleagues (1989), using a similar study design in Denmark, failed to confirm these findings.

Perhaps the most oft-quoted result is the finding from the Boeing Study, where those who 'never' enjoyed the tasks involved in their jobs were 1.7 times more likely to report a low-back pain complaint to the worksite in a 4-year follow up (Bigos et al. 1992). However Frank and colleagues (1995) have suggested that the aircraft assembly jobs with the highest job dissatisfaction are also the most physically demanding; and that since job demands were measured at the group level, and task enjoyment at the individual level, the independent effects are impossible to tease out. In any event, lack of task enjoyment, although highly statistically significant, explained only a small fraction (~2.2%) of the low-back pain reports (Bigos et al., 1992).

Injury mechanisms and biological pathways for psychosocial factors have been proposed. Bongers and colleagues (1993) propose that psychosocial factors at work "directly influence the mechanical load through changes in posture, movement, and exerted forces" (Bongers et al., 1993 p.298). In this case, the physical and psychosocial factors arising from the organization and structure of work and work tasks are inherently inseparable.

A biological pathway independent of physical load is also proposed by Bongers and colleagues (1993). The intersection of psychological demands and work supports with personal coping mechanisms may result in increased stress, which may affect the musculoskeletal system directly through changes in muscle tone or hormonal pathways. Since Seyle's seminal work in the 1940's and 50's, some state of arousal has been considered to be good ("eustress") while too much stress has been considered bad ("distress"). Brief, mild, and controllable states of challenge are considered important for emotional and intellectual development. It is the more severe, prolonged exposure to uncontrollable states of psychological and physical arousal that are considered to lead to disease states. One of the major hormonal pathways involves the release of corticotropin releasing hormone (CRH), which acts on the pituitary-adrenal axis, increasing blood glucose levels, heart rate, and blood pressure via a range of hormones including epinephrine and acetycholine (Chrousos and Gold, 1992). Indeed, physiological risk markers for cardiovascular disease

including systolic blood pressure and blood cortisol levels were found to co-vary with a measure of job strain over a one-year follow up (Theorell et al., 1988).

Recent theoretical stress models around the manifestation of stress in the workplace have focused on 'how much' stress is 'bad'. Karasek and Theorell (1990) put forth the concepts of 'psychological demands' and 'job control', and suggest that how 'bad' the psychological demands are for the individual depends on how much 'control' the worker has over the set of work tasks in the job. This framework has dominated the research into the health effects of stress at work to date, and indeed has been very successful at establishing a link between these constructs and risk for heart disease (Karasek and Theorell, 1990). More recent work by Siegrist and colleagues shifts the focus from control to the imbalance between external efforts (analogous to psychological demands) and the rewards from work (i.e., promotional prospects, social supports). The effects of this imbalance on health outcomes is moderated by intrinsic efforts, meant to capture internal behavioural coping strategies and mechanisms (Siegrist 1996).

Workers' Compensation

Workers' Compensation has been studied in conjunction with musculoskeletal disorders and low-back pain in several ways. For instance, economists are interested in the policy implications of wage replacement rates, and how they might influence not only prognosis and time on benefits, but also the frequency and incidence rates of claims, and in the 'mix' of claims (i.e., burns, lacerations, falls, sprains and strains) being filed (Worral and Appel, 1987; Johnson et al., 1998).

Rising benefit levels influence both worker and firm behaviour. As indemnification rates rise, foregone wages are reduced for the worker. Financial stresses may influence the decision to take time off work or not, regardless of injury severity or disease condition. For the firm, increasing WCB costs may promote a heightened safety consciousness, or alternatively, the firm may simply discourage claims filing, perhaps through heavy-handed means. Therefore, since benefit rates are expected to affect behaviour by both

workers and firms in opposite directions, there may not be any major overall change in rates. However studies of claim frequency have consistently found that increasing claim frequency rates are positively associated with increasing indemnity rates, suggesting that worker affects predominate[5], (Butler and Worrall, 1991; Ruser, 1998; Fortin and Lanoie 1998). The benefit elasticity for claims frequency has been estimated at roughly 0.6, and ranges from 0.4 to 1.0. This means that a 10% increase in benefits results in ~6% increase in claim frequency (Fortin and Lanoie, 1998).

The proportion of claims for soft-tissue sprains and strains has increased steadily since 1980. Claims for soft-tissue injuries, including low-back pain, rose from 45% of all claims in 1980, peaking at 53% in 1986, and falling to 51% in 1989 for a major US insurance provider representing 20 US states (see figure 2.1, from Butler et al., 1996). Analysis of these data indicates that the observed shift in claims mix to soft-tissue injuries is largely explained by two factors: 1) the rise in indemnification benefits (as measured by a wage replacement ratio), and 2) the rising proportion of firms represented by HMOs - Health Management Organizations (Butler et al., 1996). The observed HMO effect indicates a third behavioural influence of rising compensation benefits. Since HMO physicians are salaried, the 'fee-for service' reimbursement from compensation boards may drive the labeling of additional claims with a soft-tissue diagnosis, independent of actual case mix (Butler et al., 1996).

There is conflicting evidence that 'hard-to-diagnose' injuries that 'occur' off work are being reported to workers' compensation, especially so on Mondays (the so called "Monday-effect"[6]). A higher proportion of sprains and strains, including back pain, are indeed reported on Mondays (Fortin and Lanoie, 1998), leading some researchers to estimate that roughly 4% of strains and sprains are misrepresented as compensable injuries (Ruser, 1998). This notion has largely been disproved, as it has also been shown that;

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5. The exception is that for fatal injuries. Quite understandably, workers have absolutely no desire to transition into that category (Fortin and Lanoie, 1998).

6. 'Mondays' includes Tuesdays after long weekends and the first day of rotating shift schedules.

1) those without health insurance are no more likely to report sprains and strains on Mondays than other days of the week; 2) compensation rates do not exert an influence on the probability of Monday injuries; and 3) data from the Insurance Fraud Bureau do not indicate a differential distribution of disallowed claims for Mondays (Fortin and Lanoie, 1998; Ruser, 1998). In any event, low-back pain, as with other musculoskeletal conditions, is considered to have a multifactorial etiology that includes cumulative exposures. Further, over-exertion injuries may well be more likely at the beginning of a work cycle, and a consequence of return-to-work and temporary loss of conditioning after a week-end hiatus.

Compensation versus Non-Compensation among Low Back Pain Patients

In order to investigate the clinical aspects of low-back pain and compensation in more detail, literature on the issue was collected by means of a literature review. MEDline was searched on the keywords "workers' compensation", "back pain", and "occupational diseases" for the years 1974 to present. Titles and abstracts of the resulting articles were reviewed by the student. Articles selected for review included those reporting original study results, review articles, editorials, position papers, and letters to the editor concerning compensation and low-back pain. There were no 'hard rules' - hence this was a 'quasi-systematic' review - as the objective was simply a broad information gathering exercise.

Note that the term 'compensation' is not specific to workers' compensation, and indeed some studies on 'compensation' do not include any patients on workers compensation (e.g., Hayes et al., 1993). Studies that explicitly do **not** include LBP patients on workers' compensation were not reviewed, while those that have 'compensation' groups that may be combinations of workers' compensation, insurance claims (i.e., motor-vehicle collisions), or Social Security Disability Insurance were included.

Twenty articles were reviewed that compared low-back pain patients on compensation status, and these are listed in Appendix 1.A2 in chronological order, providing a brief outline of the methods, results and conclusions, as well as some notes on each. In general, these studies utilize a repeat measures design

to compare treatment results as measured by physical and functional status outcomes between the two groups. 'Baseline' demographic, clinical and functional status measures, where available, are reproduced in Table 2.3 below for comparative purposes. However, prior to discussing that literature, three etiological studies of low-back pain that utilize filing a compensation claim as a case definition studies deserve mention.

Predicting Compensation Status

In a matched case control-control analysis in a Boston Postal Office, Daltroy and colleagues (1991) accrued 235 acute low-back injury cases (of whom 222 (94%) were compensation claims). These 235 cases were matched to 235 controls based on job title (or 'craft'), thus the effects of 'job' (physical and psychosocial) could not be investigated. Results from adjusted conditional logistic regression indicate that previous back injury in the past three years was a strong predictor of subsequent low-back injury (OR=16.5 [95%CI 5.6-48.7]), although the prevalence seems low (20% vs 3% for cases and controls respectively). History or 'other' injury, perhaps surprisingly, was inversely associated with filing a LBP claim (OR=0.69 [95%CI0.9-4.4]). Younger median age (OR=3.0 [95%CI 1.7-5.4] for an 8 year median difference in age), and shorter tenure (OR=2.6 [95%CI 1.5-4.7] for a ~3 year median difference in tenure) were also significant. Also significant was a job change in previous 60 days (OR=2.5 [95%CI 1.0-6.6]) although the prevalence in cases and controls was low (9% vs 4% respectively). The wide confidence intervals on some of the risk estimates suggests, that although there were sufficient numbers of subjects, there may have been a sparse covariate problem.

In a follow-up study of 269 aircraft assemblers, Rossignol and colleagues (1993) reported that only "limitation in performing at work" at baseline (28% responded positively) was independently associated with subsequent compensation claim for low-back pain over a 1-year follow-up. Of 269 subjects at baseline, 36 visited the nursing station (13.4%), while 16 subjects were compensated for 17 episodes of LBP (16/269 = 6%), of which 7 were first time claims. In this analysis, although a history of previous compensation for LBP (30% prevalence) significantly predicted claims at the bivariate level, it did not remain in a model adjusted

for limitation in performing work. Although the paper does not present a cross-tabulation of these effects, the results suggest that workers with a history of compensation may be those that have subsequent work limitations.

The 'Boeing Study' was a longitudinal follow-up study of aircraft assemblers conducted at the company's Seattle, WA site (Battie, 1990; Bigos et al., 1991; Bigos et al., 1992). The LBP outcome, or case definition, appears to be a mix of compensated and non-compensated cases (it is unclear what proportion are claimants) identified through compensation records and onsite first-aid stations. Of 1569 workers who participated in the longitudinal study, 279 reported acute low-back pain, either to the workplace, or to their physician, or had filed a claim for compensation over an average three years follow up. This represents a (279/1569)/3 = ~5.9% annual incidence rate of LBP reporting, virtually identical to the claim rate (6%) reported by Rossignol and colleagues (1993). Confirming previous results, one of the most important predictors was a history of previous back problems (39% of subjects at baseline - similar to the 30% reported by Rossignol). Other results from this study have been discussed in more detail under the etiological risk factors above.

Compensation, Age, Gender and Education

Demographic markers for compensation versus non-compensation groups reveal some noticeable demographic patterns (see table 2.3). While group differences on these markers generally did not reach significance, the general impression is made that the compensation group is younger, tends to be male and has fewer years of education.

Compensation, Pain , and Psychological Disturbance

Several early research papers were simply cross-sectional comparisons of low-back pain patients by compensation status on pain and psychological measures (see table 2.3: Leavitt et al., 1982; Mendelson, 1984; Melzack et al., 1985). For example, Leavitt and colleagues found that while low-back pain patients did not differ on psychological disturbances as a function of compensation status (both groups ~30%), a

higher proportion of workers on compensation had unconfirmed organic disease. Among all patients with unconfirmed organic disease, reported pain did not differ as a function of compensation status; however, among patients with clearly identifiable organic disease, patients on compensation used more pain words to describe their pain.

Subsequent findings confirmed these results; Mendelson (1984) reported that low-back patients did not differ on reported pain, anxiety, or depression by compensation status although both groups had elevated levels on all measures compared to population levels. Melzack (1985) reported that compensation status did not affect reported pain measured by the McGill Pain Questionnaire. In a group of chronic pain patients with a variety of conditions including low-back pain, Mendelson (1987) reported that scores on the Conscious Exaggeration Scale (CES) did not differ across compensation status, but scores were strongly correlated with Hypochondriasis, Disease Conviction, and Irritability Scales of the Illness Behaviour Questionnaire (IBQ), suggesting conceptual overlap among these constructs.

While these studies suffer from a weak cross-sectional design, the results suggest that patients with low-back pain report psychological effects, such as anxiety and depression, that are at elevated levels from population norms, but that this is independent of compensation status. Similarly, low-back pain patients reported similar levels of pain intensity regardless of compensation status. However, this relationship appears to be modified by whether or not symptoms are accompanied by clear organic pathology. It is also important to point out that in all these studies, the patient groups were a mixture of acute and chronic patients, with the emphasis on the chronic; the point being that in acute patients, it is unlikely that enough time has passed for psychological sequelae to have presented.

Compensation, Pain, Physical Exam and Clinical Findings

Low-back pain patients have been compared on compensation status for a variety of therapeutic, functional, or surgical outcomes (see table 2.3: Jamison et al., 1988a,b; Javid 1988; Greenough and Fraser, 1989; Tollison et al., 1990; Tollison 1993; Greenough 1993; Greenough et al. 1994; Ambrosius et al., 1995;

Sanderson et al., 1995; Atlas et al., 1996; Taylor et al., 1996; Rainville et al., 1997; Vaccaro et al., 1997). These studies reveal some conflicting results. Some studies find that reported pain at presentation does not differ between compensation and non-compensation groups (Jamison et al., 1988b; Tollison et al., 1990; Ambrosius et al., 1995) while others found that patients on compensation reported significantly higher pain severity (Greenough and Fraser, 1989; Tollison 1993; Atlas et al., 1996; Rainville et al., 1997). While these studies include patients groups with mean symptom durations ranging from ~ 10 months (Tollison 1993) to ~ 4 years (Jamison et al., 1988b; Javid 1988; Rainville et al., 1997), generally within studies the compensation and non-compensation groups have similar mean symptom durations.

Physical exam and other anthropometric measures have also been found to differ between compensation and non-compensation groups (table 2.3). Within study contrasts have shown that workers on compensation have worse range of motion scores and lower straight leg raise levels (Ambrosius et al, 1995; Rainville et al., 1997). Results for other clinical measures are less clear. For instance, in a surgical population Taylor and colleagues (1996) found little difference in the proportion with herniated disc (79 vs 81%), while Hadler and colleagues (1995) found no difference in proportion of patients with sciatica (22%) among referred LBP patients. However Rainville and colleagues (1997) reported 75% of compensated patients had sciatica versus 50% of the non-compensated patients. Vaccaro and colleagues (1997) reported 'leg symptoms' in only half as many compensated patients (46 vs 82%). This picture is further muddled by the results of Atlas and colleagues (1996), who, on independent assessment of plain film x-rays, found a higher proportion of moderate to severe pathological findings (79 vs 62%) in the non-compensation group. That having been said, it is prudent to point out that while physician ratings of 'high pain behaviour' were significantly higher in compensation patients, physician rating of 'symptom exaggeration' were not (Jamison et al., 1988b). Also, an extensive literature review by the Agency for Health Care Policy and Research (AHCPR) Task Force in 1994 now indicates that the vast majority of spinal plain film x-ray findings do not correlate with or truly explain low-back pain episodes (AHCPR, 1994).

Compensation and Self-Reported Functional Disability

Measures of functional status in low-back patients in relation to compensation status only appear fairly recently in this literature. Patients on compensation scored higher (worse) on the Oswestry (Sanderson et al., 1995), the Roland (Hadler et al.,1995; Atlas et al., 1996), and lower (worse) on selected dimensions of the SF-36 (Atlas et al., 1996), indicating decreased (self-reported) function in low-back patients on compensation. However, since workers' compensation patients are more likely to be off work than those not on compensation, it is possible that items describing work / off-work status in the instruments might drive 'ceiling' effects, a scenario which can not be ruled out in any of these studies.

Compensation, Physical Therapy, and Surgical Results

It has already been shown that low-back pain patients on compensation tend to present with worse findings on some physical measures. Studies comparing treatment efficacy for functional restoration programs have shown such measures to be worse for workers on compensation (Tollison, 1993; Ambrosius et al., 1995), although evidence suggests that workers on compensation, while they do improve, do not achieve the same levels of improvement as seen in non-compensated patients (Tollison et al., 1990). While differences in therapeutic outcomes appear to converge over several months post treatment, differences in self-reported pain intensity, functional status and depression appear to persist up to 12 months after treatment (Tollison et al., 1993; Rainville et al., 1997).

Studies of surgical outcome for compensated versus non-compensated LBP patients are remarkably consistent. In a study of 214 patients undergoing chemonucleolysis, Javid (1988) found that although measurable neurological deficits improved in both groups 1 year post-operatively, fewer patients on compensation thought the procedure was 'successful' (60 vs 91% respectively). This finding was confirmed by Greenough and colleagues (1993) who found that patients on compensation reported significantly less relief of symptoms following radiological fusion two years post operatively. In a small sample of patients with chronic LBP and low-grade spondylolisthesis undergoing fusion, all 13 patients on workers

compensation were independently assigned fair or poor outcomes based on pain and functional limitation compared to only 2 of 11 patients not on compensation (Vaccaro et al., 1997). More surprisingly, however, than symptom relief, is the 'technical' finding that, after fusion operation, while complete fusion occurred in 91% of non-compensation patients, it only occurred in 66% of compensated patients (Greenough, 1993). While it may be that negative emotions or expectations post-operatively affects healing, it is also possible that the types of injury suffered by patients on compensation are qualitatively different.

An important consideration in interpreting studies of surgical outcomes comparing compensation groups are indicators for treatment. In a large study of patients with sciatica, Atlas and colleagues (1996) conclude that "despite having worse symptoms and functional status, workers' compensation patients were less likely to undergo surgery than non-compensation patients" [p.588]. Among patients on compensation, indicators for surgery included positive straight-leg raise and confirmed radiological findings, which were accompanied by reports of heightened pain and decreased function (Atlas et al., 1996).

Compensation and Physical Demands of Work

With few exceptions (Leavitt, 1990,1992; Hadler et al., 1995; Rainville et al., 1997) none of the studies listed in Table 2.3 consider the physical demands (measured or perceived) of the job and none consider the psychological demands of the job or social support at work. Studies of compensation and low-back pain have been criticized for not controlling for job demands by Leavitt (1992), who showed that a higher level of physical exertion at work was associated with injuries that occurred at work as opposed to injuries that occurred elsewhere. Of 1191 subjects injured at work, 56% self-rated their jobs as 'heavy' compared to 23% of 389 subjects injured elsewhere. Physical demands and origin of injury were both significant independent predictors of disability time in a multivariable model.

Hadler and colleagues (1995) found an association between self-reported physical demands and compensation (n=505) and noncompensation (n=861) low-back pain patients. Subjects on compensation reported significantly more physically demanding jobs, including lifting requirements, use of vibrating tools,

prolonged standing, and prolonged walking. The effect of compensation on return to a sense of well being (HRR=0.82 [95%CI0.73-0.92]) persists if job characteristics are included in the model (Hadler et al., 1995). Hadler suggests, in a fashion similar to the moral hazard argument in the economic literature around worker risk and firm safety precautions, that "...our observations are consistent with the possibility that providing workers' compensation insurance as a remedy subrogates for offering tasks that are less physically demanding." [p.2713] Rainville and colleagues (1997), in a study of treatment compliance among chronic LBP patients (pain > 4 months) found that a much higher proportion of patients on compensation reported medium/heavy jobs compared to noncompensation patients (60% vs 17%), even though 'compensation' in this instance included patients on workers' compensation, social security disability insurance, and those involved in motor vehicle collisions.

Workers with more demanding jobs (i.e., more lifting requirements) may not only be at greater risk of injury, but subsequently are at greater risk of disability - especially work related disability, measured as compensation claims, lost-time, or even loss of job - since, all other things constant, they must be 'more recovered' to return to their heavier work. In fact, Hadler suggests that "...to add insult to injury, the worker must return to the level of exertion he or she associates with the injury. No wonder the return to work is difficult and tension manifests..." [p.2713].

Conclusions

The articles attempting to disentangle the effects of compensation and low-back pain generally employ populations of workers with unresolved chronic low-back pain with the aim of comparing therapeutic and treatment outcomes between the two groups. Differences between outcomes for compensated and noncompensated patients outlined above have generally been attributed to motivation, secondary financial gain, or ability to cope for the individual worker. However, as Leavitt has pointed out, the challenge remains to assess the workplace as a source not only of varying risk for the onset of low-back pain (heavier jobs), but

also in recovery and disability.

From an epidemiological perspective, many of these studies suffer from the fact that by selecting workers who are at a chronic stage, it is no longer possible to separate out potential etiological factors for low-back pain from prognostic risk factors, including the psychological sequella of either unresolved chronic pain or involvement in the compensation system. Many of the studies lack sound methodology and appropriate statistical analysis. It is interesting to note that in a recent unpublished review of chronic pain conducted at the Institute for Work & Health, only 3 of the 20 studies on compensation status reached a score 4 out of 7, considered 'worthy' of inclusion in the review.

Table 2.1: **Positive and Negative Risk Factors for Low-Back Pain from 35 Studies Included in Literature Review by Burdorf and Sorock (1997)**

Risk Factor	Association with Low-Back Pain		
	Positive	Null	Negative
Worker (Individual) Characteristics			
Age	12	14	3
Gender	2	7	--
Height	2	10	--
Weight	1	17	--
Smoking	5	10	--
Exercise or Sport	2	12	--
Unmarried	--	7	--
Low Education	5	6	--
Biomechanical (Physical) Factors			
Lifting	16	3	--
Bending and Twisting	9	1	--
Heavy Physical Load	6	1	--
Static Work Posture	3	4	--
Repetitive Movements	1	2	--
Whole-Body Vibration	12	1	--
Psychosocial Factors			
Mental Stress	3	2	--
Job Dissatisfaction	5	2	--
High Work Pace	1	3	--
Lack of Job Support	--	2	--
Low Job Control	5	2	--

From Burdorf and Sorock, Scandinavian Journal of Work, Environment & Health 23(4):243-256 1997, Table 1. Used with permission (appendix 1.A1).

Table 2.2: Etiological Risk Factors for Low-Back Pain and their Associated Strengths

Estimated Strength of Association	Worker Characteristics	Biomechanical Factors	Psychosocial Factors
Weak (RR = 1 - 2)	Smoking Obesity	---	Job Dissatisfaction Work Pace Job Control
Medium (RR = 3 - 4)	Previous LBP History	Heavy Lifting Whole Body Vibration	---
Strong (RR ≥ 5)	---	Spinal Loading Postural Stress Dynamic Trunk Motion	---

from Frank et al. Spine 21(24):2908-2917 1996: Table 2. Used with permission (appendix 1.A2).

Table 2.3: "Baseline" Pain, Disability and Health Related Quality of Life Measures for Compensation and Non-Compensation Groups Reported in The Literature

Reference	Comparison Measure	Compensation Group		Non-Compensation Group
Articles Comparing Compensation versus Non-Compensation Groups				
Leavitt et al., **Spine** 7(4):398-402 1982	N	85		176
	mean age	40.1±10.4		42.5±12.9
	% male	69		36
	years education	12.1±2.1		12.7±3.2
	married	71%		73%
	onset of symptoms :			
	< 6 months	37%		42%
	6-12 months	21%		9%
	> 1 year	42%		49%
	non-organic disease	42%		30%
	psychological disturbance	29%		24%
Mendelson, **Pain** 20:169-177 1984	N	47		33
	mean age	37 (±9.4)		41 (±10.3)
	% male	47%		27%
	pain duration (months)	33.6 (±22.5)		114.2 (±95.3)
	VAS Pain (0-100)	60.8 (±23.8)		61.7 (±17.8)
	STAI - state	45.8 (±11.8)		44.8 (±12.9)
	STAI - trait	46.9 (±10.2)		44.7 (±11.8)
	ZUNG Depression	47.5 (±9.2)		43.1 (±9.8)
Jamison et al, **Orthopaedic Review** XVII: 1210-15 **J Psychsom Res** 32(3):277-283 1988		Time Unlimited	Time Limited	
	N	39	27	44
	Age	48.3	41.8	41.9
	% male	100	100	100
	% married	74.4	96.2	72.2
	education (years)	10.9	10.9	12.8
	symptom duration (months)	44.7	26.5	44.1
	Medication Use (%):			
	Narcotics	85%	52%	68%
	Sedatives	41%	26%	20%
	Physician Rated Depression (%)	67%	70%	52%
	Physician Rated Anxiety (%)	36%	44%	27%
	High Pain Behaviour (%)	74%	56%	49%
Tollison etal. **Orthopaedic Review** Vol XIX(8): 701-709 1990	N	15		15
	Mean age	41.3		43.8
	education	11.0 (yrs)		11.3 (yrs)
	mean duration of pain	22.4 (mnths)		25.2 (mnths)
	pain intensity [0-5]	4.1		3.9

Reference	Comparison Measure	Compensation Group	Non-Compensation Group
Leavitt, J **Psychosom Res** 34(4):447-453 1990; **Leavitt, Spine** 17(3):307-310 1992 ‡‡		"Injured at Work"	"Injured Away from Work"
	N	1192	389
	mean age	37.6	36.9
	% male	82.2%	64.1%
	education (years)	11.9 (±3.1)	12.4 (±4.2)
	duration of pain		
	0-1 months	15%	18%
	2-6 months	28%	24%
	7-12 months	20%	18%
	> 1 year	37%	41%
	prior back surgery	13.3%	11%
	Physical Exertion at Work		
	None	6%	28%
	Minimal	12%	27%
	Moderate	26%	22%
	Heavy	56%	23%
Tollison CD et al. **Southern Medical Journal** 86(11):1206-1209 November 1993	N	32	29
	age (SD)	41.6 (11.6)	42 (11.7)
	% male	53	48
	duration of symptoms (SD)	11.2 (5.8) months	10.7 (5) months
	pain intensity scale (0-10) VAS?	9.1 (1.1)	8.4 (1.1)
	% use analgesic medications	66%	69%
Ambrosius et al. **JOSPT** 21(1):7-12 January 1995	N	35	25
	age (±SD)	35.6 (9.9)	40.7 (11.1)
	% male	66	50
	duration of symptoms until therapy	14.2 (10.3) weeks	12.5 (10.9) weeks
	VAS pain scale (0-10)	3.74 (±2.4)	2.68 (±2.3)
	ROM score (degrees)	62 (±17.8)	64 (±10.8)
Sanderson et al. **Spine** 20(5):554-556 1995	Age	44.6	
	mean duration of symptoms	62 (months)	
	N	71	198
	% > 41 on Oswestry†	83%	58%
	mean Oswestry score (0 - 100)	32.4	26.6
Hadler et al. **Spine** 20(24):2710-2715 1995	N	505	861
	mean age	38.4	39.6
	% male	55%	50%
	% married	71%	69%
	% with Sciatica	22	22
	Baseline Roland-Morris (0-23)	11.3	10.7
	% symptoms > 2 wks	33	32
Taylor et al. **Spine** 21(19):2255-2259 1996 ‡	N	1502	2674
	mean age	39.1 yrs	41.9 yrs
	% male	79	56
	% with 'comorbidity"	3	4
	% with 'herniated disc' Dx	79	81

Reference	Comparison Measure	Compensation Group	Non-Compensation Group
Atlas et al. AJIM 29:584-589 1996	N	133	258
	mean age	39.4	45.0
	% male	74	45
	% graduated college	9	31
	% positive (pain) SLR	59	60
	% moderate/severe x-ray findings	62.3	79
	% extremely bothersome back symptoms (past week)	62	47
	mean Roland score (0-23)	18.6	15.7
	SF-36 Physical Function	28.0	44.0
	SF-36 Mental Health	58.3	67.8
	SF-36 General Health	71.7	78.6
Rainville et al. Spine 22(17):2016-24 1997	N	96	96
	age	39	43
	% male	47	42
	duration of symptoms	45 (months)	45 (months)
	% married	42	64
	% previous low back pain	54	39
	% with medium / heavy job	60	17
	sciatica (%)	75	50
	VAS pain scale (0 - 10)	6.8	5.0
	Beck Depression Inventory (0 - 63)	16	10
	Range of trunk flexion (degrees)	73	85
	Straight Leg Raise (degrees)	71	78
	Motor Deficit (R or L)	15	3
Vaccaro et al. Spine 22(17): 2030-2035 1997	N	13	11
	mean age	37	39
	% male	62%	35%
	leg symptoms	46(%)	82 (%)

† - scores > 41 on the Oswestry represent 'severe' disability

¶ - none of the AFC (Anticipating Financial Compensation) were WCB cases; rather, they were involved in litigation or receiving long term disability

‡ - administrative hospital discharge data Washington State

†† - data are combined from control and treatment groups (no significant differences between groups on the variables listed)

‡‡ - same study reported in both articles using slightly different populations; data from 1992 article reported here

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Chapter 3 : Building a Conceptual Framework : Risk Factors, Low-Back Pain, and Workers' Compensation

The focus of this research is on compensation claims for low-back pain. The emphasis is therefore not one of biomedically defined etiology. The research addresses not why workers get low-back pain and its component risk factors, but *why* some workers with low-back pain file for compensation and others do not.

The research questions being addressed and the sensibility of including certain variables or factors in an analysis of the etiology of low-back pain, versus an analysis of the factors that 'drive' claims laying, are different. For instance, it would not be methodologically sound to include current pain intensity and measures of low-back function in an etiological study, while these may be the focus of the latter investigation. Nonetheless, the etiological risk factors for low-back pain are likely important in the decision to file a claim as well.

Low-back pain is unique in its socio-cultural and economic context, epitomized by the dramatic rise of low-back pain disability in Western industrialized countries (Waddell, 1992; Frank et al., 1995a). In addition, the current state of medical science is unable to precisely determine the pathological basis of upwards of 90% of the low-back pain presenting to the physician's office, for which the vague catch-all diagnosis 'sprains and strains' is used (Frank et al., 1995a). This leaves workers in pain, without a specific diagnosis, and susceptible to feelings of suspicion and mistrust in the workplace about the legitimacy of their injury **and** their claim (Tarasuk and Eakin, 1995; Smith et al., 1998; Johnson, 1998).

Inspection of the medical literature surrounding workers' compensation and low-back pain reveals that much of the current research focuses on evaluating therapeutic efficacy among this group. The results of these studies do indicate a difference in outcomes between low-back pain patients on compensation versus those who are not. This has been attributed to motivations of secondary financial gain acting as a disincentive, which results in a less favourable response to treatment. This notion of disincentives generated

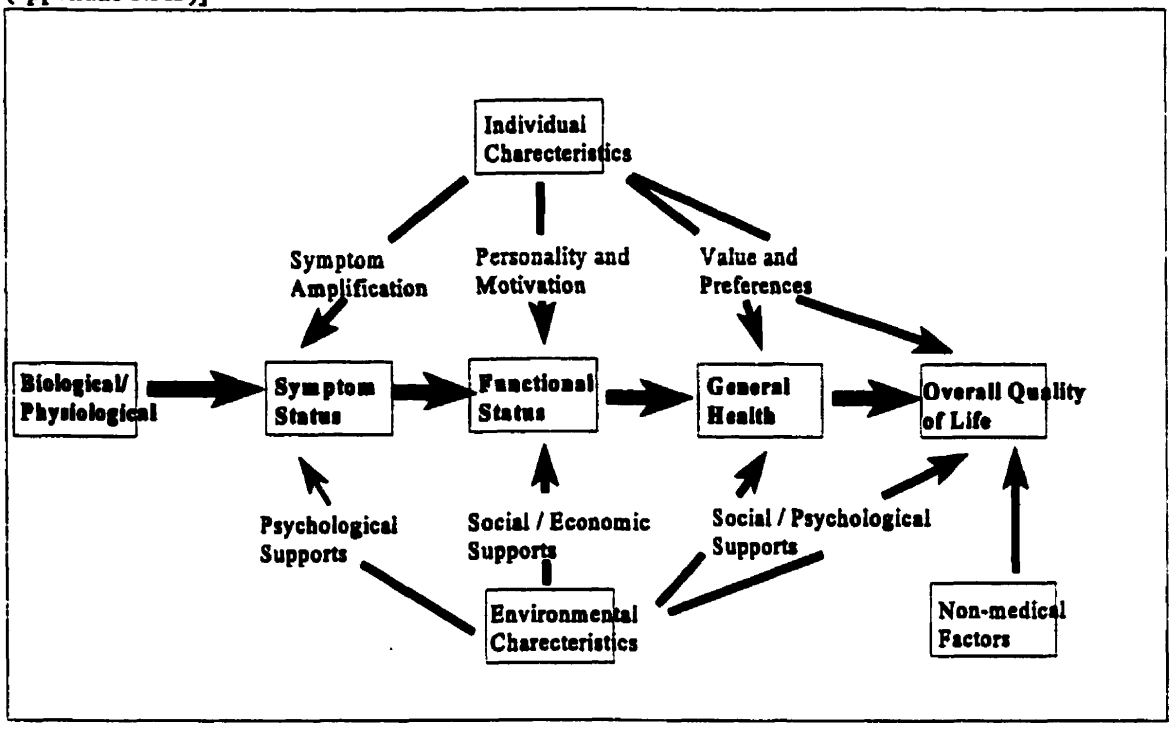
by the compensation system has been termed the 'perverse incentives' view (Frank et al., 1995b). Physicians and health care providers are advised to be 'wary' of low-back pain patients on compensation (Sullivan and Loesser, 1992; Teasell and White, 1994). However, as Leavitt so adroitly points out (Leavitt, 1992), there appears to be a fundamental difference in the type of work performed by those in industries typically covered by workers' compensation insurance, which may just as likely be responsible for observed differences in the outcomes.

A Conceptual Framework of Disability

In an attempt to link paradigms from both the biomedical and social sciences, Wilson and Cleary (1995) present a disability model that incorporates both clinical and health-related quality of life variables (see Figure 3.1). In their model, biological and physiological variables focus on the functioning of cells and organs, and include measures such as serum haemoglobin or creatinine, pulmonary function tests, or physical exam findings such as a heart murmur. The shift to 'symptoms' represents the transition from the cellular to the organism as a whole. Symptoms are defined by the authors as physical, psychophysical, and psychological. Thus a 'symptom' is the patient's perception of an abnormal physical, emotional, or cognitive state, and symptom reports "are expressions of subjective experiences that summarize and integrate data from a variety of disparate sources"[p.61].

Wilson and Cleary rightly point out that the relationship between biological or physiological factors and symptoms is quite complex and not necessarily a linear one. For instance, studies of radiographic imaging indicate little or no association between mid-to-late-life radiologic abnormalities and symptoms of low-back pain. Further, studies have shown that statistically significant reductions in erythrocyte sedimentation rate, rheumatoid factor titre, haemoglobin level, and serum IgM levels in patients with rheumatoid arthritis were not accompanied by reductions in symptom levels on any of seven measures (Wilson and Cleary, 1996 p.61).

Figure 3.1: Conceptual Model of Disability Linking Biomedical and Sociological Variables with Overall Quality of Life [From Wilson and Cleary, JAMA 273(1):59-65 1995. Used with permission] (appendix 1.A3)]



Trief and Donelson (1995) applied the Wilson-Cleary model to a discussion of the potential impact of being on compensation on symptom status and overall quality of life. They suggest that the workers' compensation system impacts negatively on workers' expectations of timely and effective medical treatment, which leads workers to heightened symptom reports. With respect to functional status, workers may be afraid to 'exercise' since 'functional improvement' and being able to 'return to work' are not equivalent (although they may be assumed to be so by employers and insurance carriers). Thus, the compensation system itself, by its very nature, may not be conducive to speedy and effective recovery.

Low-Back Pain, Disability, and Compensation

The framework presented in Figure 3.1 is easily adapted to low-back pain. The first box in the Wilson-Cleary model represents the traditional putative etiological risk factors for low-back pain. Biological

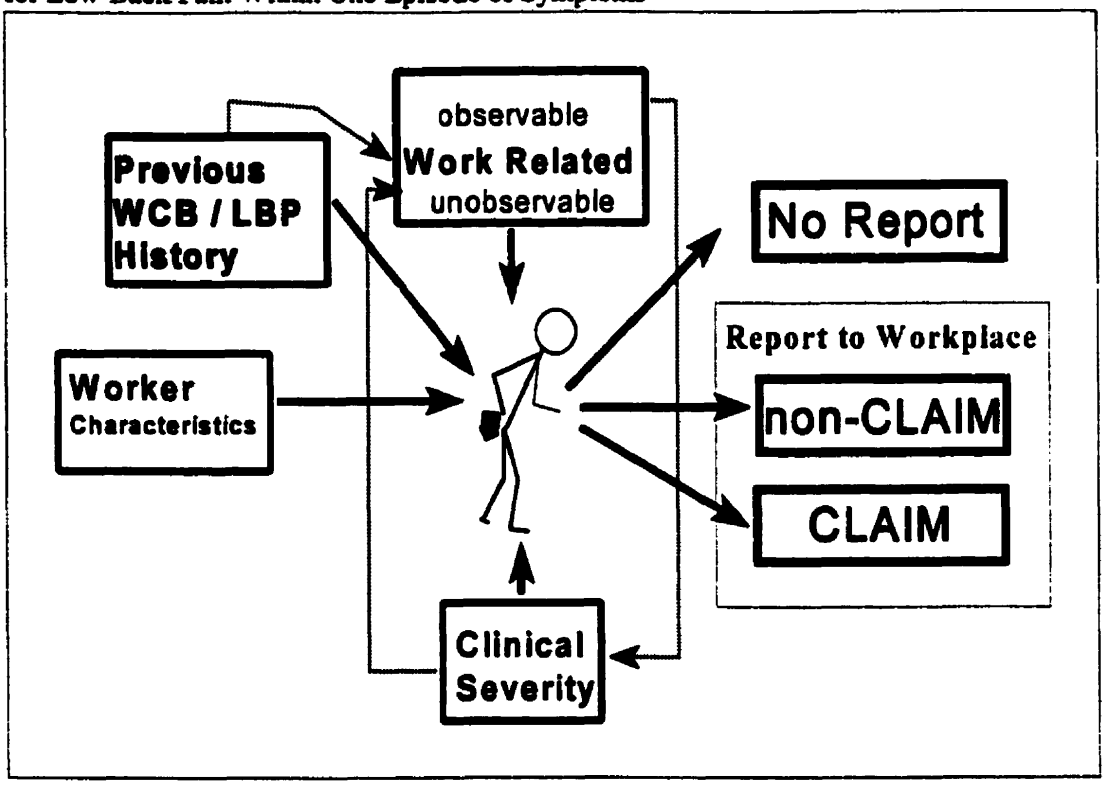
pathways have been proposed that transform emotional, psychological, and psychosocial factors into physiological stress responses that are implicated in the Wilson-Cleary transition from the cellular to the organism response levels (Lazarus, 1991; Chrousos and Gold, 1992; Bongers et al., 1993; Siegrist, 1996; NIOSH, 1997).

However incorporating "seeking compensation" (by laying a claim) into Figure 3.1 is difficult, as it does not easily fit into any one of the boxes, nor is it clear that compensation necessarily follows from any one particular junction in the disability process. Workers may file claims simply because of symptoms (i.e., an 'entitlement'). Or, the claim may be filed only after symptoms produce an inability to meet the job demands (a 'disability'). In addition, workers' compensation itself becomes a medico-legal contextual variable of sorts in this model because compensation for occupational low-back pain is due only for LBP that arose at the workplace.

In a series of editorials and commentaries, Hadler has espoused an alternative view on reasons why workers file compensation claims (1984; 1987; 1994; 1996; 1997a; 1997b). While not presented in a 'conceptual framework' *per se*, his theory is succinctly captured in the title of one of these pieces, "*To be a Patient or a Claimant with a Musculoskeletal Illness*" (Hadler 1987). Hadler suggests that because low-back pain, or 'backache', is so ubiquitous with an 85% lifetime prevalence (Frank et al., 1995a), the epidemiological search for its risk factors is not justified (Hadler, 1997a). Rather, he suggests that workers who get back pain and file compensation claims simply "can't cope" with the pain (Hadler 1987). And, according to Hadler, the medico-legal transformation of 'lumbago' or 'backache' to a compensable 'back injury' that has occurred in industrialized nations is responsible for the observed rise in disability due to low-back pain (Hadler 1994).

So why do workers with low-back pain file compensation claims? A model outlining the conceptual framework advanced in this thesis, of the relationship between work, workers and compensation claims for low-back pain is shown in Figure 3.2. Note that this is not an etiological model for low-back pain; rather,

Figure 3.2: A Conceptual Model of Factors Related to the Decision to Report, or File a Claim, for Low-Back Pain Within One Episode of Symptoms



the framework is conditional on the worker already having low-back pain. Thus, we are interested in how workers respond to their symptoms in terms of the decision to report their symptoms to the workplace, and given that they have made the decision to report, to file a compensation claim (which may include taking time off) or not.

In this model, four factors, or sets of factors, are hypothesized to influence the response to low-back pain. The first set is contained in the box called 'Worker Characteristics', which are a set of fixed characteristics the worker brings to the episode of low-back pain. These include socio-demographic factors such as age, marital status, body-mass index, number of pre-school children, and comorbidities. The second set of factors is job-related, which includes both the biomechanical and psychosocial aspects of the job. A third set of 'clinical' factors that drives reporting or claims laying is the 'severity' of the current episode of low-back pain. Measures such as pain intensity, radiating pain, and functional status fit into the clinical

severity box.

Having had a previous LBP claim is the fourth factor, and is included as a separate box since it may not only impact the decision to file a claim for a current LBP episode, but may also have influenced the job-related factors. This is indicated by the dotted line in Figure 3.2. That is, a worker with previous low-back pain episodes may become functionally disabled at lower severity thresholds with lower relative job demands. Previous claim episodes may be doubly important, as workers with a claims history may in fact have moved selectively into jobs with lower demands, or indeed their current perceptions of the psychosocial work environment may have been influenced by them (Tarasuk and Eakin 1994; Tarasuk and Eakin 1995).

Note that job-related factors are delineated as 'observable' and 'unobservable'. These labels could easily have been 'objective' and 'subjective'. Biomechanical estimates of the loads on the lumbar spine can be directly observed. Psychosocial constructs such as 'job control' are inherently measured through the lens of the individual worker.

The subjective nature of both the psychosocial (i.e., Psychological Demands) and health (i.e., Pain Intensity) measures does not invalidate their use. How people judge the loudness of sounds, the brightness of a light, or the heaviness of an object have been investigated since 1860 when Gustav Fechner published the first manuscript examining the mathematical relationship between the strength of a stimuli and its perception (McDowell and Newell, 1996). In general, the relationship between a stimulus and its response is not a linear one, incorporates the notion of a 'minimum detectable difference[1]', and has been generally been represented by

$$R = k \times S^b$$

where R is the response, k is a constant, S the level of the stimulus, and b an exponential that describes the functional form of the relationship. For example, if b is 1, as it is for judging short lengths, then the response

1. For example, a 1 lb difference between 5 vs 6 lb weights may be readily detected, but a 1 lb difference between 100 vs 101 lb weights may not.

R is a linear function of the stimulus (which justifies the use of the visual analogue scale in health measures). The value of *b* for sound pressure has been estimated at 0.67, indicating that a doubling of decibels will be judged as nearly two-thirds louder) while that for electrical stimulation is 3.5 (indicating that a doubling of intensity is judged as an increase of nearly 12 times). Pain is likely in the same magnitude as electrical stimulation (McDowell and Newell, 1996).

For pain to be understood and treated effectively, it must be measured. Yet pain is a personal experience, and can never be truly held up to a 'gold standard', in order to determine the validity of the measure. Statistical and methodological means are available to demonstrate the psychometric properties of pain measures (i.e., confirmatory factor analysis, external criterion validity). In an excellent review of the issues and the literature surrounding the validity and reliability of pain measurement, Jensen (1997) points out that

> "...despite the lack of an observable and verifiable correlate of pain experience, at least two sources of evidence indicate that self-report measures do reflect pain experiences. First, factor analytic studies....demonstrate that self-report measures provide valid estimates of 'true' pain experience. Second, the pattern of pain experience following surgery or procedures known to affect pain as shown by self-report measures, indicates that self-reports of pain intensity, more than any other pain behaviour measure, behave as if they accurately reflect the pain experience."[p.652]

The relationship between job-related and clinical factors is a complex one. Clearly, job-related factors, both biomechanical and psychosocial, have been shown to be risk-factors for the onset of low-back pain (see chapter 2). It may be that the magnitude of the 'objective' (or observable) risk-factors are correlated with the magnitude of the pain (for example, higher biomechanical demands produce more pain). In turn, the pain itself may affect 'subjective' psychosocial factors, such as social support. These inter relationships are depicted in Figure 3.2 as the dotted lines between the job-related and clinical severity boxes.

Three outcomes, or responses to pain are possible and are depicted in Figure 3.2. Given the mix of worker characteristics, job related-factors, and severity, a worker with low-back pain may i) not report the pain; ii) report the pain to the workplace (but not file a claim); or iii) file a claim. In fact, filing a claim is

nested within reporting to the workplace since a worker has to "report" in order to file a claim, but does not necessarily have to file a claim if the pain is reported.

Research Question

The focus of this thesis is to determine the relative importance of worker characteristics, workplace factors, and clinical severity associated with filing a compensation claim for low-back pain. The literature published to date and included in this review lacks findings from a simple comparative analysis of pain and functional status measures across compensation status that controls for biomechanical and psychosocial job demands. Consider the following quotes, which represent views about low-back pain patients on compensation:

"The literature that casts the negative image on the industrial worker on compensation is far less conclusive than might be inferred from the biases against this group embedded in print"[Leavitt 1992, p.307];

"seeking redress....under workers' compensation can be a gauntlet of iatrogenicity. The algorithm reeks of contentiousness.....To add insult to injury, when symptoms persist and or progress despite interventions, the honesty of the worker is impugned"[Hadler 1994, p.164];

"Fifty percent of patients...claiming lump-sum compensation stated that they would not go through the claim procedure again under similar circumstances. The reasons given were: the process had been too stressful, too slow, it had caused too much family trauma, or appeared to reduce the treatment that they were given, they had become depressed, or were unable subsequently to find a job"[Greenough and Fraser, 1989, p.953].

These quotes serve to illustrate the complex sociological processing involved in the decision to either report the pain to the workplace, or indeed to file a compensation claim for low-back pain. A conceptual framework has been advanced in this thesis that consists of sets of factors representing the worker, the workplace, and the injury, which includes a set of inter-relationships between previous claim episodes and the job-related factors, between objective job-related factors and clinical severity, and between clinical severity and subjective job-related factors. The primary research question for this thesis addresses the following:

What is the relative importance of worker characteristics, claims history, job-related biomechanical and psychosocial factors, and clinical severity on the decision to report pain or file a compensation claim for LBP?

The objective of the analysis will be to build parsimonious models explaining the two outcomes, that are based on the conceptual framework. A secondary research question will address the relationship between previous compensation claim and job-related factors:

2) Does previous WCB claim for LBP affect current job-related factors?

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PART II - THE DATA

Chapter 4 : Study Design and Subject Accrual

Study Design

From early 1991 to 1993, an extensive amount of time, effort and resources at the Institute for Work & Health went into the development of a protocol to study low-back pain, resulting in the 'Integrated Study'. The study was 'integrated' in several ways. First, the study was specifically designed to include both psychosocial and biomechanical factors measured at the individual level. Second, the study was to include both an etiological case-control component and a nested prognostic cohort. Thus, the set of measures collected included both potential etiological and prognostic factors. At the time of the protocol development and implementation, there were no published studies of rigorous methodological quality that adequately addressed the relative importance of both putative etiological factors, and a framework for disease etiology was adopted that included both of these (Beaton et al., 1993).

In order to accrue subjects with "newly reported LBP", eligibility was originally restricted to those with at least one day off work for LBP who had not 'reported' LBP to the worksite in the past year. The criteria restricting eligibility to those who had not reported in the past year was in place to limit the study to incident cases of LBP and avoid the possibility of studying putative prognostic factors along with etiological factors (Bombardier et al., 1994). Note , however, that it was quickly realized that the actual back pain prevalence at the worksite was much higher than anticipated, which forced a relaxing of the eligibility criteria once accrual had started to those who had not reported LBP to the workplace in the past three months (the day off criterion was dropped altogether). Low-back pain due to metabolic or vascular disorders, infection, neoplastic or inflammatory conditions, fractures, and pregnancy was excluded. For the prognostic component (all cases interviewed within two weeks of the report date were eligible), repeat measures were

obtained at 3 weeks, 9 weeks, and 26 weeks post report. However the analysis contained in this thesis concerns only the questionnaire data collected on subjects at baseline, thus the prognostic component will not be discussed farther.

It is important to point out that the main research question addressed in this thesis surrounds *reporting and filing a claim* for low-back pain, and not the risk factors for low-back pain per se, for which the protocol was designed. Risk factors for filing a claim due to low-back pain are not necessarily the same as the set of etiological risk factors for low-back pain itself; indeed, the risk factors for filing a claim may not be equivalent to the risk factors for reporting low-back pain to the workplace either. That said however, the risk factors for low-back pain etiology, reporting, and claims-laying certainly overlap, and in some instances the differences between outcomes may be a matter of degrees (or intensity) on the level of the factor rather than its presence or absence.

Study Setting and Population

The study setting was the General Motors Autoplex in Oshawa, 65 kilometres east of Toronto. This 650 acre facility includes car and truck assembly plants, as well as fabrication and parts manufacturing operations. Although the workforce exceeds 12,000, accrual was limited to the Car plant (in fact two assembly lines producing mid-size family cars) and a Truck Plant (one assembly line producing extended cab trucks exclusively). Eligibility was open to all hourly-paid employees, a study base of roughly 10,000 workers (~7000 and ~3000 from Car and Truck Plants respectively).

Very little traditional 'drag-chain' type assembly is still used, as extensive re-engineering in the mid-eighties had replaced that with 'Automated Guided Vehicles', or AGV's. With AGV's, the basic assembly takes place on a carrier automatically programmed to follow an electronic track buried in the floor, stopping at work-stations for a specified time (usually measured in seconds), during which assemblers perform their job tasks. This set-up allows work 'cells' where the same set of job tasks is performed simultaneously at

multiple workstations. AGV's with vehicles in various states of assembly are able to wait in 'marshalling yards', or buffer zones. ASSEMBLY work is characterized by a repetitive set of job tasks, performed roughly 500 times per shift, with the pace of work controlled by the AGV. Assemblers are required to pull a chain once they complete the job tasks to 'release' the AGV to move on to the next station. If the AGV is not released within the preset number of seconds, a red light above the workstation begins to flash.

Assembly stations are constantly supplied by SUPPORT staff, made up of material handlers, who either drive forklifts and fill parts bins or labour in the parts mall, or are group leaders. Support work may involve periods of sitting or driving, and periods of heavy physical exertion, such as filling parts racks at the line, or trouble-shooting for the group leaders. The production system is maintained by a MAINTENANCE staff of skilled tradesmen (such as electricians, machinists, and millwrights) and the workplace is maintained by cleaners and sweepers. Maintenance workers have a high degree of control over their jobs, which may involve long periods of sedentary monitoring or regular scheduled maintenance; however, when there is a breakdown on the line resulting in line stoppage, they are under pressure to fix things quickly. Sweepers and cleaners have a high degree of control over when and how to clean the area they are responsible for. In an interesting 'twist' in the job desirability hierarchy, unskilled workers with seniority tended to migrate to the cleaning jobs, since work can be done at the worker's own pace and discretion. Finally, among the production workers there are a group of UTILITY workers, or 'spare-man'. Utility workers are trained in all the jobs in their area, whether they are assemblers or support staff, and fill in for absent workers, or cover personal breaks.

Subject Accrual

Implementation of the study was conducted by a group with members from GM, CAW, the Institute for Work & Health, and the University of Waterloo. The study was publicized at the worksite under the title 'Ontario Universities Back Pain Study', or OUBPS, and the official crests of The University of Toronto,

McMaster University, University of Waterloo, General Motors, and The Canadian Auto Workers, were present on all study correspondence. The group met on a regular, frequent basis to discuss issues that arose around the study. An office was maintained on-site which served as a 'home-base' for study staff working in the field - either collecting questionnaire data, or obtaining the detailed biomechanical measurements from subjects at the workplace.

Low Back Pain "Reporters"

Workers with low-back pain were accrued as they reported to the first aid stations. 'Low-back pain' was defined as pain between the bottom of the ribcage and above the gluteal fold. Nurses were asked to provide researchers at the Institute for Work & Health the names and phone numbers of workers reporting low back pain who agreed to be contacted. The nurses were also asked to record basic demographic data (gender, age, job type, reason for refusal) from those refusing to take past (nursing forms for case accrual appear in Appendix 4.A1). Workers agreeing to be contacted were then telephoned by study staff and the study was explained to them in more detail, using a standard script, to outline the study purposes and objectives, and to explain what would be involved if the subject were to take part. Initial eligibility in terms of confirming the low-back pain and report to the first-aid station was ascertained at this point, and those not eligible were thanked for their interest. Those eligible and agreeing to take part were scheduled for a baseline interview at the earliest possible convenience. After the baseline interview had been completed, subject information was passed on to the ergonomics team via a subject info sheet (appendix 4.A2) so a biomechanical assessment could be scheduled.

Random Controls

At the same time as cases were being recruited from the first-aid stations, active plant rosters were used to generate random lists of workers' employee identification numbers. A researcher at IWH would generate a list of 50 5-digit random numbers. This list was then provided to the study representative at General Motors, who would match the random digits to the roster of active employees. Randomly selected

population controls were *not* frequency matched on age, gender, job, or plant; rather they were a randomly selected group of workers who had not reported low-back pain to the first-aid stations in a specified time-frame prior to their entry into the study. In turn, a list of names, phone numbers and addresses of potential random population controls was returned to the IWH. Subjects on this list were sent a letter advising them that their names had been selected, and that they would be receiving a phone call in the near future (appendix 4.A2). Subjects were then called to solicit participation. Having low-back pain was not in itself a reason for exclusion of the random controls, but a visit to the first-aid station for low-back pain was. The baseline interview with eligible[1] and agreeing controls was scheduled for the earliest possible convenience. After the baseline interview had been conducted, subject information on Random Controls was passed on to the ergonomics team for biomechanical assessment.

Job-Matched Controls

Built into the study design was the accrual of a group of controls matched on job to the cases. These job-matched controls would serve two purposes: i) since it was expected that some cases would not return to their pre-injury jobs because of low-back pain, controls matched to cases by job would provide proxy biomechanical data; and ii) a comparison of job-matched controls to random controls allows an examination of how the perception of putative risk factors are influenced by the presence of low-back pain symptoms (Beaton et al., 1993). Although job-matched controls were to be collected for all cases, controls for those cases not returning to pre-injury jobs were given priority. Each case's job description was obtained at the baseline interview, and this information along with information about the case's job (location in the plant, supervisor) was provided to the team of ergonomists responsible for conducting the biomechanical assessments. A 'lead' person from the assessment team was assigned to each participant in the study, and was responsible for identifying either exact or similar jobs to those performed by the case. Workers doing

1. In addition to the same eligibility criteria as applied to those reporting LBP, random controls retiring in the next six months were excluded since a 26-month follow up interview with random controls was included as part of the prognostic component.

these jobs were approached directly by the ergonomist on the shopfloor, and names and phone numbers of those agreeing to be contacted were recorded and fed back to the IWH research team (see appendix 4.A4). These subjects were then called in order as they appeared on the list, and as with the cases and random controls, the study was explained to them and eligibility[2] ascertained. Baseline interviews were conducted and subject information passed to the ergonomics team so that a biomechanical assessment could be arranged. Assessing the appropriateness of the proxy data was done on matched pairs where available using the intra-class correlation coefficient[3]. Biomechanical data from subjects matched by job to cases was substituted as proxy data where case data were missing.

The Baseline Interview

The baseline interview was generally conducted at the subject's home, although several subjects preferred to have the interview in the on-site study office. Signed, informed consent (see appendix 4.B1) was obtained from the participants at the baseline interview prior to any data collection. Because of the amount of information collected, and the time required to explain the study and sign consents, generally the baseline interview required at least one hour to complete. Subjects were free to discontinue their involvement in the study at any time. All data were kept in locked cabinets in a locked office, and names of participants were available to study staff on a need-to-know basis only.

Measures

Interviews were conducted by trained interviewers. Subjects were provided a copy of the baseline questionnaire to follow along with. Interviewers were instructed to read out the questions and record the

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2. As with random controls, the same eligibility as the cases was applied to potential job-matched controls.

3. A total of 65 matched pairs were ultimately obtained, for whom 35 had biomechanical data. ICC (Shrout and Fleiss, 1979; Dunn 1989) comparisons of biomechanical and psychosocial data have been done, with moderate to good agreement on biomechanical measures, justifying the substitution of proxy data (Kerr, 1998 pp.124-126).

answers given by the subjects. However while some subjects would wait until the interviewer had finished reading the question, other subjects would read the questions themselves and then provide the answer. Although clarification was provided where necessary, interviewers were careful not to lead the subjects in their answer choices. Clinical and psychosocial working groups were responsible for developing those sections of the questionnaire, and preference was given to validated, standardized instruments (McDonald and Bombardier, 1993a, 1993b; Beaton and Bombardier, 1993). A copy of the questionnaire is reproduced in Appendix 4.B2 and the sections are described in more detail below.

Subject Characteristics

Date of birth, gender, marital status, main wage earner status (Appendix 4.B2 question A.1,2, and 3 respectively), and number of children (4.B2 q.A.8) were ascertained using routine questions that were obtained from the Ontario Health Survey (1990). Height (in feet) and weight (in pounds) (4.B2 q.C.25-26) were converted to metres and kilograms, and body mass index (weight/height^2) was calculated. In addition, current smoking status (4.B2 q. F4), and alcohol consumption in the past year (4.B2 q.F5) were recorded. Apart from age and body-mass index, most of the measured worker characteristics were thought to be risk-markers; for instance, being married is not considered a risk factor in itself, but may represent the existence of a financial and emotional support system that allows married workers to cope with their pain in a different way than single or divorced workers.

Clinical

Physical Exam

Physical exams were conducted by trained interviewers to collect anthropometric data, and were in no way intended to provide diagnoses (Ontario Universities Back Pain Study, 1992). The data collection sheet is reproduced in Appendix 4.B3. Measures recorded were:

- finger-floor distance: subjects were told to stand with knees straight, and bend to floor as far as possible. The distance between the tips of the fingers and the floor was recorded in inches. A stool was provided for hyper-flexible subjects so negative values are possible. The first trial was recorded since evidence shows that when the motion provokes symptoms subsequent trials show reduced range of motion (Di Fabio, Mackey and Holte, 1996)
- straight leg raise: subjects were requested to lie flat on the floor, and each leg was slowly raised by the examiner until told to stop, with care taken to avoid bending of the ipsilateral knee or tilting of the pelvis. The angle of each leg to the floor was recorded. The average of the two measures was used for analysis.
- grip strength: a modified sphygnamoneter, with the cuff permanently sewn into a small bag was used. Subjects were asked to squeeze the inflated bladder as hard as they could. Three trials per hand were recorded, and the average of the six measures was used in the analysis.
- safety sit-up score: subjects were asked to perform a series of six sit-ups, each one becoming progressively more difficult, starting with the arms in front to having the arms wrapped around the head to opposite ears. Scores were recorded as 0 (can't do a sit-up) to 6, the most difficult.
- positive tender points: interviewers were trained using a dolorimetre to apply ~4 kilograms of pressure with the thumb. Sixteen sites (left and right: trapezius, lateral elbow, 2nd rib, gluteus, trochanter, above knee, below knee, and instep) were palpated, and those sites where tenderness was elicited were recorded as positive.
- reflexes: a reflex hammer was used to test the knee, hamstring and ankle reflexes. Normal reflexes were scored 2, while reflexes with more than two beats of clonus were scored 3 or 4, and those with less beats of clonus were scored a 0 or 1.

Low-Back History

Questions about low-back pain history (4.B2 q.D8-12) were based on recommendations from the

Quebec Task Force (Spitzer et. al., 1987). These include questions about number of previous episodes in the past year and number of lifetime episodes that lasted at least one day. In addition, it was recorded if any previous episodes were a compensation claim, and previous hospitalizations for surgery or other reasons were recorded (4.B2 q.F7-8). Satisfaction with previous episodes of health care for low-back pain was also recorded.

Current Symptoms

Questions about current symptoms were also drawn from the Quebec Task Force (Spitzer et al, 1987). The initial screen for current symptoms read "Have you had back pain or leg pain in the past week?" with a binary yes / no response. Symptom duration, pain radiating to the legs, numbness in legs or foot, and increased pain on cough/sneeze, were also included (4.B2 q.B1-5). In addition, questions about back symptoms specific to low-back pain affecting sleep in the past week (is your back stiff when you get up; does back pain wake you up) were included (4.B2 q.B10-11).

All subjects were administered the Chronic Pain Grade (Von Korff et al., 1992), asking about low-back pain in the past year (4.B2 q.D1-8). Two scales are constructed from the Pain Grade, a Pain Intensity Scale and a Disability Scale which each range from 0-100 based on the average of three questions each (see Figure 4.1). In addition, cases were administered an 'Acute Pain Grade', a modified version of the Chronic Pain Grade (see Appendix 4.B4). While the original instrument specifies pain in the past year; this was modified so that the questions referred to "Since your injury,....". Cases were instructed to think about the time since they reported their 'injury' to the first aid station, thus anchoring the current 'episode' for cases. Note that the terms 'injury' and episode' are both rather vague in describing the clinical course of low-back pain, but it was recognized that some term was needed to refer to the current 'episode' of back pain that was reported, for which they were entered into the study.

Participants who responded positively to having symptoms in the past week were asked to complete a pain drawing (Appendix B.5). Subjects were provided with a red pencil and simply instructed to "Please

colour in the areas on the body where you feel pain." Various scoring methods for scoring pain diagrams have been proposed in the literature, which generally either measure pain extent (Margolis, 1986,1988; Escalante 1996) or are designed to detect 'non-organic' pain patterns (Uden 1988) or those with pain of psychogenic origin (Ransford, 1976). Inter-rater reliability and construct validity of four scoring methods for the pain diagrams is currently underway (Smith and Bombardier, 1998), so is not included in the analysis.

Functional Status and Health Related Quality of Life

Roland-Morris Disability Scale

The Roland-Morris Disability Scale (Roland, 1983) is a back-specific instrument for measuring how back pain has affected physical function (4.B2 q.C1-24). The Roland attributes changes in functioning specifically to back pain (i.e., 'Because of my back pain, I try not to bend or kneel down') and refers to current function and symptoms (that is, the instructions refer the respondent to how they are doing at the time the questionnaire is filled in).

It is hypothesized that subjects with low-back pain filing for compensation will have a higher level of functional impairment. Note that several of the items might be driven by being off work. In order to avoid artificial or spurious associations between the Roland Scale and the outcome, six items were **excluded** from the modified Roland Scale used in the analyses:

1. I stay at home most of the time because of my back problem or leg pain.
6. Because of my back problem, I lie down to rest most often.
10. I only stand for short periods of time because of my back or leg pain.
11. Because of my back problem, I try not to bend or kneel down.
20. I sit down for most of the day because of my back.
24. I stay in bed most of the time because of my back problem or leg pain.

The Roland is scored by summing the binary responses and thus ranges from 0 to a maximum of 18.

MOS Short Form 36 (SF-36)

The SF-36 (4.B2 q.G1-10) is a generic functional status instrument that has been widely used in

outcome studies (Garrat, 1993). Population norms have been published for the instrument that cover a wide variety of illnesses, including low-back pain (Ware et al., 1994). The SF-36 contains 36 items that form eight dimensions, 4 physical (figure 4.2(a))- physical function, role physical, bodily pain, general health - and 4 mental (figure 4.2(b)) - role emotional, mental health, vitality, social function.

Like pain itself, functional impairment is not a 'risk factor' in itself for low-back pain; rather, it is a measure of how the pain has affected the individual. Clearly, a worker with low-back pain that has impaired his/her function to some level where they can no longer do their job is at greater risk of filing a claim.

Sleep Assessment Questionnaire (SAQ)

The baseline questionnaire included a preliminary version of the Sleep Assessment Questionnaire (SAQ) a 12-item instrument developed by researchers at the Chronobiology Lab at the Toronto Western General Hospital (4.B2 q.E1-12). The SAQ includes 5 questions that comprise a general sleep disorders scale, which ask about the frequency of symptoms related to five specific sleep pathologies (sleep apnoea, nocturnal myoclonus, night terrors, narcolepsy, and fatigue: 4.B2 q.E1-5). The rest of the questions ask about sleep in the past week and comprise two scales, Insomnia (E.7-10), and Non-Restorative Sleep (E.11-12). E.6 is included as a general sleep interference question. In addition to the SAQ, subjects were asked about their sleep schedules and shiftwork (4.B2 q.E13-15).

Comorbidity

Current comorbid conditions were assessed using a rating system developed by Charlson and colleagues (1987). Comorbidity was assessed as the simple algebraic sum of the 17 items in the chart from Section F in Appendix B.2. In addition, items from the Arthritis Impact and Measurement Scale (AIMS2) developed as a screen for arthritis in the Framingham Study were included (Guccione et al., 1990). These questions include the following single binary (yes/no) items:

1. Have you had any other injuries or conditions which have left you with permanent problems or required lost time from work?

2. On most days, do you have pain, aching or stiffness in the joints of your hands or wrists?
3. On most days, do you have pain, aching or stiffness in either of your knees?
4. Have you been told by a doctor that you have arthritis?

Hospital Anxiety and Depression / Beck Depression Inventory

Both depression and anxiety have been shown to be associated with chronic low-back pain in cross sectional studies (Mendelson, 1984; Melzack, 1985; Mendelson 1987; Mendelson 1991), although the exact etiological relationship has not yet been established. Likely, however, anxiety that develops along with unresolved pain may lead to depression in chronic pain states.

The Beck Depression Inventory (Beck, 1961), containing 21 items, was clinically derived from a series of institutionalized subjects and is intended to detect clinical depression. While no specific cut-off point is recommended by the authors of the instrument, results indicate that scores greater than 11 are associated with clinically diagnosed depression (Beck, 1961). In fact, higher cut off scores will yield greater specificity, at the cost of decreased sensitivity (that is, a higher cut off score will ensure fewer false positives, but will result in more false negatives). In contrast to the BDI, the Hospital Anxiety and Depression Scale (HAD) was developed in a non-psychiatric clinical population (Zigmond and Snaith, 1983). Respondents are directed to think about their feelings in the past week and to answer questions such "I feel tense or wound up" [Most of the time, A lot of the time, From time to time, or Not at All].

The original protocol selected the BDI as the instrument of choice. However it was recognized early in the data collection that respondents felt uncomfortable in answering some of the BDI items (i.e., "I have thoughts of killing myself"), and the HAD Depression Scale was used instead. Unfortunately, 4 of 14 questions were inadvertently left out of the final questionnaire. HAD Anxiety and Depression scales are therefore scaled 0-15 instead of 0-21 as intended. It is unclear how this omission affects the psychometric properties of the scales. However, Anxiety is measured on the 0-15 scale, while Depression is measured as a binary variable, which equaled one if the subject scored greater than 11 on the BDI or greater than 7.5 on the HAD Depression.

Dealing with the compensation system is not necessarily a pleasant experience. In fact Hadler (1994) states that "seeking redress....under workers compensation can be a gauntlet of iatrogenicity. The algorithm reeks of contentiousness"[p.164]. Therefore it may be difficult to disentangle anxiety due to low-back pain from anxiety due to dealing with the compensation system. Given that the participants in this analysis, interviewed shortly after reporting their low-back pain and early in the course of the episode, it is unlikely that they will have yet developed depression as a result of this episode, although it may be a comorbid condition in some.

Psychological / Psychosocial

Karasek-Theorell Job Content Instrument

Karasek and Theorell (1990) propose a theoretical stress model, the Demand-Control Model that hinges on the intersection of two concepts: Job Control (or Decision Latitude) and Psychological Demands. The most stressful jobs in this theory are those characterized by low Job Control and high Psychological Demands. The effect of being in these types of jobs on health outcomes is modified by Social Support. Three sources of support are identified in the model - co-worker support, supervisor support, and workplace support. Also included in the model are perceptions of physical demands and job self-worth. Section H of appendix B.2 contains the questions that comprise the various constructs, outlined below. Response choices are 4-point Likert-type frequency options (i.e., Often, Sometimes, Rarely, and Never/Almost never). Scales are simple algebraic sums of responses which are re-scaled to range from 0 to 100.

As psychosocial constructs, demands and control may well be etiological risk factors for low-back pain in the workplace (Hoekstra et al., 1994; Kerr, 1998) with a physiological basis as proposed by Bongers and colleagues (1993). However, their contribution to decisions around reporting or filing a claim for LBP may have a different interpretation. For instance, it seems reasonable that a worker in a job with a higher level of control over the work tasks in the job may be able to work with higher levels of pain than a worker

without control over job tasks.

Components of **JOB CONTROL** Scale:

1. My job requires that I learn new things
2. My job involves a lot of repetitive work.
3. My job requires a high level of skill
4. I get to do a variety of different things in my job.
5. I have an opportunity to develop my own special abilities
6. My job allows me to make a lot of decisions on my own
7. On my job, I have freedom to decide how I do my work
8. I have a lot of say about what happens on my job.
9. I have control over how my workstation is set up.*

* - not in the original questionnaire instrument

Components of the **PSYCHOLOGICAL DEMANDS** Scale:

1. My job requires working very fast.
2. My job requires working very hard
3. I have enough time to get the job done.
4. I am free from conflicting demands that others make.
5. I am asked to do an excessive amount of work.

Components of the **SUPERVISOR SUPPORT** Scale:

1. There are frequent conflicts with my supervisor.
2. My supervisor cares about those under him/her.
3. My supervisor pays attention to what I am saying.
4. My supervisor is helpful in getting the job done.
5. My supervisor is successful in getting people to work together.
6. I get along well with my supervisor.

Components of the **COWORKER SUPPORT** Scale:

1. My fellow workers are understanding when I have a bad day.
2. My fellow coworkers are supportive.
3. My fellow workers take a personal interest in me.
4. My fellow coworkers are helpful in getting the job done.

Components of the **WORKPLACE SUPPORT** Scale:

1. There is a pleasant atmosphere at my workplace.
2. I feel I am harassed at work because of my race or sex.*
3. There are frequent conflicts at my worksite.
4. There is nobody at work I can talk to about job problems.

• - not in the original questionnaire instrument

An overall Social Support Scale is constructed as the arithmetic average of the three sub-scales.

In addition to the standardized scales above, a perceived Physical Exertion Scale was constructed from two questions from the Demand-Control Model. "My job requires lots of physical effort" (4.B2 q.H13) and "My work requires rapid and continuous physical activity" (4.B2 q.H16) were combined to form a scale ranging from 0-6[4].

One other scale, Job Self-Worth, was derived from a combination of two items from the Karasek-Theorell Model and two items that were created at the Institute for Work & Health (4.B2 q.H33,34).

Components of the **JOB SELF-WORTH** Scale are[5]:

1. I am appropriately respected and rewarded by my company for my work.
2. My skills and abilities are vital to my work group or unit.
3. I feel my immediate supervisor considers my job very important.
4. My fellow workers consider my job very important.

Additional Psychosocial

In addition to the Karasek-Theorell Stress Model constructs, several other additional psychosocial constructs were included. Since task enjoyment (4.B2 q.H37) was found to be an important predictor in the Boeing Study (Bigos et al., 1992), it was included along with a general question about job satisfaction (4.B2 q.H42) from the Whitehall Study, a longitudinal occupational cohort of British civil servants. The two questions are summed algebraically to generate a scale ranging from 2-7.

Components of **JOB DISSATISFACTION** Scale[6]:

1. I enjoy the tasks involved in my job.
2. About your job in general - how satisfied are you with your job as a whole, taking everything into consideration?

The Job Dissatisfaction Scale is scaled so that a higher score represents increased dissatisfaction with the

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4. See Appendix 4.C1 for the Spearman correlation of these two items.

5. See Appendix 4.C2 for the internal consistency of these four items.

6. See Appendix 4.C3 for the Spearman correlation between these two items.

job and work. Results presented in table 2.1 suggest that higher job dissatisfaction is a risk factor for low-back pain, and it is equally likely that job dissatisfaction may lead to an increased risk of filing a compensation claim.

An additional scale constructed from the questions in section H is a Job Insecurity Scale, comprised of two questions "My job security is good" (4.B2 q.H18) and "Working at my present job gives me less seniority than my previous job" (4.B2 q.H43)[7]. Further, the question "Compared to other people in jobs like mine, my level of education is [much higher, higher, about the same, lower, much lower]" (4.B2 q.H38) captures the concept of status inconsistency, which describes the situation where workers do not feel that their current occupational position adequately reflects their education. In the recent theoretical stress literature status inconsistency has gained considerable attention as a key component of the Effort-Reward Imbalance Stress Model.

Two additional psychosocial constructs are based on the questions in Section I. Empowerment is a concept that operates above the job task level and informs at the level of the workplace. Similarly, Work Organization concerns the subjects' perceptions about the importance of health and safety concerns in the day-to-day organization of work. The components of these questions are shown below[8].

Components of **EMPOWERMENT** Scale:

1. Do you need permission or do you have to find someone to take your place if you leave your work area for 5 - 10 minutes?
2. How much do workers take part in decision making in the workplace?
3. I feel employees ideas / opinions are listened to by management.
4. I can influence the way work is organized in my work area.

Components of **WORK ORGANIZATION** Scale:

1. Safety is considered equally with production and quality goals in management thinking and plant operations.

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7. See Appendix 4.C4 for the Spearman correlation between these two items

8. The results of exploratory factor analysis with varimax orthogonal rotation confirm these two constructs (see appendix 4.C5).

2. Management is committed to keeping workers employed when injuries or disabilities occur.
3. Management encourages employees to shut down an unsafe machine or stop the work process when an unsafe condition arises.
4. Management encourages employees to promptly report physical symptoms arising from job tasks.
5. Management encourages supervisors to provide light duties or reduced working hours for workers who are recovering from an injury.

Biomechanical Assessments

After the baseline interview was complete, the subject information, including study ID and job title (4.B2 q.H.44) was passed to the UW ergonomics team. The complex protocol for the collection of biomechanical data was spearheaded by Dr.'s Bob Norman and Richard Wells of the Department of Applied Health Sciences. On-site co-ordination was directed by Patrick Neumann. Study participants were directly observed at their workplace for most of a shift, usually around 5 hours. Workers were removed from the line in order to be 'hooked up', which included electrodes for sEMG data (not reported here) and for baseline measurement (in order to calibrate the sEMG recordings). GM accommodated the data collection by providing someone to cover for the study participant.

The physical demands variables used in this analysis were collected via two posture and load sampling methods, an expert observer checklist, and a motion video of tasks (Neumann et al., 1999). The checklist was used to collect trunk posture and hand position and force information, as well as information on job tasks, such as number of times a task was performed per cycle. A motion video taken in the sagittal plane was later digitized to a computerized mannequin under the joystick control of a researcher. A quasi-dynamic 15-segment linked biomechanical model utilized information about the tasks, hand forces, and anthropometric data (i.e., height and weight) to estimate the biomechanical load at the L4-L5 spinal motion unit. Combined, these two methods measure a range of physical exposures that includes: peak (99th percentile) and cumulative (per shift) compression, moment and anterior reaction shear; postural variables such as flexion/extension angle or twist (degrees); and kinematic data such as torque velocity, flexion velocity, and degrees flexed per minute. Information on posture was used to determine variables such as per-

cent time in awkward posture, defined as greater than 20 degrees in flexion, twisted, or lateral bending (Wells et al., 1997; Norman et al., 1998).

Data Management

Questionnaires were pre-coded by the study coordinator using red ink to indicate data to be entered. An electronic version of the questionnaire with predefined variable ranges and logical skip patterns was used to directly input data into a database using ValiData (Mallinson and Mondloch, 1995). This system allows the user to predefine export formats, which creates electronic files with selected data which are easily read into SAS using the INPUT statement (SAS, 1996). SAS was used to construct all scales and conduct all statistical analyses.

SAS was used to create data entry screens for the physical exam data by the author. Physical exam sheets were coded and edited, and double entered by the author and another data entry person using PROC FSEDIT. The two data sets were then compared using the COMPARE function in SAS which produces a record for each discrepancy which were resolved by entering the appropriate data from the original data sheet. Thirty-two fields were required to enter the physical exam data (excluding date and time) for 397 subjects; 194 discrepancies from a total of 12704 fields entered equals a discrepancy rate of 1.6%, or roughly one discrepancy for every two questionnaires entered.

The biomechanical variables used in the analysis were provided by the University of Waterloo, and a more complete description of their data handling methods have been published elsewhere (Norman et al., 1998; Neumann et al., 1999).

Ethics

Ethical approval for the main study protocol was obtained from the Office of Research Services at the University of Toronto. The biomechanical sub-protocol was approved separately by an ethics committee at the University of Waterloo. All identifying information has been kept confidential in locked filing cabinets with names matched to ID numbers on a need to know basis only.

Figure 4.1: Component Questions for Chronic Pain Grade Scales in Integrated Study

Pain Intensity [0-100]

1. How would you rate your back pain on a 0-10 scale **right now**, where 0 is no pain and 10 is pain as bad as it could be? [0-10]
2. In the **past year**, how bad was your **worst** back pain, where 0 is No Pain and 10 is pain as bad as it could be? [0-10]
3. In the **past year**, on average, how intense was your back pain (that is, your usual pain at the times you were experiencing pain)? [0-10]

Disability Scale [0-100]

1. In the **past year**, how much has back pain interfered with your daily activities rated on 0-10 scale, where 0 is no interference and 10 is unable to carry on any activities? [0-10]
2. In the **past year** how much has back pain changed your ability to take part in recreational, social, and family activities where 0 is no change and 10 is extreme change? [0-10]
3. In the **past year**, how much has back pain changed your ability to work (including housework) where 0 is no change and 10 is extreme change? [0-10]

Figure 4.2(a): SF-36 Physical Health Scales

Role Physical *[4 questions]*
During the past week, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

Physical Function *[10 questions]*
The following questions are about activities you might do during a typical day. Does your health limit you in these activities?

Bodily Pain *[2 questions]*
How much bodily pain have you had in the past week?
During the past week, how much did pain interfere with your normal work (including work both outside the home and housework)?

General Health *[5 questions]*
In general would you say your health is:
I seem to get sick a little easier than other people.
I am as healthy as anybody I know.
I expect my health to get worse
My health is excellent.

Figure 4.2(b): SF-36 Mental Health Scales

Role Emotional *[3 questions]*
During the past week, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems?

Social Function *[2 questions]*
During the past week, to what extent have your physical or emotional problems interfered with your normal social activities?
How much of the time in the last week has your health limited your social activities?

Vitality *[4 questions]*
How much of the time in the last week did you feel full of pep?
How much of the time in the last week did you have a lot of energy?
How much of the time in the last week did you feel worn out?
How much of the time in the last week did you feel tired?

Mental Health *[5 questions]*
How much of the time in the last week have you been a very nervous person?
How much of the time in the last week have you felt down in the dumps?
How much of the time in the last week have you felt calm and peaceful?
How much of the time in the last week have you felt downhearted and blue?
How much of the time in the last week have you been a happy person?

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Chapter 5: Analytical Approach and Statistical Methods

In deciding upon the approach to analysis, it is important to remember that the data available were collected as part of a case-control study on risk factors for low-back pain which also had the potential for a nested prognostic component; thus, the cases accrued, the controls selected, the questions they were asked and the measurements taken were designed for this primary purpose. This thesis is asking a secondary question of these data, in particular about 'risk factors' for reporting and filing a compensation claim for low-back pain. Re-using data from a case-control study can be risky as the sampling fractions of cases and controls will determine the overall proportions of covariates; however this thesis utilizes, as the outcome measure, a subset of the original outcome, thus preserving the original case / control status. This section will describe how claimant status was determined, and then set the course for the approach, the rationale behind it and the statistical techniques employed.

Case Subject Stratification

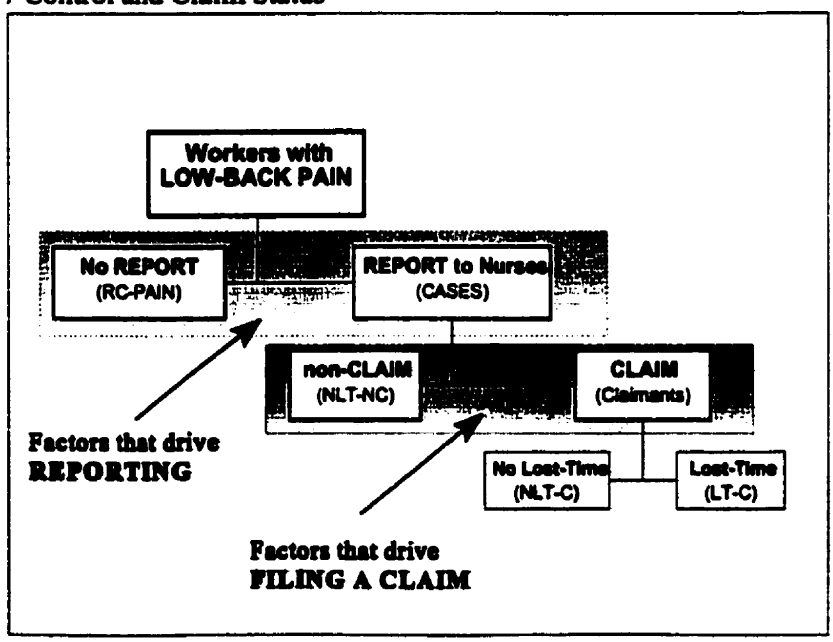
At the conclusion of subject accrual, a list of all claimants on record at GM's Personnel Office filed during the study period was obtained with the agreement of both union and management representatives. A data use agreement between the Institute for Work & Health and the Workplace Safety and Insurance Board (WSIB), allowed study staff to extract information about all claimants from GM Oshawa during the study period. These two sources of information were used to determine if, at the time of the baseline interview, participants accrued from the nursing station had filed a compensation claim, and whether or not lost time had been incurred. These subjects were categorized in one of three study groups: Lost-Time Claim [LT-C], No-Lost Time Claim [NLT-C], and No-Lost-Time No Claim [NLT-NC]. The LT-C and NLT-C were combined to form a claimant group [**CLAIM**], while the NLT-NC participants constitute the non-claimants [**NO CLAIM**] group (see figure 5.1 below).

The procedure for filing a compensation claim at the company required the injured worker to visit the nursing station within 24 hours of the injury in order to complete the necessary forms for WSIB. Legislation in Ontario requires an injured worker to notify his/her employer within 3 months of the injury, and the employer to submit the report to the WSIB within three days (Ontario Ministry of Labour, 1996). In some instances, workers would come to the plant only to file the claim. If a worker was unable to get to the nursing station to file the claim (i.e., if the worker was in hospital - actually rare for LBP nowadays in working populations) then arrangements between GM and the CAW allowed a union Health and Safety representative to submit the forms for the injured worker. Thus, by monitoring the first-aid stations, all potential subjects, including those filing claims or simply requesting analgesics, were captured.

Selection of Appropriate Controls

Lasky and Stolley (1994) provide an excellent summary of some of the issues involved in control selection, and describe four guiding principles, first proposed by Wacholder (Laskey and Stolley, 1994, p.9).

Figure 5.1: Participant Stratification into Study Groups based on Case / Control and Claim Status



These include the notion of a 'study base', from which both cases and controls are drawn. That is, controls should be eligible to be cases; for instance, a study of ovarian cancer would be restricted to females because men are obviously not at risk of developing ovarian cancer (thus they could be neither cases nor controls). Obviously, selection of the controls will affect the results and the inferences made from the analysis. It is likely that the selection of appropriate controls depends on the specific research question and the hypothesis being tested (Laskey and Stolley, 1994).

This thesis is concerned mainly with factors associated with reporting or filing a compensation claim for low-back pain (the outcomes in Figure 3.2). Thus, it is reasonable to assume that workers without low-back pain are not 'at risk' of either reporting or filing a claim for LBP (especially since a doctor's examination is required for claim submission so that actual fraud is rare[1]). Therefore the main analysis is restricted to those participants in the study who had low-back pain. Pain-free random controls were eliminated from any investigation of reporting or claims filing. The following two comparisons are proposed for the analysis:

1) **What factors are associated with the decision to REPORT LBP to the workplace?**
   REPORT vs NO REPORT : contrasting those population controls who have LBP but have not reported it to the first-aid stations (RC-Pain group) versus those who did (both claimants and non-claimants);

2) **What factors are associated with FILING A CLAIM for LBP, given that it has been reported?**
   CLAIM vs NO CLAIM : of the participants accrued who reported LBP to the workplace, those that filed a claim versus those who did not.

Analysis of the feedback loops outlined in Figure 3.2 is best performed using a longitudinal approach. This thesis is unable to address the feedback loops operating between job-related factors and clinical severity since the data are cross-sectional. It is also impossible to determine the correct temporal

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1. Claimant fraud constitutes 78% of investigated fraud cases, yet is found to be negligible. For example, in Wisconsin, an intense investigation of 95 claims (out of 200,000 total) in 1994 resulted in five deemed worthy of prosecution; three were thrown out by the DA, one conviction was obtained, and one pending. The total alleged fraud amount for the two cases was US$10,146 (Michaels, 1998 p.440).

sequence of events. An examination of the potential effect of claims history on work-related factors is possible, which will be described in more detail below.

Hierarchical-type "Cluster" Approach to Analysis

The approach to multivariable analysis adopted in this thesis is an 'hierarchical[2]' type that involves the sequential modeling of "clusters", an approach not without precedent (Kenney, 1994; Victora et al., 1997). This method is more sophisticated than a "throwing everything into the model and see what turns up significant" modeling technique (Victora et al., 1997).

An example of the hierarchical approach is found in a study of childhood mortality from diarrhoea in developing countries (Victora et al., 1997). Possible etiological factors include family income, sanitation, and nutrition. The hierarchical relationship among these variables is assessed through a series of models that include: 1) *income*: overall effect of income, not adjusted for mediating variables; 2) *income plus sanitation*; effect of both income and sanitation adjusted for each other; and 3) *income plus sanitation plus malnutrition*; effect of all three variables fully adjusted for each other. Since all models are nested, it is possible to determine the direct effect of Income, its effect mediated through Sanitation, and its effect mediated through Malnutrition. Sanitation has a direct effect and an effect mediated through Malnutrition, which has only a direct effect. Mortality is said to have both 'proximal' (i.e., malnutrition) and 'distal' (i.e., family income) determinants.

An Hierarchical Approach to Modeling Compensation Claims

An hierarchical modeling strategy of the risk factors for reporting or filing a compensation claim for LBP, based on the conceptual framework discussed above is depicted in Figure 5.2. In the proposed

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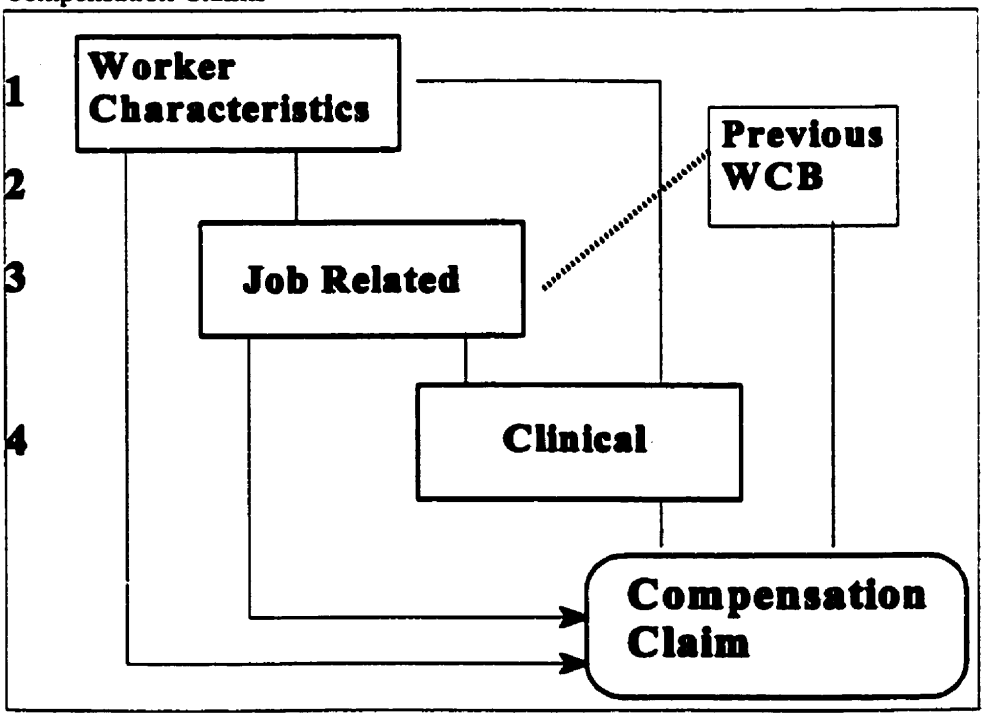
2. The term as used here is not related to its use in "hierarchical regression", which refers to a statistical method (multi-level modeling), the aim of which is to determine the effects of structural (2nd level) variables on the lower level, while accounting for interdependence among individuals in the same unit (Bravo et al., 1999).

approach, the first 'cluster' of variables to be modeled are the Worker Characteristics (set 1 in figure 5.2), including factors such as age, gender, main wage earner status, number of preschool children, mastery, and comorbidity. These variables describe the fixed characteristics of the participant as they are at the start of the episode (or entry into the study) in terms of an individual risk set, and their measurement is unlikely to be affected by the back pain episode or the claims process. Because previous WCB claim history has a unique place in the theoretical framework, it is included on its own (set 2 in figure 5.2).

The third 'cluster' of variables to be entered into the model are the work-related biomechanical and psychosocial factors (set 3 in figure 5.2). These include the measurements of spinal loading (i.e., peak compression) and spinal kinematics (i.e., flexion velocity), task-related measures (such as peak hand load), the Demand-Control constructs (such as job control and psychological demands), and the other psychosocial variables (i.e., worker sense of empowerment). In etiological models for low-back pain, biomechanical and psychosocial occupational factors have been treated separately in order to determine their relative importance

Figure 5.2.: Hierarchical Framework of Proximate and Distal Risk Factors for Compensation Claims



as etiological agents (i.e., Burton et al., 1995; Gatchel et al., 1995; Burton, 1997; Kerr, 1998). However in the conceptual framework adopted in this thesis, these two sets are combined, to represent the work-related factors that produce the physiological mechanisms leading to low-back pain. In truth, it is difficult to separate out the risk associated with a cumulative biomechanical load on tissues from a repetitive task and the psychosocial effect that load may have in terms of its being perceived as a monotonous job. In the conceptual model, these factors precede the onset of LBP and subsequent reporting or filing of a claim (although in this study, their measurement occurred after).

The last 'cluster' of variables to be modeled are the clinical factors (set 4 in figure 5.2). These include the measured physical exam (i.e., straight-leg raise), self-reported pain and symptoms (i.e., pain intensity, radiating pain), and the self-reported functional status measures (pain intensity, Roland Disability Score). In the conceptual model, these characteristics arise from or are changed by the LBP episode, and may influence whether the LBP episode is either reported or a compensation claim filed.

Figure 5.3(a): Approach to Analysis: STAGE I

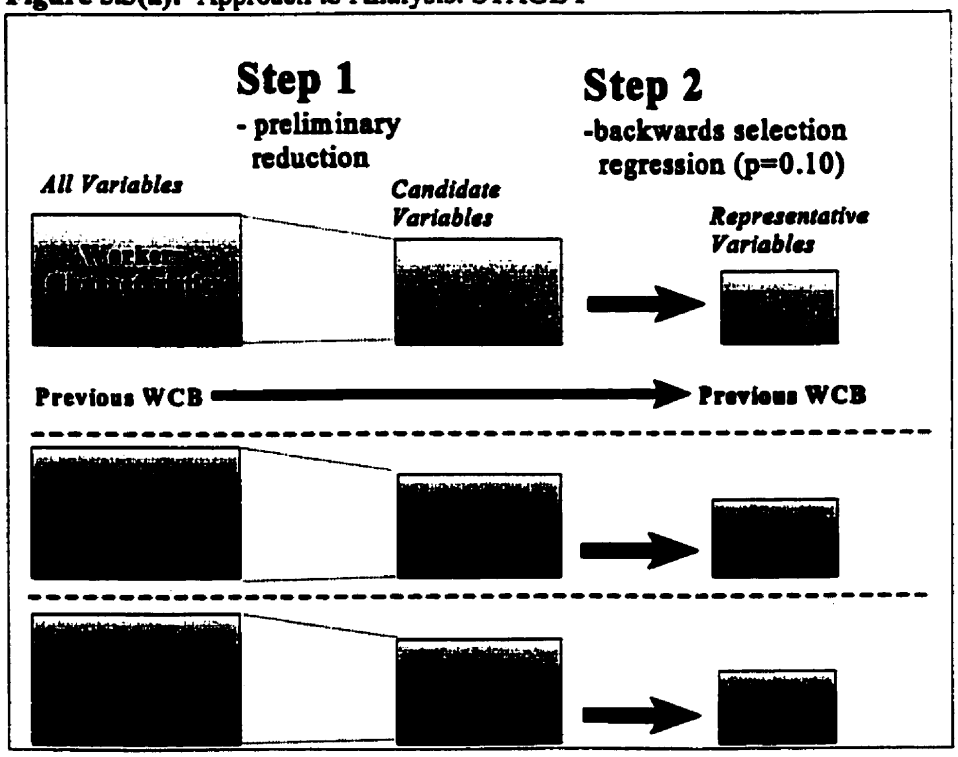


Figure 5.3(a) is a diagrammatic representation of the analytic approach, which is divided into two stages. Stage 1 has two steps and is the preliminary within-cluster reduction, performed separately on each cluster of variables. The second stage (Stage 2) of the analysis is the sequential addition of the clusters into a logistic regression model. While Stage 1 - Step 1 is done only once, the rest of the process is done twice: first for the REPORT vs No REPORT comparison and again for the CLAIM vs non-CLAIM comparison. The same preliminary (Candidate) set of variables in each cluster from the first step of Phase 1 are used in subsequent analysis (that is, both comparisons start with the same set of potential candidate predictors, but different variables may be left as Representative Variables for each model comparison).

Stage 1 - Step 1: Within-Cluster Reduction of Variables

A plethora of variables was available within each cluster. However, simply throwing all possible 'job-related' variables into a model to see which ones remained statistically significant in the end would likely violate both statistical and theoretical assumptions about the inter-relationships among the variables (Stallones, 1987; Feinstein 1977; Feinstein 1998). Thus the preliminary reduction of the variables to a manageable subset was based on professional and expert judgements (i.e., risk factors reported in the literature), as well as statistical concerns (i.e., high collinearity).

Stage 1 - Step 2: Mutivariable Within-Cluster Reduction

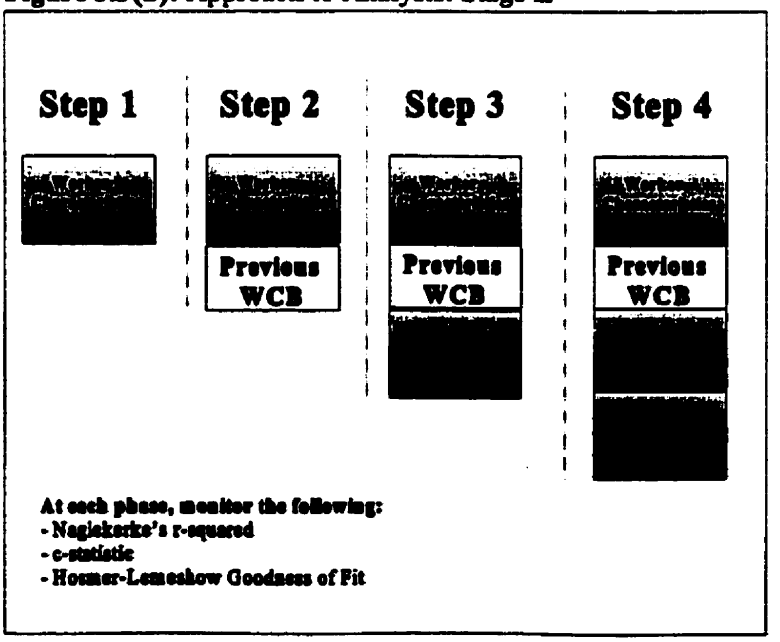
For each cluster a backwards selection procedure with logistic regression was used. Variables were removed one-by-one starting with the least significant variable, and continuing until no more variables were left with a $p > 0.10$. These remaining variables were then used to represent the cluster. This process was done separately for each comparative model (Report vs No Report and Claim vs non-Claim).

Stage 2 - Steps I - IV

Stage 2 (figure 5.3(b)) has four distinct steps: Step I: Modeling Worker Characteristics; Step II: Modeling Worker Characteristics and Previous WCB; Step III: Modeling Worker Characteristics, Previous WCB, plus Work-Related Variables; and Step IV: Modeling Worker Characteristics, Previous WCB, Work-Related Variables, plus Clinical Factors. In the first phase, the explanatory power of the Worker Characteristics Cluster on its own is examined. Subsequent phases involve adding previous WCB and the representative variables from the Work-Related and Clinical clusters in sequence.

With each subsequent addition of clusters of variables to the model, only variables significant at $p \leq 0.10$ were kept in the model, with the exception of previous WCB claim, which remained in the model regardless of it's significance. With the removal of non-significant variables, the estimated coefficients and their standard errors for variables remaining in the model were examined for changes greater than 10% in magnitude. Changes in the beta estimate or standard error of one variable with the removal of another suggests that they may be correlated, or confounded (Greenland, 1989). If large changes were noted during variable selection, model diagnostics were inspected for goodness of fit indicators and a decision was made about including the variable in the model.

Figure 5.3(b): Approach to Analysis: Stage II



The adequacy and fit of the model were assessed by recording Naglekerke's R-squared (R_N^2:1991), Hosmer-Lemeshow Goodness of Fit Index (GFI_{HW}: Hosmer and Lemeshow, 1989), and concordance (c-statistic: SAS, 1995; Harrell et al., 1996). These diagnostics were chosen because they assess model fit based on the likelihood (R_N^2), predictability of the outcome (c-statistic) and the covariate pattern (GFI_{HW}). Any final model selected had to have no evidence of lack of fit as assessed by the GFI_{HW}. Any indications of lack of fit for the data to the model was investigated with particular investigation of sparse covariate patterns and overfitting. These statistics are described in more detail below.

Previous Compensation Claim for LBP

The effect of previous claim on work-related factors will be examined separately for the NO REPORT and REPORT groups. Since previous claim is a self-reported yes / no question, potential differences across continuous work-related measures will be assessed using the t-test. Potential differences among proportions of categorical variables will be assessed using the chi-square test.

STATISTICAL METHODS

Descriptive Statistics

The descriptive statistics serve two purposes; one is to describe the three study groups with respect to the variables measured in the study, while the second is to identify possible departures from non-normality and outliers that may act as points of influence in subsequent analysis. The first comparison is that of the NO-REPORT vs REPORT groups, while the second is that of the CLAIM vs non-CLAIM. Continuous measures will be compared using a t-test, while differences among proportions in categorical variables will be assessed using the chi-square test.

Logistic Regression

Multivariable associations with filing a claim will be assessed using logistic regression. Logistic

regression has become a standard epidemiological tool for analysis of a binary outcome since its introduction in the early 1960's (Schlesselman, 1982). The logistic model is based on modeling the probability of a binary outcome. Consider a binary variable y which equals 1 if the subject is a case and 0 otherwise. If there are n cases out of N subjects then the probability p of being a case is

$$p = n/N$$

and the probability q of being a non-case is

$$q = (N-n)/N = 1 - p.$$

If **X** is a matrix of x covariates related to being a case then **X** is related to p through the *logit of p*

$$\log\left(\frac{p}{1-p}\right) = \alpha + \beta X$$

and the predicted probability for the i^{th} subject (p_i) is

$$(p_i) = \frac{1}{[1 + \exp(-\alpha - \beta X)]} = \frac{\exp(\alpha + \beta X)}{[1 + \exp(\alpha + \beta X)]}$$

where α is the intercept parameter and β is a vector of slope estimates relating **X** to p. Simple exponentiation of the estimated β's results in the odds ratio, the ratio of conditional probabilities of exposure for being a case. Interpreted within the multivariable model, the odds ratio for a given variable is the likelihood of exposure given that the subject is a case, holding all other variables in the model constant.

A Note on the Odds Ratio

The interpretation of the OR is the conditional probability of being exposed given that the subject is a case so that 'cases are more likely to be exposed to X' would be the corresponding statement of probability. The OR is perfectly symmetrical and under assumptions of rare disease prevalence, approximates the RR. Thus the probability statement 'workers exposed to X are more likely to be cases'

reflects the algebraic equivalence between the OR and RR and, perhaps more importantly, the etiologic hypothesis being tested. That said, the problem of temporal sequencing inherent in case-control studies must always be a caveat in assessing *risk* per se, and it is more prudent to talk about odds, which is what is being measured (*cf.*, Kahn and Sempos 1989 pp. 45-56).

In this study, we can only approximate odds in the analysis of the REPORT versus NO REPORT groups. However, among the reporters, we may be able to estimate the *risk* of filing a claim since we have the pre-requisite denominator (that is, number of claimants divided by all those who report, assuming our sample is representative of the study population).

Regression Model Diagnostics and Goodness-of-Fit

Naglekerke's R^2

Naglekerke (1991) has proposed a companion to the squared multiple correlation coefficient used to describe "explained variance" in linear regression for models using maximum likelihood approximation, including the logistic model. If L(0) is the maximum likelihood based on the null model and L(β) is the likelihood of the estimated model, then

$$R^2 = 1 - \{L(0)/L(\beta)\}^{1/n}.$$

Naglekereke points out that the since the maximum likelihood in a logistic model is a product of probabilities, it has an absolute maximum that is less than one, which is inconsistent with the "explained variance" notion. If

$$\max(R^2) = 1 - L(0)^{2/n}$$

the following relationship 'scales' the value so that its interpretation is equivalent to the squared multiple correlation coefficient from general linear regression:

$$R^2_N = R^2/\max(R^2).$$

The subscript 'N' is used to denote Naglekerke's r-squared. PROC LOGISTIC provides an option that

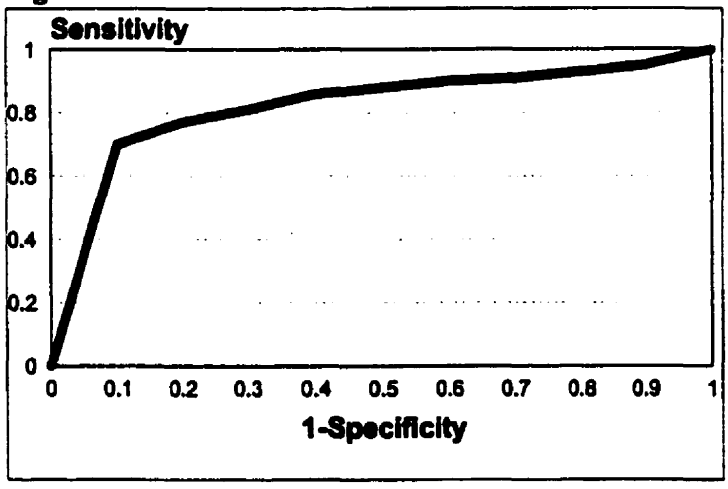
outputs Naglekerke's statistic, so it is quite convenient to use (SAS, 1995).

Mittlbock and Schemper (1996) provide an excellent review of eight proposed measures of explained variation for logistic regression, including R^2_N, which performed adequately in a simulated study compared to the other measures. The criticism of R^2_N (indeed for all likelihood based measures of explained 'variance') is that it does not provide adequate information about (p_i). However, the measure proposed below is used for exactly that purpose.

Concordance Statistic

The results of a logistic regression allow the predicted probability of Y=(1|X) (i.e., being a 'case' conditional on the given risk set) to be calculated for each subject ((p_i) from above). For example, it might be decided that subjects with (p_i) ≥ 0.5 will be predicted as cases, and those where (p_i) < 0.5 as non-cases. Four outcomes are possible with any given level of (p_i): true positives, false positives, true negatives, and false negatives. The ROC curve is a plot of the sensitivity (vertical axis) against 1-specificity (horizontal axis) for varying cut-off levels (p_i<hat>). A model that discriminates well 'crowds the corner' (see Figure 5.5). The c-statistic is the area under the curve, thus the higher the value the better the predictive ability of the model.

Figure 5.5: ROC Curve: c-statistic=area under curve



Hosmer-Lemeshow Goodness of Fit Index (GFI_{HW})

Hosmer and Lemeshow (1989) propose a goodness-of-fit statistic (GFI_{HW}) that is based on dividing the predicted probability (p_i<hat>) into deciles. Based on a 2 x *g* contingency table where *g* is the number of groups, and the rows correspond to 'cases' (y=1) and controls (y=0), the squared difference between the

observed and expected number of cases and controls is calculated and compared to the chi-square distribution with (g-2) degrees of freedom (typically g is chosen to be 10). The formula for calculating GFI_{HW} is given below:

$$GFI_{HW} = \sum_{i=1}^{g} \frac{(O_i - N_i\pi_{i\bullet})}{N_i\pi_{i\bullet}(1-\pi_{i\bullet})}$$

where

N_i is the number of observations in the i^{th} decile group
O_i is the number of 'cases' (Y=1) in the i^{th} decile group
$\pi_{i\bullet}$ is the average estimated predicted probability in the i^{th} group

The GFI_{HW} has gained wide acceptability as a measure of fit and is included as an output option from PROC LOGISTIC (SAS, 1995). Hosmer and colleagues (1997) provide an excellent summary and comparison of competing goodness-of-fit tests using simulated data. Their results suggest that GFI_{HW} performs quite adequately (power of 90%) on large data sets (N > 500) but less so on smaller data sets (power ~ 50%). These numbers compare with other goodness-of-fit measures, although none are adequately able to detect departures from the form of the logistic function or situations where quadratic functions more properly fit the data.

Final Note on the Methods

The specific analytical approach outlined above is grounded in the conceptual framework, and this chapter provides the theoretical and conceptual justification for both the hierarchical approach and the order in which the clusters were added to the model. While it must be acknowledged that a different approach or statistical method may result in a different model, the author is confident that the one selected is best suited to answer the research objectives.

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PART III: RESULTS

Chapter 6: RESULTS OF ACCRUAL

Study Participants

Workers Reporting Low-Back Pain to the Workplace

Accrual of study participants began in February 1994. However, due to extensive line redesign in the Car Plant, during which virtually all regular workers involved in assembly were temporarily laid off, accrual was restricted to subjects in the Truck Plant until November 1994. Although forms for recording names and numbers of participants were provided to the nurses, the study coordinator would telephone each first aid centre (3 in the Car Plant, one in the Truck Plant) almost daily. This provided the study team with names of potential participants in the most timely fashion, since it was critical to the study design to conduct the baseline interviews as soon as possible after the report to the first-aid stations. Incident cases were accrued until the end of December 1995. Thus there were a total of 22 months of observation in the Truck Plant and 13 months of observation in the Car Plant.

The results of accrual are shown in table 6.1. A total of 324 reports of LBP were recorded by the nurses and reported to the study staff , 190 in the Truck Plant and 134 from the Car Plant. Of these, 268 (83%) workers agreed to be contacted; from this group, 26 subsequently refused, 66 were deemed ineligible (78% due to having previously reported LBP to the nursing station), and 17 were lost-to-follow-up, leaving 159 cases for whom baseline interviews were scheduled. Another 11 refused at this point, and 11 were not eligible for the case-control study (8 'volunteered', and 3 were eligible only for the cohort portion of the study). This left 137 participants enrolled in the study with baseline questionnaire data who constitute the REPORT group. Baseline interviews were conducted on average 12.5 days after the report to the nurses.

Of the 137, there were 57 lost-time claims (LT-C) and 19 no lost-time claims (NLT-C). These two groups were combined to form the CLAIM group [N = 76]. The remaining 61 subjects who reported LBP

to the workplace but did not file a compensation claim for their low-back pain, form the NO CLAIM (NLT-NC) group.

Table 6.1: Case Accrual Results by Plant

Numbers:	Truck Plant	Car Plant	Totals
Reported to Nurses	**190**	**134**	**324**
Refuse contact	48	8	56
Agree to be Contacted	**142**	**126**	**268**
Lost to follow up	11	6	17
Refusal-eligibility not determined	12	14	26
Ineligible	36	30	66
TOTAL	**83**	**76**	**159**
Subsequent Refusals / Exclusions	16	6	22
Participating Subjects	**67**	**70**	**137**
Nurse Response Rate (Agreed / Reported)	75%	94%	83%
Study Contact Rate (Agreed-LTF / Agreed)	92%	95%	94%
Case Attainment Rate (Participating / Eligible)	81%	92%	86%

It was suggested that labour relations in the Truck Plant created a more 'combatative' place to work as compared to the Car Plant. This may be the reason for the observed difference in up-front refusals recorded at the first-aid stations by the nurses (25% in Truck vs 6% in Car - see table 6.1). However it may also simply be a bias in the rigour with which refusals were recorded by the nurses between the two plants. Nonetheless, there also remains a slightly lower (81% vs 92%) case attainment rate in the Truck Plant.

Random Controls

The results of the accrual of Random and Job-Matched Controls are shown in table 6.2. Of 565 randomly selected population controls (343 in Truck, 222 in the Car Plant), 78 were lost-to-follow up, 253 refused to participate, and 27 were ineligible, leaving 207 participants who initially agreed to take part (a

response rate of 45%, adjusted for lost-to-follow up and ineligibles). Of the 207, 28 subsequently refused after the baseline interview was scheduled, leaving 179 with baseline questionnaire data available for analysis (an 86% completion rate). Of these, 57 (32%) responded positively to the initial screen of having low-back pain in the past week (appendix 4.B2 q.B1). These 57 represent the NO REPORT Group.

Table 6.2: Control Accrual Results by Plant

Number	RANDOM			JOB-MATCHED		
	Truck	Car	Total	Truck	Car	Total
Contacted	343	222	565	79	56	135
Lost to Follow Up	54	24	78	3	1	4
Not Participating (Refusal)	162	91	253	20	10	30
Ineligible	15	12	27	10	9	19
Agreed to Participate	**112**	**95**	**207**	**46**	**36**	**82**
Subsequent Refusals	19	9	28	9	5	14
Baseline Interview complete	**93**	**86**	**179**	**37**	**31**	**68**
RESPONSE RATE (Agreed/contacted eligibles)	41%	51%	45%	70%	78%	73%
BASELINE COMPLETION RATE (completed baseline/agreeables)	83%	91%	86%	80%	86%	83%

Job-Matched Controls

A total of 135 potential job-matched controls (79 from Truck and 56 from Car) provided their names to the ergonomics team as potential job-matched controls (see table 6.2). Of these, 4 were lost-to-follow up, 19 were ineligible, and 30 refused to participate after the study had been explained to them. Subsequent refusals by 14 subjects left 68 job-matched controls who had baseline interviews, an 83% baseline completion rate. Note that the participation rate is slightly misleading, since there were 69 potential job-match controls (41 from Truck and 28 in Car) who were approached on the shopfloor by the ergonomics team, but were not interested in taking part.

The reasons for the failure to obtain job-matched controls for the remaining 69 (137-68) cases

included 7 whose pre-injury job had changed and thus no job with a similar set of job tasks remained, and 35 instances where the set of potential job-matches was exhausted (that is, all potential controls refused to take part). Accrual of job-matched controls was a time and resource intensive process, and as the case accrual wound down, it was decided that the energy of the ergonomics team would be best spent obtaining job-matched controls for cases where it was known that they would not be returning to their pre-injury job. Information regarding accrual of the Job-Matched Controls is included in this thesis since their biomechanical data will be substituted for case data where case data are missing.

Biomechanical Assessments [1]

Biomechanical assessments were scheduled for subjects once they had completed the baseline interview. Cases and randomly selected controls who refused the biomechanical assessment were still entered into the study under the rationale that their questionnaire data could still be used in a sub-analysis of the psychosocial data. Once the ergonomics team had the subject's personal and job information, two follow-up phone calls were made over the next 3-4 weeks to inquire about the ergonomic questionnaire (which had been left with them to complete after the baseline interview). The ergonomic questionnaire was intended to collect a detailed description of the subject's job, which was useful in planning the collection of the biomechanical data. Scheduling of assessments required the coordination of the worker and the supervisor, since roughly a half an hour was required to hook up the surface electromyeography (sEMG) equipment and obtain normalization recordings, during which time utility replacement workers would have to fill in on the job for the subject under observation. Attempts were made to get to the subjects for physical demands analysis as soon as possible after the baseline interview. Data available for the Random Controls (from both plants) shows that on average the assessment took place 37 ± 27 (range: 7 to 148) calendar days

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1. Although the term "assessment" is used interchangeably with "physical demands analysis", the term assessment implies that the job is being tested for something in particular. No specific ergonomic changes to jobs were actually recommended, although a Physical Loading Report (PLR) was released for each job assessed.

after the baseline interview.

The accrual results for the biomechanical assessments are shown in table 6.3. These figures show that biomechanical data is not available for 27 of 137 cases (18%) because either the worker changed jobs (n=19), or the actual job was redesigned before data collection could be scheduled (n=6), or the worker did not return to work (n=2). In fact the flux in the assembly operations was not anticipated, and a very minor change in assembly procedures or sequence, warranted for many logistical production reasons, could result in marked changes in a set of job tasks. A total of 26 subjects refused to participate in the physical demands analysis, leaving 84 case subjects who had a biomechanical assessment.

Table 6.3: Results of Biomechanical Assessments

	Cases		**Random Controls**		**Job-Match Controls**	
	Truck	**Car**	**Truck**	**Car**	**Truck**	**Car**
Subjects	**67**	**70**	**93**	**86**	**37**	**31**
Ineligible:						
Job Changed	5	1	0	1	0	0
Subject Changed Jobs	9	10	1	1	0	0
No RTW	1	1	4	2	0	0
Refused	12	14	20	11	5	2
Complete Assessments	**40**	**44**	**68**	**66**	**32**	**29**
Completion Rate (complete/(subjects-ineligibles))	73%	79%	77%	80%	86%	94%

Biomechanical data is available on 134 of 179 (75%) Random Controls. Of the 57 No-REPORT group however, there are only 37 (65%) with data. With respect to the Job-Matched Controls, 61 of 68 (90%) have biomechanical data. More importantly, 35 of these are matched with case data and can be used to compare the reliability of the proxy data, while another 21 data sets were used as proxies. Thus altogether 105 (84 + 21) case subjects have useable biomechanical data available for analysis.

The Data Set

The defining unique feature of this data set is the combined psychosocial and biomechanical data collected on each individual. However, the biomechanical data are also the limiting feature of these data as well. Table 6.4 shows the breakdown of the numbers of questionnaire and physical demands analysis data for each of the study groups. Among those who reported low-back pain, 105 of 137 (77%) have biomechanical data available, while 37 of 57 (65%) of the No-Report group have data. Among those that REPORT their LBP, 62 of 76 claimants (82%) and 43 of 57 (75%) of the non-claimants have data. Almost all of the proxy data (16 of 21) are substituted for the claimants. This is likely a result of the lost-time claimants either not returning to work or returning to a different job. The physical demands assessment team was not informed of the claimant / non-claimant status of the subjects at the baseline interview, although clearly they must be aware of the work status (i.e., off work or not) of subjects at the time they are scheduled for assessment.

Missing data is an important topic of concern in epidemiology and imputation procedures have been developed that include simple mean substitution to complex regression analyses and bootstrapping techniques (Miettenen, 1985; Rubin, 1987; Efron 1994; Rubin, 1996). Recently software has become available that automatically uses multiple imputation techniques, by drawing repeated random samples from derived probability distributions based on "propensity of missing" values (SOLAS). However single or multiple imputation techniques have as their prerequisite, assumption that there exist variables which can predict "missing" and develop propensity scores for being missing.

It is possible to use imputation techniques to "fill in" the biomechanical data where it is missing. For example, plant, shift, job title (i.e., assembler, maintenance) and body-mass index could be used to create regression equations, and missing data calculated using the estimated coefficients. However a fundamental issue in the imputation of biomechanical data for cases (and controls) has been raised by Dr.'s Norman and Wells (personal communication, 1999; Kerr, 1998 Appendix 5.3(a)). Their criticism is based on the lack of

Table 6.4: Psychosocial and Biomechanical Data by Study Group

	Psychosocial (Questionnaire)	Biomechanical Assessment	Proxy Data
Random Control (No Pain)	122	93	--
Random Control (Pain)	57	37	--
No-Lost Time / No Claim	61	43	5
Claimants	76	62	16

findings for biomechanical measures in the Boeing Study (Bigos et al., 1992), where physical demands were approximated (or imputed) based on job title (i.e., welder). Norman and Wells quote two sources as the basis of that criticism: i) there is a lack of reliable correlation between back injuries and specific job codes (Bigos et al., 1986) and ii) people nominally doing the same job have different risks of injury because the way they perform job tasks may result in different tissue forces (Hagberg 1992). The Integrated Study sought to match workers not based on nominal job title alone, but on the set of tasks performed in the job. Therefore the analysis for the main research question of this thesis is restricted to those subjects with biomechanical data, which will have implications on the power of the study and the analytical approach.

Bibliography - Chapter 6

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Chapter 7: Descriptive Results and Within Cluster Reduction

This chapter provides the descriptive bivariable results for the REPORT vs NO REPORT and CLAIM vs NO CLAIM comparisons for each of the variables within clusters. In addition, this chapter provides the rationale for the selection of the Candidate Variables Sets for each cluster- those that are pre-selected as potential variables to represent the cluster in the hierarchical modeling stage (Stage 1 - Step 1 of the analysis in Figure 5.4(a)). Thus, this chapter provides both two-way comparisons of univariate variables, and produces the set of variables that are used in backwards selection logistic regression (presented in Chapter 8).

Power, Model Building and Overfitting

The power of a logistic regression refers to the ability of the model to detect odds ratios 'significantly' different from the null (i.e., $H_0 : \beta = 0$). The ability to detect odds ratios closer to one as significant (closer to the null hypothesis) is greater for larger datasets. "Rules-of- thumb" that guide binary logistic regression generally limit the number of potential predictor variables to $m/10$ or $m/20$ where m is the smaller of the two groups (usually the 'case' or outcome category) in order to maintain adequate power (Harrell et. al., 1996; Peduzzi et al., 1996). A logistic model with 'too many' variables results in sparse covariate patterns, potentially producing statistically unstable parameter estimates. Such models are said to be 'overfit', and resulting associations have a greater chance of being spurious, based on subtleties of the particular sample drawn (Greenland, 1989; Concato et al., 1993; Harrell et al., 1996).

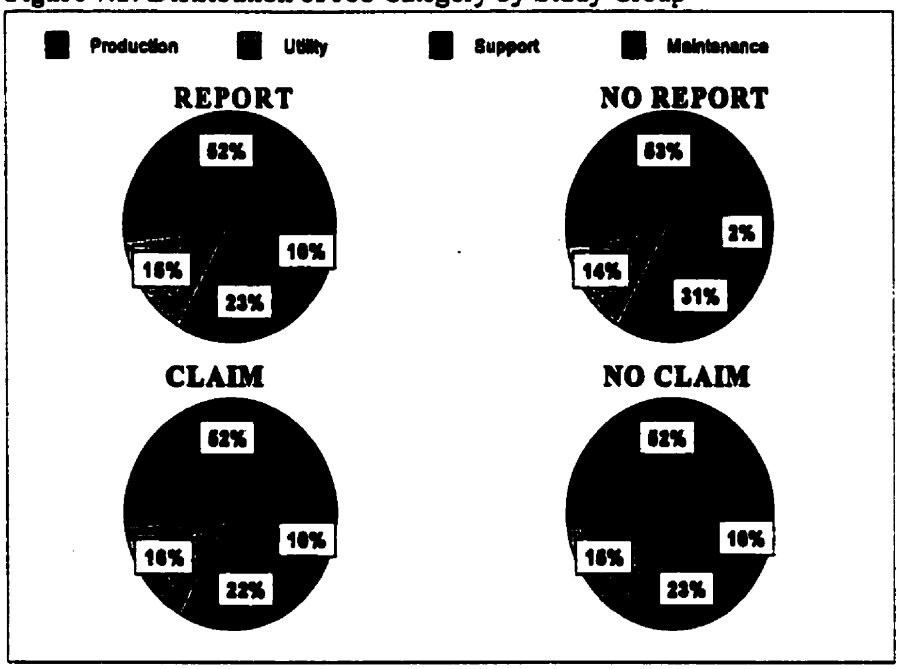
Clearly, these analyses are limited by the small sample sizes. In the first comparison, there are only 37 non-reporters with the full set of data. Therefore, any model with more than ~4 degrees of freedom is susceptible to problems of overfitting. In the second set of analyses, the NO CLAIM group (n=43) is the limiting factor, again suggesting that 4-5 covariates is the maximum number of variables reasonably expected to be fit to these data. It is anticipated that not all variables in the candidate sets will be maintained in the

final set representing the cluster, and the modelling strategy allows for model reduction following the addition of sequential hierarchical clusters. The size of the Candidate Variables set will be restricted to a maximum of ~10-12 variables each.

Job Titles and Plant

The distribution of job titles shown in Figure 7.1 indicates little difference across study groups. Slightly more than half of the participants in each group are assemblers. Support workers (material handlers) constitute 22 to 31% of the groups, utility workers make up roughly 15%, and maintenance the rest. The maintenance group was slightly under-represented in the NO REPORT group (~10% vs 2%).

Figure 7.1: Distribution of Job Category by Study Group



Low-back pain cases were accrued from the Truck Plant for longer than in the Car Plant (22 months versus 14 months respectively). Since the populations in the plants differ (N=~3000 in Truck and N=~7000 in Car), the person-months of accrual per plant are for Truck , 22*3000 = 66,000, and for Car 14*7000 = 98,000. Based on these calculations, and considering the two plants equal, one would expect roughly 33% more participants from the Car plant. In fact, of 324 low-back pain reports provided to the study team by the nursing staff, 190 (59%) were from the Truck Plant, and 134 (41%) from the Car Plant (see Table 6.1). These estimates represent annual incidence rates for *reporting low-back pain*[1] of ~34.5/1000

1. Disregarding any eligibility criteria this, or any other study might apply to these individuals.

workers per year in the Truck Plant and ~16.4 per 1000 workers per year in the Car Plant (or 23.7 per 1000 per year overall). These estimates are very crude and likely underestimates, as the number of refusals presenting to the nurses stations are probably under-reported in both plants, perhaps more so in the Car Plant.

Due to lower participation and case attainment rates in the Truck Plant, the result is an almost equal number of workers reporting low-back pain to the workplace (REPORT) represented by each plant (67 and 70 in Truck and Car plants respectively) in the final sample. Among the REPORT group, the Truck Plant was over-represented among the claimants (50 of 76, or 66%). As noted earlier, there were anecdotal reports of a more acrimonious labour-relations environment in the Truck Plant; it is unclear whether the psychosocial environment played a part in the observed distribution of claimants by assembly plant, or whether truck assembly is inherently more dangerous.

If the assumption of a non-differential case ascertainment rate for claimants and non-claimants is made for both plants, then the incidence rate of claims filing based on these numbers can be calculated. For Truck, we assume that (50/67) 74% of the reports lead to claims, an incidence rate for claims of (.74 x 34.5) 25.5 per 1000 workers per year and, for Car, (.37 x 16.4) or 6.1 claims per 1000 workers per year.

Considering the REPORT group exclusively (n=105), inspection of peak and integrated compression, moment and reaction shear fail to show any significant differences in measured biomechanical loads between plants although in each instance the mean was higher in the Truck Plant. Comparison of psychosocial measures across plants indicates that participants from the Truck Plant report slightly lower empowerment (10.3 vs 11.1, $p=0.04$) but higher supervisor support (71 vs 58, $p<0.001$). In addition, reporters in the Truck Plant felt that management was less supportive in areas of Health and Safety (10.2 vs 8.6, $p<0.001$). The distribution of job titles among cases by plant did not differ.

WORKER CHARACTERISTICS CLUSTER

REPORT vs NO REPORT

Slightly more non-reporters were married compared to those who reported LBP to the workplace (88 vs 76%, p=0.08). This is an unexpected direction, as marriage is theorized to convey a health benefit in general. Otherwise, the groups did not differ by traditional socio-demographic characteristics including age, main wage earner, smoking status, or alcohol consumption. More of the NO REPORT group report having been diagnosed with arthritis (30 vs 18%, p=0.06).

CLAIM vs NO CLAIM

The NO CLAIM group reported a marginally higher SAQ Sleep Disorders score (5.8 vs 5.0, p=0.09), which indicates that they had more sleep related conditions (as a group) such as fatigue, sleep apnea, or nocturnal myoclonus. A higher proportion of the NO CLAIM group had pre-school aged children (0-5 years) than the claimants (30 vs 14%, p=0.03). The non-claimants also reported more work-related conditions (67 vs 42%, p>0.01).

Candidate Variables Set

Eleven variables were selected for the candidate set for the Worker Characteristics Cluster, shown below in Table 7.1(b). These variables represent a diverse set of characteristics which include demographic and anthropometric variables (age, BMI, marital status), lifestyle factors (smoking status, alcohol consumption), comorbidity (number of comorbidities, previous work-related injury, pain/aching in the hands on most days) and personal characteristics (mastery, sleep disorders score, past troubling experiences).

Although the proportion of preschool children was different among the claimants compared to non-claimants, there was only one participant with preschool children who was **not** married. Thus preschool children was not included in further analysis. A higher proportion of the NO REPORT group indicated having more than 5 lifetime episodes of low-back pain that lasted at least one day; however, this question is unreliable since cases were told to 'anchor' this episode to the date that they reported the pain to the nursing station when they were entered into the study. The random controls had no such instructions.

Table 7.1(a): Worker Characteristics Cluster: Descriptive Statistics

Variable	REPORT	NO REPORT	p*	CLAIM	NO CLAIM	p
N	137	57	–	76	61	–
Group Frequency (#, %)						
Sex (% Male)	126 (92)	54 (95)	0.50	70 (92)	56 (92)	0.95
Marital Status (married / common law)	104 (76)	50 (88)	**0.08**	60 (80)	44 (72)	0.28
Education No High School	42 (31)	17 (30)	0.98	23 (30)	19 (31)	0.99
Completed High School	77 (56)	32 (56)		43 (57)	34 (56)	
Post Secondary	18 (13)	8 (14)		10 (13)	8 (13)	
Completed Apprenticeship (% Yes)	27 (20)	8 (14)	0.35	16 (21)	11 (18)	0.66
Main Wage Earner (%Yes)	112 (82)	45 (79)	0.65	59 (78)	53 (87)	0.16
Children Living with You (%Yes)	91 (66)	42 (74)	0.32	50 (66)	41 (67)	0.86
Preschool Children (< 5ys: %Yes)	29 (21)	11 (19)	0.77	11 (14)	18 (30)	**0.03**
Smoke	62 (45)	21 (37)	0.28	31 (41)	31 (51)	0.24
Drink Alcohol (daily/weekly vs No)	69 (50)	28 (49)	0.88	38 (50)	31 (51)	0.92
Doctor told you have arthritis	24 (18)	17 (30)	**0.06**	12 (16)	12 (20)	0.55
Ever Hospitalized due to LBP	11 (8)	8 (14)	0.19	5 (7)	6 (10)	0.50
¶More than 5 lifetime LBP episodes	61 (45)	40 (70)	**< 0.01**	30 (40)	31 (51)	0.18
Other Work-related Injuries / Conditions (Yes vs No)	73 (53)	34 (60)	0.42	32 (42)	41 (67)	**<0.01**
Deeply Troubling Personal Experiences in the Past Two Years (Yes vs No)	47 (34)	22 (39)	0.57	25 (33)	22 (36)	0.70
Group Mean (±SD)						
Age (years)	41 (8.5)	43 (8.7)	0.30	41 (8.4)	41 (8.8)	0.75
Number of Comorbid Conditions	1.2 (1.3)	1.3 (1.3)	0.43	1.2 (1.4)	1.1 (1.3)	0.83
BMI [weight/height^2]	26.6 (3.9)	27.2 (4.0)	0.28	26.6 (4.2)	26.6 (3.4)	0.93
SAQ Sleep Disorders [0-15]	5.4 (2.9)	5.9 (2.9)	0.21	5.0 (3.0)	5.8 (2.8)	**0.09**
Mastery [0-21]	21 (3.0)	20 (2.9)	0.52	20.8 (3.1)	21.2 (2.8)	0.36

¶ - 'episode' was anchored differently for cases and controls, thus results for this variable are not reliable
p-values in **bold** are ≤ 0.10
• - p-value is based on the chi-square test (categorical) or t-test (continuous).

Table 7.1(b): Worker Characteristics Cluster: CANDIDATE SET

	Variable	Description	Type
1	age	chronological age	continuous
2	married	marital status	binary (married versus other)
3	BMI	Body Mass Index	continuous
4	smoke	currently smoke cigarettes	binary (Yes versus No)
5	drink	alcohol consumption in past year	binary (daily/weekly versus sometimes/never)
6	comorb	number of Comorbidities	discrete
7	hands	pain/aching in hands on most days	binary (Yes vs No)
8	injury	previous injuries / conditions	binary (Yes versus No)
9	sleep	SAQ Sleep Disorders Score	continuous (0-15)
10	mastery	Pearlins Mastery Score	continuous (7-28)
11	trbl_ex	deeply troubling experience in past 2 years	binary (Yes versus No)

Table 7.2: Previous WCB Claim

Variable	REPORT	NO REPORT	p*	CLAIM	NO CLAIM	p
N	**137**	**57**	**–**	**76**	**61**	**–**
Group Frequency (#, %)						
Previous WCB Claim for LBP	69 (51)	29 (53)	0.84	44 (59)	25 (41)	**0.05**

Previous WCB Claim

Interestingly, the proportion with previous WCB Claim for LBP (see table 7.2) did not differ across REPORT and NO REPORT (51 vs 53%, p = 0.84). However, a significantly higher proportion of claimants had previous claims compared to the non-claimants (41 vs 59%, p=0.05). This finding is somewhat surprising, since one might expect the two report groups to have a higher proportion than the Random Controls given that previous claim has been established as a risk factor for LBP in the literature. Among the NO REPORT group, there is a substantial proportion of subjects (n=22, or 39%) who have been in pain for

more than 6 months, which is associated with previous WCB claim (p=0.06). This suggests that there are a number of subjects with a claim history, who are working with residual, chronic work-related low-back pain. Previous WCB Claim has a critical interpretation in the conceptual framework. Since it is represented by a single variable, previous WCB Claim will be kept in all final models regardless of its significance.

WORK-RELATED CLUSTER

Biomechanical - REPORT vs NO REPORT

Table 7.3(a): Work-Related Cluster - BIOMECHANICAL: Descriptive Statistics

Variable	REPORT	NO REPORT	p*	CLAIM	NO CLAIM	p
BIOMECHANICAL [N]	**105**	**37**		**62**	**43**	
Group Mean (±SD)						
Peak Spinal Compression [N]	3402 (1133)	2682 (1132)	**<0.01**	3383 (1177)	3430 (1744)	0.88
Integrated Compression [N/shift]	21.0×10^6 (4.7×10^6)	19.5×10^6 (4.1×10^6)	**0.08**	21.5×10^6 (4.9×10^6)	20.3×10^6 (4.4×10^6)	0.23
Peak Moment [Nm]	180 (85)	135 (68)	**<0.01**	183 (70)	177 (103)	0.77
Integrated Moment [Nm/shift]	5.5×10^5 (2.4×10^5)	4.63×10^5 (1.44×10^5)	**<0.01**	5.69×10^5 (2.41×10^5)	5.29×10^5 (2.38×10^5)	0.41
Peak Reaction Shear [N]	462 (178)	331 (181)	**<0.01**	467 (151)	454 (213)	0.74
Integrated Reaction Shear [N]	1.5×10^6 (6.4×10^5)	1.31×10^6 (4.89×10^5)	**0.08**	1.59×10^6 (6.34×10^5)	1.40×10^6 (6.39×10^5)	0.13
Peak Hand Load [kg]	22.4 (20.5)	14.5 (12.2)	**<0.01**	20.0 (17.3)	25.8 (24.2)	0.18
Usual Hand Load [kg]	8.7 (6.9)	4.8 (3.2)	**<0.01**	8.7 (6.9)	8.8 (6.9)	0.89
Flexion Moves / Minute	2.9 (2.1)	2.6 (2.6)	0.47	2.8 (2.0)	3.1 (2.3)	0.5
Degrees Flexed / Minute [deg/min]	306 (136)	279 (131)	0.28	300 (138)	317 (135)	0.54
Peak Flexion [deg]	51 (22)	40 (25)	**0.01**	52 (22)	50 (23)	0.59
Peak Flexor Velocity [deg/s]	41 (15)	39 (19)	0.42	41 (15)	41 (15)	0.9
% time in Awkward posture	21 (20)	18 (19)	0.46	21 (20)	21 (18)	0.86

p-values in **bold** are ≤ 0.10

* - p-value is based on the chi-square test (categorical) or t-test (continuous).

Figure 7.2(a): Cumulative Spinal Compression (Million Newtons / per shift) at the L4-L5 Spinal Motion Unit by Study Group

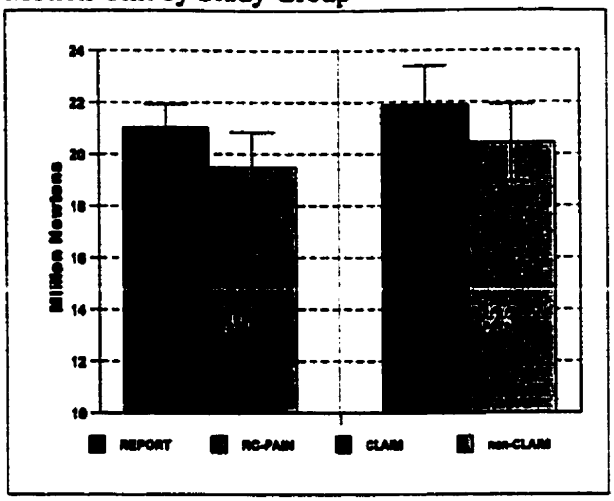
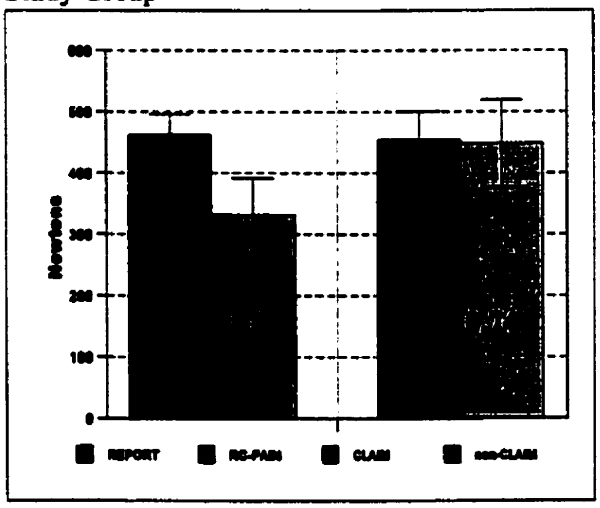


Figure 7.2(b): Peak Spinal Reaction Shear (Newtons) at the L4-L5 Spinal Motion Unit by Study Group

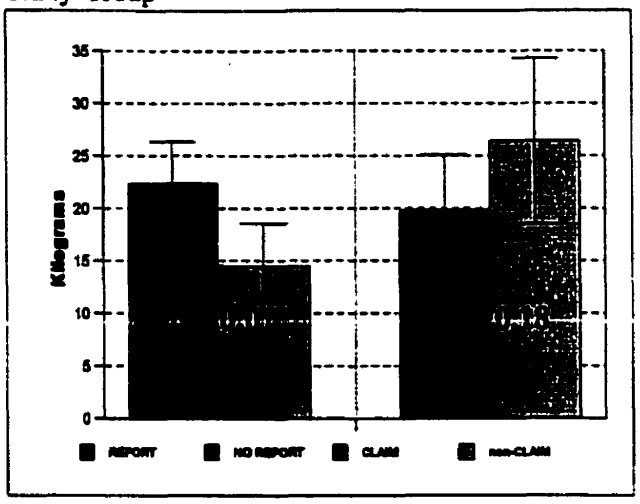


Univariate results for the biomechanical variables in the Work-Related Cluster are shown in table 7.3(a). Note the reduction in sample size for the biomechanical measures. Table 7.3(a) indicates that workers who report low-back pain measured **higher** as a group on virtually every biomechanical variable measured, including cumulative compression and peak reaction shear (figures 7.2(a) and (b)). The exception is peak flexor velocity and per-cent time in an awkward position. Although prolonged exposure to awkward postures has been postulated to be a precursor for potentially disabling disorders of musculoskeletal tissue and peripheral nerves (Keyserling et al., 1991), and has been shown to be an important risk factor for reported low-back pain in automobile workers in previous studies (Keyserling et al., 1988; Punnett et al., 1991), these data do not show an association between awkward postures and reporting low-back pain to the workplace.

Biomechanical - CLAIM vs NO CLAIM

Biomechanical loads do not differ greatly among the two CLAIM groups. In fact, there are no significant bivariate associations or trends in the data to speak of. Mean peak hand load was *higher* in non-claimants versus claimants (25.8 vs 20.0 kilograms, $p > 0.18$), although both measures have fairly wide

Figure 7.3: Peak Hand Load Force (kilograms) by Study Group



dispersions (see figure 7.3).

These results imply that the jobs done by workers reporting low-back pain to the workplace are more demanding, producing greater biomechanical loads on the lumbar spine (a recognized etiological risk factor) when compared to the NO REPORT group, in a sense 'legitimizing' the LBP report to the workplace. That there were few differences in biomechanical variables between the CLAIM and NO CLAIM group, both of whom reported their pain to the nursing station, suggests that filing a claim may not depend on the biomechanical spinal loads produced by the job tasks themselves, but may be based on some other factors.

Psychosocial Factors - REPORT vs NO REPORT

Univariate results for the psychosocial variables are shown in Table 7.3(b). 'Status Inconsistency', a self-reported perception of being over educated for the job compared to others in similar jobs, was slightly higher among those who report low-back pain to the workplace (32 vs 20%, p=0.07). Status Inconsistency was an important multivariate predictor of case status in the etiological risk factor analysis conducted by Kerr (1998). Inspection of educational level and completion of an apprenticeship do not reveal statistical differences across REPORT and NO REPORT groups. However within both groups, a perception of being overeducated was associated with both higher education and having completed an apprenticeship.

Coworker support was slightly higher among those workers who reported their low-back pain compared to the NO REPORT group (69 vs 64, p=0.10). Supervisor support was not found to be different across the two groups. Job Control, Psychological Demands, and Social Support are shown in Figure 7.4, none of which were different by reporting status. Mean Psychological Demands exceeded Job Control.

Table 7.3(b): Work-Related Cluster - PSYCHOSOCIAL VARIABLES: Descriptive Statistics

Variable	REPORT	NO REPORT	p*	CLAIM	NO CLAIM	p
N	105	57	–	76	61	–
Group Frequency (#, %)						
Over Educated for job (%Yes)	44 (32)	11 (20)	**0.07**	24 (32)	20 (32)	0.92
Good Job Security (% disagree)	25 (18)	12 (21)	0.65	15 (20)	10 (16)	0.62
Group Mean (±SD)						
Job Control [0-100]	46 (23)	43 (22)	0.32	46 (22)	47 (25)	0.97
Psychological Demands [0-100]	59 (18)	55 (22)	0.18	61 (18)	58 (19)	0.36
Job Strain Ratio (Demands/Control)	1.26 (.57)	1.26 (.57)	0.99	1.27 (.57)	1.25 (.59)	0.87
Physical Exertion [0-8]	6.9 (1.3)	6.3 (1.5)	**<0.01**	7.0 (1.2)	6.8 (1.4)	0.33
Social Support [0-100]	62 (11)	60 (9)	0.17	64 (12)	61 (10)	0.12
Supervisor Support [0-100]	66 (24)	62 (22)	0.41	66 (26)	66 (20)	0.69
Coworker Support [0-100]	69 (17)	64 (17)	**0.09**	72 (15)	65 (18)	**<0.01**
Workplace Support [0-100]	53 (8.7)	54 (9)	0.59	53 (8)	53 (9)	0.67
Empowerment [0-15]	4.8 (2.5)	4.7 (2.4)	0.75	5.2 (2.2)	4.4 (2.7)	**0.07**
Job Dissatisfaction [2-7]	3.6 (1.3)	4.2 (1.1)	**<0.01**	3.6 (1.3)	3.8 (1.2)	0.39
Job Self Worth [0-100]	66 (25)	54 (24)	**<0.01**	69 (24)	62 (27)	**0.09**
OHS/ Work Organization [0-20]	9.3 (2.9)	8.8 (2.8)	0.24	9.7 (2.8)	8.9 (2.9)	0.13

p-values in **bold** are ≤ 0.10

* - p-value is based on the chi-square test (categorical) or t-test (continuous).

Perceived physical exertion (see Figure 7.5) was significantly higher among workers reporting low-back pain compared to the NO REPORT group (6.9 vs 6.3, $p < 0.01$). This is hardly surprising, as it has already been shown that the group of workers reporting low-back pain have higher task demands on the low-back on virtually every measure. It is also likely that perceived exertion is in part a function of back pain itself; that is, a worker with back pain is likely to report his/her job to be more demanding because of the

Figure 7.4: Job Control, Psychological Demands, and Social Support by Study Group

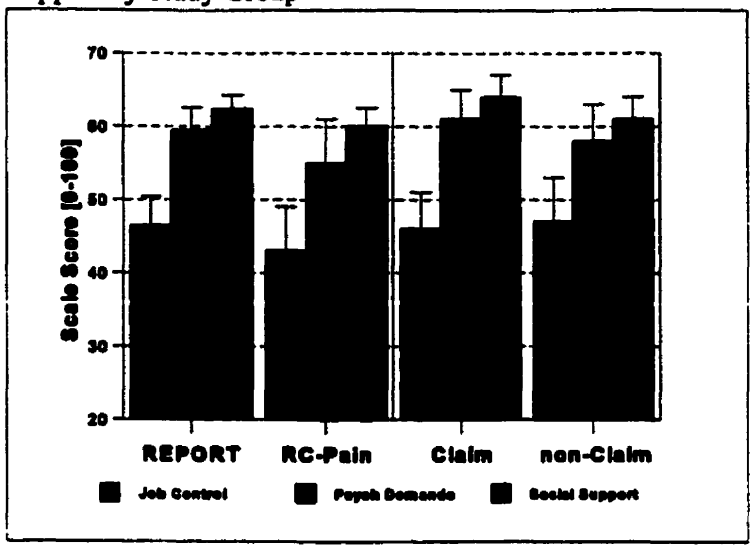
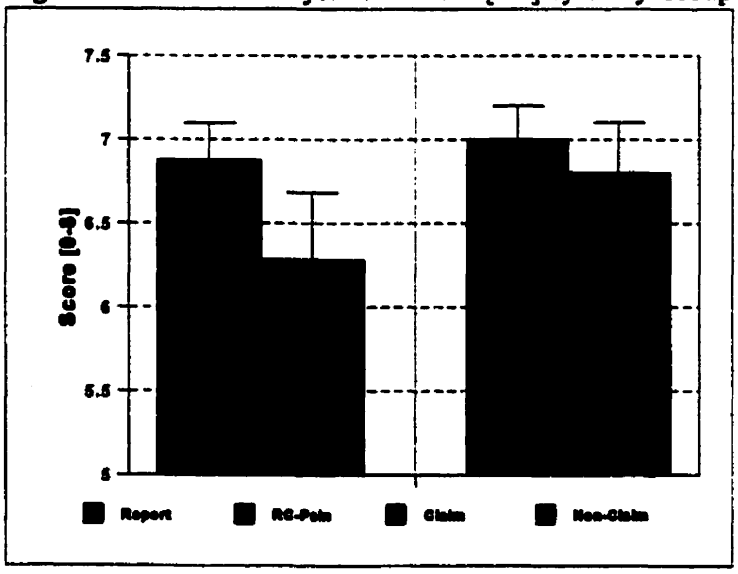


Figure 7.5: Perceived Physical Exertion [0-8] by Study Group



back pain[2].

In contrast to previously published work, especially that of Bigos and colleagues (Bigos et al., 1992) job *dis*satisfaction was found to be *lower* in the group reporting occupational low-back pain (3.6 vs 4.2, $p < 0.01$). Similarly, Job Self-Worth, a measure of the participants' perception about the importance of their job to the work unit, was higher among those reporting low-back pain (66 vs 54, $p < 0.01$). These results are not intuitive nor predicted by other literature, since one might expect that workers reporting low-back pain to be dissatisfied with their work and feel less committed to their jobs or the organization. However, they may also reflect an underlying support structure, within which workers feel more able to report symptoms arising from job tasks.

Psychosocial Factors - CLAIM vs non-CLAIM

None of Job Control, Psychological Demands, or Social Support were significantly different across

[2]This is issue is addressed in more detail in the comparison of cases to job-matched controls, which suggests that cases do indeed report their jobs to be more demanding compared to healthy job-matched controls who have not reported low-back pain to the workplace (Kerr, 1998).

the claim versus non-claim groups. Mean Psychological Demands exceeded mean Job Control in both groups. Higher coworker support (rather than lower supervisor support) was observed among the claimant group (72 vs 65, $p < 0.01$). Worker empowerment was also higher among the claimants compared to the non-claimants (5.2 vs 4.4, $p = 0.07$).

Perceived physical exertion was slightly higher among the claimants, although the difference failed to reach statistical significance (7.0 vs 6.8, p=0.33; figure 7.5). Again, this is consistent with the biomechanical results, where few measures were found to be different between these two groups. There were no differences on Job Dissatisfaction or Job Self-Worth observed between claimants and non-claimants.

Candidate Variables Set

Twelve variables were selected as candidates for the Job-Related Cluster (see Table 7.3(c)). These include five biomechanical measures (integrated compression [N/shift], peak reaction shear [N], peak hand load [kg], peak flexion velocity [deg/second], and peak flexion [deg]) and seven psychosocial measures (Job Control [0-100], Psychological Demands [0-100], Physical Exertion [0-8], Social Support [0-100], Empowerment [0-15], Job Dissatisfaction [2-7], and Job Self-Worth [0-100]).

The correlations among the biomechanical variables derived from the WatBack model were very high since they utilize similar inputs (posture, BMI, hand load, and direction of force). Integrated compression correlated very highly with both integrated moment ($\rho = 0.89$) and integrated reaction shear ($\rho = 0.77$). Similarly, peak reaction shear was strongly correlated with peak moment ($\rho = 0.86$) and peak compression ($\rho = 0.89$). The selection of integrated compression and peak reaction shear was based on their inclusion in the previously developed etiological risk factor model (Kerr, 1998) and the personal modeling preference of the leading biomechanists on the study team (Bob Norman, Richard Wells, personal communication 1999). Additionally, these measures cover both cumulative and peak tissue loading measures, important and distinct potential risk factor metrics (Wells et al, 1997). The additional biomechanical measures, peak flexion, peak flexion velocity, and peak hand load, were selected by the

Table 7.3(c): Work-Related Cluster: CANDIDATE VARIABLES

	Variable	Description	Type
1	int_comp	integrated compression (Newtons / shift)	continuous
2	pk_rxsh	peak reaction shear (Newtons)	continuous
3	t14_pk	peak hand load (kilograms)	continuous
4	mv5_pp42	peak flexion velocity (degrees / second)	continuous
5	pf5_pp8	peak flexion (degrees)	continuous
6	control	Job Control Score	continuous (0-100)
7	psychdem	Psychological Demands Score	continuous (0-100)
8	exertion	Perceived Exertion	discrete (0-6)
9	socsup2	Social Support Score	continuous (0-100)
10	empower	Worker Empowerment	discrete (0-15)
11	job_dis	Job Dissatisfaction	discrete (2-7)
12	jobworth	Job Self-Worth	continuous (0-100)

biomechanists based on their investigation of these variables as they: i) related to other variables; ii) discriminated between cases and controls; and iii) represented the basic biomechanical exposure metrics of force and kinematics (Wells et al., 1997).

Selection of the psychosocial variables was based partly on theoretical justification and partly on the strength of the univariate relationships. "Job Control" and "Psychological Demands" are included as separate constructs rather than as the ratio between them, and despite their lack of univariate association, since they may operate in different ways (but in tandem) as risk factors for either reporting or filing a claim for low-back pain. Higher Job Control and the ability to sequence job tasks in response to symptoms may help a worker cope with the pain at work (thus higher job control may be protective against reporting or filing a claim). Perhaps the effect of job control is only present ***after*** task demands are accounted for.

Social support may moderate the relationship between risk factors for low-back pain. Supervisor discretion concerning the worker at an individual level may influence the ability of the worker to effectively

'deal' with low-back pain symptoms at work (Scandura and Graben, 1984; Tarasuk and Eakin, 1995; Roberts et al., 1999). Anecdotal information gained by the student during the interviews with individual workers participating in the study informs this conjecture. A worker with a poor relationship with his immediate supervisor stayed off work until his symptoms were nearly resolved because he was not counting on 'getting any slack'[3] if his job tasks aggravated his symptoms. Contrasted is a worker who was told by his supervisor to come in, and that flexibility around job tasks could be arranged if his symptoms persisted or were aggravated (this worker did not file a claim or lose time). The data do not suggest an overall difference in supervisor support among the study groups. It appears from the univariate analysis that ***higher*** Coworker Support is associated with filing a claim, suggesting that a good, supportive relationship with coworkers is positively associated with reporting and filing a claim for LBP. However due to a lack of degrees of freedom because of the limited sample size, the combined Social Support score was included rather than the three individual support scales.

Worker Empowerment is a variable capturing perceptions about work relationships conceptually above the level of the job, in the workplace. While empowerment is conceptually distinct from job control, several items in the constructs do overlap slightly, resulting in a Pearson correlation coefficient between empowerment and job control of ρ=0.51 (n=192). Empowerment is included in the Candidate Variables set due to its conceptual importance and it's univariate association with filing a claim.

The Job Dissatisfaction Scale was included since it has been reported as a risk factor for reporting LBP to the workplace (Bigos et al., 1992; van Poppel 1999). However job dissatisfaction was shown to be 'protective' in the etiological risk factor model for these data (Kerr, 1998). Job Self-Worth is an interesting variable since it reflects the inherent value a worker places on his/her job. One might theorize that a worker who considers his/her job 'more important' is *less likely* to file a claim and possibly be off work; however, the univariate results suggest otherwise.

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[3]Not a direct quote. Quotation marks are to set off author's emphasis on the vernacular.

Clinical, Physical Exam, and Functional Status Cluster

REPORT vs NO REPORT

Comparisons of clinical variables show remarkable differences in disease markers across those who report their low-back pain and those who do not (see Table 7.4(a)). Those who report LBP to the workplace had worse scores on all 5 physical exam measures. Reporters had lower straight leg raise (61 vs 66 degrees, p=0.08), higher finger-floor distance (7.5 vs 4.6 inches, $p < 0.01$), lower sit-up score (3.2 vs 4.7, $p<0.01$), more positive tender points (4.3 vs 3.1, $p = 0.02$), and a lower grip strength (465 vs 497 mmHg, $p =0.10$). Straight-leg raise and finger-floor distance (see Figure 7.6) are range of motion measures that would be expected to be 'worse' among those with more 'severe' disease. Sit-ups are obviously more difficult to perform when your back hurts. Observed differences between positive tender points and grip strength are less well explained by the presence of back pain. Note that removing the gluteal sites, which are susceptible to false positives because of their proximity to the pain in the low-back, dose not explain the observed difference between reporters and NO REPORT groups.

Higher proportions of reporters had LBP that woke them up from sleep (54 vs 31%, $p < 0.01$) and more woke with a stiff back (76 vs 54%, $p < 0.01$), which tended to last longer (3.04 vs 1.09 hours, $p < 0.01$). Those who report low-back pain scored significantly higher (worse) on the Von-Korff Chronic Pain Grade Pain Intensity (62 vs 51, $p < 0.01$; see Figure 7.7(a)) and Disability (58 vs 32, $p < 0.01$) Scales, and also on the modified Roland (9.3 vs 6.3, $p < 0.01$; see Figure 7.7(b)). The group that reported LBP to the workplace scored significantly lower (worse) on three of the four physical dimensions of the SF-36 (Role Physical [25 vs 62, $p < 0.01$], Physical Function 61 vs 77, $p < 0.01$], and Bodily Pain [38 vs 57, $p < 0.01$]), but not on General Health (72 vs 73, $p = 0.87$). On the Mental Health dimensions, there were no differences between the groups on Role Emotional, Mental Health, and Vitality. It is interesting to note that the group reporting LBP to the workplace, not only score worse on the physical function and pain scales, but also on the SF-36 Social Function scale, indicating that their pain not only affects their ability to work, but also impairs their

Table 7.4(a): Clinical, Physical Exam, and Functional Status Cluster: Descriptive Statistics

Variable		REPORT	NO REPORT	p*	CLAIM	NO CLAIM	p
N		105	57		76	61	
Physical Exam (x̄, ±sd)							
Straight Leg Raise [degrees]		61 (18)	66 (21)	**0.08**	57 (19)	67 (15)	**<0.01**
Safety Sit-Up Score [0-6]		3.2 (2.6)	4.7 (2.2)	**<0.01**	2.4 (2.5)	4.0 (2.4)	**<0.01**
Finger-floor distance [cm]		7.5 (7.1)	4.6 (5.2)	**<0.01**	9.1 (6.8)	5.5 (7.0)	**<0.01**
Positive Tender Points [0-16]		4.3 (3.2)	3.1 (2.8)	**0.02**	4 (3.0)	4 (3.4)	0.88
Grip Strength [mmHg]		465 (113)	497 (131)	**0.10**	450 (121)	485 (101)	**0.07**
Ankle Reflex	absent/diminished	29 (23)	5 (10)		22 (31)	7 (13)	
	normal	93 (74)	44 (88)	0.13	49 (68)	44 (83)	**0.06**
	hyper	3 (3)	1 (2)		1 (1)	2 (4)	
Knee Reflex	absent/diminished	14 (12)	5 (10)		7 (11)	7 (13)	
	normal	103 (85)	42 (84)	0.71	60 (88)	43 (81)	0.37
	hyper	4 (3)	3 (6)		1 (1)	3 (6)	
Hamstring Reflex	absent/diminished	21 (21)	8 (20)		16 (27)	5 (13)	
	normal	75 (77)	31 (76)	0.65	42 (71)	33 (85)	0.24
	hyper	2 (2)	2 (5)		1 (1)	1 (3)	
Group Frequency (#, %)							
Pain Radiates to Legs (% Yes)		63 (46)	22 (39)	0.35	40 (53)	23 (38)	0.12
Pain is worse when cough/sneeze OR numbness in leg or foot (% Yes)		47 (34)	14 (25)	0.18	29 (38)	18 (30)	0.29
LBP wakes you up (% Yes)		73 (54)	17 (31)	**<0.01**	49 (65)	24 (39)	**<0.01**
Back is stiff when you get up (% Yes)		104 (76)	31 (54)	**<0.01**	64 (85)	40 (66)	**<0.01**
Problem Sleeping / past week? (% Sometimes / Often)		89 (66)	31 (55)	0.15	53 (72)	36 (60)	0.16
Current condition compared to expectations of problem are:	Better	66 (54)	20 (36)		38 (52)	28 (56)	
	As Expected	18 (15)	20 (36)	**<0.01**	10 (14)	8 (16)	0.76
	Worse	39 (32)	15 (28)		25 (34)	14 (28)	

Variable	REPORT	NO REPORT	p*	CLAIM	NO CLAIM	p
N	105	57		76	61	
Depressed (%)‡	11 (8)	1 (2)	**0.10**	8 (11)	3 (5)	0.23
Group Means (±SD)						
Duration of Stiffness [hours]	3.04 (6.3)	1.09 (3.2)	**<0.01**	2.04 (3.9)	4.28 (8.3)	**0.06**
CPG Pain Intensity [0-100]	62 (16)	51 (20)	**<0.01**	70 (35)	56 (17)	**<0.01**
CPG Disability Score [0-100]††	58 (29)	32 (24)	**<0.01**	66 (25)	48 (30)	**<0.01**
Roland [0-18]†	9.3 (5.5)	6.3 (5)	**<0.01**	11.1 (5)	7.0 (6)	**<0.01**
SF-36 Role Physical [0-100]††	25 (36)	62 (40)	**<0.01**	14 (29)	40 (40)	**<0.01**
SF-36 Physical Function [0-100]	61 (29)	77 (22)	**<0.01**	54 (30)	69 (26)	**<0.01**
SF-36 Bodily Pain [0-100]††	38 (24)	57 (18)	**<0.01**	33 (22)	46 (24)	**<0.01**
SF-36 General Health [0-100]	72 (15)	72 (17)	0.87	72 (17)	73 (14)	0.65
SF-36 Vitality [0-100]	47 (22)	48 (22)	0.76	46 (23)	48 (21)	0.47
SF-36 Social Function [0-100]	63 (30)	84 (18)	**<0.01**	53 (30)	76 (26)	**<0.01**
SF-36 Mental Health [0-100]	76 (16)	76 (16)	0.77	75 (17)	77 (15)	0.47
SF-36 Role Emotional [0-100]	81 (35)	81 (35)	0.99	77 (39)	87 (27)	**0.08**
HAD Anxiety [0-15]	4.3 (3.0)	4.4 (2.1)	0.72	4.6 (2.8)	3.9 (2.3)	0.18
SAQ Insomnia Scale [0-12]	6.7 (3.4)	6.5 (3.5)	0.65	6.7 (3.6)	6.8 (3.3)	0.86
SAQ Non-Restorative Sleep Scale [0-6]	4.5 (1.4)	4.6 (1.3)	0.91	4.4 (1.6)	4.7 (1.3)	0.17

p-values in **bold** are ≤ 0.10

‡ - based on BDI and HAD scales (see text for details)

†Scale was modified to remove specific items that might drive scores for those off work. See text for details.

††Contain items that might drive differences in scale means due to being off work.

● - p-value is based on the chi-square test (categorical) or t-test (continuous).

normal social function (see Figure 7.8). No differences between the two groups were observed on the (modified) HAD Anxiety or Depression Scales, nor on the SAQ Insomnia or Non-Restorative Sleep Scales.

Those who report their low-back pain to the workplace appear to be doing better than they had anticipated with respect to their current condition (54 vs 36% 'Better', $p < 0.01$). However, there is some

Figure 7.6: Finger-Floor Distance (inches) by Study Group

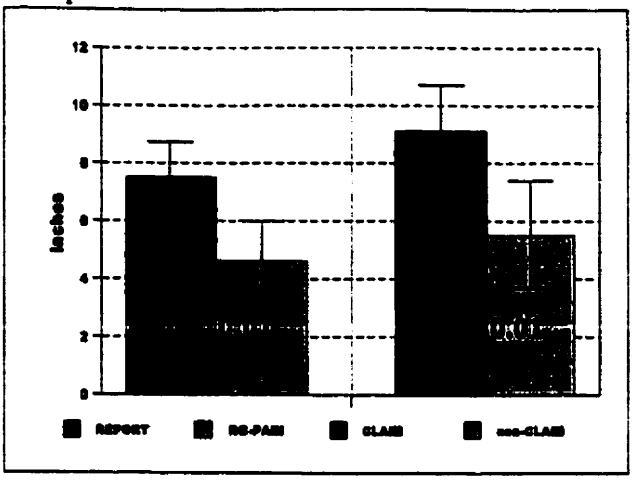


Figure 7.7(a): Von Korff Chronic Pain Grade Pain Intensity [scored 0-100] by Study Group

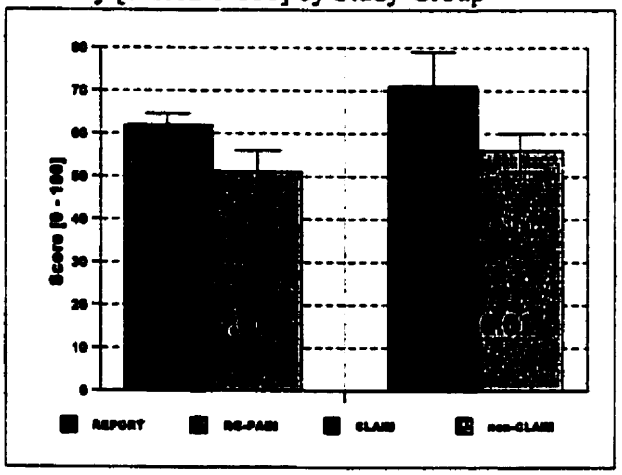
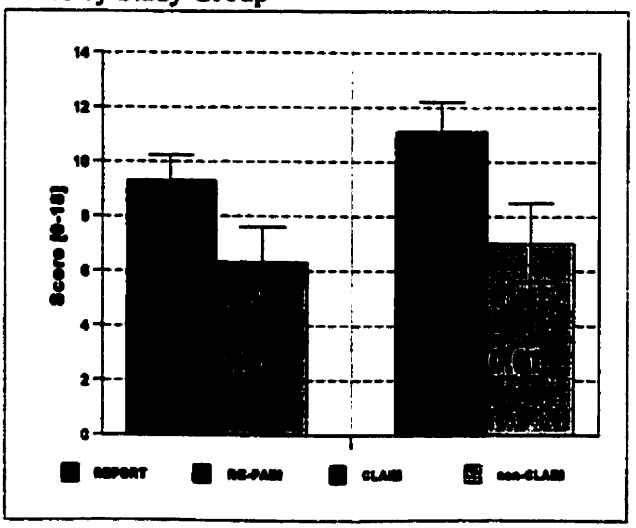


Figure 7.7(b): Modified Roland-Morris Disability Score by Study Group

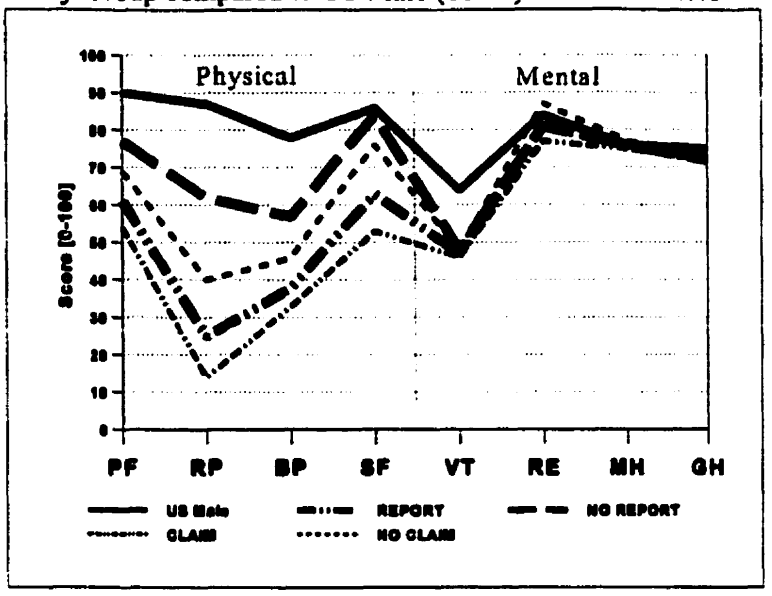


suspicion that participants in fact responded to the question in terms of how they were doing **now** compared to previously; thus, subjects who have improved respond "much/somewhat better" regardless of how their current condition might compare with their previous expectations of how they might be doing. Participants in the REPORT group, given the acute nature of their current episode, have more room to improve, and a misinterpretation of the question as described above would put more of them into the 'Better' category (recall also that the NO REPORT group contains a number of individuals with chronic, more 'stable' low-back pain - see under Previous WCB heading above). Alternatively, it may well be that reporting to the workplace helps a worker to progress faster than expected because of treatment; this alternative is not likely given the limited medical attention dispensed a the first-aid centres

CLAIM vs NO CLAIM

Claimants were significantly worse on three of the physical exam measures (lower straight-leg raise [57 vs 67 degrees, $p < 0.10$], higher finger-floor distance [9.1 vs 5.5 inches, $p < 0.01$] and

Figure 7.8: Mean SF-36 General Health Dimension Scores by Study Group compared to US Male (18-44) Standard Scores



lower sit-up score [2.4 vs 4.0, $p < 0.01$]). In addition, claimants measured marginally lower on grip strength (450 vs 485 mmHg, $p = 0.07$). Note that if grip strength is a true measure of general fitness and strength, as suggested in the rationale for its inclusion in this study by the Clinical Subgroup of the Ontario Universities Back Pain Study (1993), and it is unaffected by the presence of low-back pain, then these data suggest that claimants, and reporters in general, are weaker than their NO CLAIM and NO REPORT colleagues respectively. Given that reporters also have heavier jobs, it is unclear whether a 'heavy' job results in poorer physical fitness, or whether the combination of 'weakness' and heavy job demands results in more severe low-back pain.

Table 7.4(a) lists the reflex results for the knee, hamstring, and ankle. Data for both the left and right reflex were combined (that is, a participant with a hyper reflex in either left or right knee will be in the hyper category). Since the clinical data were collected by non-clinicians in a non-clinical setting (usually interviews were conducted in participants' homes), the reflex data, the most difficult measure to collect, are likely the least reliable. For instance, often the physical exam would be conducted with the subject wearing work pants or jeans, and socks. Inspection of the reflex data indicate a large number of missing values (see Table 7.4(b)).

Given the reduced ability to detect a reflex through fabric, it is likely that the proportion of subjects with absent or diminished reflex scores is *overestimated*. However there is no reason to suspect that this is a differential bias or error with respect to report or claim status. Although the data in Table 7.4(a) indicate

a significantly higher number of claimants with reduced or diminished ankle reflexes (31 vs 13%, p = 0.06), it is difficult to draw any inference from this result, even though the ankle was perhaps the best measured of the three sites. It is interesting to note, however, that impaired ankle reflex (as administered by a fully trained clinician) has a sensitivity of ~90% in patients with surgically confirmed disc herniations (Deyo et al., 1992).

Table 7.4(b): Physical Exam Data Results: Missing Data for Reflex Measures by Study Group

	CLAIM	non-CLAIM	NO REPORT
N	**76**	**61**	**57**
Knee	8 (11%)	7 (12%)	8 (13%)
Hamstring	17 (22%)	22 (36%)	16 (28%)
Ankle	4 (5%)	8 (13%)	7 (12%)

Claimants were significantly more likely to have LBP that wakes them up (65 vs 39%, p <0.01) and to have a stiff back when they wake up (85 vs 66%, p < 0.01). In this case however the non-Claimants had stiffness that lasted significantly longer than claimants (4.28 vs 2.04 hours, p =0.06). Claimants scored significantly higher (worse) on Von Korff's Chronic Pain Grade Pain Intensity (70 vs 56, p < 0.01) and Disability (66 vs 48, p < 0.01) scales, as well as the Roland (11.1 vs 7.0, p < 0.01), indicating that claimants have more intense and disabling pain.

Inspection of the SF-36 General Health Scales reveal a pattern similar to that observed for Report vs NO REPORT (see Figure 7.8). In addition, claimants scored significantly lower (worse) on the Role Emotional Scale (77 vs 87, p = 0.08). It is tempting to interpret that the claims process has a negative effect on one's emotional circumstance, although these data lack the required temporal sequencing. Note also that the Role Emotional Scale questions whether a respondent has "cut down on amount of time you spent on work or other activities"; clearly, workers off work with a lost time claim (75% of the claimants) may respond positively irrespective of the attribution to an emotional problem, driving the score on this scale.

In fact, many of the SF-36 items are framed to ask about differences among subjects who are either working or who have lost-time from work. Being off work with low-back pain (or having filed a lost-time WCB claim) is an important indicator of the level of functional impairment; however, it is also the outcome of interest in this analysis. Since some scales are composed of two or three items only, modifying the scales might mean removing half or more of a construct's items, resulting in undesirable effects on reliability and validity. Therefore the SF-36 constructs will be considered as a descriptive measure only, and will not be considered in the multivariable analyses.

The results for the Hospital Anxiety and Depression Anxiety scale do not suggest an increased level of anxiety for the claimants. Increased anxiety has been associated with acute pain episodes (Burton et al., 1995), which may lead to depression in chronic pain (Turk, 1997). Alternatively, Gallagher and colleagues reported that emotional distress reduced the probability of receiving compensation (Gallagher et al., 1995). Using cutoff points indicating depressed for the BDI (of 11) and for the HAD (of 8) suggested by the authors of the respective scales, results in 11 vs 1% ($p = 0.10$) for Report vs NO REPORT and 8 vs 3% ($p = 0.23$) for Claim versus non-claim. Elevated depression at presentation has been associated with the subsequent development of chronic pain (Turk, 1997); however, the numbers in these cells are too small to use in a statistical model.

Candidate Variables Set

Nine variables were selected as candidates for the Clinical Cluster (see Table 7.4(c)). A binary variable created from positive responses to either radiating pain on cough or sneeze, or pain/numbness in the legs or foot (Spitzer et al., 1987) was included to represent red flags for nerve entrapment. Pain radiating below the knee has been an important measure of low-back symptomatology in studies comparing patients on compensation status (Di Fabio 1995; Le Claire 1996; Infante-Rivard, 1996; Vaccaro, 1997) and has been suggested to be an important prognostic risk factor (Hogg-Johnson et al., 1998).

Mean SAQ Non-Restorative Sleep Scale scores were significantly associated with the binary variable

"In the past week, was your back usually stiff when you got up?". Since the SAQ scale contains an item "Have you awakened with aches or pain or stiffness?" (which also refers to the past week), the single binary question more specific to low-back pain was included in the Candidate set. Similarly, the SAQ Insomnia scale was significantly associated with the question "In the past week, if you had pain when you slept, did

Table 7.4(c): Clinical Cluster: CANDIDATE VARIABLES

	Variable	Description	Type
1	red flag-leg	pain on cough/sneeze or pain/numbness in leg	binary
2	radiate	pain radiates to legs	binary
3	bp_stff_u	back is stiff when you get up	binary
4	slr_av	straight-leg raise (combined left/right) [degrees]	continuous
5	ff_dist	finger-floor distance (inches)	continuous
6	roland	modified Roland-Morris Disability [0-18]	continuous
7	anxiety	HAD Anxiety Scale [0-15]	discrete
8	insomnia	SAQ Insomnia Scale [0-12]	discrete
9	pain int	CPG Pain Intensity [0-100]	continuous

it wake you up?". The decision was made to include the SAQ Insomnia scale, based on the idea that since it contained more items, it would be a more accurate and valid measure of the impact of low-back pain on sleep.

Two physical exam measures were included in the Candidate Variables Set, straight-leg raise and finger-floor distance. These measures have been included as important measures of function in studies of compensation and low-back pain (Ambrosius et al., 1995; Le Claire et al., 1996; Di Fabio et al., 1995; Di Fabio et al., 1996; Rainville, 1997) and have been shown to be an important physical exam measure in diagnosis of low-back disorders such as sciatica and ankylosing spondylitis (Deyo et al., 1992).

The modified Roland-Morris scale was included to measure functional status (Hadler et al., 1995;

Atlas et al., 1996; Le Claire et al., 1996). Although the Chronic Pain Grade includes a Disability Scale, the question "...how much has back pain changed your ability to work?" is confounded with the lost-time outcome. Therefore, the modified Roland was chosen. The Chronic Pain Grade Pain Intensity Scale was used to measure pain intensity. Finally, the HAD Anxiety scale was included to see if compensation claims or reporting was associated with elevated anxiety (Burton et al., 1995).

Previous Compensation Claim for Low-Back Pain: Effects on Work-Related Factors

The conceptual model in Figure 3.2 suggests a pathway for previous WCB claims for LBP to potentially influence current work-related factors. For example, workers with claims may have made a transition - either selectively or through medical restrictions - to jobs with lower physical demands. Greenough and Fraser (1989) suggested that the adversarial nature of the compensation system was associated with a poor outcome, and that among patients actively looking for work, a claims history was a significant handicap.

The effect of previous claim on work-related factors was assessed separately for REPORT and for the NO REPORT groups. Potential factors investigated were limited to the Candidate Variables Set for the Work-Related Factors (see table 7.4). Since all of these factors are continuous, this was done using a simple t-test. The results are presented below in Tables 7.5(a) and (b).

Nearly half of all those who reported low-back pain to the workplace had a claim history. There are no differences among Reporters on previous WCB status on either the biomechanical or psychosocial factors; in fact the two groups are nearly identical. However, among the NO REPORT group, although there are no differences among the biomechanical variables, workers with a claims history reported significantly higher job dissatisfaction scores (4.7 vs 3.2, $p<0.01$), lower social support (57 vs 63, $p=0.02$) and lower Job Self Worth scores (47 vs 60, $p=0.04$). In addition, workers with previous WCB claims for LBP reported marginally lower Job Control (37 vs 47, $p=0.07$).

These data suggest that there may be negative longer term implications of a claims history with respect to factors in the psychosocial environment at work. Note that almost 2/3 of the NO REPORT group with a previous claim were the 'chronic' group (that is, the current episode has lasted more than 6 months). This is contrary to the picture emerging from the bivariate associations, which suggest that claims are associated with higher job satisfaction and social support, and increased feelings of job self-worth.

Table 7.5 (a): Candidate Work-Related Factors by Previous WCB Claim for LBP: REPORT

	Previous WCB Claim		
Variable	**NO**	**YES**	**p-value**
N	66 (49%)	69 (51%)	–
Integrated Compression [mil N/shift]	20.8	21.2	0.64
Peak Shear [N]	460	466	0.87
Peak Flexion [degrees]	52	50	0.55
Peak Flexion Velocity [deg/s]	43	40	0.34
Peak Hand Load [kg]	24	21	0.4
% time in Awkward Posture [%]	22	19	0.42
Job Control [0-100]	48	46	0.63
Psychological Demands [0-100]	57	61	0.32
Physical Exertion [0-8]	6.8	6.9	0.93
Social Support [0-100]	63	62	0.47
Job Dissatisfaction [2-8]	3.7	3.6	0.79
Empowerment [0-15]	4.8	4.8	0.98
Job Worth [0-100]	67	66	0.66

p-values in **bold** are ≤ 0.10

Table 7.5 (b): Candidate Work-Related Factors by Previous WCB Claim for LBP: NO REPORT

	Previous WCB Claim		
Variable	**NO**	**YES**	**p-value**
N	26 (47%)	29 (53%)	--
Integrated Compression [mil N/shift]	18.7	20.1	0.31
Peak Shear [N]	292	365	0.23
Peak Flexion [degrees]	42	37	0.57
Peak Flexion Velocity [deg/s]	41	37	0.61
Peak Hand Load [kg]	16	14	0.65
% time in Awkward Posture [%]	22	15	0.32
Job Control [0-100]	47	37	**0.07**
Psychological Demands [0-100]	53	59	0.29
Physical Exertion [0-8]	6.2	6.5	0.47
Social Support [0-100]	63	57	**0.02**
Job Dissatisfaction [2-8]	3.8	4.7	**<0.01**
Empowerment [0-15]	4.8	4.6	0.71
Job Worth [0-100]	60	47	**0.04**

p-values in **bold** are ≤ 0.10

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Chapter 8: Results of Analysis - Stage II: Logistic Regression Models

This chapter is divided into two parts. Section I describes the results for the first comparison, REPORT vs NO REPORT and addresses the factors associated with reporting low-back pain to the nursing station. Section II describes the results for the comparison of CLAIM vs NO CLAIM and addresses the factors associated with filing a claim (given the report to the workplace). The presentation of results is laid out to follow the hierarchical-type cluster approach. First, the results of the within-cluster reduction (using backwards selection logistic regression) of each Candidate Variables Set to the Representative Variables is reported. The subsequent modeling of each sequential cluster as specified in Chapter 5 (see Figure 5.3) is then presented and discussed.

The number of subjects in each regression was held constant so that the levels of the hierarchical models are nested. Direct comparison of models is therefore possible, and the effects of adding the variables in the proximate clusters on the variables in the distal clusters can be assessed by monitoring individual beta coefficients for each variable and changes in the log-likelihood ratio. In addition, the model diagnostics Naglekerke's R-Square (R_N^2), concordance, and the Hosmer-Lemeshow Goodness of Fit Index (GFI_{HW}) are monitored with the addition of each subsequent cluster.

Section 1: Factors Associated with Reporting to Nursing Station: REPORT vs NO REPORT

Stage I - Step II - Representative Variables Sets

Worker Characteristics Cluster

The results of the within-cluster reduction for the REPORT vs NO REPORT comparison is shown in Table 8.1(a). There were no Worker Characteristic variables that were able to distinguish between the two groups at $p \leq 0.10$ in a multivariable model.

Table 8.1(a): Factors Associated with Reporting to the Workplace: REPORT [N=103] versus NO REPORT [N=36]: Representative Variable Sets

Cluster / Variable	Units	OR	95%CI	Risk [REPORT more likely to:]
Worker Characteristics Cluster				
none significant at $p < 0.10$				
Previous WCB Claim				
Previous WCB Claim	Yes vs No	**0.91**	0.43 - 1.93¶	No difference
Job-Related Cluster				
Peak Reaction Shear [Newtons]	250	**2.64**	1.41 - 4.97	have ***higher*** Peak Shear
Physical Exertion [0-6]	2	**2.26**	1.15 - 4.41	have ***higher*** perceived physical exertion
Job Dissatisfaction [2-7]	1	**0.72**	0.47 - 0.96	have ***higher*** job satisfaction
Clinical Cluster				
Roland [0-18]	8	**3.13**	1.72 - 5.69	have ***increased*** functional limitations

¶ - p-value > 0.10

Previous WCB Claim

The point estimate of 0.91 [95%CI 0.43-1.93] for the prevalence odds ratio for previous WCB claim was far from significant (p=0.91). The inability of any of the preceding variables to discriminate those who report from those who do not among workers with low-back pain is interesting in and of itself, since some of these variables, especially previous WCB Claim, have been well established as risk factors for low-back pain. The model with previous claim only as a predictor variable explained none of the variance ($R_N^2 = 0$) and did not discriminate the subjects any better than chance alone (c=0.51).

Work-Related Cluster

Both biomechanical and psychosocial factors were represented in the Work-Related Cluster. Remaining were higher peak reaction shear (OR=2.64 [95%CI 1.41-4.97] for an increase of 250 Newtons) and higher perceived physical exertion (OR=2.26 [95%CI 1.15-4.41] for an increase of 2 points [scale 2-8]). The inclusion of peak reaction shear gives some indication that the REPORT group do indeed have higher peak spinal loads due to job tasks.

There are several interpretations possible to explain the inclusion of perceived physical exertion in the model, with an odds ratio almost equivalent to that of the measured physical demands. One explanation suggests that not only are the REPORT groups jobs actually heavier, but that they perceive their jobs to be even heavier - or at least more physically demanding. Given the assumption that reporters' low-back pain is more 'severe', this is entirely possible - that is, a worker's perception of 'physically demanding' is a function not only of absolute physical demands, but also of the current physical condition of the individual. The second interpretation is that peak reaction shear does not capture all aspects of physical demands of the job. That is, there are aerobic and biophysical expenditures from the bends, twists and lifts associated with the collection of tasks in a job, which are captured by the physical exertion variable.

Workers who report their low-back pain were more likely to report lower job dissatisfaction (OR=0.72 [95%CI 0.47-0.96] for an increase of 1 point). Thus reporters are more likely to be satisfied with their jobs, which is contrary to results reported from two longitudinal studies (Bigos et al., 1992; von Poppel, 1999) published to date. However, job dissatisfaction, although highly significant in the Boeing study, actually explained very little of the variance (less than 1%), while in the von Poppel study the authors admit that the job satisfaction scale may have captured aspects of the physical work environment, which may be responsible for the observed association. The determinants of job satisfaction include relationships with peers and supervisors (Smith et al, 1985) and may therefore be a marker for a positive psychosocial environment (Falcione et al., 1977) in which workers feel comfortable enough and confident enough to report the pain to the workplace. The importance of the supervisor - worker relationship has long been studied by organizational psychologists (Jablin, 1979; Dienesch and Liden, 1986; Knicki and Vechio, 1994) and has been identified as an important consideration in effective primary prevention programs (Yassi, 1995) and in the prognosis of musculoskeletal disorders (Linton, 1991; Smith et al., 1998).

The three variables representing the Work-Related Cluster led to an acceptable model fit to the data ($c=0.74$, $GFI_{HW}=4.97$ ($p=0.76$)) and explained 22% of the variance.

Clinical Cluster

The only variable remaining in the Clinical Cluster at $p \leq 0.10$ was the modified Roland Scale (OR=3.13 [95%CI 1.72-5.69] for an 8 point increase). Thus workers who report their low-back pain to the workplace are more likely to have increased functional impairment. Recall that since the Roland Scale was modified to avoid items tautological with work absence / presence, the term 'impairment' in this case is limited to a stricter interpretation of 'physical impairment' rather than 'work impairment' *per se*.

Pain Intensity is the last variable to be removed from the Clinical Cluster model at p=0.14. When it is removed, as expected given the collinearity between itself and the Roland, the odds ratio for Roland changes from OR = 2.09 [95%CI 0.94 - 4.61] to that listed in table 8.1(a) (OR= 3.13 [95%CI 1.72 - 5.69]). Inspection of nested models containing both or either of the two variables suggests that the model with both variables has similar model diagnostics as a model containing either Pain Intensity or Roland. This is interesting, since although 'pain' and 'impairment' are distinct clinical concepts, statistically they overlap as predictors of reporting low-back pain to the workplace. Since the objective of this analysis is to build a parsimonious hierarchical model with representative variables, only the Roland Scale was retained to represent the Clinical Cluster as it remained following the methods set out for modelling and to prevent overfitting.

REPORT vs NO REPORT: Hierarchical Analysis of Clusters

Stage II - Step I: Worker Characteristics Cluster

There were no variables significant in a multivariable model with $p \leq 0.10$.

Stage II - Step II: Worker Characteristics Cluster and Previous WCB Claim

This level of the model consists simply of the bivariate relationship between previous WCB claim and the REPORT vs NO REPORT outcome, shown below in Table 8.1(b). There was no association observed between previous WCB claim and reporting low-back pain (OR = 0.91 [95%CI 0.43-1.94]).

Table 8.1(b): Factors Associated with Reporting to the Workplace: REPORT [N=103] versus NO REPORT [N=36] : Hierarchical Modeling of Worker Characteristics and Previous WCB

Cluster / Variable	Units	OR	95%CI	Risk [CASES are more likely to:]
Previous WCB Claim	Yes vs No	0.91	0.43 - 1.93¶	No difference

¶ - p-value > 0.10

Stage II Step III: Worker Characteristics, Previous WCB, and Work-Related Cluster

The addition of peak reaction shear, perceived exertion, and job dissatisfaction to previous WCB is shown in table 8.1(c). The point estimate of the OR for previous claim decreases by 14% to 0.77 [95%CI 0.33-1.78]. The odds ratios for peak reaction shear (OR=2.65 [95%CI 1.47-4.91]) and perceived physical exertion (OR=2.28 [95%CI 1.16-4.48]) remain virtually unchanged. The odds ratio for job dissatisfaction decreases slightly to 0.66 [95%CI 0.46-0.96]. This may in part be due to the positive association observed among the NO REPORT group, whereby lower job satisfaction (higher job dissatisfaction scores) is observed among those with a claims history (table 7.5(b)).

Table 8.1(c): Factors Associated with Reporting to the Workplace: REPORT [N=103] versus NO REPORT [N=36] : Hierarchical Modeling of Worker Characteristics, Previous WCB, and Job-Related Clusters

Cluster / Variable	Units	OR	95%CI	Risk [CASES are more likely to:]
Previous WCB Claim	Yes vs No	0.77	0.33 - 1.78¶	***not*** have had a previous claim
Peak Reaction Shear [Newtons]	250	2.65	1.41 - 4.97	have ***higher*** Peak Shear
Physical Exertion [0-6]	2	2.28	1.16 - 4.48	have ***higher*** perceived physical exertion
Job Dissatisfaction [2-7]	1	0.66	0.46 - 0.96	have ***higher*** job satisfaction

¶ - p-value > 0.10

Stage II - Step IV: Worker Characteristics, Previous WCB, Work-Related Factors, and Clinical Factors

The addition of the modified Roland Scale produced a further decrease in the point estimate of the odds ratio for previous WCB claim to 0.51, a decrease of 44% from the bivariate odds ratio (see table 8.1(d)). The odds ratio for the modified Roland Scale itself increases from 3.13 to 4.09 [95%CI 1.93-8.77], an

increase of 31%. Inspection of the modified Roland Scale by previous WCB claim indicates an association between these two variables in that workers with a claims history report higher Roland scores (and indeed, higher Pain Intensity scores). This suggests that the effect of the Roland score on the outcome may be dependent on previous WCB status. However, in a fully specified model with these two variables only, the interaction term was not significant and the main effects were consistent with the results in table 8.1(d). Point estimates for peak reaction shear and perceived exertion again remained relatively unchanged, while the odds ratio for job dissatisfaction returned to the magnitude seen in Stage I Step II.

Table 8.1(d): Factors Associated with Reporting to the Workplace: REPORT [N=103] versus NO REPORT [N=36] : Hierarchical Modeling of Worker Characteristics, Previous WCB, Job-Related Factors, and Clinical Clusters

Cluster / Variable	Units	OR	95%CI	Risk [CASES are more likely to:]
Previous WCB Claim	Yes vs No	**0.51**	0.19 - 1.31¶	***not*** have had a previous claim
Peak Reaction Shear [Newtons]	250	**3.09**	1.56 - 6.11	have ***higher*** Peak Shear
Physical Exertion [0-6]	2	**2.50**	1.16 - 5.37	have ***higher*** perceived physical exertion
Job Dissatisfaction [2-7]	1	**0.71**	0.47 - 1.05	have ***higher*** job satisfaction
Roland [0-18]	8	**4.09**	1.91 - 8.77	have ***increased*** functional limitations

¶ - p-value > 0.10

Inspection of table 8.1(e) indicates that a model containing only previous WCB claim as a predictor variable does very poorly in predicting the status of those reporting low-back pain to the nursing station. All three model diagnostics indicate an unacceptable model fit with little of the outcome explained. Note that the GFI_{HW} is not calculated for a model with a single binary predictor since it is based on deciles of risk (and in this case there are only two). However, the sensitivity for a previous WCB claim of 51/104 = 0.49 and specificity of 18/37=0.48 clearly demonstrates the lack of any predictive ability, at the bivariate level, for previous WCB claim in predicting the reporting status of those with current low-back pain symptoms.

For the model in Step II $R_N^2 = 0.23$ (i.e., 23% of the 'variance' explained), c=0.76 and $GFI_{HW} = 11.7$ (p=0.16). Adding the Clinical Cluster (modified Roland) results in 37% of the variance explained, c=0.82,

Table 8.1(e): Factors Associated with Reporting to the Workplace: REPORT [N=103] versus NO REPORT [N=36] : Model Diagnostics

Cluster	STEP I (1)	STEP II (1 + 2)	STEP III (1 + 2 + 3)	STEP IV (1 + 2 + 3 + 4)
Worker Characteristics none	N/A	$R_N^2 = 0$ c = 0.51 GFI_{HW} = N/A	$R_N^2 = 0.23$ c = 0.76 GFI_{HW} = 11.73 (p=0.16)	$R_N^2 = 0.37$ c = 0.82 GFI_{HW} = 5.37 (p=0.72)
Previous WCB Previous WCB				
Job Related Peak Reaction Shear Physical Exertion Job Dissatisfaction				
Clinical Roland				

and an acceptable fit (GFI_{HW} = 5.37 [p=0.72]).

The results of the analysis for factors associated with reporting low-back pain among those with current symptoms suggests several things of interest. First, although not statistically significant, the multivariate results for "previous WCB claim" suggest that there are among the NO REPORT group a number of workers effectively 'disenfranchised' with the compensation system who, although they have symptoms admittedly less 'severe' than reporters yet potentially more 'chronic', do not report their symptoms to the workplace. In addition, a previous WCB claim may potentially influence how someone reports symptom severity and disability. Workers who report LBP to the workplace are characterized by having higher measured peak reaction shear from job tasks, and simultaneously higher perceived physical exertion required from their jobs. In addition, workers who report low-back pain to the nursing station report lower job dissatisfaction (that is, they are more satisfied with their jobs).

The significance and magnitude of the odds ratio for the modified Roland Scale is important, and may have a number of interpretations. Since both physical job demands and functional impairment remain in the multivariable model, it suggests that workers reporting LBP symptoms to the workplace become more

functionally impaired at the same level of physical job demands. A biomedical interpretation of this suggests a lower 'threshold' in terms of tissue tolerance among the REPORT group (one might expect similar levels of both functional impairment and pain intensity for a given load). Thus higher job demands may result in higher functional impairment and more pain. Note that while Pain Intensity and the Roland are moderately well correlated with each other, neither are correlated at all with peak reaction shear.

Alternatively, a psychosocial interpretation is that workers reporting LBP to the workplace simply over-report their level of functional impairment. Since only half of the reporters in fact have claims, it is difficult to suggest that over-reporting functional disability is motivated by secondary financial gain. Another explanation, one championed by Hadler, is that LBP patients simply do not have the 'coping mechanisms' to deal with the low-back pain and it's sequelae; however other than Mastery, which is neither significant at the bivariate (see table 7.1) or the multivariate level, there are no other measures of coping strategies in this study with which to test this hypothesis.

Section II: Factors Associated with Filing a Compensation Claim: CLAIM vs NO CLAIM

Stage 1 - Step II - Representative Variables Set

Worker Characteristics Cluster

The results of the within-cluster reduction of the Candidate Variable Sets to the Representative Variables Sets in the analysis of CLAIM vs NO CLAIM are shown in table 8.2(a). Included in the Worker Characteristics Set is the variable "Have you had any previous injuries or conditions which have left you with persistent problems and/or required lost time from work?" (Question F.10 from Appendix 4.B2). Claimants are *less likely* to respond positively (OR =0.45 [95%CI 0.20 - 1.03] for Yes vs No). One explanation for this finding is that for those workers who visit the nursing station for an aspirin or analgesic balm (the non-claimants), their low-back pain is part of a more systemic, wide-spread musculoskeletal condition, perhaps

Table 8.2(a): Factors Associated with Filing a Claim: CLAIM [n=61] versus NO CLAIM [n=43] : Representative Variables Sets

Cluster / Variable	Units	OR	95%CI	Risk [Claimants are more likely to:]
Worker Characteristics				
SAQ Sleep Disorders [0-15]	4	**0.57**	0.32 - 1.01	score ***lower*** on sleep disorders scale
previous injuries / conditions	Yes vs No	**0.45**	0.20 - 1.03	***not have*** previous injuries / conditions
Previous WCB				
Previous WCB	Yes vs No	**1.93**	0.87 - 4.26¶	***have*** a previous claim
Job Related Biomechanical / Psychosocial				
Peak Hand Load [kg]	14	**0.74**	0.55 - 1.01	have a ***lower*** peak hand load
Physical Exertion [0-6]	2	**2.25**	1.06 - 4.79	report ***higher*** physical exertion
Empowerment [0-15]	3	**3.53**	1.43 - 8.70	are ***more*** empowered
Clinical, Physical Exam, and Functional Status				
Finger-Floor Distance (inches)	8.5	**1.84**	1.0 - 3.39	have a ***higher*** [worse] score
CPG Pain Intensity [0-100]	30	**4.46**	1.68 - 11.8	report ***higher*** pain intensity

¶ - p-value > 0.10

caused by or aggravated by a work-related incident, or indeed, the everyday conditions of their jobs. There is some evidence of this, albeit weak, in that there is a consistently higher proportion among non-claimants with regular aches, pains and stiffness in their hands (38% vs 29%), who report activity limitation (51% vs 41%) due to joints (excluding back and hips), and with self-reported doctor-diagnosed arthritis (20% vs 16%).

The odds ratio for SAQ Sleep Disorders Score (OR=0.57 [95%CI 0.32 - 1.01] for a 4 point increase in score [0-15]) suggests claimants are *less likely* to suffer from specific sleep problems, which is contrary to published findings. For instance, sleep researchers have hypothesized that nocturnal myoclonus, or 'restless leg syndrome' (one of the 5 Sleep Score items), is responsible for difficulties in initiating or maintaining sleep (insomnia) or for daytime sleepiness or drowsiness and has been positively associated with fibrositis symptoms (Moldofsky, 1986). A study of accident patients (motor vehicle or work related) who

attended a sleep laboratory and underwent polysomnography found no difference in sleep disturbance patterns between those with resolved or unresolved litigation, either WCB or personal motor vehicle insurance (Moldofsky et al., 1993). A study of sleep disturbance and low-back pain, using a later version of the SAQ used in this study, found a higher SAQ score among cases compared to controls (Cesta, 1998).

Previous WCB Claim

In contrast to the previous results, previous WCB claim was positively, albeit marginally, associated with the *current* decision to file a claim at a bivariate level (OR= 1.93 [95%CI=0.87- 4.26] for Yes vs No). Thus it appears that claimants are more likely to have a claims history compared to non-claimants, and as a group, the CLAIM group are less likely (in the multivariate model) to have a claims history compared to the NO CLAIM group.

Work-Related Cluster

The results of the within-cluster reduction of the Work-Related Variables indicates that claimants are less likely to have a higher peak hand load (OR = 0.74 [95%CI 0.55-1.01] for an increase of 14 kg). Inspection of the candidate Work-Related variables by job title reveals some interesting patterns (see figures 8.1(a) and (b)). Assembly work is clearly characterized by high psychosocial demands and low control compared to Support, Utility, and Maintenance work. While no differences among the job title classifications are observed for social support or integrated compression, peak shear and peak hand load do show rank-order associations with job title. Thus, the presence of peak hand load in the Representative Variables Set is interpreted as a marker for job title, which captures differences in the amount of job control and psychological demands. Recall that assembly work is characterized by light, repetitive, and monotonous machine-paced work, while maintenance is characterized by periods of sedentary monitoring of mechanical or electrical systems, with a high amount of control over scheduled maintenance tasks. Indeed, substituting "Job Control" for "Peak hand load" in the Representative Variable set for the Work-Related Cluster in this instance results in a model with comparable model diagnostics in terms of model fit (c=0.69) and explained

Figure 8.1(a): Job Control, Psychological Demands, and Social Support by Job Title Among REPORTERS (N=137)

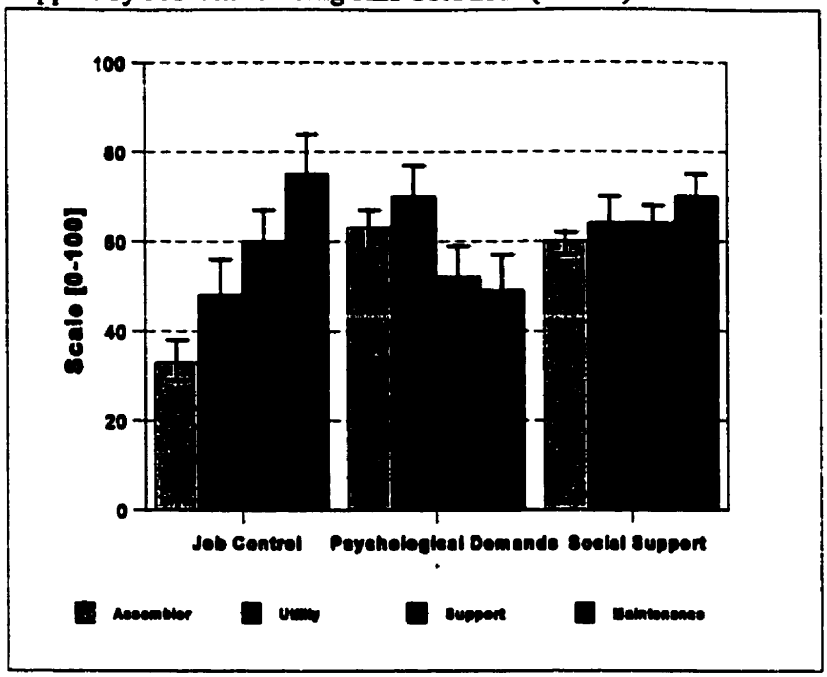
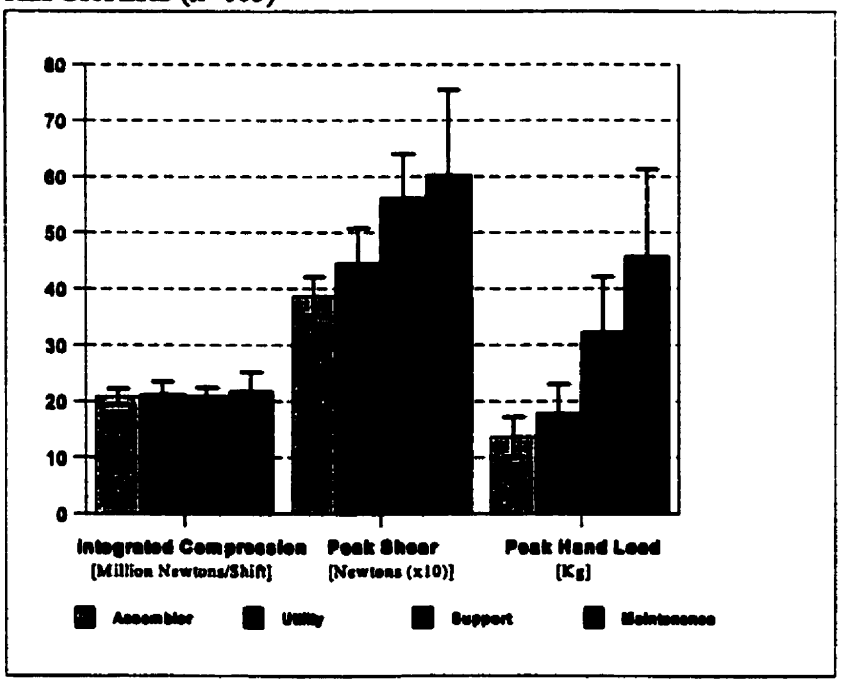


Figure 8.1(b) Integrated Compression (mil N/shift), Peak Reaction Shear (N x 10), and Peak Hand Load (Kilograms) by Job Title for REPORTERS (n=105)



variance (R_N^2 = 0.14), although the point estimate for job control is slightly less significant (p=0.09) than that for peak hand load (p=0.05).

It is worthwhile to point out that at the point in the backwards selection process when peak flexion velocity is removed, both peak reaction shear and job control change from being marginally significant to being completely non-significant. Inspection of model diagnostics suggests that a model with these three variables was not a good fit to the data (possible overfit), and they were allowed to be removed from the model.

Claimants have a higher perceived physical exertion score (OR= 2.25 [95%CI 1.06-4.79], for a 2 point increase in score [0-6]) compared to non-claimants. The interpretation of this finding is similar to that for the REPORT vs NO

REPORT comparison. The suggestion is that perceived exertion may be in part affected by symptom severity, and that the exertion variable more succinctly captures aerobic and physiological elements of the physical demands of the job.

A simple linear regression of integrated compression, peak reaction shear, awkward posture, peak flexion, and flexion velocity on perceived exertion explains 20% of the variance among the n=105 REPORT group; adding pain intensity and Roland score improves that only slightly to 22% variance explained.

Claimants were more likely to report *higher* worker empowerment scores (OR=3.53 [95%CI 1.43-8.70] for a 3 point increase [0-15]). The work empowerment scale measures the ability of the worker to participate in the workplace and possibly affect change *beyond* the scope of the worker's current job and set of work tasks. Empowerment is distinguished from Job Control as the latter scale addresses control over immediate job tasks. The inclusion of worker empowerment in the Work-Related Cluster suggests that a feeling of adequacy and investment in the workplace enable workers to file compensation claims without fear of reproach or negative consequence.

Clinical Cluster

Two variables represent the Clinical Cluster. Finger-floor distance (OR = 1.84 [95%CI 1.0 - 3.39] for an increase of 8.5 inches [a higher score is 'worse']) and Pain Intensity from the Chronic Pain Grade (OR=4.46 [95%CI 1.66-11.8] for an increase of 30 points [scale 0-100]). These two variables represent the physical exam findings, an 'observable' measure, and also the 'unobservable' self-reported pain intensity. An interpretation of having both variables in the model is that, holding the physical finding constant, claimants report higher pain.

Pain intensity has been reported to be higher among claimants in previous studies (Tollison 1993; Ambrosius 1995; Rainville 1997) although not in others (Mendelson, 1984; Tollison, 1990). Several studies report an increased finger-floor distance or reduced range of motion (Rainville et al., 1997), while others failed to find that low-back patients differed by compensation status (Ambrosius et al., 1995).

Pain Intensity and Roland again overlap statistically in this model. The Roland Score is the last variable removed from the Clinical Cluster, and models containing either Roland or Pain Intensity with finger-floor distance have similar model diagnostics ($R^2_N \sim 0.25$, $c \sim 0.75$). In two previous studies, one found no difference on the Roland between compensated and non-compensated low-back patients (Hadler et al., 1995) while one study reported significantly higher Roland scores among compensation claimants (Atlas et al., 1996). In this case, since Pain Intensity remained in the model following the rules set out for analysis, it was retained in the model and the Roland measure was not.

CLAIM vs NO CLAIM: Hierarchical Analysis of Clusters

Stage II - Step I: Worker Characteristics Cluster

The model in this stage contains the two variables as listed in table 8.2(a).

Stage II - Step II: Worker Characteristics Cluster and Previous WCB Claim

The model with previous claim and the Worker Characteristics Cluster is shown in table 8.2(b). While none of the point estimates changes more than 20%, the odds ratio for previous injuries and conditions becomes insignificant with $p > 0.10$ and is removed from the model. Previous WCB, which is forced into the model, is significant at $p \leq 0.10$ (OR = 2.07 [95%CI 0.91-4.68]) in the model with sleep disorders.

Table 8.2(b): Factors Associated with Filing a Claim: CLAIM [n=61] versus NO CLAIM [n=43]: Hierarchical Modeling of Worker Characteristics and Previous WCB Clusters

Cluster / Variable	Units	OR	95%CI	Risk [Claimants are more likely to:]
previous injuries / conditions	Yes vs No	**0.51**	0.22 - 1.18¶	***not have*** previous injuries / conditions
SAQ Sleep Disorders [0-15]	4	**0.55**	0.31 - 0.98	have ***fewer*** sleep disorders
Previous WCB	Yes vs No	**1.89**	0.82 - 4.36¶	***have*** a previous claim
Reduced Model:				
SAQ Sleep Disorders [0-15]	4	**0.52**	0.29 - 0.92	have ***fewer*** sleep disorders
Previous WCB	Yes vs No	**2.07**	0.91 - 4.68	***have*** a previous claim

¶ - p-value > 0.10

Stage II Step III: Worker Characteristics, Previous WCB, and Work-Related Cluster

With the addition of the representative variables from the Work-Related Cluster, all the odds ratios remain significant at $p \leq 0.10$ and no variables are removed from the model at this stage (table 8.2(c)). The odds ratio for worker empowerment increases 22% from 3.53 to 4.29 [95%CI 1.65 - 11.2]. Table 7.5(a) indicates that worker empowerment does **not** differ by previous WCB status among those who report their LBP to the workplace.

Table 8.2(c): Factors Associated with Filing a Claim: CLAIM [n=61] versus NO CLAIM [n=43] : Hierarchical Modeling of Worker Characteristics, Previous WCB, and Work-Related Clusters

Cluster / Variable	Units	OR	95%CI	Risk [Claimants are more likely to:]
SAQ Sleep Disorders [0-15]	4	**0.47**	0.25 - 0.89	have ***fewer*** sleep disorders
Previous WCB	Yes vs No	**2.21**	0.92 - 5.36	***have*** a previous claim
Peak Hand Load [kg]	14	**0.74**	0.54 - 1.01	have a ***lower*** peak hand load
Physical Exertion [0-6]	2	**2.22**	1.02 - 4.81	report ***higher*** physical exertion
Empowerment [0-15]	3	**4.29**	1.65 - 11.2	are ***more*** empowered

Stage II - Step IV: Worker Characteristics, Previous WCB, Work-Related Factors, and Clinical Factors

With the addition of the representative variables from the Clinical Cluster, finger-floor distance (first, at p=0.21) and peak-hand load (second, at p=0.18) are removed from the model. The odds ratio for Pain Intensity increases 43% from 4.46 to 6.04 [95%CI 2.37 - 17.3] in the final reduced model. Both 'Pain Intensity' and 'Empowerment' display fairly wide confidence intervals, which is a caution that there may be some sparse covariate patterns at this point in the model.

The final model in the CLAIM vs NO CLAIM comparison suggests that, although no specific biomechanical variable remains, perceived physical exertion is an important predictor of claims status. The interpretation of this variable has already been provided - it may be picking up aerobic and physiological demands of the job not captured in the biomechanical risk factors set. Claimants appear to suffer from *fewer*

specific sleep pathologies compared to non-claimants; this is an unexpected finding, since it had been expected that claimants may suffer from more sleep disorders. Claimants were more likely to be more

Table 8.2(d): Factors Associated with Filing a Claim: CLAIM [n=61] versus NO CLAIM [n=43] : Hierarchical Modeling of Worker Characteristics, Previous WCB, Work-Related and Clinical Clusters

Cluster / Variable	Units	OR	95%CI	Risk [Claimants are more likely to:]
SAQ Sleep Disorders [0-15]	4	**0.43**	0.21 - 0.88	have ***fewer*** sleep disorders
Previous WCB	Yes vs No	**1.98**	0.71 - 5.53¶	***have*** a previous claim
Peak Hand Load [kg]	14	**0.79**	0.55 - 1.11¶	have a ***lower*** peak hand load
Physical Exertion [0-6]	2	**3.05**	1.19 - 7.79	report ***higher*** physical exertion
Empowerment [0-15]	4	**6.04**	1.97 - 18.7	are ***more*** empowered
Finger-Floor Distance (inches)	8.5	**1.58**	0.77 - 3.22¶	have a ***higher*** [worse] score
CPG Pain Intensity [0-100]	30	**5.94**	1.89 - 18.7	report ***higher*** pain intensity
Reduced Model:				
SAQ Sleep Disorders [0-15]	4	**0.45**	0.23 - 0.90	have ***fewer*** sleep disorders
Previous WCB	Yes vs No	**2.20**	0.85 - 5.67¶	***have*** a previous claim
Physical Exertion [0-6]	2	**2.61**	1.13 - 6.03	report ***higher*** physical exertion
Empowerment [0-15]	4	**4.23**	1.61 - 11.1	are ***more*** empowered
CPG Pain Intensity [0-100]	30	**6.40**	2.37 - 17.3	report ***higher*** pain intensity

¶ - p-value > 0.10

empowered, indicating that their perception of the psychosocial environment above the level of their immediate job and supervisor is an important factor. Lastly, claimants were more likely to be in more intense pain.

Table 8.2(e) shows the diagnostics from the sequential hierarchical models. The Worker Characteristics Cluster explains 11% of the variance and fits the data well (c=0.67, GFI_{HW} = 11.2, p=0.19). The second level of the model, with the addition of 'previous WCB claim' and removal of 'previous injuries and conditions', results in a very similar model (R_N^2 = 0.10, c=0.65, GFI_{HW} = 9.69, p=0.29). Adding the variables in the Work-Related cluster improves R_N^2 = 0.24, c = 0.74, and GFI_{HW} = 4.81 (p=0.78). None of

the variables were removed at this stage of the model. With the addition of the Clinical Cluster, finger-floor distance and peak hand load are removed, leaving five variables in the final model ('previous WCB claim' is non-significant at $p \leq 0.10$). R_N^2 increases to 0.38, c=0.81, and the Hosmer-Lemeshow statistic indicates an acceptable fit to the data.

Table 8.2(e): Factors Associated with Filing a Claim: CLAIM [n=61] versus NO CLAIM [n=43] : Model Diagnostics

Cluster	Step I (1)	Step II‡ (1 + 2)	Step III (1 + 2 + 3)	Step IV (1 + 2 + 3 + 4)
1. Worker Characteristics Sleep Disorders Previous Injuries / Conditions†	$R_N^2 = 0.11$ c = 0.67 $GFI_{HW} = 11.18$ (p=0.19)	$R_N^2 = 0.10$ c = 0.65 $GFI_{HW} = 9.69$ (p=0.29)	$R_N^2 = 0.24$ c = 0.74 $GFI_{HW} = 4.81$ (p=0.78)	$R_N^2 = 0.38$ c = 0.81 $GFI_{HW} = 11.8$ (p=0.16)
2. Previous WCB Previous WCB				
3. Job Related Peak Hand Load† Physical Exertion Empowerment				
4. Clinical Finger-Floor Distance† Pain Intensity				

† - Variable removed from final reduced model ($p > 0.10$) with the addition of sequential clusters

‡ - Model diagnostics refers to reduced model after removal of variables where $p > 0.10$

Bibliography - Chapter 8

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Chapter 9 - Discussion, Limitations and Strengths, and Final Conclusions

Discussion

Incidence Rates of Report and Claim Laying

The overall incidence rate for reporting LBP in this study was estimated at 23.7 reports per 1000 workers per year, with a confidence interval (using the values weighted for person-months accrual by plant)for small values of p calculated by the method suggested by Fleiss of 15.5 to 34.5 reports per 1000 workers per year (Fleiss, 1981). Just over half of these lead to claims (13.0 claims per 1000 workers per year). These observed rates of injury reporting and claims laying compare with Daltroy and colleagues (1991) who followed 4000 postal workers (sorters and mail handlers) for 40 months (March 1985 to June 1988). A total of 235 events (claims) were observed, a claim rate of 17.6 claims per 1000 workers per year. Similarly, Bigos and colleagues (1992) followed 3020 aircraft assemblers for 4 years, reporting an incidence rate of 23.1 reports per 1000 workers per year. Rossignol and colleagues (1993), following 269 aircraft assemblers for 12 months, reported a somewhat lower claim rate at 5.0 claims per 1000 workers per year. Thus the estimated reporting and claims rates observed in this study are similar to others reported in the literature.

Reporting and claim rates were both found to differ between the Truck and Car Plants. It was suggested that the higher proportion of claimants among the cases accrued from the Truck Plant was more likely due to adversarial labour-management relations rather than truck assembly being inherently more dangerous, or risky. Among the cases in this study, those in the Truck plant reported lower empowerment and were less satisfied with the perceived support from management with respect to health and safety issues. This observation, on the structural importance of social relations in the broader social environment, underlies the importance of psychosocial factors and social relations at the individual level.

A study by Heaney and colleagues (1993) found that a participatory intervention aimed at reducing

workplace stress was less effective in a plant with a management style characterized by detailed task specialization with few opportunities to influence the work process or participate directly in work-related decisions (a 'mass-production paradigm'), compared to one where workers actively participated in solving work-related problems. In the second plant, management fully endorsed the intervention project, took an active role in it's implementation, and was much more successful at actually reducing stress levels, especially so for those workers with more involvement in the project (Heaney et al., 1993).

Worker Characteristics and Previous Workers' Compensation Claim

Previous claim was considered an important factor in the conceptual framework. These data suggest that for some workers a claims history may result in longer term adverse consequences (table 7.5(a)). Among the NO REPORT group, previous WCB claim was positively associated with more chronic low-back pain, lower job satisfaction, marginally lower job control, and lower Job Self Worth scores. Given that *higher* job satisfaction was associated with the decision to report to the workplace, perhaps the reaction in the workplace of coworkers and supervisors to the claim, although positive at first, might ultimately evolve into a more neutral or adversarial relationship. Roberts and Markel (1999) reported a significant effect of 'interactional justice' (referring to the quality of the interaction between an individual and a superior) in the decision to file a claim, but no effect for having filed a claim on repeat measures of justice and fairness. However, the one year follow-up schedule for the repeat measures may not have been long enough for some of the negative consequences to have developed and be detected. A higher proportion of 'psychological disturbance' among compensated LBP cases was reported over a five-year follow up by Greenough and Fraser (1989).

Previous claimants may also become sceptical of the efficacy of reporting LBP to the workplace. Certainly, anecdotal evidence garnered from contact with workers suggests that some workers took to managing their symptoms themselves, either through the use of analgesics at the worksite, or through regular 'maintenance' visits to chiropractors or physiotherapists. There is no hard data *per se* to support this hypothesis, but the insight gained is provided as a possible explanation of the patterns in the data for previous

claimants.

Additional anecdotal evidence from the nurses suggests that workers with a low-back condition are encouraged to maintain 'continuity' for the claim. Consider a worker who files an accepted compensation claim for low-back pain. Perhaps time off work is required, but ultimately the worker 'heals' and returns to work. That is not to suggest that the worker does not continue to experience symptoms - recall that in these data, 32% of randomly selected population controls had unreported current low-back symptoms in the previous week[1]. After some time - say 6 months - the injury is considered 'healed' by the administrative process at the Board[2]. Should the worker have a relapse of symptoms, a subsequent submission of claim might be rejected, since the injury had already been compensated and was considered healed. Thus visits to the nursing station with those milder, transient and recurring symptoms may assist in establishing medical continuity of the condition and therefore facilitate re-opening of the claim if it becomes necessary.

Previous WCB Claim status was negatively associated with REPORTING low-back pain (OR=0.51 [95%CI 0.19-1.31]) although the confidence interval is fairly wide. This is contrary to published findings, which has established previous claim (and a history of past low-back pain episodes) as a risk factor for future low-back pain symptoms, and indeed for claims (i.e., Daltroy et al., 1991; Rossignol, 1993). The odds ratio for previous claim associated with filing a claim for current LBP symptoms was found to be 2.20 [95%CI 0.85-5.67], although it was only of borderline significance. Perhaps the positive association with previous and current claim (given the report to the workplace) is explained by workers' learning to be more 'successful' within the system.

The lowest proportion of previous claim was observed among the non-claimants, and it has been

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1. Similarly, in a study of upper extremity disorders, only about one third of workers with symptoms had reported to the workplace (Polanyi et al., 1997).

2. The current government attempted to restrict entitlement for 'chronic pain' to 6 months by explicitly writing it into Bill 99; organized opposition to this was mounted, and the scientific evidence around chronic pain is currently under review by an Expert Panel at the WSIB.

suggested that these workers seem to have a qualitatively different set of aches and pains, of which low-back pain is part. Non-claimants were more likely to have a previous injury or condition which had left them with persistent pain, although this did not remain significant in the final model. Nonetheless, a similar finding was reported by Daltroy and colleagues (1992), who found a inverse association between 'other injuries' and LBP claim (OR=0.69). Previous injuries reported by participants in the OUBPS study were not necessarily low-back injuries, and did not necessarily lead to a claim. However, it may explain why non-claimants also experience *more* sleep disturbances (OR=0.45 [95%CI .23-0.90]), which remained a significant factor associated with filing a claim for LBP. Sleep disorders have been associated with systemic musculoskeletal conditions such as fibromyalgia and chronic fatigue syndrome (Moldofsky, 1986; Moldofsky, 1989).

Workplace Characteristics - Biomechanical and Psychosocial

A striking feature of these data is the remarkable split between reporters and non-reporters on virtually every biomechanical measure at the bivariate level (table 7.3(a)). Biomechanical demands were represented in the final multivariable model for reporting low-back pain (table 8.1 (d)) by peak reaction shear (OR=3.09 [95%CI 1.56-6.11] for an increase of 250 Newtons). Thus workers who *report* their low-back pain symptoms to the workplace have quantitatively higher task demands than those who do not. Clearly, these results provide legitimacy to the visits to the nursing station. Table 7.3(a) clearly indicates that workers who reported their symptoms to the workplace had higher measures on virtually every physical demands measure listed. Per-cent time in an awkward posture, a significant risk factor reported by Punnett and colleagues (1991), was not significant in this analysis.

As striking is the difference on biomechanical measures associated with reporting LBP symptoms, the similarity on biomechanical measures associated with laying a claim for LBP symptoms is just as noticeable (table 7.3(a)). Peak hand load, representing workplace factors associated with filing a claim (see table 8.2(a)), was in a direction contrary to expectations (OR=0.74 [95%CI 0.55-1.01]). Peak hand load may be interpreted to be a marker for jobs that have high decision latitude and control over work tasks (see figures

8.1(a) and (b)), allowing symptomatic workers to self-manage their symptoms at the workplace by modifying job tasks or duties as required. An inverse relationship between back symptoms and Job Control was reported by Hoekstra and colleagues (1994). These work conditions are less likely to occur among assemblers, whose work is characterized by machine-paced, repetitive and monotonous work. In any event, peak hand load did not remain in the final multivariable model (table 8.2(d)).

It is also possible that the observed similarity between claimants and non-claimants on biomechanical measures is due to the self-selection of those workers who ultimately file a claim for low-back pain to jobs with relatively lower demands on the low-back. The start of the current 'episode' of symptoms was somewhat arbitrarily anchored to the date of the report to nurses, although workers may have been experiencing pain prior to their accrual into the study. It may be that the decision to file a claim is subsequent to the inability of a job change to alleviate symptoms. Recent job change was found to be to be a significant risk factor for claim laying in a case referent analysis (Daltroy et al., 1991); however, there was no significant difference between claimants and non-claimants on time on current job in these data (3.4 (±5.4) vs 3.0 (±4.8) years respectively, p=0.68).

It is important to note that the results for biomechanical demands in this analysis does not apply to the *onset* of low-back pain. Epidemiology has established a strong etiological relationship between biomechanical work demands and the onset of low-back pain (i.e., Burdorf and Sorrock, 1997; NIOSH, 1997; Shelerud 1998) and the biological mechanism for disease has been shown (i.e., Garg, 1992; Adams and Dolan, 1995). The results of this analysis indicate that even among symptomatic workers, those with job tasks that produce higher loads on the lumbar spine are more likely to report their low-back pain to the workplace, even after controlling for perceived physical exertion and LBP severity as measured by the Roland, table 8.1(d). However among workers who do report their LBP, direct biomechanical loads on the lumbar spine do not appear to be associated with the decision to file a compensation claim.

A measure that straddles the psychosocial and biomechanical domains is perceived physical exertion.

Perceived physical demands remained in both models and was a strong factor in both reporting (OR 2.5 [95%CI 1.16-5.37]) and claims laying (OR 2.61 [95%CI 1.13-6.03]). Both measured and perceived biomechanical demands remained in the model for reporting low-back pain (table 8.1(d)). But what exactly does it measure? The measured biomechanical forces on the lumbar spine capture only a small portion of its variance. In addition to lumbar forces, there are also aerobic and metabolic demands associated with job tasks, which may be collinear with high spinal demands. Conversely, it may be that workers reporting low-back pain perceive their jobs to be more physically demanding, which may be in part due to more intense or severe symptoms and pain.

The psychosocial variables remaining in the two models are in truth very similar. From an organizational psychology perspective, job satisfaction and empowerment are distinct constructs. However, they are somewhat collinear from a statistical perspective ($r = -0.49$ among those who report and $r = -0.41$ among those who do not) and path analysis has shown that empowerment is a powerful antecedent to job satisfaction, as well as being an independent predictor of upper extremity musculoskeletal pain intensity (Ibrahim and Smith, 1999). Reporting low-back pain was associated with *higher* job satisfaction (the inverse of the odds ratio in table 8.1(d) is 1.41) while laying a claim was associated with higher worker empowerment with an OR of 4.23 (table 8.2(d)).

Since there is little difference in measured biomechanical loads between the CLAIM and NO CLAIM groups, the result for worker empowerment suggests an important role for the ability of the worker to make claims for physical symptoms arising from job tasks with impunity, whether the threat of reprisal from the workplace is real or perceived. The role of worker empowerment in low-back pain reporting or claims laying has not been studied in any great detail. However a recent review indicates that successful prevention strategies for LBP includes a positive acceptance of worker-reported low-back pain and a company policy of encouraging workers to report all LBP symptoms (Kaplansky et al., 1998).

Low job satisfaction has consistently been associated with the onset of low-back pain symptoms.

Five of seven studies included in the Burdorf review found low-job satisfaction to be associated with low-back pain (Burdorf and Sorock,1997), while 9 of 12 studies reviewed by Bongers and colleagues found a positive association (Bongers et al., 1993). No studies included in those reviews found higher job satisfaction associated with low-back pain, a key finding in this research. The result for job satisfaction in this study is contrary to those reported by Bigos and colleagues (1992) and von Poppel (1999). Workers who 'never' enjoyed the tasks involved in their jobs were 1.7 times more likely to report a low-back pain complaint to the worksite in a 4-year follow up. As pointed out by Frank and colleagues (1995) the Bigos result was not adjusted for physical demands, and in this thesis task enjoyment was combined with overall job satisfaction to form the construct.

This disparity between the results from this study and the Boeing Study may be due to several factors. First, the odds ratio reported in this thesis is based on a smaller number of subjects and is not significant at the traditional $\alpha = 0.05$ level, thus the 95% confidence limit includes unity (95%CI 0.47-1.05). Second, this study is cross-sectional and a differential selection bias may have resulted in those workers reporting LBP to the workplace who are truly dissatisfied to be less likely to take part in the study. Third, the control group in this study consists of symptomatic workers, and is different from the comparative group in the Boeing study. Fourth, job satisfaction may have been influenced by the injury, although this is unlikely since the time between the notification of report to the study team and the baseline interview was generally less than two weeks. Keyes and colleagues (1997) reported that job satisfaction measures before and after injury were not different on a paired t-test, nor were they different based on satisfaction with medical care.

Clinical Factors

Consistent with the theoretical framework laid out in chapter 3, symptom severity was important in both the decision to report low-back pain and to file a claim. Workers who report their symptoms to the workplace have increased functional limitation as measured by the modified Roland Scale (OR=4.09 [95%CI

1.91-8.77]), while among those who report, those that file a claim report higher pain intensity (OR=6.40 [95%CI 2.37-17.3]). These findings are consistent with previously published results listed in table 2.3 (Atlas et al., 1996; Rainville et al., 1997). Pain (i.e., CPG Pain Intensity) and disability (i.e., Roland Scale) are conceptually and clinically distinct constructs (Waddell, 1992), but are closely related statistically in this sample (r=0.66 among those who report and r=0.54 among those who do not). Thus, although different variables represent the clinical cluster in each model, they are in fact remarkably similar.

The inclusion of finger-floor distance along with pain intensity representing the clinical cluster comparing claimants to non-claimants is an interesting finding, and consistent with previously published results listed in table 2.3 (Ambrosius et al., 95; Rainville et al., 1997). The statistical interpretation of the Representative model for the Clinical Cluster in table 8.2(a) is that for similar levels of measured physical impairment, claimants report higher pain intensity. This could be due to a heightened pain sensitivity or awareness among claimants. Claimants were not as strong as non-claimants as measured by grip strength (450 vs 485, p=0.07), which was included in the physical exam as a surrogate measure of general fitness (OUBPS Clinical Subgroup, 1993). This suggests a lower tissue tolerance among the claimants, in that similar biomechanical forces may result in more tissue damage and increased pain intensity.

It is also possible that claimants consciously over-exaggerate their symptoms, although overt malingering is rare, occurring in less than 5% of patients (Leavitt and Sweet, 1986) and intense investigation of fraudulent claims results in very few convictions (Michaels, 1998). In any event, finger-floor distance did not remain in the final model of factors associated with filing a claim. Keep in mind that conscious over-exaggeration of symptoms, if accepted as an explanation for the observed results, may be a strategy for acceptance of a claim in an adversarial regulatory environment, and not simply motivated by financial gain without work. Claimants were also more likely to report higher physical exertion (suggested to capture task demands other than spinal loads), which may account for the observed higher pain intensity in claimants.

Since both physical job demands and functional impairment remain in the multivariable model for

reporting LBP to the workplace, it suggests that workers who report LBP to the workplace become more functionally impaired at the same level of physical job demands. A biomedical interpretation of this suggests a lower 'threshold' in terms of tissue tolerance among the REPORT group, or a heightened sensitivity to pain perhaps leading to increased functional disability. Inspection of table 7.4(a) indicates lower scores for grip strength among both reporters and claimants than their comparators; grip strength was included in the physical exam as a proxy for the overall level of fitness (OUBPS Clinical Subgroup, 1993), which may explain the observed results. An alternative 'tautological' explanation is also possible, in that performance of more demanding job tasks may be become impaired at lower levels of injury severity.

Limitations

Temporal Relationship

Case-control (or case-referent) studies such as this one are subject to several limitations due to the study design. An incidence-density sampling strategy was used to accrue the sample of workers who appeared to first-aid stations to report low-back pain symptoms or file compensation claims. These subjects were then interviewed and the biomechanical demands of their job's were measured. Although the case-control design is far more efficient and less costly than a prospective study, the drawback is a potential 'distortion' of risk factors. In this study, for instance, low-back pain symptoms may affect how a worker performs his/her job tasks, resulting in bias in the measured demands. Similarly, interactions with the medical staff, supervisors, coworkers, and the WSIB following an LBP episode may have influenced responses on the psychosocial questions. Given that the average elapsed time was 12 days (range 1-30), this is likely not a problem in these data.

Selection Bias

Several comparisons are possible to assess potential bias in the representativeness of the sample accrued to the underlying sampling frame. Based on a list of names from GM's personnel office obtained

with the approval of both union and management, Kerr (1998) has shown that the study was notified of 24% (90 of 381) of workers who filed a claim during the accrual period in the two plants. By matching claim numbers from WSIB records (which are available to IWH researchers through a data access agreement with the Board) it was determined that workers with compensation claims 'captured' by the accrual did not differ from those 'escapees' on age, gender, time at current job, and claim duration (Kerr, 1998; p.101).

Workers at GM must go through the first-aid station to file a compensation claim. The study coordinator was in virtual daily contact with the nursing teams at both plants in order to collect names of possible participants and counts of front-end refusals. This accrual strategy was meant to maximize the capture of all possible claims and workplace reports of low-back pain. The low claim ascertainment rate can only be explained by the burden of a heavy workload among the nurses who may have forgotten to ask potential study participants, and that the upfront refusal rate to the nurses was likely much higher than is recorded in table 6.1. In addition, the accrual process protected participant confidentiality with the nursing staff, and the conduct of the study by the IWH and U of W researchers ensured that the study was not seen in the workplace as a management initiative.

The option of bypassing the plant medical services and going to their own health-care provider for an LBP episode is certainly open to all workers, and in this case, such individuals would not be in the study unless they participated as a randomly selected control. It is also possible that workers with low-back pain might choose alternative coverage options to workers' compensation. The benefits structure at GM allow a small number of personal days, and symptomatic workers may choose to take a personal day rather than file a claim. For lost-time episodes of longer than a day or two, workers may choose short-term disability coverage. These last two options, however, are likely not very probable given the emphasis by the union and the company on reporting work-related symptoms.

Missing Data

Comparison of questionnaire and physical exam data by completion of the physical demands analysis

reveals some interesting findings. Among the symptomatic random controls, those who did not have a biomechanical assessment (20 / 57) reported significantly **lower** social support (56 vs 62, p=0.04). Since this analysis included only those with biomechanical data, this may explain in part why social support did not remain in the model examining factors associated with reporting (i.e., higher social support may indeed be associated with reporting LBP symptoms to the workplace). In addition, symptomatic non-reporters without a biomechanical assessment reported **higher** disability on the Roland (8.1 vs 5.3, p=0.04), which may have resulted in an underestimation of the odds ratio that appears in table 8.1(d).

Among claimants, those who did not receive a biomechanical assessment reported significantly **lower** perceived exertion compared to those whose jobs were assessed (6.4±1.3 vs 7.1±1.1, p=0.06). Therefore the odds ratio for perceived exertion in the model examining factors associated with filing a claim (table 8.2(d)) may be overestimated. Among non-claimants, those without a biomechanical assessment had lower sleep disorder scores compared to those with assessments (4.3 ±2.7 vs 6.4 ±2.7, $p < 0.01$). Thus the odds ratio for sleep disorders in table 8.2(d) may have been overestimated.

Proxy Data

Using proxy assessment data may have introduced error into the biomechanical data, particularly given the objection raised by Dr's Norman and Wells (Hagberg, 1992). Tables 9.1(a) and (b) show the changes in the odds ratios in the final models by removing the 21 proxy data sets. The effect estimate for peak reaction shear (table 9.1(a)) in the sensitivity analysis is relatively unchanged. This suggests that there is no reason to suspect systematic bias in using the job-matched control data as proxy. This is consistent with the moderate to good agreement observed for biomechanical measures reported by Kerr (1998). Fairly large changes are observed in the effect estimates for previous WCB and pain intensity in the sensitivity analysis for the second model. This is likely explained by the association between claims and the ascertainment rate for biomechanical assessments (see table 6.4).

Sample Size, Power, and Model Validity

The small numbers of participants available for analysis is a limitation of the study. While this is in part due to the accrual, restricting the analysis to those with biomechanical data further reduces the power

Table 9.1(a): Results of Sensitivity Analysis (Removal of Proxy Biomechanical Data): Factors Associated with REPORTING Low-Back Pain: REPORT [n=83] vs No-Report [n=36]

Variable	OR (Sensitivity Model)	% change from table 8.1(d)
Previous WCB	0.55	+ 8%
Peak Reaction Shear	2.74	- 11%
Physical Exertion	2.56	+ 2%
Job Dissatisfaction	0.65	- 9%
Roland	3.77	- 8%

Table 9.1(b): Results of Sensitivity Analysis (Removal of Proxy Biomechanical Data): Factors Associated with CLAIM for Low-Back Pain: CLAIM [n=46] vs non-CLAIM [n=38]

Variable	OR (Sensitivity Model)	% change from table 8.2(d)
Sleep Disorders	0.37	- 18%
Previous WCB	2.78	+ 26%
Physical Exertion	2.71	+ 4%
Empowerment	3.96	- 6%
Pain Intensity	8.17	+ 28%

of the study to detect differences between groups. The power of a study refers to its ability to detect true significant associations (rejecting the null hypothesis H_o: $\beta=0$ when it is false). In order to detect weaker associations, more subjects are needed in order to rule out chance. Small sample studies are also particularly vulnerable to statistical problems that arise from sparse covariate patterns. Simulation studies by Peduzzi and colleagues (1996) show that events per variable (EPV) ratios of less than 10 results in increases in bidirectional bias of coefficients and a loss of statistical precision. In this study, 5 variables were left in the

model explaining reporting to the workplace (EPV=7) and 5 in the model explaining filing a claim (EPV=9), therefor bias is a possibility.

Large confidence intervals were observed for Pain Intensity and Empowerment in table 8.2(d). Inspection of odds ratios in univariate logistic models for dummy variables representing high and medium scores compared to low (based on tertiles) did not suggest departures from the linear risk assumption of the logistic model, suggesting a stable and sensible relationship; thus Pain Intensity and Empowerment remained in the model in their continuous forms. The final models were able to detect odds ratios of ~2.0 and ~2.5 respectively with power of roughly 0.86 (the second model, although a smaller N, had a higher proportion of outcomes to total number of subjects). The analytical approach deliberately set out to minimize the number of variables in the final two models in order to avoid some of these problems. That significant odds ratios were found is a testament to the strength of the association between reporting or claims laying, and the measured work-related and clinical variables.

Strengths

There are several unique features of this analysis which contribute to its strength. First, the conceptual framework was developed using advances from the biomedical model of disease to incorporate pathological, psychological, and social factors. The study measures included extensive clinical, psychosocial, and biomechanical factors recorded at an individual level. This rich supply of data is likely one of a kind in the world today. The outcomes were explicit in being socio-medical, rather than being based on a pathological definition of disease. Thus it is not a traditional etiological risk factor study per se; rather, a socio-medical paradigm of low-back pain has been adopted with analysis of decision thresholds in the production of human and social disability (Deyo, 1993; Von Korff, 1994; McGill, 1996).

Second, the analytical methods utilized an hierarchical-type approach which is based on the conceptual framework. The within-cluster reduction of variables to a Representative Set allowed a

parsimonious examination of these clusters. The analytical approach of within cluster reduction and modelling of sequential clusters consistent with the conceptual model allowed a coherent investigation into these factors, without grossly violating any statistical or methodological guidelines. The inclusion of job-matched controls is an indication of the foresight of the original study investigators, which allowed the utilization of an additional 20% of cases in the analysis.

Final Conclusions

Researchers have been challenged to move away from traditional medical models of disease and illness and to adopt conceptual designs of low-back pain that incorporate physical, psychological, and social elements (Waddell, 1992; Deyo, 1993; Von Korff, 1994; Frank et al., 1996). Wilson and Cleary (1995) present a conceptual framework that combines biomedical and psychosocial paradigms in the production of disease and disability, and their impact on quality of life. This thesis is the first study to simultaneously explore factors associated with reporting and claims laying for low-back pain. The analysis contained herein includes as risk factors physical and psychosocial aspects of the work and workplace, pre-existing risk factors (such as previous injuries and claims), and also a measure of 'severity' of the underlying pathology (pain and disability). The outcome is unique in that it is not the onset of low-back pain under scrutiny, but explicitly defines key sociological and medico-legal thresholds in the natural history of low-back pain, namely the decision to i) report low-back pain to the workplace and ii) to file a compensation claim.

The results indicate that elements of the job, including both specific biomechanical loads on the lumbar spine **and** physiological or aerobic demands as perceived by the worker, are important in reporting low-back pain to the workplace. Among those who do report however, it appears that psychosocial variables are important in laying claims for symptoms and work disability. Additionally, control over job tasks and the ability to self-manage symptoms at work) is an important factor in the decision file a claim. Workers who feel empowered in this workplace likely do not fear reprisal from coworkers or supervisors for doing so, and

thus are more confident in filing claims.

These findings have the greatest impact for the workplace. Interventions at both the work level (job task, or job design) and workplace level (work organization) are needed in order to reduce the burden of occupational low-back pain and resulting disability. That being said however, job redesign is a huge undertaking for an automobile assembly plant, where current engineering and assembly methods are based on nearly a century of experience and tradition.

These results suggest that job tasks producing higher spinal loads in workers with prevalent musculoskeletal conditions and associated sleep impairments due to injuries or accidents at work, result in heightened LBP symptoms. While these workers are less likely to file a claim for their current symptoms, they nonetheless are compelled to report those symptoms to the workplace. Among symptomatic workers who have not reported their current symptoms, these data suggest adverse long-term effects at the workplace among those with a claims history.

The observed roles for work demands and opportunities for self-management of symptoms at the workplace, possibly mediated through worker control over job tasks and empowerment have considerable implications for organizations. Current production methods in the automotive industry are the result of nearly a century of manufacturing experience, and are not likely amenable to intervention overnight. The role of biomechanical loading from job tasks, as a risk factor for low-back pain and more importantly, as demonstrated in this analysis, as a risk factor for socio-medically defined thresholds in low-back disability, can't be ignored. This analysis has shown that the decision to report low-back pain to the workplace, and to file a compensation claim for symptoms, are complex socio-medical decisions which are undertaken by interpreting LBP symptoms within a complex social environment.

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The excerpt to be reprinted is Figure 1 (p.60) from Wilson & Cleary JAMA, January 4 1995 273(1):59-65. I plan to use their framework as a basis on which I formulate a conceptual model linking work, worker, and injury factors with two socio-medical outcomes, reporting low-back pain to the workplace and filing a workers' compensation claim.

✓

If these arrangements meet with your approval, please sign this letter where indicated below and return it to me in via fax at (416) 927-4167 or to the address indicated above. Thank you for your assistance in this matter.

Yours sincerely,

Jonathan M. Smith

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Appendix 2.A1: Studies of Low-Back Pain: Design, Sample Size, and Covariate Adjustment

Reference	Study Design	Sample Size	LBP Definition	Main Effect / Covariate Adjustment
Arad 1986	cross-sectional prevalence survey	831 Nurses	LBP in last month (42%)	lifts per shift (no covariate adjustment)
Battie 1990	longitudinal (four year follow-up)	3020 (279 events)	report to workplace or compensation claim	straight-leg raise, age, weight (women); straight-leg raise, LBP history (men)
Bergenudd 1988	retrospective analysis of occupational exposure from a cross -sectional LBP population prevalence survey (longitudinal design)	575 (56% male)	point prevalence (current LBP)	work heaviness (light, moderate, heavy); no covariate adjustment
Biering-Sorensen 1989	cross-sectional prevalence survey (Denmark)	928 (aged 30,40,50,60; 50% male)	recurrence / persistence of LBP symptoms over 12 months (62%)	Men: change in symptoms, symptom frequency, sciatica, live alone. Women: time since last episode, LBP wakes you up, aggravation of symptoms on standing, epigastric symptoms, smoking
Bigos 1992	longitudinal (four year follow-up)	3020 (279 events)	report to workplace or compensation claim	task enjoyment, positive SLR, previous chiropractic treatment, MMPI (scale 3), health locus of control
Boshuizen 1992	Data from occupational health service routine clinical exam/questionnaire (Netherlands)	4054 males (25-55)	prevalent LBP (~35-40%)	smoking status, occupation, age, height, weight, marital status, leisure time, physical exertion, stress, physical work environment, time pressure, mental strain, job satisfaction, work organization, career opportunity, mobility at work, comorbidity
Bovensi 1994	cross-sectional (comparing tractor drivers versus revenue officers)	1151 drivers vs 255 officers (all male)	12-month prevalence, 1 month prevalence	whole-body vibration, age, BMI, education, sport activity, car driving, marital status, mental stress, climactic conditions, back trauma, postural load
Burdorf 1990	cross-sectional survey of crane operators	33 (matched on age to 30 non-crane operators)	12-month prevalence (61% among crane operators, vs 27% among controls)	age, height, weight, heavy work
Hansen, 1982	cross-sectional prevalence survey (slaughterhouse workers)			
Heliovaara 1991	cross-sectional prevalence survey (Finland)	2496 women 2727 males	presence of sciatica (based on clinical exam findings) [N=289, 6%]	age, LBP history, physical stress, mental stress, BMI, smoking status, alcohol consumption

Heliovaara 1991 (continued)			unspecified LBP (based on clinical exam findings) [N=660, 13%]	age, sex, height, BMI, LBP history, physical stress, mental stress, driving, smoking status, alcohol consumption
Hoekstra 1994	cross-sectional prevalence survey (teleservice operators, US Social Security Administration)	108 workers at 2 call centres	LBP symptoms of ≥moderate severity for 1+ month or ≥1 week, no previous trauma	sex, non-optimal chair (wrt adjustment), Job Control
Houtman 1994	cross-sectional prevalence survey (Netherlands)	5865 (18-64, employed)	Back pain complaints (25%)	work pace, intellectual discretion, physical stressors, gender, age, education level, sports
Kelsey 1984	case-control (lumbar x-ray or myelogram at 3 hospitals; hospital controls)	232 matched pairs (sex, age, service)	herniated lumbar intervertebral disc	lifting, twisting, carrying on current job
Leigh 1989	cross-sectional prevalence survey (United Sates)	1114 (working)	trouble with back or spine over past year (20%)	gender, race, occupation, education, height, smoking status, physical effort, repetitive work
Leino 1993	longitudinal 10-year follow-up [1973,78,87] (Finland)	607 who participated in all 3 surveys	separate regressions for self-reported symptoms (?%) and clinical findings (?%)	Age, occupational class, comorbidity index (separate models for stress and depression)
Liira, 1996	cross-sectional prevalence survey (Ontario)	31140 (16-64, working)	long-term serious back problems (7.8%)	gender, age, smoking status, white/blue collar, physical exposure index
Liles 1984	prospective follow-up (2-year maximum)	449 volunteers in 28 companies doing ~100 jobs	lifting injury to back reported to company	Job Severity Index for Lifting (no covariate adjustment)
Marras 1993	cross-sectional	403 jobs in 48 plants	retrospective search of medical records for LBP injuries associated with jobs	lift rate, twisting velocity, peak moment, peak flexion, peak lateral velocity
Mannion 1996	longitudinal follow-up design (0,6,12,18 months)	403 (18-40, 'volunters', no previous serious LBP)	subsequent LBP: 'serious' (required medical attention or absenteeism)	non-serious LBP in the past, ZUNG +MSPQ, gender
Punnett 1991	case-control study (automobile assemblers)	95 cases 124 controls	cases accrued from medical department reporting LBP; controls did not report during study period, were symptom-free	time non-neutral, lift ≥45N, age, previous LBP
Riihimaki 1994	prospective follow-up (3 years) in carpenters, heavy equipment operators, and office workers (all males)	533 (c), 688 (heo), 591(ow)	LBP symptoms in previous 7 days with pain radiating to legs (sciatica)	age, previous LBP episode, history of back accidents, mental distress, general health, smoking status, lifestyle factors, level of education

Saraste 1987	cross-sectional prevalence survey [Sweden]	2872	LBP symptoms (36%)	univariate results for bends/twists, daily heavy lifting, whole-body vibration, repetitive work
Skovron 1994	cross-sectional prevalence survey (Begium)	3829 (≥15 yrs) 1865 working	lifetime history of LBP (59%)	age, gender, french speaking, occupation, work status, job satisfaction, gender*language, gender*age
Smedley 1995	cross-sectional prevalence survey (nurses, USA)	1616 (all female)	LBP in past 12 months (45%)	mental stress, lifting (>1pt /day), age, height
Svensson 1983	cross-sectional prevalence survey (Sweden)	940 males aged 40-47	31% with prevalent LBP symptoms	none
Svensson 1989	cross-sectional prevalence survey (Sweden)	1760 females aged 38-64	35% with prevalent LBP symptoms	none

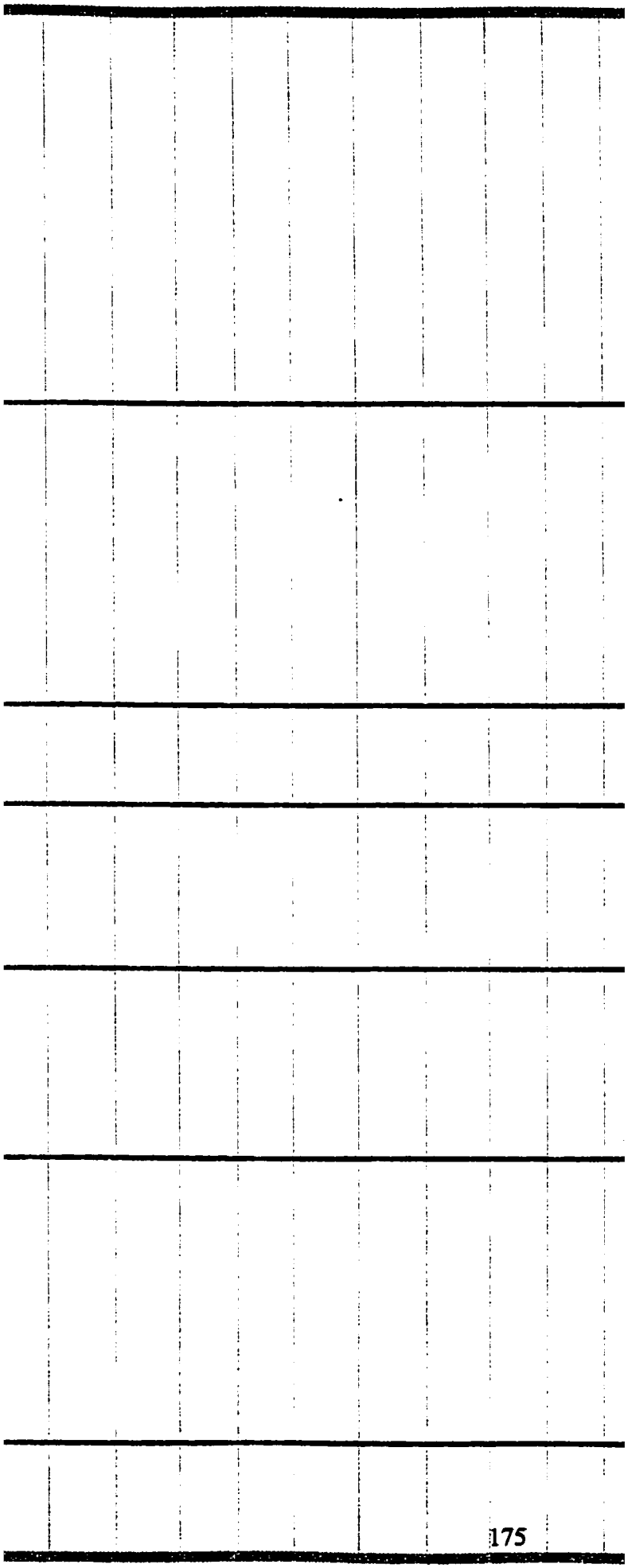
Appendix 2.A2: Review of Studies on Compensation and Low-Back Pain: Studies Comparing Clinical Outcomes of Compensated [COMP] and Non-Compensated [N-COMP] Groups with Low-Back Pain

Reference	Study Design / Outline	Conclusions/ Notes
Leavitt et al., **Spine** 7(4):398-402 1982	***Methods:*** Subjects were recruited (volunteers) from hospital referrals for LBP. 3 year recruitment period of those on compensation (n=85) versus those not (n=179). ***Results:*** Groups were not different on demographics except sex: COMP [age=40.1±10.4; 70% male; 71% married; education 12.1±2.1 years] vs N-COMP [age=42.5±12.9; 36% male; 73% married; education 12.7±3.2 years). Symptom duration (COMP[<6=37%; 6-12=21%;>12=42%] vs NON-COMP[<6=42%; 6-12=9;>12=49%]) did not differ. However COMP group had more 'non-organic disease' (42% vs 30%, ns) and psychological disturbance (29% vs 24%, ns). ***Conclusions:*** Among patients with organic findings, those on compensation reported 'worse' pain than those not on compensation. However among those without clear organic findings, reports of pain were not different across compensation groups. Pain reports across compensation groups did not differ by psychological disturbance status.	Non-organic status was determined through consensus of 9 ortho / neuro surgeons, based on clinical / physical / diagnostic / history. What about psychological disturbance by symptom onset? i.e., is psych dist more prevalent with longer durations (chronic)? Suggest a 4 stage sequence of pts on comp that reinforces symptoms but not producing psychological disturbance.
Mendelson, **Pain** 20:169-177 1984	***Methods:*** Subjects were 80 consecutive patients referred to Pain Tx Clinic. ***Results:*** COMP [n=47, mean age=37.1±9.4; 47% male; mean pain duration 33.6±22.5 months] differed from N-COMP [n=33, mean age=41.0±10.3; 27 male; mean pain duration 114.2±95.6] on gender ratio only. At presentation VAS pain [60.8±23.8 vs 61.7±17.8 (0-100), ns]; McGill Pain Qnaire [Sensory 14.9±7.5 vs 14.8±8.6, ns; Affective 2.9±2.9 vs 2.6±2.8 ns; Evaluative 2.5±1.6 vs 2.9±1.5, ns]; Personality [Neuroticism 15.1±4.3 vs 13.3±6.5, ns; Extraversion 13.3±3.2 vs 13.4±3.1, ns]; Anxiety [A-state 45.8±11.8 vs 44.8±12.9, ns; A-trait 46.9±10.2 vs 44.7±11.8, ns]; Hostility [17.3±6.4 vs 15.0±6.1 ns]; or Depression [47.5±9.2 vs 43.1±9.8, ns]. ***Conclusions:*** As a group, LBP patients had significantly elevated scores on Neuroticism, Anxiety (A-state and A-trait), Hostility and Depression from population norms.	NOTE : mix of compensation cases MVC [n=20] and WCB [n=27]. Conclude that there is no evidence to support the claim that patients on compensation describe their pain as more severe, nor that patients with compensation are more psychologically disturbed than similar patients not claiming compensation.
Melzack et al., **Pain** 23:101-112 1985	***Methods:*** Subjects were n=81 [42% male, mean age=43.3] consecutive patients referred to Pain Clinic (Montreal) by their physicians '78-'82. ***Results:*** COMP [n=27] and N-COMP [n=54] did not differ on Pain Rating Index (Sensory [17.1 vs 17.8]; Evaluative [2.7 vs 3.1]; Miscellaneous [6.4 vs 7.0]), MMPI (Depression [26.4 vs 29]; Hysteria [23.0 vs 22.9]; Hypochondriasis [29.9 vs 31.1]), # of consultants (3.9 vs 4.5), duration of pain (5.3 vs 6.0 [years]), or hours of sleep (6.3 hrs, both); they did differ on Pain Rating Index-Affective (6.0 vs 8.9, $p<0.05$). ***Conclusions:*** Patterns of pain descriptors similar across groups; patients on compensation do not report higher levels of pain then patients not on compensation. COMP pts do not differ from N-COMP group on emotional or psychological disturbance measures (MMPI, STAI, Eysenck), but did score worse than population norms.	NOTE: analysis includes comp vs non-comp for 'musculoskeletal' not shown here. Higher AFFECTIVE pain index scores are obtained by describing pain as "Tiring", "Exhausting", or "Sickening".
Jamison et al, **Orthopaedic Review** XVII: 1210-15 1988; Jamison et al., **J Psychsom Res** 32(3):277-283 1988	***Methods:*** Subjects were 110 male patients referred to Pain Control Centre for treatment of chronic LBP. Placed in 3 groups [N-COMP [n=44], time-limited COMP [n=27], unlimited COMP [n=39]. Time-limited comp tends to be from state WCB, while unlimited from federal SSDI etc; ***Results:*** groups were not different on age, marital status, race, or pain duration, nor in physical symptoms (range of motion, postural defects, motor functioning, reflexes) or radiological findings. Trends in physician rated high pain behaviour (49%, 54%, 74% respectively) and symptom exaggeration (23%, 19%, 33%), but not in depression (52%, 70%, 67%) or anxiety (27%, 44%, 36%). Unlimited comp group reported higher use of both narcotics(68%, 52%, 85%) and sedatives (20%, 26%, 41%) respectively. ***Conclusions:*** results suggest that time-limited compensation may not affect outcome/treatment, while unlimited compensation may have adverse effects.	Were doctors blinded to comp status when they made their assessment of pain behaviour, exaggeration, depression and anxiety? NOTE: SAME STUDY REPORTED IN BOTH PAPERS

Javid, **Spine** 13(12):1428-1437 1988	***Methods:*** Subjects were 214 consecutive patients undergoing chemonucleolysis for herniated lumbar disc. ***Results:*** At 6 months, COMP group had not improved as well as N-COMP group (58% vs 89% pain free/improved; 21% vs 5% limited forward flexion; 35 vs 15% sensory loss; 26 vs 8% motor loss); At 1 year post-injection, the procedure was successful in reducing symptoms of 91% of 172 non-compensation patients, and 60% of 42 compensation patients ($p<0.001$). However the groups were not significantly different on neurological indicators. ***Conclusions:*** Chemonucleolysis is an effective procedure in "scrupulously selected" patients.	Of 14 patients (7 comp, 7 non-comp) compensated patients did less well on subsequent laminectomy due to failed chemonucleolysis.
Greenough and Fraser, **Spine** 14(9):947-955 1989	***Methods:*** Retrospective, cross-sectional design: 300 subjects [15 each of male/female, COMP / N-COMP from 5 years '83-'87] were solicited; 274[92%] took part. Exclusion criteria included those who did not have an identifiable incident associated with onset [48% of exclusions due to this]. ***Results***: At follow-up, one third of the compensated group were 'psychologically disturbed' (scored positive on 3 or more of 7 tests) while only ~5% of those not on compensation were disturbed. Psychological disturbance was also associated with unemployment at follow-up. Workers on compensation reported higher pain, worse disability, and more impairment (males especially). Unemployment affected reporting of pain, disability and impairment (worse). ***Conclusions:*** Payment of compensation delays recovery from low-back pain	Potential for selection bias is large (2957 case records were examined to get 300 subjects [*first time consultations for low-back pain*])
Tollison et al., **Orthopaedic Rev** XIX(8): 701-706 1990	***Methods:*** Subjects were patients from the Pain Therapy Centers of Greenville (18 day multi disciplinary treatment program); COMP (n=15, mean age 41.3, education 11 yrs, duration of pain =22.4 mnths, pain intensity [0-5]=4.1) vs N-COMP (n=15, mean age 43.8, education 11.3, duration of pain = 25.2, pain intensity [0-5]=3.9), ***Results*** - slight differences at baseline on pain, but no differences in return to function or physical activity were observed at follow-up (3 months). ***Conclusions:*** Compensation has no effect on treatment	Note small sample size (n=15 in each group); NOTE that 3 subjects were rejected for the program because they "were judged to lack the motivation required (for completion)" [p.703]
Leavitt, J **Psychosom Res** 34(4):447-453 1990; Leavitt, **Spine** 17(3):307-310 1992	***Methods:*** The major purpose of this study was to assess the effect of compensation on disability time when physical demands of the job were accounted for. The study sample was drawn from 1580 orthopaedic patients; injured on the job (n=1191) [COMP] versus those injured elsewhere (n=389) [N-COMP]; ***Results:*** physical exertion at work significantly associated with origin of injury ($\chi^2 = 223$, $p < 0.001$) and with disability time ($\chi^2 = 223$, $p < 0.001$); ***Conclusions:*** COMP group do jobs that are qualitatively different and require significantly more physical exertion.	"The literature that casts the negative image on the industrial worker on compensation is far less conclusive than might be inferred from the biases against this group embedded in print" [p.307] "Because financial incentives not to work are commonplace in job-related injuries, there is natural tendency to view the etiology of extended, compensated pain with suspicion"[p 307].
Tollison, **Southern Med J** 86(11): 1206-1209 1993	***Methods:*** COMP [n=32] versus N-COMP [n=29] recruited from Pain Treatment Centre ***Results:*** No difference in sex (~50%), age(~42), duration of symptoms(~11mnths). COMP reported higher pain intensity at baseline [9.7 vs 8.4] and at 6 month follow-up than N-COMP; fewer in comp group (13 v 31%) rtw at discharge, but not at 6 mnths; COMP used more prescription meds at 6 months ***Conclusions:***Compensation has an adverse effect on treatment outcome	patients referred to Pain Treatment clinic - who pays for presc meds??

Greenough, **Acta Orthop Scand** (Suppl 251) 64: 126-129 1993; Greenough et al., **Clinical Orth and Related Res** 300: 30-37 1994	***Methods:*** Intro refers to studies where satisfaction with surgical outcome is affected by compensation status; sample N=151 (77 men age=40; 74 women age=42) undergoing anterior lumbar fusion; N=106 (64 men / 42 women) claiming compensation at time of operation; NOTE that q're data was collected ~40 months after surgery; distribution of indications equal for COMP / N-COMP; ***Results:*** significant difference in social groups (26/44 N-COMP = 4 [Ann Daniel social group Scale]); COMP scored significantly worse (lower) in functional recovery on the Low Back Outcome Scale and reported less symptom relief (37% COMP had "little or no symptom relief" vs 20% N-COMP, 18% COMP had "almost complete relief" vs 38% N-COMP); interestingly, while only 65% of the COMP had operative success (fusion), 91% of N-COMP had a successful fusion. ***Conclusions:*** results suggests that either these groups were different to start, or differences in the groups throughout recovery and return to work made a difference in surgical outcome.	NOTE: without a notion of PRIOR job heaviness, there remains the possibility of an actiological association of WCB with 'heavier' job; "Alternatively, a strong clinical impression was gained by the treating author that compensation patients are more likely to strain their backs in the early rehabilitation period by falling, lifting, or bending"[p36]
Ambrosius, **JOSPT** 21(1): 7-11 1995	***Methods:*** COMP (n=35) vs N-COMP (n=25) in active physio program; ***Results:*** COMP younger (36 vs 41, ns), less educated (ns), more males (66 vs 50%), report higher pain at baseline (3.7 vs 2.7, 0-10, ns), higher chest press (66 vs 58, kg), lower treadmill O_2 Mets (5.8vs6.3); not different on ROM/flexion scores. Most N-COMP continued work during therapy, COMP were off work. 91%(comp) and 92%(noncomp) had 'successful' RTW (incl modified/new job). At follow-up (last visit to therapy), comp group still had higher pain, lower treadmill capacity, higher chest press, although both groups improved in all categories. ***Conclusions:*** active physio program efficacious for COMP LBP	Took COMP group longer on average to get to therapy than N-COMP group (14 vs 12 weeks, ns). Use results to show 'effectiveness' of structured functional rehab program
Sanderson et al., **Spine** 20(5): 554-556 1995	***Methods:*** Retrospective cohort; 269 consecutive patients to a 'problem back clinic'[UK] 86-91; mean symptom duration from onset to treatment 62 mnths (4-168); 73% male; mean age 44.6 yrs; COMP (n=71) vs N-COMP (n= 198); ***Results:*** COMP reported higher disability (>41) on Oswestry (83% vs 58% p<0.05); unemployed reported higher disability (>41) on Oswestry (80%vs40% p<0.05); of those employed, COMP not significantly different in Oswestry score from N-COMP; ***Conclusion:*** unemployment has a greater affect on disability than compensation staus	These data suggest that unemployment, rather than compensation versus non-compensation, has a greater effect on disability. NOTE: questions in Oswestry that drive 'off work' disability???
Hadler et al, **Spine** 20(24): 2710-2715 1995	***Methods:*** North Carolina Back Pain Project [208 practitioners participated]; eligibility criteria was <10 wks pain duration; outcome was perception of wellness; N=1366 (COMP=505, N-COMP=861). ***Results:*** Age ~39, 55% male, 22% had sciatica, baseline Roland=11.3 vs 10.7, 70% married (none are statistically different for COMP vs N-COMP); KM log-rank for COMP vs N-COMP p=0.046 (18 vs 15.4 days); COX model for time until 'functional recovery' [level of well being enjoyed before this episode of LBP] included comp (HRR=0.82), Roland (HRR=0.55 10pt change), sciatica (HRR=0.89), income and education; comp group reported more physical demands (lifting, standing, walking, vibrating tools); HRR for comp did not change when COX model adjusted for perceived physical demands. ***Conclusions:*** Compensation affects time until return to wellness, but not to work.	Says NLT-C only, but talk about RTW; does not stratify on this variable. Determination of WCB eligibility in NC?? "Personal price is a consequence of the more demanding nature of tasks performed for employers who provide compensation insurance" (p 2712)
Taylor et al., **Spine** 21(19): 2255-2259 1996	***Methods:*** Study group included relevant primary / secondary diagnosis (low back- cervical thoracic back excluded) and at least one of discectomy, laminectomy, or fusion [index cases; pts with previous surgery excluded] Washington State 1988-1991; "lumbago" and "strain" dx's were excluded; ***Results:*** pts were classified according to payer; COMP (n=1502, age 38, 79% male) and N-COMP (n=2674, age 41, 56% male); COMP group had a greater chance of re-operative surgery (18% vs 10%); COMP group had a slightly but significantly higher cost for all surgeries combined ($4174 vs 4031 US1987) for 3 year; ***Conclusions:*** compensation pts have higher rates of fusion and are at greater risk of re-operation (at slightly increased cost).	Hospital administrative discharge data (no self-report data); compensation group more likely to undergo fusion surgery [17% vs 14%; adjusted OR=1.37]

Atlas et al, **AJIM** 29:584-589 1996	***Methods:*** Maine Lumbar Spine Study is a prospective cohort of pts with sciatica treated surgically or non-surgically; Dx of sciatica made by physician (no radiographs required); subjects had to have undergone at least 2 weeks of unsuccessful conservative treatment within two months of presentation. ***Results:*** Subjects were classified at baseline on COMP status; COMP [n=133] N-COMP [n=258]; COMP was younger (39.4 vs 45 yrs), male (74% vs 55%) and less educated (9% vs 31% graduated college); physical exam findings similar (59% +'ve SLR), N-COMP more likely to have independently assessed moderate/severe radiological findings; COMP group reported sig worse back symptoms (62% vs 47% extremely bothersome in past week), but not leg pain (69% vs 62%), worse functional status (Roland (0-23) mean score 18.6 vs 15.7), and worse SF-36 scores [physical function (28.0 vs 44.0), mental health (58.3 vs 67.8), and general health (71.7 vs 78.6)]; within COMP those treated surgically had a higher +'ve SLR, more moderate/severe radiograph findings, more bothersome leg symptoms, higher Roland mean score, worse physical function (SF-36) and *better* general health (SF-36) ***Conclusions:*** Surgical tx moderates compensation affect on time to return to work	Independent radiograph images: more in N-COMP because they are older (i.e., sub-clinical disease = symptoms = functional limitation); no mention of job heaviness; surgically treated comp group had better general health; contraindication of 'comorbidity' or suspicion of surgeon? Or a result of having the 'diagnostic label' and 'treatment cure'???
Vaccaro et al., **Spine** 22(17): 2030-35 1997	***Methods:*** Between Aug '81 and Oct '87 254 pts with onset LBP *and* low-grade ischemic spondylolisthesis first detected during normal work-up; 24 ultimately underwent surgery due to failure of conventional physical therapy; ***Results:*** COMP (n=13, mean age=36.7, 8/13 (62%) male, 5 employed in heavy manual labour, 1 in light manual labour, 5 in sedentary work [2 unemployed]; 6 had LBP with leg symptoms); versus N-COMP non-comp group (n=11, mean age 39, 5/11 (45%) male, work? 9/11 had LBP with leg symptoms); outcome of surgery assessed at 36 months (COMP) and 38 months (N-COMP) and *a score assigned* using overall outcome scale (Kim 1990); all 13 comp group pts had fair or poor results, while 9 (of 11) pts in non-comp group had good or excellent outcome. Age, gender, fusion to L4 and pseudoarthritis were non-significant for the outcome. ***Conclusions:*** Compensation had an adverse affect on treatment outcome in this group.	NOTE: outcome not self-reported, but assigned by an 'expert'
Rainville et al., **Spine** 22(17): 2016-2024 1997	***Methods:*** 192 consecutive patients referred to spine rehab centre; were able to compare them at baseline based on COMP (WCB, Social Security Disability, private dis ins N=96) vs N-COMP (N=96). 85 were referred to/agreed/completed spine rehab program (47 COMP vs 38 N-COMP). ***Results:*** COMP were younger (39 vs 43 yrs), less educated, injury related to event (54 vs 39%), had worse trunk flexion (73 vs 85°), SLR (71vs78°), more sciatica (75vs50%), higher pain intensity (7 vs 5, 10 cm VAS), heavier jobs (60 vs 17% moderate to heavy). ANCOVA (VAS, OSWESTRY=comp, educ, age, BDI) shows comp is significant in VAS scores. Treatment compliance not different between groups; both groups improved over 12 months follow up; comp group started worse and ended worse (BDI, flexion, VAS, SLR, Oswestry). ***Conclusions:*** compensation patients are qualitatively different from N-COMP in their presentation and treatment efficacy; may be due to patient expectations.	NOTE defn of chronic (LBP > 4 mnths) - excellent ref for comparison of baseline measures NOTE they include self-reported job heaviness - not clear if they controlled for this VAS ANCOVA. Suggest that comp involvement causes patients to cluster in term of subj symptoms; note explanation of job event / job heaviness / entitlement / fulfilment



February 10, 1995

FIELD(1)

Dear FIELD(2):

Injuries which occur at work, particularly back injuries, can have a significant impact on the overall quality and enjoyment of life. Currently, a group of researchers from the University of Toronto, the University of Waterloo, and McMaster University are involved in a study (the Ontario Universities Back Pain Study) to learn more about the causes of back pain, and the factors affecting recovery. We hope information collected in this study can be used to help prevent future injuries and improve the care and treatment of those already affected by back pain.

We Can't Do It Alone!

We need your help, and all we require is some of your time and patience. Over the next few weeks, you may be contacted by phone by study staff asking for your cooperation. Please remember that we need your help even if you don't suffer from lower back pain. This information is just as valuable and is essential for research comparison purposes.

We will call you first to see if you can help us out, and then arrange a time to meet at your convenience. Your participation is voluntary, and we won't take up much of your time. In fact, we will accommodate your schedule to make your participation as enjoyable, effortless, and comfortable as possible.

Both the CAW and GM management have given their permission to conduct the study. **All personal information will be kept strictly confidential and will not be given to the company, the union(s), the WCB or anyone outside the research team.** As well, whether you participate in the study or not will have no effect on compensation benefits or the adjudication of any compensation claim pending.

The Ontario Universities Back Pain Study is funded by the Institute for Work & Health, not GM or the CAW. The Institute is comprised of university-based scientists and research staff dedicated to the study of causes, prevention, and treatment of work-related disability.

So, if you receive a call from us sometime soon asking for your help, please say yes. We really do need you.

Sincerely,

Dr. John Frank
Director of Research

R. \ Sue \ RAD.LET

OUBPS Subject Information Sheet **Date to Waterloo:** dd/ mm/ yr

Subject Name: _____

Study Status: _____ **Work Status:** _____

Baseline Conducted: _____ **RC&PC Scheduled for:** _____

Telephone: (___) _____ **Plant:** _____ **Shift:** _____

Job Category: _____

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Special Instructions on Questionnaire: _____

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Notes: _____

_____

Job Matched Control Selection Sheet

Wat. Op: _____

Case Name: _____ **Plant:** _____ **Shift:** _____

Shift	Name	(area) tel#	Comments	Outcome

Number of front end Refusals (tally): _____

Notes:

University of Waterloo Physical Loading Report

Data Collected By: Date:

Participant Code: Location:
Job Title:
Brief Job Description:

As part of the Ontario Universities Back Pain Study, physical loading of this job was measured. The results are summarized below.

Tasks Evaluated (if more than 5 tasks, list overleaf):

Task 1:
Task 2:
Task 3:
Task 4:
Task 5:

Job	1	2	3	4	5
puSH / puLL / liFT (Kg)	n/a	n/a	n/a	n/a	n/a
Max. compressive force (N)	n/a	n/a	n/a	n/a	n/a
Max. shear force (N)	n/a	n/a	n/a	n/a	n/a
Max. moment (N·m)	n/a	n/a	n/a	n/a	n/a
Maximum Permissible Limit	n/a	n/a	n/a	n/a	n/a
50% capable	n/a	n/a	n/a	n/a	n/a
Rest heart rate (beats/min)	n/a				
Work heart rate (beats/min)	n/a				
Severe Flexion (% time > 45° bend)	n/a				
Twist (% time > 20° twist)	n/a				
Lateral bend (% time > 20° bend)	n/a				
ISO weighted (m/s²)	n/a				

The measures used are specific to the low back research project being conducted and do not constitute a complete ergonomic analysis of the worksite.

☐ Further study not indicated

☐ Further study required

Report Compiled By:

CONSENT FORM
ONTARIO UNIVERSITIES BACK PAIN STUDY

A group of researchers from the University of Toronto, McMaster University, and the University of Waterloo is interested in learning more about low-back pain occurring in the workplace. Information collected in this study may help to prevent these injuries. The researchers also hope to improve the care and treatment of people who have been injured at work. The study is being funded by the Ontario Workers' Compensation Institute (OWCI), which is not part of the Ontario Workers' Compensation Board (WCB). The research unit at OWCI is directed by scientists who are university professors and are not employees of the WCB. They are in no way connected to the claims process at the WCB.

A. Questionnaires

If I agree to participate in this study, I understand that:

1. I will be in contact with a trained research interviewer concerning back pain and the factors that may affect it;

2. I may be interviewed up to five times over a period of six months in order to complete and return a set of questionnaires;

B. Physical Examination

I understand that an examination of my lower back will be conducted by a trained interviewer. This involves six simple tests often done on back pain patients.

These will be:

1. a test of my grip strength (to measure overall fitness) which involves squeezing as hard as possible a pressure sensitive bag;

2. measuring the distance between my fingers and the floor when I bend over without bending my knees;

3. testing my knee, ankle, and hamstring reflexes with a reflex hammer;

4. lying on my back and raising each of my legs as high as I can without pain;

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Faculty of Applied Health Sciences
University of Waterloo
Waterloo, Ontario
N2L 3G1

Ontario Workers' Compensation Institute
Research Department
250 Bloor Street East
Toronto, Ontario
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5. the application of modest pressure to my neck, collarbone area, arms, hips, legs and feet to test for tenderness;

6. modified sit-ups using a back support.

I understand that:

1. participation in each part of the study is voluntary;

2. apart from the analysis of the physical loads of my job, any information I provide will be treated as confidential, will not be given to the company, the union(s), the WCB or anyone outside the research team, and will be reported in ways which ensure that I cannot be identified;

3. decisions I make regarding this study will have no affect on my medical treatment or my work;

4. decisions I make regarding this study will not affect my sickness or compensation (WCB) benefits or the adjudication of any WCB claim I have pending.

5. I may refuse to complete any tests which are of concern to me;

6. I may ask the research staff to stop any test which causes me discomfort.

7. the person administering the physical examination will collect information about my back and will not be a physician who can make a diagnosis or prescribe treatment for me.

_____ _____

(Signature of Participant) (Signature of Interviewer)

_____

(Date)

For further information please contact
Sue Ferrier, Study Coordinator, at 1-800-661-2079

QUESTIONNAIRE

ONTARIO UNIVERSITIES BACK PAIN STUDY

Date of Interview ____/____/____
day mo yr

A. We would like to begin by asking you a few questions about yourself.

1. Your sex *(circle number of your answer)*

   1 MALE
   2 FEMALE

2. What is your date of birth? ____/____/19____
   DAY MONTH YEAR

3. What is your marital status? *(circle number)*

   1 NOW MARRIED OR LIVING COMMON LAW.
   2 SINGLE (NEVER MARRIED).
   3 WIDOW OR WIDOWER.
   4 SEPARATED OR DIVORCED.

4. In what country were you born? *(please specify)* _____

5. If you were not born in Canada, in what year did you immigrate to Canada? 19___

6. To which ethnic or cultural group(s) do you or did your ancestors belong? *(I'll circle as many numbers as you give me.)*

   1 FRENCH
   2 ENGLISH
   3 GERMAN
   4 SCOTTISH
   5 IRISH
   6 ITALIAN
   7 UKRAINIAN
   8 DUTCH
   9 CHINESE
   10 JEWISH
   11 EAST INDIAN
   12 HUNGARIAN
   13 POLISH
   14 PORTUGUESE
   15 NORTH AMERICAN INDIAN
   16 METIS
   17 INUIT
   18 CANADIAN
   19 OTHER *(please specify)*_____

7.(a) Have you completed an apprenticeship program? *(circle number)*

   1 YES
   2 NO

(b) Other than an apprenticeship, what is the highest level of education that you have completed? *(circle number)*

1 NO FORMAL SCHOOLING
2 SOME PRIMARY SCHOOL
3 PRIMARY SCHOOL
4 SOME SECONDARY OR HIGH SCHOOL
5 COMPLETED SECONDARY OR HIGH SCHOOL
6 SOME COMMUNITY COLLEGE, TECHNICAL COLLEGE, CEGEP, OR NURSING PROGRAM
7 COMPLETED COMMUNITY COLLEGE, TECHNICAL COLLEGE, CEGEP, OR NURSING PROGRAM
8 SOME UNIVERSITY (NOT COMPLETED)
9 UNIVERSITY DEGREE (COMPLETED)

8. (a) Do you have children living with you (either your own or from another relationship)? *(circle number)*

1 YES
2 NO → Go to Question 9.

(b) If YES, how many children? *(please specify)* _____

(c) If YES, what are their ages? *(please specify)* _____, _____, _____, _____

(d) If YES, who carries the bulk of responsibility for household tasks and childcare in your home? *(circle number)*

1 I DO.
2 MY SPOUSE/PARTNER DOES.
3 WE SHARE EQUALLY.
4 NONE OF THE ABOVE.

9. Are you the main wage earner in your household? *(circle number)*

1 YES
2 NO

B. Next we want to ask you some questions about the back pain which you reported at work. Throughout this section, by back pain we mean pain in the back or buttocks, by leg pain we mean pain in the lower limb (including foot) coming from the back (sciatica).

1. **HAVE YOU HAD BACK PAIN OR LEG PAIN IN THE PAST WEEK?** *(circle number)*

→ 1 YES
2 NO → Go to Question 25.

1a. → If YES, for how long has this episode of back pain or leg pain (sciatica) lasted? *(Check one box in each row)*

	< 1 Week	1-6 Wks.	6 Wks. 3 Mos.	3-6 Mos.	>6 Mos.	None During This Episode
BACK PAIN/ INCLUDING BUTTOCKS	☐	☐	☐	☐	☐	☐
LEG OR FOOT PAIN (SCIATICA)	☐	☐	☐	☐	☐	☐

2. Where was this pain? *(circle one or more numbers)*

1 BACK AND/OR BUTTOCKS ONLY → Go to Question 7.
2 TRAVELLED INTO ONE LEG
3 TRAVELLED INTO BOTH LEGS

3. If the pain travelled into your legs, did it: *(circle number)*

1 TRAVEL TO THE THIGH ONLY (ABOVE THE KNEE)?
2 TRAVEL BELOW THE KNEE (TO THE CALF OR FOOT)?

4. Have you also sometimes had numbness in the legs or foot? *(circle number)*

1 YES
2 NO

5. If the pain travelled into your legs, did it sometimes get worse with coughing or sneezing? *(circle number)*

1 YES
2 NO

6. If the pain travelled into your legs, was the back pain worse or was the leg pain worse? *(circle number)*

1 BACK PAIN IS WORSE
2 LEG PAIN IS WORSE
3 BOTH PAINS ARE ABOUT THE SAME OR IT VARIES FROM ONE TO THE OTHER

7. Which of the following problems has limited your activity the most? *(circle number)*

1 BACK-RELATED PROBLEM OR LEG PAIN (SCIATICA)
2 PAIN IN OTHER JOINTS, SUCH AS HIPS OR KNEES
3 OTHER SYMPTOMS, SUCH AS BREATHING PROBLEMS OR HEART PROBLEMS
4 NOTHING, HAD NO LIMITATIONS

8. Have you, in association with your back pain, lost the control of your bladder or bowels? *(circle number)*

1 YES
2 NO

9. When have you had pain in the back? *(I will circle as many numbers as you give me.)*

1 AT WORK
2 DURING RECREATIONAL ACTIVITIES
3 AT REST
4 AT NIGHT
5 ALL THE TIME
6 OTHER *(please specify)* _____

10a. In the past week, if you had pain when you slept, did it wake you up? *(circle number)*

1 YES
2 NO

10b. → If YES, did the pain improve if you got up? *(circle number)*

1 YES
2 NO
3 DON'T KNOW

11. In the past week, was your back usually stiff when you got up? *(circle number)*

1 YES
2 NO

→ If YES, how long did the stiffness last? *(please specify length of time)* _____

12. Have you tried complete bed rest for 3 days or more for your back/leg pain? *(circle number)*

1 YES
2 NO

→ If YES, did you get any relief from your pain? *("✓" appropriate box)*

☐ Not at all [0] ☐ Slight [1] ☐ Moderate [2] ☐ Significant [3]

13. Overall, is your back or leg pain (sciatica) problem better or worse than you expected it to be at this point? *("✓" appropriate box)*

☐ Much [0] Better Worse	☐ Somewhat [1] Better	☐ What I Expected	☐ Somewhat [3] Worse	☐ Much [4]

14. If you were to spend the rest of your life with your back symptoms just the way they are now, how would you feel about that? *(circle number)*

1 DELIGHTED
2 PLEASED
3 MOSTLY SATISFIED
4 MIXED (ABOUT EQUALLY SATISFIED AND DISSATISFIED)
5 MOSTLY DISSATISFIED
6 UNHAPPY
7 TERRIBLE

C. When your back or leg hurts, you may find it difficult to do some of the things you normally do. This list contains some sentences that people have used to describe themselves when they have back pain or sciatica. As I read them, you may find that some stand out because they describe you today. Please think of yourself right now. When I read a sentence that describes you today please tell me and I will circle "1" for YES and "2" for NO.

1. I stay at home most of the time because of my back problem or leg pain (sciatica).

1 YES
2 NO

2. I change position frequently to try and get my back or leg comfortable.

1 YES
2 NO

3. I walk more slowly than usual because of my back problem or leg pain (sciatica).

1 YES
2 NO

4 Because of my back problem, I am not doing any of the jobs that I usually do around the house.

1 YES
2 NO

5. Because of my back problem, I use a handrail to get upstairs.

1 YES
2 NO

6. Because of my back problem, I lie down to rest most often.

1 YES
2 NO

7. Because of my back problem, I have to hold onto something to get out of an easy chair.

1 YES
2 NO

8. Because of my back, I try to get other people to do things for me.

1 YES
2 NO

9. I get dressed more slowly than usual because of my back problem or leg pain.

1 YES
2 NO

10. I only stand for short periods of time because of my back or leg pain.

1 YES
2 NO

11. Because of my back problem, I try not to bend or kneel down.

1 YES
2 NO

12. I find it difficult to turn over in bed because of my back problem or leg pain.

1 YES
2 NO

13. My back or leg is painful almost all the time.

1 YES
2 NO

14. I find it difficult to get out of a chair because of my back problem or leg pain (sciatica).

1 YES
2 NO

15. My appetite is not very good because of my back pain.

1 YES
2 NO

16. I have trouble putting on my socks (or stockings) because of my back problem or leg pain (sciatica).

1 YES
2 NO

17. I only walk short distances because of my back problem or leg pain (sciatica).

1 YES
2 NO

18. I sleep less well because of my back problem.

1 YES
2 NO

19. Because of my back pain, I get dressed with the help of someone else.

1 YES
2 NO

20. I sit down for most of the day because of my back.

1 YES
2 NO

21. I avoid heavy jobs around the house because of my back problem.

1 YES
2 NO

22. Because of my back problem I am irritable and bad tempered with people more than usual.

1 YES
2 NO

23. Because of my back problem, I go up stairs more slowly than usual.

1 YES
2 NO

24. I stay in bed most of the time because of my back problem or leg pain (sciatica).

1 YES
2 NO

25. What is your height? (*please specify*) _____ feet + inches or _____cm

26. What is your weight? (*please specify*) _____lbs. or _____kg

D.

Our next questions are about back problems before this current episode of back pain. Therefore, we would like to ask you about other back pain which you may have experienced and how that pain may have affected your day-to-day activities. Reminder: By back pain we mean pain in the back or buttocks, by leg pain we mean pain in the lower limb (including foot) coming from the back (sciatica).

1. Have you had back pain in the last year? (*circle number*)

1 YES
2 NO → Go to Question 9.

2. In the past year, how bad was your worst back pain, where 0 is No Pain and 10 is pain As bad as it could be?

0	1	2	3	4	5	6	7	8	9	10
No pain										As bad as it could be

3. In the past year, on average, how intense was your back pain (that is, your usual pain at the times you were experiencing pain)?

0	1	2	3	4	5	6	7	8	9	10
No pain										As bad as it could be

4. About how many days in the last year have you been kept from your work because of back pain?
_____ DAYS

5. In the past year, how much has back pain interfered with your daily activities rated on a 0-10 scale, where 0 is no interference and 10 is unable to carry on any activities?

0	1	2	3	4	5	6	7	8	9	10
No Interference										Unable to carry on any activities

6. In the past year, how much has back pain changed your ability to take part in recreational, social and family activities where 0 is no change and 10 is extreme change?

0	1	2	3	4	5	6	7	8	9	10
No Change										Extreme Change

7. In the past year, how much has back pain changed your ability to work (including housework) where 0 is no change and 10 is extreme change?

0	1	2	3	4	5	6	7	8	9	10
No Change										Extreme Change

8a. In the past year, have you had an episode of back pain or leg pain that lasted at least one day? *(circle number)*

→ 1 YES
2 NO → Go to Question 9.

8b. → If YES, have any of these episodes lasted more than one week? *(circle number)*

1 YES
2 NO

8c. In the past year, have you had 5 or more episodes that lasted more than one day? *(circle number)*

1 YES
2 NO

9. In your lifetime, how many episodes of back pain or leg pain (sciatica) have you had that lasted at least one day, but eventually went away completely? *(circle number)*

1 NONE → Go to Question 11a.
2 1-5 EPISODES
3 MORE THAN 5 EPISODES

10. Were any of these episodes a Workers' Compensation claim? *(circle number)*

1 YES
2 NO

11a. Prior to this episode of back pain, did you ever consult a doctor or other health care provider for any episode of back or leg pain (sciatica)? *(circle number)*

→ 1 YES
2 NO → Go to Section E, Page 10.

11b. → If YES, how many months or years ago did you first consult a doctor or other health care provider? *(write in number)*

___ Months or ___ Years Ago

12. If yes, how would you rate the following overall for these previous episodes of back or leg pain? *(Do not include current episode. Place a "✓" in one appropriate box on each line.)*

The concern health care providers showed for your problem?
☐ Excellent (1) ☐ Very Good (2) ☐ Good (3) ☐ Fair (4) ☐ Poor (5)

The effectiveness of the treatment prescribed for you?
☐ Excellent (1) ☐ Very Good (2) ☐ Good (3) ☐ Fair (4) ☐ Poor (5)

The care you received, overall, for your problem?
☐ Excellent (1) ☐ Very Good (2) ☐ Good (3) ☐ Fair (4) ☐ Poor (5)

E. Now we would like to ask you a few questions about how you sleep. Please answer each question by choosing the one answer that best fits.

		Never	Rarely	Some-times	Often	Don't Know
1.	Do you have forceful snoring and/or interruptions to your breathing during sleep?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
2.	Have you been told you are a restless sleeper, e.g., move your legs or kick?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
3.	Do you suffer from nightmares or wake up frightened and crying out?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
4.	Do you sleep or fall asleep when you are sitting, e.g., reading, watching TV?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
5.	Do you feel sleepy or fall asleep when you are doing something, e.g., driving, talking to people?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)

The next questions ask you to describe your experience of sleep in the last week.

6.	Have you had any problem sleeping?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
7.	Have you had any difficulty falling asleep?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
8.	Have you awakened before you want to?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
9.	Have you slept for less than five hours?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
10.	Have you repeatedly awakened during your sleep time?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
11.	Have you awakened from sleep not feeling refreshed or thoroughly rested?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)
12.	Have you awakened with aches or pains or stiffness?	☐(0)	☐(1)	☐(2)	☐(3)	☐(4)

13. Do you work shifts? *(circle number)*
    1 YES
    2 NO

14. During regular working hours at what time do you normally go to bed? *(please write in time and specify if a.m. or p.m.)* →

DAY SHIFT	NIGHT SHIFT

15. During regular working hours at what time do you normally get up? *(please write in time and specify if a.m. or p.m.)* →

DAY SHIFT	NIGHT SHIFT

F. 1. Other health conditions are sometimes related to back pain. In the past year, have you had any other health conditions which appear on the following list? Please tell me and I will check the appropriate box. If you have seen a doctor or received medication for this condition, please tell me that as well.

HEALTH CONDITION	DO YOU HAVE THIS CONDITION?		BEEN TREATED IN THE LAST YEAR? (i.e. saw doctor, taking pills)	
	YES	NO	YES	NO
ASTHMA/BRONCHITIS/EMPHYSEMA				
HIGH BLOOD PRESSURE				
HEART TROUBLE/PACEMAKER				
EFFECTS OF STROKE				
TROUBLES WITH BALANCE				
EPILEPSY				
DEPRESSION/ANXIETY				
DIABETES				
VISION LOSS EVEN WITH GLASSES				
HEARING LOSS				
CHRONIC FOOT TROUBLE				
KIDNEY TROUBLES/URINE INFECTION				
STOMACH ULCERS				
CANCER (OTHER THAN SKIN)				
PSORIASIS				
SKIN INFECTION				
INTESTINAL DISORDERS				

The following questions ask about other recent aspects of your health.

2. Have you had persistent fevers in the past two weeks (over 37.7 degrees Celsius or 99.9 degrees Fahrenheit)? *(circle number)*

    1 YES
    2 NO
    3 DON'T KNOW

3a. In the last two months have you lost any weight? *(circle number)*

- 1 YES
  2 NO → Go to Question 4.
  3 DON'T KNOW

3b. → If YES, how much weight have you lost? *(write in answer)*

____ lbs. or ____ kg.

3c. Were you trying to lose weight? *(circle number)*

1 YES
2 NO

4. Do you smoke cigarettes? *(circle number)*

1 YES
2 NO

5. In the past 12 months, have you taken an alcoholic drink? *(Please check one box)*

Twice a day or more [77]	Daily or almost daily [09]	Once or twice a week [05]	Once or twice a month [02]	Special Occasions only [01]	No [00]
☐	☐	☐	☐	☐	☐

6a. Have you ever taken cortisone or prednisone regularly in the past? *(circle number)*

- 1 YES
  2 NO

6b. → If YES, are you still taking it regularly? *(circle number)*

1 YES
2 NO

The following questions ask about hospitalizations.

7. Have you ever been hospitalized for back surgery? *(circle number)*

- 1 YES
  2 NO

→ If YES, when did it occur? *(please specify)* _____

8. Other than back surgery, have you ever been hospitalized because of your back? *(circle number)*

- 1 YES
  2 NO

→ If YES, please state why, where, and when it occurred.

HOSPITALIZATIONS FOR BACK

REASON	LOCATION	YEAR

9. In the past 5 years, have you had any other major surgery or hospitalization?

- 1 YES
  2 NO

→ If YES, please state what it was for and when it occurred. (*We've put one in as an example.*)

OTHER SURGERIES/HOSPITALIZATIONS

REASON	YEAR
example: appendectomy	*1989*

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The following questions ask about injuries or work-related conditions not mentioned above.

10. Have you had any other injuries or conditions which have left you with persistent problems and/or required lost time from work? *(circle number)*

→ 1 YES
2 NO

→ If YES, please fill in the following chart.

INJURIES/CONDITIONS WITH PERSISTENT PROBLEMS

PART OF BODY INJURED	TYPE OF INJURY/CONDITION	DESCRIBE YOUR PERSISTENT PROBLEM	YEAR	WCB CLAIM? YES/NO
example: arm	*tendinitis*	*pain*	*1990*	*yes*

11a. On most days do you have pain, aching, or stiffness in the joints of your hands or wrists? *(circle number)*

→ 1 YES
2 NO

11b. → If YES, is the pain, aching, or stiffness mild, moderate or severe? *(place "✓" on appropriate lines)*

LEFT HAND: _ NONE _ MILD _ MODERATE _ SEVERE

RIGHT HAND: _ NONE _ MILD _ MODERATE _ SEVERE

12a. On most days do you have pain, aching, or stiffness in either of your knees? *(circle number)*

→ 1 YES
2 NO

12b. → If YES, is the pain, aching or stiffness mild, moderate or severe? *(place "✓" on appropriate lines)*

LEFT KNEE: _ NONE _ MILD _ MODERATE _ SEVERE

RIGHT KNEE: _ NONE _ MILD _ MODERATE _ SEVERE

13. On most days, do you have pain, aching, or stiffness in any of your joints? *(Do not include back. Circle number.)*

1 YES
2 NO

14a. Has your doctor ever told you that you have arthritis? *(circle number)*

1 YES
2 NO → Go to Question 15.

14b. What type of arthritis were you told you had? *(circle numbers which apply)*

1 OSTEOARTHRITIS (ALSO CALLED DEGENERATIVE ARTHRITIS)
2 RHEUMATOID ARTHRITIS
3 GOUT
4 OTHER *(please specify)* _____

15. During the past 4 weeks, did the condition of any of the following joints limit your usual activities? *(circle one number for each line)*

	YES	NO
SHOULDER	1	2
ELBOWS	1	2
HANDS	1	2
NECK	1	2
HIPS	1	2
KNEES	1	2
ANKLE OR FOOT	1	2

G.

These next questions ask for your views about your health. Answer every question by telling me the appropriate number. If you are unsure about how to answer a question, please give the best answer you can. I can write a comment in the left margin if you wish.

1. In general, would you say your health is: *(circle one number)*

1 EXCELLENT
2 VERY GOOD
3 GOOD
4 FAIR
5 POOR

2. Compared to one year ago, how would you rate your health in general *now*? *(circle one number)*

1 MUCH BETTER NOW THAN ONE YEAR AGO
2 SOMEWHAT BETTER NOW THAN ONE YEAR AGO
3 ABOUT THE SAME

4 SOMEWHAT WORSE NOW THAN ONE YEAR AGO
5 MUCH WORSE NOW THAN ONE YEAR AGO

HEALTH AND DAILY ACTIVITIES

3. The following questions are about activities you might do during a typical day. Does your health limit you in these activities? *If so, how much? (circle 1, 2, or 3 on each line)*

	Yes Limited a Lot	Yes, Limited a Little	No,Not Limited at All
a. Vigorous activities such as running, lifting heavy objects, participating in strenuous sports.	1	2	3
b. Moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
c. Lifting or carrying groceries	1	2	3
d. Climbing several flights of stairs	1	2	3
e. Climbing one flight of stairs	1	2	3
f. Bending, kneeling, or stooping	1	2	3
g. Walking more than a mile	1	2	3
h. Walking several blocks	1	2	3
i. Walking one block	1	2	3
j. Bathing or dressing yourself	1	2	3

4. During the past week, have you had any of the following problems with your work or other regular daily activities as a result of your physical health? *(Please answer YES or NO for each question by circling 1 or 2 on each line)*

	YES	NO
a. Cut down on the amount of time you spent on work or other activities	1	2
b. Accomplished less than you would like	1	2
c. Were limited in the kind of work or other activities	1	2
d. Had difficulty performing the work or other activities (for example, it took extra effort)	1	2

5. During the past week, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems *(such as feeling depressed or anxious)*? *(Please answer YES or NO for each question by circling 1 or 2 on each line.)*

	YES	NO
a. Cut down on the amount of time you spent on work or other activities	1	2
b. Accomplished less than you would like	1	2
c. Didn't do work or other activities as carefully as usual	1	2

6. During the past week, to what extent have your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups? *(circle one number)*

1 NOT AT ALL
2 SLIGHTLY
3 MODERATELY
4 QUITE A BIT
5 EXTREMELY

7. How much bodily pain have you had during the past week? *(circle one number)*

1 NONE
2 VERY MILD
3 MILD
4 MODERATE
5 SEVERE
6 VERY SEVERE

8. During the past week, how much did pain interfere with your normal work *(including work both outside the home and housework)*? *(circle one number)*

1 NOT AT ALL
2 A LITTLE BIT
3 MODERATELY
4 QUITE A BIT
5 EXTREMELY

YOUR FEELINGS

9. These questions are about how you feel and how things have been with you during the past week. For each question, please indicate the one answer that comes closest to the way you have been feeling.

How much of the time during the last week .... *(circle one number on each line)*

	All of the time	Most of the Time	A Good Bit of the Time	Some of the Time	A little of the Time	None of the Time
a. did you feel full of pep?	1	2	3	4	5	6
b. have you been a very nervous person?	1	2	3	4	5	6
c. have you felt so down in the dumps nothing could cheer you up?	1	2	3	4	5	6
d. have you felt calm and peaceful?	1	2	3	4	5	6
e. did you have a lot of energy?	1	2	3	4	5	6
f. have you felt downhearted and blue?	1	2	3	4	5	6
g. did you feel worn out?	1	2	3	4	5	6
h. have you been a happy person?	1	2	3	4	5	6
i. did you feel tired?	1	2	3	4	5	6
j. has your health limited your social activities (*like visiting with friends or close relatives*)?	1	2	3	4	5	6

10. Please choose the answer that best describes how true or false each of the following statements is for you. *(circle one number on each line)*

	Definitely True	Mostly True	Not Sure	Mostly False	Definitely False
a. I seem to get sick a little easier than other people.	1	2	3	4	5
b. I am as healthy as anybody I know.	1	2	3	4	5
c. I expect my health to get worse.	1	2	3	4	5
d. My health is excellent.	1	2	3	4	5

H. YOUR WORK

Please tell me the one answer that best fits your job situation. Sometimes none of the answers fits exactly.

1. My job requires that I learn new things.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

2. My job involves a lot of repetitive work.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

3. My job requires me to be creative.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

4. My job allows me to make a lot of decisions on my own.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

5. My job requires a high level of skill.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

6. On my job, I have freedom to decide how I do my work.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

7. I get to do a variety of different things on my job.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

8. I have a lot of say about what happens on my job.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

9. I have an opportunity to develop my own special abilities.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

10. I have control over how my work area is set up. (e.g. I can change the height of my chair, alter positioning of equipment, vary my bench heights, etc.)

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

11. My job requires working very fast.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

12. My job requires working very hard.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

13. My job requires lots of physical effort.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

14. I am asked to do an excessive amount of work.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

15. I have enough time to get the job done.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

16. My work requires rapid and continuous physical activity.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

17. I am free from conflicting demands that others make.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

18. My job security is good.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

19. My supervisor cares about those under him/her.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

20. My supervisor pays attention to what I am saying.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

21. My supervisor is helpful in getting the job done.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

22. My supervisor is successful in getting people to work together.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

23. I get along well with my supervisor.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

24. There is a pleasant atmosphere at my workplace.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

25. My fellow workers are understanding when I have a bad day.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

26. My fellow workers are supportive.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

27. There are frequent conflicts with my supervisor.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

28. I feel I am harassed at work because of my race or sex.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

29. There are frequent conflicts at my work site.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

30. There is nobody at work I can talk to about job problems.

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4]

31. My fellow workers take a personal interest in me.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

32. My fellow workers are helpful in getting the job done.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

33. I am appropriately respected and rewarded by my company for my work.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

34. My skills and abilities are "vital" to my work group or unit.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

35. I feel my immediate supervisor considers my job very important.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

36. My fellow workers consider my job very important.

☐ Often [1] ☐ Sometimes [2] ☐ Rarely [3] ☐ Never/Almost never [4]

37. I enjoy the tasks involved in my job.

☐ Almost always [1] ☐ Some of the time [2] ☐ Never [3]

38. Compared to other people in jobs like mine, my level of education (school, college, etc.) is:

Much Higher [1] ☐ Higher [2] ☐ About the same [3] ☐ Lower [4] ☐ Much lower [5] ☐

39. Compared with previous jobs, my current job requires less skill. *(Do not count previous jobs you have held for less than 6 months.)*

☐ Strongly agree [1] ☐ Agree [2] ☐ Disagree [3] ☐ Strongly disagree [4] ☐ No previous job [5]

40. Compared with 1 year ago, the physical demands of my job (e.g. lifting, twisting, and so on) are:

Much less [1]	A little less [2]	About the same [3]	A little more [4]	Much more [5]	Not employed 1 year ago [6]
☐	☐	☐	☐	☐	☐

41. Compared with 1 year ago, the control I have over my work is:

Much less [1]	A little less [2]	About the same [3]	A little more [4]	Much more [5]	Not employed 1 year ago [6]
☐	☐	☐	☐	☐	☐

42. About your job in general - how satisfied are you with your job as a whole taking everything into consideration?

☐ Very satisfied [1] ☐ Satisfied [2] ☐ Dissatisfied [3] ☐ Very dissatisfied [4]

43. Working at my present job gives me less seniority than my previous job.

☐ Strongly agree (1) ☐ Agree (2) ☐ Disagree (3) ☐ Strongly disagree (4) ☐ No previous job (5)

44. What is your current job title/trade?

Job title/Trade: _____

Describe your job: _____

_____

_____

_____

Cycle time (if applicable): _____

Starting date of current job: Month _____ Year _____
[Not starting date for G.M.]

45. How physically demanding on your body is your job? *(circle number)*

0
1 very, very light
2
3 very light
4
5 usually light
6
7 a bit demanding
8
9 demanding
10
11 very demanding
12
13 very,very demanding
14

I. Next we want to ask you a few more questions about your job.

1. Do you need permission or do you have to find someone to take your place if you leave your work area for five or ten minutes? *(check box)*

☐ Never (1) ☐ Sometimes (2) ☐ Always (3)

2. How much do workers take part in decision making in the workplace?

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

3. I feel employees ideas/opinions are listened to by management.

☐ Strongly agree (1) ☐ Agree (2) ☐ Disagree (3) ☐ Strongly disagree (4)

4. I can influence the way work is organised in my work area.

☐ Strongly agree (1) ☐ Agree (2) ☐ Disagree (3) ☐ Strongly disagree (4)

5. Safety is considered equally with production and quality goals in management thinking and plant operations.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

6. Management is committed to keeping workers employed when injuries or disabilities occur.

☐ Often (1) ☐ Sometimes (2) ☐ Rarely (3) ☐ Never/Almost never (4)

7. Management encourages employees to shut down an unsafe machine or stop the work process when an unsafe condition arises.

☐ Strongly agree (1) ☐ Agree (2) ☐ Disagree (3) ☐ Strongly disagree (4)

8. Management encourages employees to promptly report physical symptoms arising from job tasks.

☐ Strongly agree (1) ☐ Agree (2) ☐ Disagree (3) ☐ Strongly disagree (4)

9. Management encourages supervisors to provide "light duties" or reduced working hours for workers who are recovering from an injury.

☐ Strongly agree (1) ☐ Agree (2) ☐ Disagree (3) ☐ Strongly disagree (4)

J. In the last 2 years have you had any deeply troubling personal experiences or severe stress (e.g., loss of a loved one, serious marital, financial, or legal problems, robberies, etc.)?

- 1 YES
  2 NO

- If yes, please specify. _____

K. Next we would like to know about how you have been feeling in the past week. Please tell me the phrase or number below which comes closest and I will circle it. Don't take too long over your replies: your immediate reaction to each item will probably be more accurate than a long thought-out response.

1. I feel tense or 'wound-up':

   1 Most of the time
   2 A lot of the time
   3 Time to time, occasionally
   4 Not at all

2. I still enjoy the things I used to enjoy:

   1 Definitely as much
   2 Not quite so much
   3 Only a little
   4 Hardly at all

3. I get a sort of frightened feeling as if something awful is about to happen:

   1 Very definitely and quite badly
   2 Yes, but not too badly
   3 A little, but it doesn't worry me
   4 Not at all

4. I can laugh and see the funny side of things:

   1 As much as I always could
   2 Not quite so much now
   3 Definitely not so much now
   4 Not at all

5. Worrying thoughts go through my mind:

   1 A great deal of the time
   2 A lot of the time
   3 From time to time but not too often
   4 Only occasionally

6. I feel cheerful:

   1 Not at all
   2 Not often
   3 Sometimes
   4 Most of the time

7. I can sit at ease and feel relaxed:

   1 Definitely
   2 Usually
   3 Not often
   4 Not at all

8. I feel as if I am slowed down:

   1 Nearly all the time
   2 Very often
   3 Sometimes
   4 Not at all

9. I get a sort of frightened feeling like 'butterflies' in the stomach:

   1 Not at all
   2 Occasionally
   3 Quite often
   4 Very often

10. I have lost interest in my appearance:

    1 Definitely
    2 I don't take so much care as I should
    3 I may ;not take quite as much care
    4 I take just as much care as ever

L. People's lives are very different. In this section we would like to ask you about how you see yourself and your situation. How strongly do you agree or disagree with each of the following statements as they describe your life?

1. I have little control over the things that happen to me. *(check appropriate box)*

Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

2. There is really no way I can solve some of the problems I have.

Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

3. There is little I can do to change many of the important things in my life.

Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

4. I often feel helpless in dealing with the problems of life.

Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

5. Sometimes I feel that I'm being pushed around in life.

Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

6. What happens to me in the future mostly depends on me.

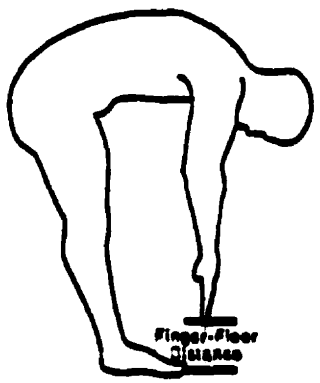
Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

7. I can do just about anything I really set my mind to do.

Strongly agree (1)	*Agree* (2)	*Disagree* (3)	*Strongly disagree* (4)
☐	☐	☐	☐

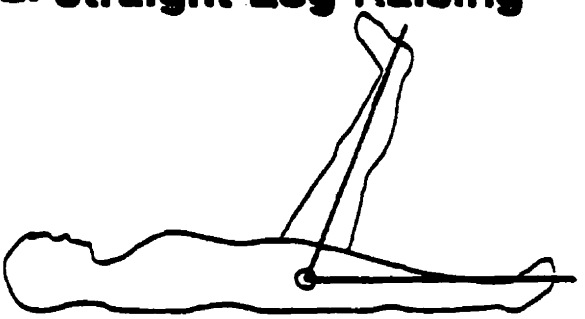
HOME ASSESSMENTS OF BACK PROBLEMS

1. Restricted Range



Finger-floor distance, _____ in. / cm.
Use a 6" block to record negative values.

2. straight Leg Raising



Right _____°; Left _____°
(do not round to nearest 5°)
Mark location of pain, if experienced.
Diagram shows _____° ?

3. Suck-in Sit-ups

Safety: The exercise must be painless.

The spine must form a smooth, C-shaped curve, with no movement at the belt line. Begin with a strong pelvic tilt, then tilt the head forward until the chin is on the chest. Smoothly bring the elbows to the knees, and lay back pushing the belt line down.

Scoring Scale:

0. Can't do a sit-up.
1. Needs 2 or more pillows.
2. Flat, arms stretched toward knees.
3. Hands to opposite elbows.
4. Hands to opposite shoulders.
5. Hands behind neck.
6. Arms behind head, fingers touching opposite ears.

Sit-up score _____

Revised, 9 jun, 93; Hugh Smythe

4. Grip Strength

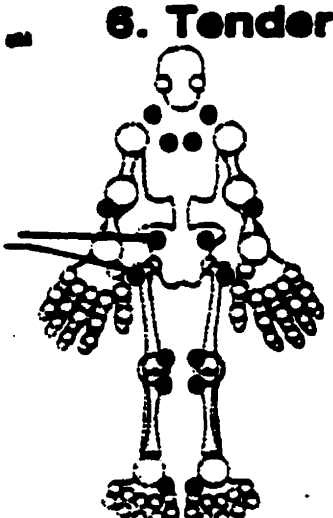
Right	Left
.....	.....

5. Reflexes

Score: 0 to 4; normal 2.

Site	Right	Left
Knee (L3-4)	.....	.....
Hamstring (L5)	.....	.....
Ankle (S1)	.....	.....

6. Tenderness



Score: nontender = 0, tender = 1

Site	Right	Left
Trapezius	.....	.....
2nd rib	.....	.....
Elbow	.....	.....
Gluteus	.....	.....
Trochanter	.....	.....
Above knee	.....	.....
Below knee	.....	.....
Instep	.....	.....

Total number of tender sites: _____

We would like to ask you about your back pain and how your pain affects your day-to-day activities. Please answer each of the following questions by circling one number for each answer.

1. How would you rate your back pain on a 0-10 scale **right now**, where **0** is **No Pain** and **10** is **Pain as bad as it could be**?

0	1	2	3	4	5	6	7	8	9	10
No pain										As bad as it could be

2. Since your injury, how bad was your **worst** back pain?

0	1	2	3	4	5	6	7	8	9	10
No pain										As bad as it could be

3. Since your injury, on **average**, how intense was your back pain (that is, your usual pain at the times you were experiencing pain)?

0	1	2	3	4	5	6	7	8	9	10
No pain										As bad as it could be

4. About how many days since your injury, have you been kept from your usual activities (work, school or housework) because of back pain? _____ DAYS

5. Since your injury, how much has back pain interfered with your **daily activities** rated on a **0-10** scale, where **0** is **no interference** and **10** is **unable to carry on any activities**?

0	1	2	3	4	5	6	7	8	9	10
No Interference										As bad as on any activities

6. Since your injury, how much has back pain changed your ability to take part in **recreational, social and family activities** where **0** is **no change** and **10** is **extreme change**?

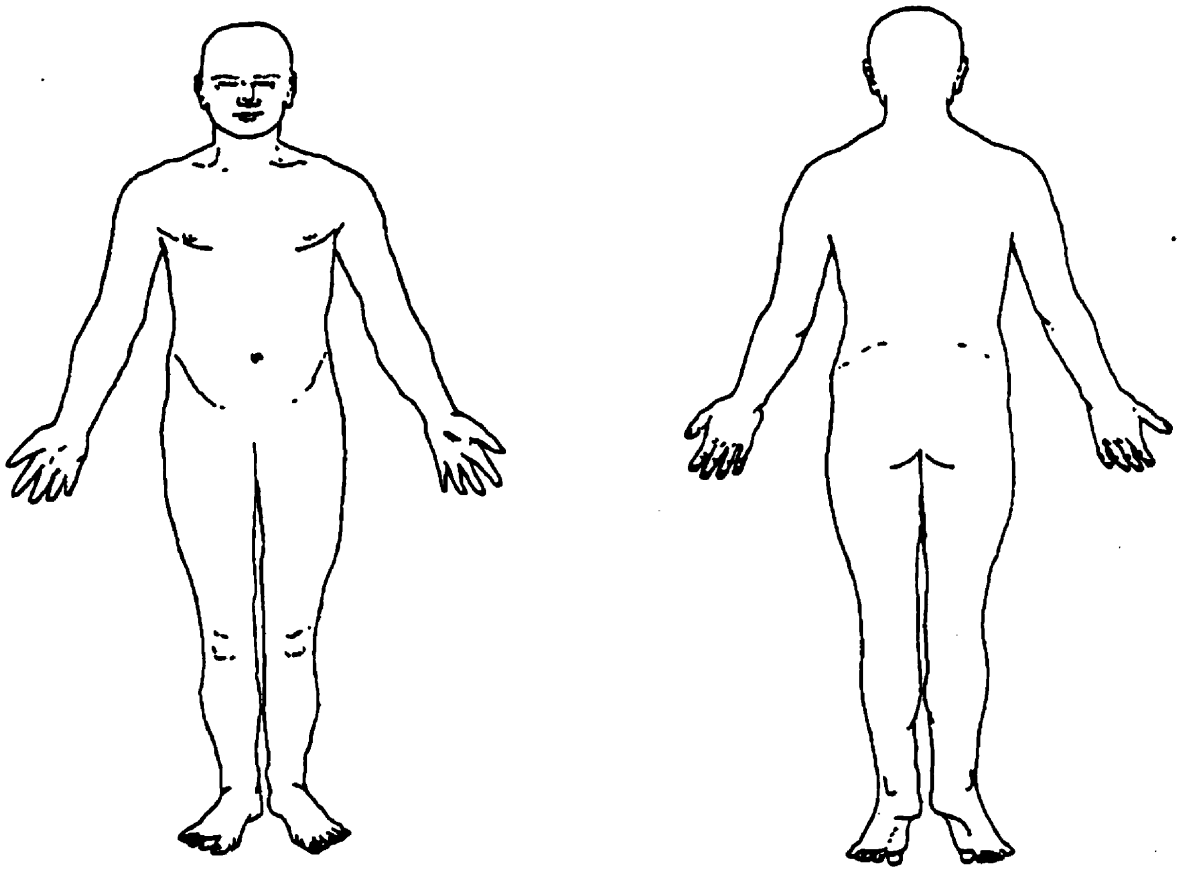
0	1	2	3	4	5	6	7	8	9	10
No Change										Extreme Change

7. Since your injury, how much has back pain changed your ability to **work (including housework)** where **0** is **no change** and **10** is **extreme change**?

0	1	2	3	4	5	6	7	8	9	10
No Change										Extreme Change

Please "colour in" (pencil is fine) the areas on the body where you feel pain. "Colour" as much of the drawings as you need to. This will tell us where your pain is now. If you are free of pain, please leave the drawings blank.

Please circle the area where the pain bothers you the most.



Appendix 4.C1: Construct Validity (Spearman Correlation) for Physical Exertion Scale

POPULATION CONTROLS (N=179)

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 179

	LTS_PHYS	RPD_CNTN
LTS_PHYS	1.00000	0.61317
Job requires physical effort? (H13)	0.0	0.0001
RPD_CNTN	0.61317	1.00000
Job requires rapid activity? (H16)	0.0001	0.0

REPORT TO WORKPLACE (N=137)

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 137

	LTS_PHYS	RPD_CNTN
LTS_PHYS	1.00000	0.49858
Job requires physical effort? (H13)	0.0	0.0001
RPD_CNTN	0.49858	1.00000
Job requires rapid activity? (H16)	0.0001	0.0

Appendix 4.C2: Internal Consistency (Cronbach's Alpha) and Item Total Correlation (ITC) for the Job Self-Worth Scale

POPULATION CONTROLS (N=179)

Cronbach Coefficient Alpha

for RAW variables : 0.700500
for STANDARDIZED variables: 0.700759

	Raw Variables		Std. Variables		
Deleted Variable	Correlation with Total	Alpha	Correlation with Total	Alpha	Label
APPRP_RS	0.302590	0.741848	0.300554	0.745380	Respected by company for work? (H33)
SKLS_VTL	0.499294	0.627759	0.502707	0.626147	Skills vital to work unit? (H34)
SPRV_IM	0.590959	0.574046	0.586675	0.571731	Supervisor sees job as important? (H35)
COW_IMPR	0.569129	0.580595	0.571242	0.581956	Coworkers see job as important? (H36)

REPORT TO WORKPLACE (N=137)

Cronbach Coefficient Alpha

for RAW variables : 0.760224
for STANDARDIZED variables: 0.767014

	Raw Variables		Std. Variables		
Deleted Variable	Correlation with Total	Alpha	Correlation with Total	Alpha	Label
APPRP_RS	0.406476	0.792385	0.405278	0.793735	Respected by company for work? (H33)
SKLS_VTL	0.635603	0.660225	0.648654	0.667013	Skills vital to work unit? (H34)
SPRV_IM	0.602694	0.684840	0.607800	0.689628	Supervisor sees job as important? (H35)
COW_IMPR	0.618541	0.671042	0.619787	0.683050	Coworkers see job as important? (H36)

Appendix 4.C3: Construct Validity (Spearman Correlation) of the Job Dissatisfaction Scale

POPULATION CONTROLS (N=179)

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 179

	ENJY_TSK	JB_STSFC
ENJY_TSK	1.00000 0.0	0.49373 0.0001
JB_STSFC	0.49373 0.0001	1.00000 0.0

REPORT TO WORKPLACE (N=137)

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 137

	ENJY_TSK	JB_STSFC
ENJY_TSK	1.00000 0.0	0.48016 0.0001
JB_STSFC	0.48016 0.0001	1.00000 0.0

Appendix 4.C4: Construct Validity (Spearman Correlation) of the Job Insecurity Scale

POPULATION CONTROLS (N=179)

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0 / Number of Observations

	JB_SCRTY	LS_SNRTY
JB_SCRTY Job security is good? (H18)	1.00000 0.0	-0.29420 0.0001
LS_SNRTY Job has less seniority? (H43)	-0.29420 0.0001	1.00000 0.0

REPORT TO WORKPLACE (N=137)

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0 / Number of Observations

	JB_SCRTY	LS_SNRTY
JB_SCRTY Job security is good? (H18)	1.00000 0.0	-0.29525 0.0005
LS_SNRTY Job has less seniority? (H43)	-0.29525 0.0005	1.00000 0.0

Appendix 4.C5: Construct Validity (Exploratory Factor Analysis) for Empowerment and Work Organization Scales

POPULATION CONTROLS (N=179)

Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2
1	0.85205	0.52346
2	-0.52346	0.85205

Rotated Factor Pattern

	FACTOR1	FACTOR2	
PRMSSN_W	-0.00684	0.78439	Need permission to leave (I1)
WRKRS_DC	*0.36431*	0.71118	Workers take part in decisions (I2)
EMPLY_ID	*0.52575*	0.37248	Employee ideas listened to (I3)
INFLNC_O	0.07401	0.78080	Can influence work in own area (I5)
SFTY_EQL	0.73955	0.04021	Safety considerd equally (I5)
MNGMNT_C	0.58736	0.06092	Mgmnt committed to injured workers (I6)
ENCRG_SH	0.75868	0.08576	Mngmnt - discourages unsafe work (I7)
ENCRG_SY	0.65252	0.21013	Mngmnt - encourages symptom report (I8)
LGHT_DTS	0.68684	0.08687	Mngmnt - provide light duties (I9)

Variance explained by each factor

FACTOR1	FACTOR2
2.779722	1.933815

Final Communality Estimates: Total = 4.713537

PRMSSN_W	WRKRS_DC	EMPLY_ID	INFLNC_O	SFTY_EQL	MNGMNT_C	ENCRG_SH	ENCRG_SY	LGHT_DTS
0.615309	0.638501	0.415160	0.615124	0.548548	0.348704	0.582953	0.469942	0.479295

REPORT TO WORKPLACE (N=137)

Rotation Method: Varimax Orthogonal Transformation Matrix

	1	2
1	0.73965	0.67299
2	-0.67299	0.73965

Rotated Factor Pattern

	FACTOR1	FACTOR2	
PRMSSN_W	0.00624	0.64060	Need permission to leave (I1)
WRKRS_DC	0.05283	0.74789	Workers take part in decisions (I2)
EMPLY_ID	*0.40130*	0.52854	Employee ideas listened to (I3)
INFLNC_O	0.16095	0.73169	Can influence work in own area (I5)
SFTY_EQL	0.61352	0.45602	Safety considerd equally (I5)
MNGMNT_C	0.60141	-0.14171	Mgmnt committed to injured workers (I6)
ENCRG_SH	0.64852	*0.38508*	Mngmnt - discourages unsafe work (I7)
ENCRG_SY	0.66978	0.24002	Mngmnt - encourages symptom report (I8)
LGHT_DTS	0.78455	0.04669	Mngmnt - provide light duties (I9)

Variance explained by each factor

FACTOR1	FACTOR2
2.412591	2.220551

Final Communality Estimates: Total = 4.633142

PRMSSN_W	WRKRS_DC	EMPLY_ID	INFLNC_O	SFTY_EQL	MNGMNT_C	ENCRG_SH	ENCRG_SY	LGHT_DTS
0.410410	0.562134	0.440399	0.561274	0.584362	0.381774	0.568865	0.506218	0.617705