WORK ORGANIZATION FACTORS AND MUSCULOSKELETAL SYMPTOMS AND CLAIMS AMONG HEALTH CARE WORKERS

by

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Abstract

This dissertation is a study of health care workers and the relationship between work organization factors and work-related musculoskeletal outcomes. It was hypothesized that rates of upper-body and lower-body musculoskeletal symptoms and compensation claims would increase with exposure to adverse work organization factors defined by low job control, low work support, high job demands or time pressures, and high levels of workload, while controlling for individual and biomechanical risk factors.

Theoretically, both models of work-related musculoskeletal morbidity and job stress informed the study. Musculoskeletal morbidity is believed to develop when the conditions of work exceed the capacity of the worker. These conditions may be the result of adverse work organization factors that produce a stress response among workers with a direct effect on the musculoskeletal system, or they may modify other workplace factors that in turn influence musculoskeletal conditions.

The study employed a retrospective, longitudinal cohort design and followed 4020 health care workers from an acute-care hospital over a four-year period. Workers were enumerated from hospital personnel records and outcome data were ascertained from the hospital's occupational health and safety database. Biomechanical scores for occupations were assessed by direct observation and scored using checklists. Scores for the work organization measures of control, demands, support and pressure were assigned to cohort members using a job exposure matrix. The matrix was developed from responses to validated scales included in three random sample surveys of employees over the four-year study period. Workload measures were defined by time-varying levels of departmental sicktime, overtime and work units, calculated from financial reports. The risk of musculoskeletal symptoms and claims associated with work organization factors, controlling for individual and biomechanical factors, was assessed using Poisson regression.

In the final models, low levels of job control and work support, as well as high levels of workload related to departmental sicktime, were significantly associated with an elevated risk of upper-body musculoskeletal symptoms and claims. The risk of lower-body musculoskeletal symptoms and claims was significantly elevated for workload due to high levels of departmental sicktime, and that for lower-body compensation claims with low job control. Individual and biomechanical factors were also significant predictors of musculoskeletal outcomes, which gives support to the idea that these outcomes have a multi-factorial etiology.

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Chapter I Literature Review

1.1 Work-related Musculoskeletal Morbidity among Health Care Workers

For many of us, work is a source of health and well-being. It provides for our basic human needs of mental or physical challenge, social interaction and financial security. However, increased rates of mortality and morbidity have been found among workers in certain occupations or industries, suggesting an adverse link between health and work conditions. Work-related musculoskeletal morbidity among health care workers is one example.

Definitions vary but musculoskeletal morbidity generally involves strains, sprains or trauma to the musculoskeletal system, primarily the muscles, joints, spinal discs and associated tendons, ligaments, cartilage, and nerves. Musculoskeletal problems are considered work-related when cumulative exposure to workplace conditions and work tasks contributes to their development (WHO 1985). Work-related musculoskeletal outcomes include symptoms, pain, or discomfort in localized areas such as the low-back or the neck; and clinically recognized conditions such as carpal tunnel syndrome, tendinitis or de Quervain's disease. Musculoskeletal pain has been the most common health outcome investigated in workplace studies (Bernard et al 1997). Symptoms and conditions are often categorized by their anatomical location into upper-body musculoskeletal morbidity involving the upper-limb, neck or cervical region of the back; low-back morbidity involving the lumbar region of the back; and lower-limb musculoskeletal morbidity involving the hip, thigh, knee or foot.

There are an estimated 1.1 million health care workers in Canada, representing approximately 4% of the Canadian population and 8% of the workforce (Statistics Canada 1996). Studies on compensation claims data indicate that musculoskeletal morbidity is the dominant type of disability to workers in the Canadian health care sector (Choi et al, 1996), affecting the health of a significant portion of the population. Within the province of British Columbia, for example, musculoskeletal-related claims accounted for almost three-quarters of all claims in the health care sector in the five-year period from 1991 to 1995. In 1997, employees in the health care sector accrued a total of 169,579 lost days to strain-related disability and 8,744 days to repetitive motion disability (WCB 1998).

Published studies (Appendix 1) show a significant portion of workers in the health care sector reporting upper-body and lower-body (i.e. low-back and lower-limb) musculoskeletal symptoms. The reported period prevalence for upper-body musculoskeletal symptoms ranged from 12% for neck pain experienced once a month among American nurses in a study by Prezant and colleagues (1986), to 74% for shoulder pain in the last month among Swedish nursing personnel in a study by Ahlberg-Hultén and colleagues (1995). The period prevalence in the remaining studies was evenly distributed within this range, with the majority of studies reporting a prevalence of upper-body outcomes between 20% and 60%. For lower-body musculoskeletal outcomes, Yassi and colleagues (1995) reported a two-year period prevalence of 19% for incident reports of back injuries among Canadian nurses, while Moens and colleagues (1993) found a 12-month period prevalence of 72% for self-reported low-back symptoms among home care workers. A quarter of all studies reported a period prevalence between 40-49% for lower-body musculoskeletal symptoms.

The Health Canada Report on the Economic Burden of Illness (Moore et al 1997) ranked musculoskeletal disorders second only to cardiovascular disease for total costs to society. Musculoskeletal disorders were estimated to cost over 2 billion dollars in direct care costs (e.g. drugs, physician visits, hospital stays) and over 15 billion in indirect costs (e.g. short-term and long-term disability). Another study (Coyte et al 1998) estimated the total economic burden of musculoskeletal disorders for Canadians was 25.6 billion dollars (in 1994 dollars) or 3.4% of the gross domestic product of Canada. This study included the indirect costs associated with lost productivity. In terms of work-related musculoskeletal morbidity, Workers' Compensation Boards in Canada (Association of Workers' Compensation Boards in Canada, 1997) accepted more than half a million time-loss claims for work-related disability each year during the period 1982 to 1990. In 1995, $5.7 billion in benefits costs were paid for all lost-time occupational injuries in Canada. Musculoskeletal injuries typically account for over half of all of these claims costs. In British Columbia, the costs associated with 1997 claims in the health care sector totalled almost $17 million, excluding health care and rehabilitation costs (WCB 1998).

The prevalence of work-related musculoskeletal problems among health care workers and the associated economic impact demonstrate its substantial public health burden. As the prevalence and impact of work-related musculoskeletal morbidity have become known, researchers have directed their attention to understanding the variables associated with the development of morbidity in an effort to prevent the magnitude and severity of the problem. While the etiologic mechanisms are not clearly understood, there is increasing evidence that suggests work organization factors play a role in the development of work-related musculoskeletal disorders (Bongers et al 1993). However, at present, the difficulty in determining the importance of work organization factors in the etiology of musculoskeletal disorders among health care workers is a) inconsistency of findings (see section 1.7.2); b) a predominance of cross-sectional research (Bongers et al 1993; Burdorf and Sorock 1997; Carayon 1995; Lagerström et al 1998; Norman 1994); c) a limited number of studies on female workers or non-industrial sectors such as health care (Veazie et al 1994); d) few studies that investigate work organization factors as part of multi-variable analyses that adequately measure or adjust for biomechanical factors (Burdorf 1992; Kilbom 1994; Winkel and Westgaard 1992); and e) subjective or single-point estimates of work organization factors.

1.2 Purpose of the Study

The purpose of this study was to investigate the relationship between work organization factors and musculoskeletal outcomes among health care workers, as part a cohort study design that adequately measured biomechanical factors and incorporated objective, time-varying measures of work organization factors. The intent of the study is not to diminish the importance of biomechanical or individual factors in the etiology of work-related musculoskeletal morbidity, but to suggest a multi-factor model that includes work organization variables. The following sections outline the conceptual and theoretical foundations for the study of work organization factors. This is followed by a review of the evidence for work organization factors and musculoskeletal outcomes in the literature, and based on this evidence, the selection of variables to investigate further in the current study.

1.3 Conceptual Framework for the Study

There has been increasing recognition of the complex nature of work-related musculoskeletal morbidity (Armstrong et al 1993; Hagberg et al 1995; WHO 1985). Most studies investigate the importance of individual and/or biomechanical factors in causation. While these factors are associated with musculoskeletal outcomes, they may not represent a complete picture of the multi-factor nature of morbidity. As a consequence, characteristics pertaining to the way in which work is organized have gained attention as potential risk factors.

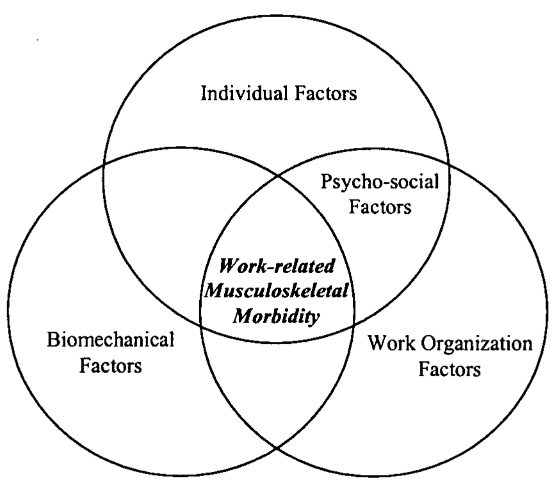

Figure 1: Conceptual Model of Factors Associated with Work-Related Musculoskeletal Morbidity

The individual domain includes characteristics of the worker such as age, gender, experience, physical fitness, personality, mental health, socio-economic status, and health habits. The ergonomic or biomechanical domain includes physical characteristics associated with work tasks such as heavy lifting, repetitive tasks, forceful movements, or awkward postures; and characteristics associated with the physical working environment such as workstation and equipment design, or noise and temperature levels. The work organization domain recognizes the more global influences of work structures and processes associated with the cognitive stress and strain of work, as opposed to the physical strain of work. It includes such factors as time pressures, workload levels, social milieu, intellectual challenges, control over work decision, and work schedules.

While factors in each domain may function independently, there is a great deal of overlap whereby factors in one domain may modify or interact with factors in another. For example, work tasks that are structured with little variety or challenge (i.e. work organization factor) may be directly related to performing highly repetitive tasks (i.e. biomechanical factor). Likewise, the amount of control in a job (i.e. work organization factor) may be influenced by worker attitudes (i.e. individual factor). The subjective aspects of work organization are often termed psychosocial factors. In this thesis, factors such as workload levels and job control were measured at the department level or predicted for like-occupations. As such they are termed work organization factors, as opposed to psychosocial factors. The overlap between domains also indicates that while work organization factors may be directly related to the development of musculoskeletal problems, they may also be predictors of other risk factors. For example, a worker with low job control may have higher biomechanical demands because of an inability to take a break from a repetitive tasks when needed, which in turn may influence the development of musculoskeletal problems. Section 1.6 describes in further detail the possible mechanisms or pathways by which work organization factors influence musculoskeletal morbidity.

1.4 Models of Work-related Musculoskeletal Morbidity

In general, models describe work-related musculoskeletal morbidity as the result of dynamic interactions between the worker and conditions in the working environment (Smith and Carayon-Sainfort 1989; Armstrong et al 1993; Moore et al 1991; Tanaka and McGlothin 1993; Hagberg et al 1995; Burdorf et al 1997; Gibson 1994; Waddell 1992). In an 'equilibrium state' (Burdorf et al 1997), the worker is capable of responding to the conditions of the work environment. The pathological process is triggered when work conditions interfere with the equilibrium and produce a 'stress load' on the worker (Smith and Carayon-Sainfort 1989). The response of the worker to this load can be physiological such as biomechanical loading of muscles or increased levels of stress hormones; psychological such as mental fatigue or altered perceptions; or behavioural such as changes in work practices or absenteeism (Hagberg et al, 1995; Lim et al, 1997; Bergqvist 1984; Bongers et al 1993; Bernard et al 1993; Sauter and Swanson 1996; Ursin et al 1988). These physiological, psychological or behavioural consequences may lead to work-related musculoskeletal morbidity, either independently by producing a physical response of the musculoskeletal system or through intervening pathways by influencing other risk factors. Several models include 'cascading' (Hagberg et al 1995) or 'iterative' processes (Burdorf et al 1997) whereby workers experience cycles of symptoms or disability, or workers move between various states from no symptoms to disability. While many models focus on the relationship between physical stressors and the biomechanical load on muscles and joints, models have evolved to recognize the broader influences of work organization on the health of workers (Hagberg et al 1995; Sauter and Swanson 1996). Models of work stress provide insight into the work characteristics and conditions that may be important in an ecological model of musculoskeletal morbidity that includes work organization factors.

1.5 Models of Work Stress – The Role of Work Organization Factors

The work system model (Smith and Carayon-Sainfort 1989) identifies work tasks, technology and the environment as negative aspects that can create a stress load on the worker. The accumulation of negative aspects if not compensated by positive aspects such as additional resources and a positive social environment can lead to stress reactions. The action regulation theory (Hacker 1994; Oesterreich and Volpert 1986; Volpert 1982) defines stressors as work conditions which, because of poor technical or organizational work design, interfere with the ability of the worker to complete the task in a certain way. A taxonomy of working conditions by Kasl (1992) identifies the important risk factors associated with stress among workers as the physical components of work, temporal characteristics (e.g. shift work), job content, interpersonal relationships, organizational aspects (e.g. bureaucracy), financial structures and community features (e.g. status).

One of the most well known models of job strain or occupational stress is that proposed by Karasek (Karasek 1979; Karasek and Theorell 1990) which defines job strain as a combination of mental demands and job control. The job demands dimension is related to the cognitive strain of work and is assessed by questions on conflicting demands and organizational conditions that interfere with the completion of job tasks (Karasek et al 1998). Job control is related to a worker's influence over the performance of their job and is defined by the two sub-dimensions of skill discretion and decision authority. Skill discretion is assessed by questions on the level of skill required on the job, and the flexibility permitted by the worker in deciding what skills to use (Karasek et al 1998). Decision authority is assessed by questions on the organizational conditions that affect the worker's ability to make decisions about their work, such as participation in decision-making (Karasek et al 1998). Johnson and Hall (1988) expanded the demand/control model with the addition of a measure of social support. Social relations are recognized as potential resources that influence the risk of illness or injury at work. Social support is measured by a set of questions on the helpful behaviours of co-workers or supervisors in the completion of work, as well as the ability to work together to complete job tasks. The basic hypothesis of the model is that adverse health reactions of job strain occur when the mental demands of the job are high and the worker's control over job decisions is low. Social relations at work can modify this job strain. The aim is to effect job characteristics and in turn worker health by changing work organizations and not individual behaviours (Karasek and Theorell 1990).

The stress response to job strain imposed by working conditions in often considered beneficial in the short term, mobilizing our mental and physical resources to address day to day challenges. In the longer term, however, stress responses may have damaging effects on health. Despite differences in methodology and working populations, job strain factors such as low control, high demands and social support have been shown to be associated with increased mortality (Amick et al 1999; House et al 1988) and morbidity, such as hypertension (Schnall et al 1990; Landsbergis et al 1995; Landsbergis et al 1999; Schnall et al 1999; Unden et al 1991), heart disease (Alfredsson et al 1985; Theorell et al 1998; Johnson et al 1996; Schnall et al 1994; Landsbergis et al 1994), immune function/infections (Cohen et al 1991; Meijman et al 1995), mental health (Amick et al 1999; Langsbergis 1988; Gardell et al 1982), and more recently musculoskeletal problems (Cahill and Landsbergis 1996; Bongers et al 1993). Work organization factors are thought to influence musculoskeletal morbidity by either a stress-response or biomechanical pathway.

1.6 Pathways between Work Organization Factors and Musculoskeletal Morbidity

1.6.1 Job Strain Mechanism

Work organization factors may be related to musculoskeletal morbidity directly through a job strain mechanism. Frankenhaeuser and Johansson's (1986) research showed two primary physiological responses to stress (adrenaline and cortisol related) with the job control and job demands dimensions of Karasek's job strain model. Theorell and colleagues (1993) similarly showed that job strain defined by high demands and low control was associated with increased blood pressure among female hospital workers after adjustment for individual confounders. Such stress responses due to adverse work organization factors may increase muscle tension, or exacerbate existing physical loads on muscles, leading to musculoskeletal symptoms (Smith and Carayon-Sainfort 1989). Laboratory experiments and workplace studies have shown that mental stress can significantly increase activity in the muscles as measured by EMG activity. For example, abnormal EMG recordings were recorded among subjects with back pain exposed to experimental stressful situations (Flor et al, 1985). Gomer and colleagues (1987) reported increased EMG activity in the forearm and increased musculoskeletal discomfort associated with visual and memory demands among postal workers. Waersted and Westgaard (1991) found increases in muscle tension induced by the complexity and mental demands of video display terminal work, and Arndt (1987) reported increases in EMG activity associated with assembly workers who were unable to respond to a request to speed up production. Finally, studies of monotonous work among women indicated that when psychological loads were added to ergonomic loads, electrical muscle activity increased considerably (Lundberg et al 1994).

Alternatively, physiological stress responses to work organization factors may exacerbate existing physical strain on the musculoskeletal system. Early work by Frankenhaeuser and colleagues (Frankenhaeuser and Gardell 1976; Frankehnaeuser et al 1980; Frankenhaeuser and Johanssen 1986; Frankenhaeuser and Johanssen 1976; Lundberg and Frankenhaeuser 1980), followed by others (Harenstam and Theorell 1990; Cox et al 1982; Rissler et al 1977; Lundberg et al 1989; Caplan et al 1975; Johansson et al 1978; Theorell et al 1991; Fox et al 1993; Tattersall and Farmer 1995), demonstrated increased cortisol, catecholamine and adrenaline secretions associated with work organization conditions defined by low social support, poor management style, monotonous work, repetitive tasks, high job demands, time pressures, high workload levels and overtime. A comprehensive review of 81 articles by Uchino and colleagues (1996), on the relationship between social support and physiological responses, concluded that social support was consistently related to effects of the cardiovascular, endocrine and immune systems. Physiological reactions to work organization factors such as low control, high workload and high job demands, have also been documented among health care workers (Fox et al 1993; Theorell et al 1993). Melin and colleagues (in press) found a high prevalence of musculoskeletal disorders associated with elevated physiological stress as marked by epinephrine and norepinephrine levels. Armstrong and colleagues (1993) believe that such biochemical reactions can exacerbate existing musculoskeletal strain by increasing fluid retention in the body tissues leading to pressure or pinching of the nerves.

1.6.2 Biomechanical Mechanism

Alternatively, work organization factors may define the nature, strength and duration of exposure to biomechanical factors (Hagberg et al 1995). For example, workload levels determine the amount of work to be completed in a period of time with direct implications for the number of manual lifts, the duration of awkward postures or the rate of repetition that workers are exposed to. The psychological response of workers to adverse work organization factors may also result in altered work behaviours or work methods in a way that increases biomechanical strain (Bernard et al 1993; Smith and Carayon-Sainfort 1989; Hagberg et al 1995; Murphy 1985). Workers who are depressed, angry or fatigued, for example, may use more force to complete a lifting or typing task, or perform tasks in isolation without co-worker assistance, resulting in additional physical strain on the musculoskeletal system (Sauter and Swanson 1996). In support of this casual pathway, Kobayashi and colleagues (1999), in a study of Japanese workers, found low control and low support to be significant for depressive symptoms. A cohort study of office workers (Carayon et al 1995) found that workload, work pressure, social support, and task clarity were important predictors of boredom, dissatisfaction, tension-anxiety, depression, anger, and fatigue. A cohort study of emergency medicine residents (Revicki and Whitley 1995), nurses (Revicki and May 1989) and medical technicians (Revicki et al 1988) found that measures of job strain, group support and task clarity were related to symptoms of depression. Furthermore, several workplace studies have demonstrated an increased risk of musculoskeletal outcomes with psychological variables such as depression, fear, emotional distress and anger (Holmström et al 1992; Bergqvist et al, 1995; Bigos et al 1992; Estlander et al 1998). Some authors have suggested that altered psychological states may also make musculoskeletal symptoms more evident by increasing pain perceptions (Sauter and Swanson, 1996), or that more severe pathological changes may occur as a result of suppressing pain to meet job demands (Theorell, et al 1993).

1.7 Factors Associated with Work-related Musculoskeletal Morbidity

1.7.1 Process for Reviewing the Literature

The objective of this section was to examine the evidence for an association between work organization factors and work-related musculoskeletal morbidity and, based on the evidence, identify factors that require further investigation in a cohort study of health care workers. The multi-factorial nature of musculoskeletal morbidity also requires a review and discussion of individual and biomechanical factors.

Both Medline and CIHNL databases were searched for studies on the epidemiology of work-related musculoskeletal outcomes. Papers included cross-sectional, case-control, and cohort study designs, as well as papers on workers in the health care and non-health care sectors. Additional studies were obtained by searching the bibliography of these papers. Papers were limited to working populations. The following sections summarize the weight of the evidence from reviewed papers for work organization factors (job control, job demands, work support, job stress/strain, workload measures, job satisfaction, monotonous work), as well as that for individual (age, sex, previous musculoskeletal problems, work experience, anthropometric measures, fitness/strength measures, smoking status, and socio-economic status) and biomechanical factors (exposure to lifting, manual handling, awkward postures, repetition, vibration, forces, static postures, or exposure by job title or work area). Specific studies are cited to illustrate the overall findings from the literature with reference to differences across study designs, between upper-body and lower-body musculoskeletal outcomes or between health care and non-health care study populations. A more detailed description of findings from studies in the health care sector is provided in Appendix 1.

1.7.2 Evidence Relating Work Organization Factors to Musculoskeletal Outcomes

Bernard and colleagues (1997), in a comprehensive review on the work-relatedness of musculoskeletal disorders, found evidence for intensified workload, monotonous work and low support related to upper-body outcomes. The review also suggested some evidence for lack of control and job dissatisfaction. For the lower-body, intensified workload and high perceived time pressures were important risk factors, while evidence for job satisfaction, low control and monotonous work was inconclusive. Bongers and colleagues (1993), in a comprehensive review of work organization and psychosocial factors, concluded that monotonous work, high workload and time pressures were related to musculoskeletal symptoms. Low control and low support were also considered important work organization risk factors. A review of studies on work-related low-back problems in nursing (Lagerström et al 1998) identified staff density, work overload/stress, and job satisfaction as potentially important variables. Most of the findings from the preceding reviews were qualified because of methodological limitations and inconsistent results across studies (Bongers et al 1993; Bernard et al 1997; Burdorf and Sorock 1997). The following review of studies on musculoskeletal disorders, including studies in the health care sector, also found inconsistent findings for work organization factors. However, the weight of the evidence across studies suggests some work organizations may be important risk factors for musculoskeletal morbidity.

Job Control

Overall, evidence from the literature suggests that low job control may be an important risk factor for musculoskeletal outcomes, particularly for neck and shoulder-related problems. Hughes and colleagues (1997), in a cross-sectional study of aluminium smelter workers, reported a significant four-fold increased risk of shoulder disorders (OR=4.5) associated with low job control in analyses adjusted for individual and biomechanical factors. Ekberg and colleagues (1995) found that low authority over decisions was significantly related to an elevated risk of neck and shoulder symptoms (OR=1.3) among a Swedish working population in a cross-sectional study that adjusted for individual factors and repetitive movements. In another study of Swedish workers, Karasek et al (1987) reported that more job control was protective for musculoskeletal symptoms among males (OR=0.89) and females (OR=0.78), after adjustment for individual factors. A cross-sectional study of white-collar and blue-collar workers across eight companies (Johansson and Rubenowitz 1994) reported that shoulder symptoms were significantly correlated with low job control ($p<0.05$), adjusted for age and sex.

Despite the fact that many studies suggested a positive association between low job control and upper-body outcomes, results for the lower-body are inconclusive. Hemingway et al (1997), in a cohort study of over 10,000 British civil servants, found that low job control was significantly related to absences due to back pain (RR=1.76 and 1.64) in models adjusted for age and gender. Holmström and colleagues (1992), in a cross-sectional study of construction workers, found that high job discretion was significantly protective for back pain (PRR=0.8), but unrelated to severe back pain (PRR=1.00). Hughes and colleagues (1997) in the aforementioned study of aluminium workers, reported a two-fold increased risk of back pain with low job control (OR=2.3), although the confidence interval included '1'. Similarly, Kerr (1998) reported a two-fold increased risk of back pain associated with low control among automobile workers after adjustment for individual factors and direct measures of biomechanical factors, with a confidence interval that included '1'. Skov and colleagues (1996), in a cross-sectional study of sales personnel, reported no association between low control over work and back pain. Similarly, Krause and colleagues (1998), in a cohort study of transit workers, reported no association between low job control and the incidence of back injury in models adjusted for individual factors and driving hours.

Studies among health care workers provide conflicting results for both upper-body and lower-body musculoskeletal outcomes. Johansson (1995), in a cross-sectional study of home care workers, reported elevated risks of neck, shoulder and back symptoms (RR from 1.18 to 1.30) associated with low control over work. However, all of the risk ratios were borderline for significance, and the relationships did not remain in regression analyses controlling for individual and biomechanical factors. Josephson et al (1998), in a case-control study of nursing personnel, reported a two-fold increased risk of back pain with low control over decisions. Again, the odds ratio was reduced in magnitude and significance in models adjusted for individual and biomechanical factors. Ahlberg-Hultén and colleagues (1995), in a cross-sectional study of nursing personnel, found that back pain, but not shoulder or neck pain, was related ($p=0.05$) to low job control at the uni-variable level. Finally, Lagerström and colleagues (1995), in a cross-sectional study of nursing personnel, reported an increased risk of shoulder symptoms, but not neck symptoms, with low control at work ($OR=1.73$) in multi-variate analyses adjusted for individual factors and occupation.

Work Support

Evidence for a relationship between low work support and upper-body musculoskeletal outcomes is inconsistent. Ohlsson et al (1995) reported that industrial workers without neck and upper limb symptoms had more social interaction at work than those with symptoms ($p<0.001$). Social interaction did not contribute significantly to morbidity in the final multi-variable model adjusted for age and exposure to repetition. Whereas Polanyi and colleagues (1997), in a cross-sectional study of newspaper employees, showed that higher levels of social support at work were protective for upper-limb pain ($OR=0.72$) in models adjusted for biomechanical factors. Bernard and colleagues (1997) reported an elevated risk of hand and wrist symptoms ($OR=1.5$), but not neck and shoulder symptoms, among newspaper workers associated with a lack of supervisor support in final models adjusted for individual factors and hours spent typing. Hales and colleagues (1994), on the other hand, reported no association between neck, shoulder or limb disorders with poor co-worker or supervisor support among newspaper workers. Similarly, Holness and colleagues (1998) reported no difference in co-worker or supervisor support between bank workers with upper-extremity symptoms and those without ($p=0.63$ to 0.71).

Studies investigating work support and lower-body musculoskeletal outcomes suggest that supervisor support may be an important element of the social milieu at work. Krause and colleagues (1998), in the previously mentioned cohort study of transit workers, found that low supervisor support, but not co-worker support, was associated with an elevated risk of back injury (OR=1.30) in multi-variable analyses. Similarly, Johansson and Rubenowitz (1994) reported that poor supervisor relations, but not co-worker relations, were significantly associated with lower-body pain among blue-collar workers. Other papers provide inconsistent results for more general measures of work support and lower-body musculoskeletal outcomes. Leino and Hänninen (1995), in a study of metal workers, reported that poor social relations significantly predicted musculoskeletal morbidity (upper and lower combined) over a ten-year follow-up period ($p<0.009$). The aforementioned cohort study of office workers (Hemingway et al 1997) found no relationship between poor work support and short or long-term absences due to back pain in adjusted models. Finally, Kerr (1998) in a case-control study of automobile workers, found that higher, not lower, co-worker support significantly increased the risk of low-back pain (OR=1.6).

Despite the preceding inconsistent findings among workers in non-health care sectors, work support appears to be related to musculoskeletal outcomes among health care workers. Josephson and colleagues for example (1998), in the case-control study of nursing personnel, found insufficient social support associated with an elevated risk of reported low-back pain (OR=2.4) in final models adjusted for individual and biomechanical factors. Lagerström et al (1995) also documented a significant increased risk of back pain with low support (OR=1.79), after adjustment for confounders, among nursing personnel. Bru and colleagues (1996), in a cross-sectional study of hospital workers, reported that neck, shoulder and low-back pain was significantly related to poor social relations at work among those with high perceived ergonomic loads ($p<0.02$). Studies on upper-body outcomes are limited and those investigating the role of work support are inconsistent, with some finding an association (Kamwendo et al, 1991; Linton and Kamwendo 1989) and others no association (Johansson 1995; Dehlin and Berg 1977). For example, Lagerström and colleagues (1995), in the previously mentioned study of nursing personnel, reported an increased risk of neck symptoms, but not shoulder symptoms, with low supervisor support (OR=2.03) in multivariable analyses.

Job Demands or Time Pressures

Many studies report that higher cognitive demands at work are positively associated with musculoskeletal outcomes. A cross-sectional survey of Canadian newspaper employees (Polanyi et al 1997), for example, found that the risk of upper-limb symptoms, adjusted for confounders, was significantly elevated with weekly deadlines, (OR=4.05) and higher job demands (OR=1.38). Similarly, the results of multi-variable analyses indicated that psychological demands and conflicting demands were associated with upper-extremity symptoms ($p=0.04$ and 0.02) in a cross-sectional study of bank workers (Holness et al 1998). Ferreira and colleagues (1997), in a two-year retrospective study of bank workers, also reported that time pressures were significantly associated with the incidence of upper-extremity musculoskeletal disorders ($P=0.008$) in models adjusted for ergonomic hazards.

Studies of lower-body musculoskeletal outcomes have similarly found evidence for an association with job demands or time pressures. Theorell and colleagues (1991), in a study of six different occupations, found that high demands were significantly related to musculoskeletal symptoms, including back symptoms ($p<0.01$) after adjusted for individual factors and physical stressors. Houtman and colleagues (1994), in a study of the Dutch working population, documented significant elevated risks of back complaints (OR=1.21) with higher work pressures after adjustment for individual factors and physical stressors. Krause and colleagues (1998), in the cohort study of transit workers mentioned above, reported a significant elevated odds ratio for back injury (OR=1.5) associated with high psychological demands in models adjusted for individual and physical factors.

Some health care studies have documented similar findings. Bru et al (1996), in a cross-sectional study of hospital workers from 21 departments, found that job demands and pressures were significantly associated with neck, shoulder and low-back pain ($p<0.03$) in multi-variable analyses adjusted for ergonomic loads. Similarly, Engels and colleagues (1996), in a survey of nursing personnel, reported significant elevated odds ratios for back (POR=1.94), and arm/neck pain (POR=2.71) associated with work pressures, such as the need to slow down or difficult work rates. However, other health care studies do not support the preceding findings. For example, Linton and Kamwendo (1989) reported that work demands were not related to neck or shoulder symptoms ($p=0.46$ and 0.73) in a cross-sectional survey of medical secretaries. Similarly, Ahlberg-Hultén et al (1995) found job demands unrelated to neck or shoulder pain in a cross-sectional study of nurses and nurses aides. Lagerström et al (1995), in their survey of nursing personnel, reported no association between work demands and low-back pain in multi-variable models, but an elevated risk with severe symptoms of the neck and shoulder (OR=1.82 and 1.65). Josephson and colleagues (1998), in a case-control study of nurses, reported that an elevated risk of low-back pain associated with high job demands (OR=2.7) disappeared in multi-variable models adjusted for biomechanical factors and other work organization factors.

Job Strain/Work Stress Variables

The weight of the evidence from reviewed papers suggests that general measures of job stress, or a combination of work organization factors defined as job strain, may be related to upper-body musculoskeletal outcomes. In a cross sectional study of office workers for example, Marcus and Gerr (1996) found that a high level of job stress in the past 2 weeks was significantly associated with the risk of arm and hand symptoms (OR=2.04) after adjustment for physical factors. Mental stress at work was significantly associated with an elevated risk of neck pain (OR=1.27) among Finnish workers in analyses adjusted for individual factors and physical stressors (Mäkelä et al 1991). Likewise, stress at work was significantly associated with back pain in a cross sectional study of Swedish male workers (Bergenudd and Johnell 1991). Magnusson and colleagues (1996), in a case-control study of drivers, also found that perceived job stress was significantly associated with work loss due to low-back pain ($p<0.05$). Stress at work was similarly associated with a significant elevated risk of low-back pain and recurrent low-back pain among white-collar workers (OR=2.48 and 2.42) and blue-collar workers (OR=1.72 and 1.59) in a cross sectional study by Wickström and Pentti (1998). Krause and colleagues (1998), in their cohort of transit workers, found an elevated risk of back injury (OR=1.28) associated with high job strain, although the risk was not significantly different from those with low strain. It should be noted that other studies have not found an association between job stress and upper-body (Ursin et al, 1988; Bergenudd et al 1990) or lower-body musculoskeletal outcomes (Foppa and Noack 1996; Hildebrandt et al, 1996). Leino and colleagues (1995), in their study of metal workers for example, found that overstrain, while associated with musculoskeletal outcomes initially ($p<0.0001$), was not associated with upper-body or lower-body musculoskeletal disorders during the ten-year follow-up period.

Results from studies in the health care sector provide conflicting results on the importance of job stress or strain. Ahlberg-Hultén and colleagues (1995), in a cross-sectional study of nursing personnel, found that job strain was significantly associated with the risk of lower-back pain ($p=0.03$), but not neck ($p=0.62$) or shoulder pain ($p=0.52$), in adjusted analyses adjusted for confounders. Niedhammer and colleagues (1994) on the other hand, in their cohort study of nurses, found psychosocial work strain associated with neck pain (OR=2.70), but not back pain (OR=1.1.4) in final models adjusted for individual and physical factors. A case-control study of nursing personnel (Josephson et al 1998) found an elevated risk of low-back pain associated with job strain

(OR=1.2), but no effect in the multi-variable analysis adjusted for individual and biomechanical factors. Similarly, Smedley and colleagues (1995), in a cohort study of nurses, reported that job stress was initially associated with back pain (OR=1.3), but not prospectively over a two-year period (OR=1.1).

Workload Measures

Several papers have examined more objective measures of workload on musculoskeletal outcomes. Definitions of workload varied from overtime among postal workers, to patient-staff ratios among nurses, to percentage of productivity norms for electronics employees. It is not surprising, given this diversity, that results are inconclusive. In a cross-sectional study of newspaper employees conducted by Bernard and colleagues (1994) for example, more hours spent under a deadline per week were significantly associated with neck (OR=1.7) and hand/wrist symptoms (OR=1.6), but not shoulder symptoms. The results lost significance in a subsequent analysis of jobs having a comparable number of men and women. Ohlsson and colleagues (1989), in a cross-sectional study of female assembly workers, reported that the risk of neck and shoulder disorders demonstrated an inverted u-shaped relationship with the rate of items completed per hour. The risk of upper-body musculoskeletal disorders among female electronic workers was significantly related ($p<0.05$) to higher productivity levels, as a percentage of the norm, in the first year of a prospective study but not the second year (Jonsson et al 1988). Finally, Schibye and colleagues (1995), in a longitudinal study of sewing machine operators, reported that the prevalence of neck symptoms tended to be related to high efficiency levels (i.e. number of units finished per day relative to a standard number), although this relationship was not statistically significant.

Results are similarly conflicting for lower-body musculoskeletal outcomes. In a cohort study of sewing machine operators for example, using multi-variable survival analysis, Waersted and Westgaard (1991) found that the number of daily work hours were borderline significant factors in the development of upper-body ($p=0.058$) and back disorders ($p<0.056$). Krause and colleagues (1998), in their cohort study of transit workers, reported a significant three-fold increased risk of back injury associated with overtime per week among cable car drivers. While Daltroy and colleagues (1991), in a case-control study of postal workers, found that overtime in the past two weeks was not a significant risk factor for low back injury.

Workload measures in health care studies are equally diverse and inconclusive. The number of procedures performed per day was unrelated to upper-body musculoskeletal symptoms among sonographers in a cross-sectional study conducted by Vanderpool and colleagues (1993). Harber and colleagues (1985), in a cross-sectional study of nurses, showed that the number of hours worked per day did not affect the risk of low-back pain, but that there was a tendency for the availability of another person to assist with lifting tasks to decrease the risk ($p=0.06$). Larese and Fiorito (1994), in a cross-sectional study of two hospital departments, reported that the department with the higher rate of musculoskeletal injuries also had double the number of patients per nurse. Fuortes and colleagues (1994) found that hours of strenuous work were significantly associated with back pain in a case-control study of nurses (OR=1.26), although this variable did not remain in the final multi-variable model adjusted for individual factors and physical exposures.

Job Satisfaction

Studies examining the relationship between levels of job satisfaction and musculoskeletal outcomes are not consistent. Foppa and Noack (1996) for example, showed that low job satisfaction was associated with back pain among Swiss workers in a multi-variable analysis that included individual and other work organization factors. Bigos and colleagues (1992), in a prospective study of aircraft employees, reported that job dissatisfaction was a significant predictor of reported back injury ($p<0.0001$), although this study has been criticized for not properly controlling for physical demands. High job dissatisfaction was significantly related to an elevated risk of back injury (OR=1.56) among transit workers, adjusted for individual and biomechanical factors, in the previously mentioned follow-up study by Krause and colleagues (1998). Conversely, several studies have found no association between lower body outcomes and job satisfaction (Hemingway et al 1997; Magnusson et al 1996), while still others have reported an increased risk of morbidity with higher levels of satisfaction (Hughes et al, 1997). Kerr (1998), for example, in a case-control study of automobile workers reported a significant elevated risk of low-back pain (OR=1.7) associated with higher job satisfaction in analyses adjusted for individual factors and biomechanical exposures. Alternatively, other authors have suggested that job dissatisfaction may be a consequence of workplace stress or even musculoskeletal injuries, as opposed to a stressor itself (Bongers et al, 1993; Hales and Bernard, 1996).

Findings for an association between job satisfaction and upper-body musculoskeletal events are limited. Polanyi and colleagues (1997), in the previously mentioned study of newspaper workers, found that workers with musculoskeletal disorders were less satisfied with their job than non-cases, although this variable did not remain in the final regression model. Tola and colleagues (1988), in a study of machine operators, showed that poor job satisfaction was related to a significant increased risk of neck and shoulder symptoms (RR=1.2) in analysis adjusted for age and working postures. Conversely, Hughes and colleagues (1997), in a study of aluminium workers, reported a decreased risk of hand and wrist disorders, but not shoulder disorders, associated with low job satisfaction (OR=0.30, p=0.08).

Studies on the importance of job satisfaction among health care workers are also limited and those that have investigated the relationship with musculoskeletal outcomes provide conflicting results. In one follow-up study of nurses by Ready and colleagues (1993), job satisfaction discriminated between injured and non-injured groups, but did not effectively predict back injury in the cohort analysis. In a comparison of nursing aides, Dehlin and Berg (1977) reported that those with back symptoms showed lower overall satisfaction with their job than those without symptoms ($p<0.01$). This same study found no association between job satisfaction and upper-body symptoms. Gerdle and colleagues (1994), in a comparison of home care workers, found that job satisfaction was not significantly different between those with musculoskeletal complaints and 'healthy' workers.

Work Content/Monotonous Work

Findings from studies tend to support an association between musculoskeletal outcomes and poor work content or monotonous work. Hales and colleagues (1994), in a cross-sectional survey of telecommunications workers, found monotonous work to be significantly associated with an elevated risk of neck (OR=4.2) and elbow disorders (OR=2.8) in models adjusted for individual factors. Similarly, Linton (1990) reported an elevated risk of neck pain associated with monotonous work in combination with a poor psychosocial environment among Swedish workers (OR=3.61). Ekberg and colleagues (1995), in their case-control study of Swedish workers, reported an elevated risk of neck and shoulder symptoms associated with low work content compared to those free of musculoskeletal symptoms (OR=10.5), although confidence intervals were very wide (range of 1.4 to 79.0).

For lower-body studies, Houtman and colleagues (1994) reported a significant elevated risk of back complaints associated with monotonous work (OR=1.21) in models adjusted for individual and physical factors. Linton (1990), in the previously mentioned study of Swedish workers, also reported a significant increased risk of back pain with monotonous work in conjunction with a poor psychosocial work environment (OR=2.58). While Holmström and colleagues (1992) found that under-stimulation at work was significantly associated with severe low-back pain among construction workers (PRR=2.2).

A few studies in the health care sector investigated the effect of monotonous work on musculoskeletal outcomes with inconsistent results. Johansson (1995), in the previously mentioned study of home care workers, reported a significant association between monotonous work and shoulder symptoms ($p<0.01$), but not symptoms of the neck or low-back. Bru and colleagues (1996), in the study of hospital staff representing 21 different departments, reported that poor work content was significantly associated ($p<0.05$) with neck and shoulder complaints, but not low-back complaints, in analyses stratified by high and low ergonomic load. Conversely, medical secretaries with low-back pain had significantly different ($p=0.04$) levels of self-reported interesting and stimulating work (Kamwendo et al 1991). This relationship was not found among medical secretaries with neck or shoulder pain.

Summary of Work Organization Factors

Overall, studies in non-health care sectors provide evidence of an association between work organization factors and upper-body (Table 1 on page 44) and lower-body (Table 2 on page 45) musculoskeletal outcomes. The weight of the evidence suggests that lower-body musculoskeletal outcomes may be related to high job demands or work pressures, high job stress or strain, and monotonous work. Although the findings were more conflicting across studies, there was also some evidence of an association between lower-body outcomes and low job control, low work support and workload levels. For upper-body musculoskeletal outcomes, studies consistently showed a relationship with low job control, high job demands or time pressures, and monotonous work. There was also some evidence to suggest that high levels of workload, low work support and general measures of job strain were related to upper-body outcomes.

In general, studies evaluating the relationship between work organization factors and musculoskeletal outcomes among health care workers are limited, particularly for the upper-body (Appendix 1). Those that have investigated work organization factors provide inconsistent findings for the influence of low job control, job stress or strain, job satisfaction and monotony (Tables 1 and 2). However, low work support and high workload factors did appear to be related to upper-body musculoskeletal outcomes (Table 1), and that of high job demands or time pressures factors with lower-body musculoskeletal outcomes (Table 2).

1.7.3 Evidence Relating Individual Factors to Musculoskeletal Outcomes

Age

Overall, the weight of the evidence from reviewed papers suggests that increasing age may be an important risk factor associated with musculoskeletal outcomes. Holmström and colleagues (1992) for example, showed that the prevalence of severe low-back pain was significantly associated with increased age among construction workers (PRR=6.55 among those aged 50-59 years). Houtman and colleagues (1994), in a large survey of Dutch workers, reported an increased risk of back complaints among those over the age of 55 years (OR=1.69), compared to those under 35 years. Leino and Hänninen (1995), in a ten-year follow-up study of workers in the metal industry, found increasing age significantly associated with back and limb morbidity ($p<0.0001$) at the beginning of the study, and at follow-up, for both reported symptoms and clinical findings. Similarly for the upper-body, Punnett and colleagues (1985), in a cross-sectional study of garment workers, reported that a 10-year increase in age was associated with a significant elevated risk of upper-body pain (OR=1.6). English and colleagues (1995), in a case-control study of UK workers, reported an elevated risk of shoulder conditions (OR=1.37) per 5 years of age. Likewise, Andersen and Gaardboe (1993) demonstrated that neck and shoulder pain increased significantly (OR=1.48) among a cohort of sewing machine operators over the age of 40 years, after adjustment for confounders.

It should be noted that other studies have reported no association between age and musculoskeletal outcomes, or an inverse association. For example, Hughes and colleagues (1997) found that the risk of reported or clinical low-back pain was not associated with age (OR=0.97 to 1.0) among aluminium workers in multi-variable models. Polanyi et al (1997) also found that age was not significantly different ($p=0.29$) between newspaper employees with upper-body musculoskeletal disorders and their counterparts. Likewise, Punnett and colleagues (1991), in a case-control study of automobile assembly workers found that age was unrelated to back disorders in final logistic models (OR=0.96); and Cannon et al (1981), in a study of workers in an aircraft company, reported no significant difference in age between cases and controls (p=0.56). Other studies, such as the cross-sectional study of fork-lift and tractor drivers by Boshuizen and colleagues (1992), found the highest elevated risks of back pain (OR=4.2) among the youngest age group (25-34 years) in models adjusted for individual and biomechanical factors. Likewise, Zwerling and colleagues (1993), in a case-control study of postal workers, reported that age at the time of pre-employment screening was inversely related to low-back injury (OR=0.70) after adjustment for occupation and individual factors.

Health care studies provide some evidence of an association between age and musculoskeletal outcomes, although the findings tend to be inconsistent for the lower-body. Bru et al (1996), for example, reported that increasing age was significantly (p=0.04) associated with low-back complaints among full-time hospital workers with high perceived ergonomic loads. Yassi and colleagues (1995), on the other hand, reported that injured nurses were two years younger compared to non-injured nurses (p<0.001). Lagerström and colleagues (1995) found no association between low-back pain and age among nursing personnel. Studies on upper-body musculoskeletal problems tend to support a positive association with age. Punnett (1987), for example, reported that hospital workers with upper-limb musculoskeletal pain were almost 10 years older than those without pain (p<0.02). Kamwendo et al (1991) also reported that neck and should pain increased significantly with age among medical secretaries (p<0.002). In adjusted analysis, Niedhammer and colleagues (1994), in the previously mentioned cohort study of nurses, found that the risk of cervical pain increased with age from an odds ratio of '1' among those less than 35 years of age to 12.6 among those over 45 years.

Males and Females

While several studies have shown an elevated risk of lower-body musculoskeletal outcomes among women, many of these findings lost significance in multi-variable models adjusted for individual and biomechanical factors. For example, Krause and colleagues (1998) in their cohort study of transit drivers, reported a 50% increased risk of spinal injury among females, but the results were not significantly different from males (95% CI=0.95-2.32). Pietri and colleagues (1992), in a cohort study of commercial traveller, also found a 50% increased risk of low-back pain among women that was not significantly different from men (95% CI=0.80-2.9). Likewise, studies by Tsai et al (1992) and Leigh and Sheetz (1989) reported a 20% increased risk of back injury among women (RR=1.24 and OR=1.21 respectively) with confidence intervals that included '1'(95% CI=0.86-1.79 and 0.64-2.28 respectively). These findings are consistent with results from the health care sector. Fuortes et al (1994), reported an elevated risk of low-back injury among hospital nurses (OR=1.59) that was not significantly different from males (95% CI= 0.39-4.24). Similarly, Yassi and colleagues (1995) reported a higher percentage of females nurses (20%) with back injuries compared to males (16%), although the difference was not significant (p=0.34).

In contrast, studies on upper-body musculoskeletal outcomes have tended to find significantly higher risks of morbidity among women. For example, Punnett (1998) reported an increased prevalence of upper-body musculoskeletal outcomes (PR up to 2.7), adjusted for biomechanical exposures, among women in a vehicle manufacturing plant. Polanyi and colleagues (1997) similarly reported a significant two-fold increased risk of upper-body symptoms among female newspaper workers in their final adjusted model (OR=2.20). Tanaka's follow-up study of US workers (1995) reported a significant two-fold increased risk of both self-reported (OR=1.92) and clinical carpal tunnel syndrome (OR=2.23) in analysis adjusted for confounders. Leino and Hänninen (1995), in a ten-year follow-up study of metal workers, found gender to be a significant predictor of musculoskeletal symptoms, both at the beginning of the study and at follow-up ($p<0.0001$).

Prior Musculoskeletal Episodes

A history of previous musculoskeletal pain, symptoms or disorders is the single most consistent predictor of musculoskeletal outcomes in published studies. An elevated risk of musculoskeletal outcomes was observed in cross-sectional (Westgaard and Jansen 1992), case-control (Daltroy et al 1991), and cohort studies (Ready et al 1993); as well as studies pertaining to upper-body musculoskeletal outcomes (Westgaard and Jansen 1992; Niedhammer et al 1994), lower-body outcomes (Westgaard et al 1993; Fuortes et al 1994) or a combination of the two (Leino and Hänninen 1995). For example, previous neck or shoulder pain was significantly associated (OR=1.97) with chronic neck syndrome among Finnish workers (Mäkelä et al 1991) in multivariable analyses adjusted for individual and physical factors. Likewise, Jonsson and colleagues (1988), in a two-year follow-up study of electronics workers, reported that shoulder or neck tenderness on first examination was associated with a significant increased risk of not remaining healthy during the follow-up period (OR=0.62). Previous symptoms were also associated with musculoskeletal outcomes in the health care sector (Rydén et al 1989; Venning et al 1987). Niedhammer et al (1994), in the cross-sectional phase of a follow-up study among nurses, reported a significant two-fold increased risk of neck pain associated with a previous musculoskeletal disorder.

For the lower-body, Punnett (1991), in her case-control study of workers in a vehicle manufacturing plant, found an elevated risk of back pain (OR=2.37) associated with a history of back injury. Bigos and colleagues (1992), in a longitudinal follow-up of aircraft workers, reported that back pain on physical examination, previous chiropractic treatments and number of doctor visits were all significant ($p<0.04$) predictors of low-back injury in final multi-variable models. Likewise, in a study of office workers, the number of back pain reports significantly predicted (RR up to 6.55) short term and long term absences due to back pain in a dose-response fashion, over a four year period (Hemingway et al 1997). Estryn-Behar and colleagues (1990) reported an adjusted odds ratio of 9.74 for back pain among female hospital staff associated with prior pain in analyses that included individual factors and occupation. Finally, a longer duration of previous low-back pain among nurses (Smedley et al 1997), in combination with more recent pain, was associated with a significant increased risk of low-back pain during follow-up (OR=6.1), and with pain leading to absence from work (OR=7.3).

Work Experience

In general, the reviewed papers provide conflicting evidence for an association between musculoskeletal outcomes and work experience. Tsai et al (1992) for example, found that years of employment were not associated with an elevated risk of back injury (RR=0.99) among oil company workers in models adjusted for individual factors and heavy physical demands. Conversely, the frequency of back pain among pulp and paper workers in a study by Åstrand (1987) was positively related to duration of employment in multiple logistic regression models. However, in a cohort study of transit workers (Krause et al 1998), the risk of back injury decreased with occupational experience from an odds ratio of 6.07 among those with 5 years of driving experience to 0.49 among those with more than 15 years of experience. Finally, Heuer and colleagues (1996), in a follow-up study of bricklayers, initially found a significant decline in low-back pain with longer employment, but documented a selection effect due to a high turnover rate among those with musculoskeletal problems in the subsequent follow-up analyses.

Polanyi and colleagues (1997), in the previously mentioned study of newspaper employees, found no difference between cases and non-cases of upper-body musculoskeletal symptoms by years of employment ($p=0.76$). Likewise, Waersted and Westgaard (1991), in a cohort study of sewing machine operators, found that years of employment did not influence the survival time to sick leave for upper-body musculoskeletal complaints ($p>0.03$). Conversely, Silverstein et al (1987), in a study of workers across 7 industrial sites, found that years in the job were negatively associated with carpal tunnel syndrome ($P<0.001$) in multiple regression analysis controlling for repetition and force.

Finally, the risk of neck and shoulder complaints (OR=8.03) increased with years as a sewing machine operator, adjusted for confounders, in the cohort study by Andersen and Gaardboe (1993).

Results are also inconsistent for health care studies. Yassi and colleagues (1995) reported that injured nurses had less seniority, as measured by hours on the ward, than their non-injured counterparts. The difference was not statistically significant. Lee and Chiou (1994), reported the opposite relationship with a two-fold increased risk of low-back pain among nurses (OR=2.33) in analyses adjusted for age and physical demands. Ready and colleagues (1993), on the other hand, found that employment time in current unit did not discriminate between injured and non-injured groups in an 18-month follow-up study of nurses. For the upper-body, Kamwendo and colleagues (1991) reported that working more than 5 years as a medical secretary increased the risk of shoulder pain (OR=1.94) and neck pain (OR=1.61). Whereas Ahlberg-Hultén et al (1995), in a cross-sectional study of nursing personnel, reported that the number of years of health care work had no association with pain in the neck or shoulders.

Interpretation of the findings for work experience is made difficult by potentially conflicting risk mechanisms. Employees with fewer years on the job may be at an increased risk of musculoskeletal problems because of a lack of experience or training, while those with a longer job history may be at an increased risk due to cumulative exposure. Also, the true relationship between years of experience and musculoskeletal problems may be masked by a healthy worker effect, whereby workers with problems may be more likely to leave a job within the first few years (Heuer et al 1996).

Anthropometry

Weight, height and body mass index have been identified in some studies as potential risk factors for lower-body (Heliövaara et al 1987) and upper-body musculoskeletal outcomes (Nathan et al 1994). However, most occupational studies have not found measures of anthropometry to be associated with musculoskeletal outcomes among workers. For example, the prospective study of workers in aircraft manufacturing by Bigos et al (1992) found that an employee's height and weight were not significant predictors of reported back injury in final multivariable analyses. Likewise, Krause and colleagues (1998), in the cohort study of transit workers, found that the risk of back injury was not elevated with increasing height or weight. Estlander et al (1998), in a two-year follow-up study of forestry workers, reported that body mass index (a combination of height and weight) was statistically significant for musculoskeletal pain in the first year of follow-up, but not in the second year. Niedhammer and colleagues (1994) in a cohort study of nurses, and Fuortes and colleagues (1994) in a case-control study of nurses, reported an association between back pain and weight at the uni-variable level, but not in the final model adjusted for confounders. Several other studies in the health-care sector did not find a relationship between lower-body outcomes and skinfold measurements (Ready et al 1993), height and weight (Rydén et al 1989; Smedley et al 1997), or body mass index (Lagerström et al 1995; Estryn-Behar et al 1990).

For the upper body, Mäkelä et al (1991) in the aforementioned study of Finnish workers, reported increased risks of neck pain associated with a higher body mass index (OR up to 1.96) in multi-variable analyses. However, all of the confidence intervals included '1' and the highest category was shown to have a decreased risk. Polanyi and colleagues (1997), and Punnett and colleagues (1998), did not find significant differences in body mass index among cases of upper-extremity disorders and non-cases. Nor did Bjelle and colleagues (1981), or Westerling and Jonsson (1980), find measures of height or weight to be statistically different between workers with shoulder or neck problems and those without. The two studies in the health care industry investigating anthropometry found no association between body mass index and arm/neck complaints (Engels et al 1996), or cervical pain (Niedhammer et al 1994).

Physical Fitness/Strength Measures

Studies in non-health care sectors provide little evidence for an association between lower-body musculoskeletal outcomes and measures of physical fitness or strength. The prospective study of workers in aircraft manufacturing (Bigos et al 1991), for example, failed to identify flexibility, strength or aerobic capacity as significant predictors of back pain reports. A ten-year follow-up study of metal workers (Leino et al 1987) reported no association between muscle function at baseline and either the ten-year incidence of self-reported low-back symptoms or clinical disease. Riihimäki and colleagues (1989), in a follow-up study of concrete workers and house painters, did not find that poor back muscle strength (RR=0.6) or poor abdominal strength (RR=0.9) was associated with the five-year cumulative incidence of back pain. While some health care studies have found a relationship between lower-body outcomes and strength measurements (Klaber-Moffet et al 1993) or poor physical fitness (Lagerström et al 1995), others have not. Ready and colleagues (1993), for example, did not find measures of strength and flexibility correlated with the incidence of back injury among nurses. Similarly, a follow-up study of nurses (Niedhammer et al 1994) and a case-control study of hospital employees (Rydén et al 1989), found exercise levels and sports activities were unrelated to back problems. Mostardi and colleagues (1992), in a study investigating the importance of lifting strength, reported that none of the strength variables were associated with the incidence of pain or injury among nurses.

Few studies reported an association between upper-body musculoskeletal outcomes and activity or exercise levels (Holness et al 1998; Kilbom & Persson 1987; Jonsson et al, 1988). For example, while exercise appeared to be protective of neck and upper limb pain among a cohort of sewing machine operators (Andersen and Gaardboe 1993), none of the odds ratios remained statistically significant in models adjusted for other individual factors. Westerling and Jonsson (1980), in a cross-sectional study of Swedish workers, reported no association between predicted maximum oxygen uptake and neck-shoulder problems, controlling for age, sex, height and weight. While Jonsson and colleagues (1988), in a two year follow-up study of electronic workers, found shoulder strength was significantly associated with neck disorders, other studies have not found measures of strength to be associated with upper-body outcomes. For example, Kilbom and Persson (1987), in a two-year follow-up study of industrial workers, reported that low muscle strength did not seem to increase the risk of neck disorders. Likewise, Bjelle and colleagues (1981), in a case-control study of industrial workers, did not find a significant difference in grip strength between those with shoulder/neck disorders and their counterparts. Leino and colleagues (1987), in a ten-year follow-up study of metal industry workers, found no association between muscle function at baseline and the ten-year incidence of chronic low-back disease.

Smoking

Evidence for an association between musculoskeletal morbidity and smoking are inconsistent. Mäkelä and colleagues (1991) reported that current smoking status was associated with an elevated risk of neck pain (OR=1.25) among Finnish workers, adjusted for individual and physical factors. Likewise, in the previously mentioned cross-sectional study of construction workers by Holmström and colleagues (1992), current smokers had a 20% increased risk of neck/shoulder tension compared to non-smokers. Skov and colleagues (1996), in a survey of sales personnel, reported current smoking status was associated with an elevated risk of shoulder symptoms (OR=1.46), but not neck symptoms, in final models adjusted for individual and physical factors. Whereas Holness and colleagues (1998), in a cross-sectional study of bank workers, and Ekberg and colleagues (1995) in a cross-sectional study of Swedish workers, found that smoking was not significantly associated with upper-extremity disorders in multi-variable models.

Results are also inconsistent for lower-body musculoskeletal outcomes. Leigh and Sheetz (1989), in a survey of US workers, reported a 50% increased risk of back pain associated with current smoking, compared to non-smokers, in final models. However, Hughes and colleagues (1997) in their study of aluminium workers, and Bovenzi and Zadini (1992) in their study of bus drivers, did not find smoking associated with the risk of low-back outcomes. The case-control study by Kerr (1998) reported an elevated risk of low-back pain associated with smoking, but the confidence interval included '1' (OR=1.30; 0.64-2.60). Riihimäki and colleagues (1989), in their five-year follow-up study of concrete workers and painters, reported no elevated risk of back pain for smokers compared to non-smokers (OR=1.0).

Health care studies also provide conflicting evidence for the importance of smoking and lower-body outcomes. Josephson's case-control study among nursing personnel (1998) reported that current smoking status was not related to an elevated risk of low-back pain, while Niedhammer and colleagues' cohort study among nurses (1994) found the opposite relationship (OR=1.79). Ready and colleagues (1993) in their follow-up study, reported that nurses who sustained back injuries were more likely to be current smokers than those who were not injured, although the differences were not statistically significant.

Socio-economic Factors

The evidence is inconsistent for a relationship between musculoskeletal outcomes and socio-economic status, primarily defined by education, income or employment grade. The risk of chronic shoulder pain among sewing machine operators (Andersen and Gaardboe 1993), although elevated (OR=1.46), was not significantly different between employees with high verses low employment grades (95% CI=0.77-2.76). Mäkelä et al (1991), in their study of Finnish workers, reported a two-fold increased risk of chronic neck syndrome associated with less education (OR=2.44) in analyses adjusted for age and sex. Education did not enter models adjusted for mental and physical stress at work. Conversely, in the ten-year follow-up study by Leino and Hänninen (1995), occupational class was significantly associated ($p<0.03$) with self-reported musculoskeletal symptoms and clinical outcomes in models adjusted for individual factors and physical demands.

Results are similarly inconsistent for lower-body musculoskeletal outcomes. Socio-economic variables (e.g. education level, blue-collar verses white collar, immigrant status, living alone) were not significant predictors of reported back pain among Swiss workers (Foppa and Noack 1996) in final multi-variate models. In the previously mentioned survey of Belgian adults (Skovron et al 1994), a higher social class was protective for the first episode of low-back pain, although all of the confidence intervals included '1' and social class did not appear to be important in multi-variable analysis. Hemingway and colleagues (1997) reported a significant inverse relationship between increasing employment grade and sickness absence due to back pain among office workers in a four-year follow-up study ($p<0.05$). Kerr (1998), on the other hand, reported that higher education for workers in similar jobs was associated with a two-fold increased risk of low-back pain among autoplant workers in multi-variable models. Socio-economic factors were not reported in studies on health care workers.

Summary of Individual Factors

Findings from the reviewed papers provide consistent evidence of an association between musculoskeletal outcomes and a history of previous problems. There appears to be an increased risk of musculoskeletal outcomes among female workers, although results are more conflicting for lower-body outcomes, and studies among health care workers have not shown this to be the case. Overall, the weight of the evidence from studies suggests that increasing age is associated with an increased risk of upper-body and lower-body outcomes. Evidence for the influence of work experience, smoking status and socio-economic status is inconsistent, while there is little evidence to suggest that anthropometric or fitness/strength measures are related to musculoskeletal morbidity.

1.7.4 Evidence Relating Biomechanical Factors to Musculoskeletal Outcomes

Lower-body Musculoskeletal Outcomes and Biomechanical Factors

Burdorf and Sorock (1997), in a review of the published evidence, identified lifting, manual handling, whole-body vibration, and awkward postures as the biomechanical factors consistently associated with work-related back disorders. Lifting/forceful movements and whole body vibration were the two risk factors for which there was strong evidence of an association with back disorders in the comprehensive NIOSH review of musculoskeletal disorders (Bernard et al 1997). There was also evidence that awkward postures and heavy physical work were associated with an increased risk. Frequent, heavy lifting and awkward postures were identified as the biomechanical factors of importance to nurses in reviews of the literature (McAbee 1988; Lagerström et al 1998).

Despite differences in measurement (e.g. self-reports, job title, expert assessment, observations, direct measures), occupational biomechanical factors were consistently associated with an increased risk of musculoskeletal outcomes across published studies. For example, Holmström and colleagues (1992), in a their cross-sectional study of construction workers, found that back pain was significantly elevated in association with a higher self-reported frequency or duration of manual materials handling (PRR=1.12), stooping (PRR=1.2) and kneeling (PRR=1.1). A higher frequency of self-reported measures of twisting or bent postures at work was associated with a significant increased risk of low-back pain (OR=1.5) in a cross-sectional study of several occupations by Riihimäki and colleagues (1989). In a large cross-sectional study of Swedish workers, Linton (1990) reported elevated odds ratios for neck pain associated with heavy lifting (OR=1.83), uncomfortable postures (OR=2.42) and vibration (OR=1.84). A combination of a poor psychosocial environment (control, support and demands) and heavy lifting (OR=2.68) or awkward postures (OR=3.45) produced the highest risks for neck pain. Bovenzi and Zadini (1992), in a study of bus drivers, demonstrated increased risks of low-back symptoms with years of exposure to vibration (OR up to 4.25) and total vibration dose (OR up to 4.48) after adjustment for individual and other biomechanical factors. Wickström and Pentti

(1998), in a two-year study of metal workers, found self-reported biomechanical factors (combination of lifting, pushing/pulling, awkward postures, standing, sitting) associated with an elevated risk of low-back pain (OR=3.11 and 6.83) and future back pain (OR=4.08 and 4.70) among blue-collar and white-collar workers respectively. In the study of Canadian automobile workers, Kerr (1998) reported significantly elevated risks of low-back pain associated with higher perceived exertion at work (OR=3.0), and direct measurements of back forces (OR=1.7) or lumbar compressions (OR=2.0). Longer exposure to vibration, assessed by direct observations of a random sample of workers, was the strongest predictor of length of sick leave due to low-back pain ($p<0.0008$) in a cohort study of bus and truck drivers (Magnusson et al 1996). Similarly, in a case-control study of postal workers (Zwerling et al 1993), jobs categorized as involving heavy lifting and frequent pushing/pulling were associated with an elevated risk of low-back injury (OR=1.91) in multi-variable analysis. In a case-control study of automobile assembly workers by Punnett and colleagues (1991), the duration of nonneutral postures (OR=8.09) and peak biomechanical forces during lifting (OR=2.16) were significantly associated with back disorders in final adjusted models.

Upper-body Musculoskeletal Outcomes and Biomechanical Factors

The aforementioned NIOSH review (Bernard et al 1997) reported strong evidence of a relationship between upper-body musculoskeletal outcomes and vibration, as well as a combination of repetition, force and awkward postures. A review of studies on shoulder disorders (Sommerich et al 1993) identified awkward or static postures and repetitive movements as risk factors associated with cumulative trauma disorders. A meta-analysis of three methodologically strong studies by Stock (1991) found evidence of a relationship between upper-limb musculoskeletal disorders and both repetition and forceful work.

A case-control study of Swedish workers (Ekberg et al 1994) found self-reported measures of high repetition (OR=7.5), lifting (OR=13.6), uncomfortable sitting (OR=3.6), and awkward arm postures

(OR=4.8) were associated with a significant increased risk of neck and shoulder disorders. Self-reported measures of pinch grip (RR=4.03), repetition (RR=1.42), and shoulder rotation (RR=1.62) were significantly associated with an elevated risk of upper-body conditions in a case-control study of UK workers (English et al 1995). Shoulder elevation, as a percentage of the work-cycle, was a significant predictor of neck disorders ($p<0.05$) among electronics workers in a two-year follow-up study by Jonsson and colleagues (1988). In another study of electronics workers, Kilbom and Persson (1987) reported that the percentage of the work cycle in neck flexion or arm abduction/extension, and the number of shoulder elevations or neck flexions, were significant predictors of neck-shoulder-arm disorders during one and two-year follow-up periods. High ergonomic exposure scores (i.e. awkward postures, vibration, and manual forces), based on observation and questionnaire data, were associated with a significant increased risk of upper-body disorders (PRR=2.3 to 3.5) among workers in a vehicle manufacturing plant (Punnett 1998). Tanaka et al (1995), in a retrospective cohort study of US workers, reported elevated risks of cumulative trauma syndrome associated with self-reported measures of vibration (OR=1.58), and bending or twisting of the hand (OR=3.01). Finally, Silverstein and colleagues (1987), using direct observations and EMG recordings, found various combinations of force and repetition (high verses low) associated with a significant increased risk of carpal tunnel syndrome in multi-variable analysis. The risk was highest for the combination of high force and high repetition (OR=15.5). In separate analyses, repetition was associated with a five-fold increased risk (OR=5.50) and force with a three-fold increased risk (OR=2.9).

Biomechanical Factors and the Health Care Sector

The strong evidence of an association between biomechanical factors and musculoskeletal outcomes described above is also found in studies in the health care sector. The majority of studies in the health care-sector focused on lifting and awkward postures. Jensen (1990), in a meta-analysis of six studies, reported an increased risk of low-back pain (RR=3.7) associated with frequent patient lifting compared to infrequent lifting. Likewise, self-reported measures of lifting (OR=2.20 and 3.33), bending (OR=2.22 and 1.63) and awkward postures (OR=1.99 and 1.74) were significantly associated with both upper and lower-body complaints among nurses, after adjustment for confounders (Engels et al 1994). Self-reported measures of high levels of lifting, twisted postures, awkward shoulder postures and forward trunk flexion were significantly associated (RR range 1.29 to 2.50) with neck, shoulder and lower-back symptoms among groups of home care workers (Johansson 1995). Josephson and colleagues (1998), in a case-control study of nursing personnel, found working in forward-flexion for more than 60 minutes per day, based on interview data, was associated with an significant increased risk of back injury in multivariable models. Reported measures of twisting and lifting (OR=4.84) were significantly associated with back injury, adjusted for individual confounders, in a case-control study of nurses by Fuortes et al (1994). Finally, Smedley and colleagues (1995), in a cohort study of nurses, found that a higher number of patient transfers in an average shift, based on self-reported data, was associated with an elevated risk of low-back pain (OR up to 2.1).

Summary of Biomechanical Factors

Heavy physical loads, high forces, awkward postures and vibration appear to be important risk factors associated with musculoskeletal morbidity. There is also evidence for an association between repetition and upper-body musculoskeletal outcomes. In the health care sector, heavy lifting and awkward postures are consistently found to be associated with lower-body musculoskeletal outcomes. Health care studies on upper-body musculoskeletal outcomes and biomechanical factors are limited.

1.8 Need for Further Research Among Health Care Workers

A total of eight studies in the health care sector were found that investigated the influence of work organization factors in multi-variable analyses that adjusted for physical demands (Bru et al, 1996; Engels et al 1996; Fuortes et al 1994; Johansson 1995; Josephson et al 1998; Lagerström et al 1995; Niedhammer et al 1994; Skovron et al, 1987). All of the studies relied on self-reported data or job titles to assess biomechanical exposures, with the exception of the case-control study by Josephson and colleagues (1998). Josephson's study employed interviews and expert assessments by physiotherapists. Only Niedhammer and colleagues (1994) investigated the effect of work organization in a longitudinal manner with a prospective ten-year follow-up study of nurses. The study was limited to one work organization variable on the number of self-reported stress factors in the workplace (e.g. shift work, shortage of staff, mental load and psychological load). Four studies were found in the health care sector that investigated musculoskeletal outcomes across multiple hospital departments (Rydén et al, 1989; Bru et al 1996; Estryn-Behar et al 1990; Punnett et al 1987) and five others that investigated specific occupations other than nursing personnel, including physical therapists (Molumphy et al 1985; Bork et al 1996), medical secretaries (Kamwendo et al, 1991), and radiologists (Moore et al, 1991b; Pike et al 1998). Of these studies, only the one by Bru et al (1996) investigated work organization factors in multi-variable analysis stratified by perceived levels of ergonomic load.

This study was undertaken to investigate the relationship between work organization factors and musculoskeletal outcomes among health care workers in a cohort study design that adequately measured and controlled for biomechanical factors. It was designed to improve upon previous studies by assessing biomechanical factors through direct observations and by incorporating objective, time-varying measures of work organization factors. It was also undertaken to provide much needed research on non-nursing occupations, female workers, and upper-body musculoskeletal outcomes.

1.9 Variables Included in the Study of Health Care Workers

1.9.1 Work Organization Factors Included in the Study

To assist with the generation of the research question on work organization factors and musculoskeletal morbidity, three focus groups were conducted with health care workers in the province of British Columbia, and the responses compared to the weight of the evidence from the literature. Participants in the focus groups were asked to respond to one question, 'What are the factors associated with work-related musculoskeletal problems in your hospital?'. See Appendix 2 for a description of the focus groups and a list of responses. Although stated in different terms, the work organization factors identified by all three focus groups were job control, job demands or time pressures, work support and workload levels. The weight of the evidence from all sources of the literature suggest some evidence of an association between these variables and work-related musculoskeletal outcomes, and all five were included in the cohort study of health care workers. A measure of both job demands and time pressures, as well as three measures of workload, were included in the study to investigate the various cognitive and objective production demands that health care workers identified as important in the etiology of musculoskeletal outcomes. Lack of data on job satisfaction, job stress and monotonous work also precluded investigating these work organization factors among the health care cohort population.

In the present study, job demands and job control were measured using the Job Content Questionnaire (JCQ) developed by Karasek (1979; Karasek and Theorell 1990) and that of time pressures and work support using the Work Environment Scale (WES) developed by Insel and Moos (1974; Moos 1986). The job demands and time pressure constructs are measures of the cognitive strain associated with task requirements (Karasek et al 1998). The job demands construct is defined by questions investigating work conditions such as excessive work, conflicting demands, insufficient time, fast pace and working hard. The time pressures construct is defined by questions inquiring about overtime, and the constancy and urgency of deadlines, as well as the ability to keep up, to get work done, and to meet deadlines. The job control construct is a measure of the occupation-based 'influence' that workers have over work situations and outcomes (Johnson 1991; Aronsson 1991). Job control is defined by questions inquiring about opportunities to learn or develop new skills, as well as the variety of tasks, the freedom to make decisions, and the ability to choose how to perform work. The construct of social support is a measure of the effect of relationships at work on working conditions. It is defined by questions inquiring about whether supervisors talk down to employees, compliment work, criticize minor things, expect too much, or discuss problems. Finally, the workload construct is an indicator of stress or strain associated with the quantitative production demands of work within a hospital department in a specified time period. It is defined by the proportion of sicktime or overtime hours in a department per month, as well as the number of service or production units completed per employee by department and month.

The core questions for the JCQ were taken from three nationally representative samples of the Quality of Employment Surveys administered by the University of Michigan Survey Research Centre in 1969, 1972 and 1977 for the US Department of Labor (Karasek and Theorell 1990). Each of the surveys investigated over 1,000 aspects of work experience. Karasek and colleagues (1988; Schwartz et al 1988) conducted analyses to assess the 'theoretical coherence and the predictive ability' of the questions. Based on the results, a subset of the questions was selected to create the control/demand sub-scales of the JCQ. Validity studies were conducted with a similar set of questions in a longitudinal national survey database from Sweden, which included comprehensive health outcome data (Karasek and Theorell, 1990). Subsequent studies have supported the ability of the model to predict health outcomes (Karasek et al 1981; Karasek et al 1988; Pieper et al 1989) with a few exceptions (Reed et al 1989). The JCQ does well on test-retest reliability and internal scale reliability tests (Karasek & Theorell, 1990). In a recent international comparison of the JCQ scales in 6 studies across 4 countries (Karasek et al 1998), the internal consistency of the scales tended to be similar across populations with an overall average Cronbach's alpha coefficient of .73 for women and .74 for men. In general, the researchers from the four countries concluded that the JCQ sub-scales were reliable based on similarity in means, standard deviations, and correlations among the scales across studies. The control/demand dimensions of the JCQ have been shown to be predictive of musculoskeletal outcomes (Kerr 1998).

Items included in the WES are based on information gathered in interviews with employees from different work settings (Moos 1986). Three domains of the work environment, chosen from domains included in other work environment scales, were used to guide the selection of survey items. These three domains are interpersonal relationships, personal growth or goal orientation, and organizational structure of the work setting. An initial 138-item scale was developed and administered to a sample of employees and managers from 44 different work groups. Based on analysis of the data and psychometric properties of the survey items, the final version of the WES was developed. Items selected within a sub-scale demonstrated high correlation coefficients, while correlations between sub-scales were low to moderate. Each item was able to discriminate among work settings. Normative data for the WES was subsequently obtained from 1,442 employees in general work groups and 1,607 employees in a variety of health care work groups. Chronbach's Alpha coefficients for each of the ten sub-scales were all in an acceptable range (.69 to .86) and indicated that the sub-scales measured distinct but somewhat related aspects of the work environment. Also, the test-retest reliabilities were all in an acceptable range for a one-month interval (.69 to .83) and a twelve-month interval (.51 to .63). The WES has been used in a number of studies to assess stress in the work environment, including studies in the health care sector (Baker et al 1994; Carlisle et al 1992).

1.9.2 Individual and Biomechanical Factors Included in the Study

The scientific literature suggests that certain individual and biomechanical factors are also associated with musculoskeletal outcomes. Findings from the reviewed papers provided evidence of an association between musculoskeletal outcomes and age, gender, work experience, and previous musculoskeletal symptoms. The two individual factors identified by the health care focus groups were age and experience. These factors were included in the current study as potentially important variables. Gender was not mentioned by the focus groups but was included in the study as a potential confounder. Identified by some but not all of the focus groups, a history of previous musculoskeletal problems was included in the current study based on the overwhelming evidence of an association with musculoskeletal outcomes in the literature.

The findings for biomechanical factors suggest that musculoskeletal outcomes are associated with heavy physical loads, awkward postures, vibration, repetition, forces, or a combination of risk factors. Health care workers in all three of the focus groups identified heavy physical load, awkward postures and a combination of risk factors associated with equipment and workstation design. Direct observations of upper-body and lower-body biomechanical factors, including awkward postures, patient lifting, manual handling, repetition, vibration, and forces, were completed for all occupations in the study and scores summed across factors for a composite measure of biomechanical exposures (See section 2.4 in the Methods Chapter).

Table 1: Summary of Evidence for Variables Associated with Upper-body Musculoskeletal Morbidity

- \+ Evidence from studies supports an association
- \- Evidence from studies does not support an association
- ++ Strong evidence of an association
- +/- Evidence is contradictory
- Blank cell indicates variable was not studied or described in studies or by focus groups
- * Evidence based on 3 or fewer studies

	Non-Health Care Sector		Health Care Sector		
Variable	**Cross-sectional Studies**	**Case-Control/ Cohort**	**Cross-sectional Studies**	**Case-Control/ Cohort**	**Focus Groups**
WORK ORGANIZATION					
Low Job Control	+		+/-		+
Low Work Support	+/-	+*	+/-		+
High Demands/Pressures	+	+*	+/-		+
High Job Strain/Stress	+/-	+*	+/-	+*	
High Workload Levels	+/-	+	+/-		+
Low Job Satisfaction	+/-		+/-*		
Monotonous Work	+/-	+	+*		
Individual Factors					
Increasing Age	+/-	+	+	+*	+
Female	+	+	+/-*		
Previous Symptoms	+	+	+	+*	
Work Experience	+/-	+/-	+/-		+
Anthropometry	+/-	+/-			
Physical Fitness/Strength	-	-	+/-*	-*	
Smoking	+/-	-			
Socio-economic Status	+/-	+/-			
Biomechanical Factors					
Combination of Factors	+	+/-*	+/-	+*	+
Heavy Physical Load	+/-	+	+		+
Awkward Postures	+	+	+		+
Vibration	+/-	+			
Repetition	+	+	+		
Static Postures	-	+	+		
Forces		+			
Job title/work unit	∅	∅	+/-	+*	

Table 2: Summary of Evidence for Variables Associated with Lower-body Musculoskeletal Morbidity

\+ Evidence from studies supports an association
\- Evidence from studies does not support an association
++ Strong evidence of an association
+/- Evidence is contradictory
Blank cell indicates variable was not studied or described in studies or by focus groups
* Evidence based on 3 or fewer studies

	Non-Health Care Sector		Health Care Sector		
Variable	**Cross-sectional Studies**	**Case-Control/ Cohort**	**Cross-sectional Studies**	**Case-Control/ Cohort**	**Focus Groups**
Work Organization					
Low Job Control	+/-	+/-	+/-		+
Low Work Support	+/-	+/-	+		+
High Demand/Pressure	+	+/-	+/-		+
High Job Strain/Stress	+	+	+/-	-	
High Workload	+/-	+/-	+/-	+/-	+
Low Job Satisfaction	+/-	+/-	+/-	-*	
Monotonous Work	+	+*	+/-	-*	
Individual Factors					
Increasing Age	+	+/-	+	+/-	+
Female	+/-	+/-	-	-	
Previous Symptoms	+	++	++	++	
Work Experience	+/-	+/-	+/-	+/-	+
Anthropometry	-	-	-	-	
Fitness/Strength	-	-	+/-	-	
Smoking	+/-	-	+/-	+/-	
Socioeconomic Status	+/-	+/-			
Biomechanical Factors					
Combination of Factors	+	+/-	+	+	+
Heavy Physical Load	++	++	++	+	+
Awkward Postures	++	+	+	+	+
Vibration	+	+			
Static Postures	+/-*	+*	+/-*		
Forces		+*	+/-*		
Job Title/Work Unit	+	+	+/-	+/-	

1.10 Research Question

In summary, the aims of this study were first, to examine the relationship between the risk of upper and lower-body musculoskeletal symptoms and claims, and work organization factors as part of a multi-factorial model of morbidity that included individual and biomechanical factors; second, to address the need for more research on work organization factors among health care workers, who comprise a significant portion of the Canadian workforce and who are at high risk of musculoskeletal morbidity; third, to build upon previous research by studying work organization factors in a cohort study design, incorporating objective, time-varying measures of work organization factors, and comprehensive biomechanical measurements based on direct observation; and finally, to address the need for more research on non-nursing occupations and upper-body musculoskeletal outcomes in the health care sector. Given these objectives and the evidence from the literature, the following research question was posed:

Are measures of low job control, low work support, high mental demands or time pressures, and high workload related to an increased risk of upper-body and lower-body musculoskeletal symptoms and compensation claims among health care workers, after adjusting for individual (age, sex, experience and previous musculoskeletal symptoms) and biomechanical factors (composite score)?

Chapter II Methods

Summary of Methods

This was a retrospective cohort study with follow-up of 4020 health care workers during the period January 1, 1992 to December 31, 1995. The follow-up period was defined by the availability of outcome and exposure data. Five measures of work organization (job control, work support, job demands or time pressure, and workload level) were investigated for associations with work-related musculoskeletal outcomes. The analyses were adjusted for four demographic variables (age, sex, years in current occupation and time in months since previous musculoskeletal symptoms) and two biomechanical variables (composite score for upper and lower-body factors). Upper-body (i.e. upper-limb, neck and upper-back) and lower-body (i.e. lumbar back and lower-limb) musculoskeletal symptoms, as recorded in a hospital OH&S incident database, and upper-body and lower-body accepted compensation claims, as recorded in the same database, were the four dependent variables. For purposes of brevity, these variables are referred to as upper-body and lower-body musculoskeletal symptoms and upper-body and lower-body musculoskeletal claims.

Cohort members were enumerated from hospital personnel records. Demographic data were obtained from these same records. Scores for work organization factors were assigned to cohort members using a job exposure matrix based on questionnaire data obtained from three random samples of employees between 1991 and 1994. Workload was defined three ways using sicktime and overtime hours, and work units data obtained from hospital financial reports. Biomechanical factors were assessed by direct observation of all unique occupations in the study. The assessments were completed by a trained observer and scored using a validated checklist. Data on musculoskeletal symptoms and accepted claims was ascertained from the hospital's occupational health and safety database. Poisson regression was used to assess the risk of musculoskeletal outcomes associated with work organization factors, while controlling for individual and biomechanical variables.

Detailed Description of Methods

2.1 Enumeration of the Cohort Population

All employees of one acute care hospital located in the lower mainland of British Columbia were the source population for the study. The hospital was selected as the study site based on the availability of retrospective exposure and outcome data, and sufficient sample size (Appendix 3) to support the statistical analyses. Employees were enumerated from hospital personnel records. Those with a minimum one-month employment between January 1, 1992 and December 31, 1995 were included in the cohort. Follow-up ceased upon separation from the hospital, if applicable, or the end of the study period. Physicians, students and off-site workers were ineligible for inclusion in the study population due to a lack of exposure and denominator data.

A total of 4286 employees were employed at the hospital between January 1, 1992 and December 31, 1995, of whom 4020 were included in the analyses. Three employees were excluded for missing/erroneous data fields and 123 for employment of less than 1 month. One hundred and forty employees were ineligible as physicians, students and off-site workers. The remaining 3186 females and 834 males contributed 142,269 person-months of observation over the four-year follow-up period. Approximately two-thirds of the study population were followed for the entire four-year study period, with one-third moving in and out of the hospital during that time. Two sub-cohort populations were enumerated to test hypotheses related to workload measures. Data on workload measures was only available retrospectively for a sub-set of hospital departments. The sub-cohort population for which sicktime/overtime data was available included 3769 employees (2985 females/784 males) contributing 126,877 person-months, and the sub-cohort population for which work units data was available, 2525 employees (2148 females/377 males) contributing 66,158 person-months.

2.2 Denominator Data – Person-months of Observation

Occupational histories and the corresponding person-months denominator data were obtained from hospital employee records. A total of 11855 employee records were downloaded from the hospital database, of which 11086 represented the 4020 included employees. Multiple records exist for employees who change jobs within the hospital setting, as well as for employees who hold multiple jobs at one time (e.g. registered nurse working in both intensive care and emergency departments). This database is herein referred to as the employee database.

2.2.1 Restructuring Employee Database

Records in the employee database were restructured to create unique exposure periods for the predictor variables. A total of 4906 records were collapsed into a preceding record to eliminate duplication of exposure time for employees holding multiple occupations at the same time. A total of 158,139 records were added to the database to create unique exposure periods for person-months of observation and to appropriately attribute person-months to categories of predictor variables.

2.2.2 New Study Variables in Employee Database

New variables for age and years of occupational experience were computed for each exposure record using the start date for the record and either the date of birth or occupation start date respectively. The variable 'time since last musculoskeletal symptom' was calculated as the cumulative sum of person-months of observation from the start of follow-up to the date of a reported symptom, and between dates of symptoms, if applicable. Variables were categorized as follows:

Age (years)		Years of Experience (years)		Time Since Previous Symptoms (months)
< 30		< 2		≤ 3
30 - 39		2 – 5		4 – 6
40 - 49		6 – 10		7 – 12
50 - 59	Combined (low numbers in 60+ group	11 – 20	Combined (low numbers in 20+ group)	13 – 24
≥ 60		> 20		> 24

2.3 Numerator Data – Work-related Musculoskeletal Symptoms and Claims

Musculoskeletal morbidity was defined two ways, first as a functional health outcome and second as a medical health outcome. The functional health outcome was defined as a musculoskeletal symptom resulting in an interruption of work, as recorded in the hospital's occupational health and safety incident database. The medical health outcome was defined as a musculoskeletal symptom resulting in disability compensation, as recorded in the same database. Numerator data on musculoskeletal symptoms and compensation claims was extracted from the hospital's database of occupational health and safety incidents. Hospital procedures require employees to complete a written report (See Appendix 5) for all work-related episodes affecting the physical health and safety of workers. A supervisor or first aid attendant may complete sections of the form, if applicable. A work-related episode is defined by the hospital as 'any situation that results in, or has the potential to result in, a physical injury to an employee while at work'. This includes a hazardous situation ('an unsafe action, condition or combination of both in the work environment'), a first aid injury ('a minor injury where treatment can be carried out without compensation costs'), a medical aid injury ('a work-related injury which requires treatment or a service resulting in compensation costs but no time loss from work') or a lost time injury ('work-related injury which results in time lost from work beyond the day of the injury and compensation costs')."

All reports with a date of January 1, 1992 through to December 31, 1995 inclusive were downloaded from the occupational health and safety database. This database is herein referred to as the musculoskeletal database. The musculoskeletal database contained 3836 reports of work-related occupational health and safety episodes, of which 3614 were used to identify musculoskeletal episodes. A total of 222 reports were excluded from the database for missing/erroneous unique identifiers or for ineligible occupations (i.e. physicians and students).

2.3.1 New Study Variables in Musculoskeletal Database

The 3614 occupational health and safety reports were read by the principal investigator and coded for musculoskeletal symptoms. The principal investigator was blinded to occupation and department codes. A report was coded as a musculoskeletal symptom if it described sprains, strains, tears, pulls, discomfort, inflammation, soreness, pain, swelling, stiffness, numbness, or twisting involving the neck, back, shoulder, arm, hand, fingers, hip, groin, thigh, leg, foot, toes, ligaments, muscles or tendons. A combination of any two terms, one from the symptom list (e.g. sprain, strain) and one from the musculoskeletal system list (e.g. neck, back), was acceptable to code the report as a musculoskeletal symptom. Reports that failed to describe a term from the symptom list and a term from the musculoskeletal system list were coded as non-musculoskeletal reports. Episodes that were caused by a sudden impact of external force such as falls from heights or being struck by objects were excluded, as were fractures to the musculoskeletal system. Reports were read and coded on two separate occasions. Discrepancies in coding between the two readings were resolved by re-reading the report and deciding on a final code. A report was further coded as an upper-body musculoskeletal symptom if it involved the upper limb, shoulder, neck or cervical region of the back, and coded as a lower-body symptom if it involved the lower limb or lumbar back. Due to small numbers, musculoskeletal symptoms involving the lower limb were combined with those of the lower back for the study. Occupational health and safety reports were coded for compensation claim status by the hospital. This code was used to ascertain accepted compensation claim outcomes for the study.

2.4 Biomechanical Predictor Variables

Data on biomechanical factors was collected by direct observation of unique occupations in the study and scored using the Occupational Safety and Health Administration checklists (OSHA 1995) for upper and lower-body risk factors (Appendix 6). The checklists were used to quantify biomechanical risks based on the observed presence, frequency, duration and magnitude of 12 upper-body factors (repetition, hand force (x3), awkward postures (x4), contact stress, vibration, temperature) and 16 lower-body factors (awkward postures (x9), contact stress (x2), vibration, pushing/pulling (x2), manual handling, patient lifting). The observation technique provided a practical method to assess multiple occupations, and improve upon the reliability and validity of self-reports or job titles to assess biomechanical exposures (Burdorf et al 1997; Burdorf 1995).

2.4.1 Training for Job Observations

The principal investigator trained with an ergonomist[1], working in the British Columbia health care industry, to assess biomechanical factors by direct observation. Under the supervision of the ergonomist, the principal investigator observed approximately 20 hours of videotape footage of health care workers performing their jobs and scored the observed biomechanical factors using the OSHA checklists. The principal investigator piloted the assessment protocol (Section 2.6.2) and OSHA checklists with seven departments of an acute care hospital in British Columbia, other than the study site. Issues arising from the assessment and scoring of risk factors were resolved with the ergonomist. For additional experience, the trained observer also accompanied ergonomists on four other hospital ergonomic assessments prior to the completion of the assessments for the study.

2.4.2 Direct Observation Assessment Protocol

A total of 183 direct observations were completed over an eight-month period to assess the biomechanical factors associated with all unique occupations included in the cohort population. The following steps were completed for the direct observation of a unique occupation:

1. Send memo of introduction and explanation to managers and/or department heads.
2. Contact manager, director or designate (supervisor, co-ordinator) for each hospital department.

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[1] Masters degree in ergonomics and registered member of the Human Factors Association of Canada.

3. Describe the study and explain the direct observation protocol. Ask manager/supervisor/co-ordinator to designate a contact person in their area to help arrange the direct observations.

4. Ask contact person to identify all unique occupations within their respective departments and cross reference with the list of unique occupations generated from the employee database [2]

5. Arrange a minimum four-hour period[3] to observe employees in an occupation. Ask contact person to select a day of the week and a time of the day that is representative of a typical workday.

6. Meet with contact person prior to the start of the arranged observation period. Explain the study and describe the study protocol to the employees within the work area being observed. Ask employees if they have any questions.

7. Observe/'shadow' a minimum of two employees, if applicable, during the arranged time period. Confer with employees on the presence of biomechanical factors, the frequency/duration with which they perform tasks and the weight of objects, if appropriate.

8. Maintain written notes on work tasks, and the frequency and duration of exposure to tasks.

9. Complete the OSHA checklists for upper and lower-body at the end of the observation period.

10. Resolve scoring problems with employees and/or ergonomist.

2.4.3 New Study Variables in Biomechanical Database

The sum of scores for the sixteen lower-body biomechanical factors was categorized as low risk for scores of 2 or less, medium for 3-5, high for 6-8, and very high for scores of 9 or higher. The sum of scores for the twelve upper-body biomechanical factors was categorized in the same way. The

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[2]The score for an occupation in one department was applied to the same occupation code in a different department if the job tasks were confirmed to be the same by employees and job descriptions (e.g. registered nurse in Medical Unit A performed the same job tasks as registered nurse in Medical Unit B; accountant in Accounts Payable performed the same job tasks as an accountant in Accounts Receivable). In some instances, direct observations were completed for one occupation (i.e. secretary) across numerous departments to confirm that job tasks were the same. Employees that circulate in the hospital (i.e. registered nurse in the float pool) were given the mean upper and lower-body scores for their occupation across department codes. It was not always feasible to observe employees at work due to patient confidentiality (i.e. one-to-one therapy session and the delivery room), and some occupations were obsolete at the time of observation. In both instances, discussions with employees and a review of job descriptions were used to find the most comparable surrogate occupation.

[3] A four-hour observation period was not appropriate for all occupations and was reduced to two-hour observations for employees who perform the same tasks throughout their day (e.g. data entry clerks). In other areas the observation period was increased (one to two days) to observe employees in occupations involving multiple work stations such as the kitchen, central supply department, physiotherapy department, laboratories and pharmacy department.

occupations with a maximum score of 9 were combined with scores of 6-8 due to low numbers, thereby eliminating the very high-risk category for the upper-body. The instrument was designed in such a way that exposure to at least two risk factors for more than half of a work shift would result in a score higher than 5, indicating a risk of injury to the worker associated with biomechanical factors. Representative exposure scores for upper-body and lower-body biomechanical factors were extrapolated to workers not monitored by occupation and department codes.

2.5 Work Organization Predictor Variables

A work organization exposure matrix for measures of job control, job demands, work support and work pressures was developed from responses to random sample surveys of employees administered by the hospital in 1991, 1993 and 1994. The hospital population was stratified to obtain a representative sample of employees within the three major hospital unions and a fourth non-contract group (See Appendix 7 for sampling strategy and responses rates). A total of 912 survey responses were obtained over the three years.

The hospital survey (Appendix 8) was a compilation of previously validated scales. The Job Content Questionnaire or JCQ (Karasek 1985; Karasek and Theorell 1990) provided data for predicted measures of job control and job demands, and the Work Environment Scale or WES (Insel and Moos 1974; Moos 1986) provided data for predicted measures of work pressure and work support. See Appendix 9 for JCQ and WES items included in the hospital survey. The job demands scale is the weighted sum of 5 items that measure the level of cognitive demands at work (excessive work, conflicting demands, insufficient time, fast pace and working hard). The job control scale is the weighted sum of 2 sub-scales: skill discretion as measured by 6 items (learning, develop skills, job requires skills, task variety, non repetitious work, creativity) and decision authority as measured by 3 items (freedom to make decisions, choose how to perform work and have a say on the job).

Respondents answered the JCQ questions on a four-point scale from strongly agree to strongly disagree.

The work pressure scale is the sum of 9 items related to time pressures (constant pressure, urgency, cannot relax, work too hard, hard to keep up, able to get your work done, always deadlines to be met, frequent overtime), and the work support scale the sum of 9 items related to supervisor support (talk down to employees, compliment work, discourage criticisms, full credit for ideas, criticized for minor things, feel free to ask for raise, expect too much, discuss problems, defends employees). Both are binary scales with a yes or no response. Prior to the construction of the exposure matrix of predicted values, the data were cleaned and missing values replaced, as described below.

2.5.1 Cleaning the Data

Fifty-one records in the survey database had missing or erroneous demographic data and were excluded from the study leaving 861 for the prediction of work organization scores and the construction of the exposure matrix. Ten of the original 14 JCQ items and 17 of the original 18 WES items were included in the hospital survey in all years. Original formulae for calculating control and demand, and pressure and support scores (Appendix 10) were weighted to account for sub-scale items that were missing for all three years of the survey.

Further, in some years and for some union groups, additional items from each scale were excluded. Non-respondents to survey items also resulted in a further 311 cells with missing data. Appendix 11 provides a summary of non-respondent fields and excluded items. As this represented a large potential loss of data, the investigators replaced excluded and non-respondent cells, as follows.

2.5.2 Replacing Missing Cells for Non-respondents

Mean scores for survey items were significantly different by categories of demographic variables and by job areas, at the 0.05 level. Missing cells for non-respondents to work organization items were replaced with mean values by union, supervisor status and job area, as well as age, sex, and years of experience, if significant. Table A28 in Appendix 12 provides the list of significant demographic variables used to calculate the means for non-respondents to each survey item.

2.5.3 Replacing Missing Cells for Omitted Survey Items

Responses for JCQ items not asked in 1994 were predicted using responses to the same items from previous years. The data were entered into regression models with demographic variables and other sub-scale items as potential predictors. Only significant predictors at the 0.05 level were retained in the final models. Omitted items were replaced with predicted mean values using the final regression equations.

Five work pressure items and two work support items were omitted from the survey administered to one union sample in 1993 and 1994. As the survey was not administered to this union group in 1991, missing cells could not be imputed from previous data. Rather, total work pressure and work support scores for employees from this union in 1993 and 1994 were calculated by summing the responses to the included items, multiplied by a fraction to compensate for the excluded questions. Appendix 12 provides a summary of the methods used to replace values for non respondents and for omitted items.

Following the replacement of missing and omitted items, scores for job control, job demands, work pressure and work support were calculated from their respective sub-scale items according to instrument formulae (Appendix 10).

2.5.4 Construction of Work Organization Exposure Matrix

Total scores for job control, job demands, work pressure and work support, from responses to the JCQ and WES based on the 861 included respondents, were used to predict work organization scores for the entire cohort population. Scores were predicted using linear regression and significant predictor variables available for the entire cohort: age, experience, sex, and a combined variable of occupation with union (Appendix 13). Scores for the work organization factors and all potential predictor variables were entered into regression models and the *SAS* R^2 procedure (SAS Institute Incorporated, North Carolina, US) used as an initial strategy to find the combination of variables that resulted in the 'best model fit' (i.e. highest adjusted R^2). The resulting models, with the combination of variables that best predicted job control, job demand, work support and work pressure scores were then reviewed. Variables at the 0.10 level of significance or higher were dropped from the models and the models re-run with only significant predictor variables (Appendix 14).

In order to maximize the number of data points and minimize data loss, models were built first using all 861 records without the variable age, as this variable was omitted from the 1994 survey. Age was then added to the 'final' models, using the sub-set of data for which age was available. Age was a significant predictor of all four work organization scores and was retained in the final models. Using the final regression models, scores were estimated for job control, job demand, work support and work pressure by levels of significant predictor variables and assigned to cohort members using a work organization exposure matrix.

2.5.5 New Variables for Work Organization Exposures

After assigning predicted scores to the population for the entire follow-up period using the exposure matrix, job control and work support scores were categorized by quartiles based on the distribution of the variables in the total population: a reference or theoretically low exposure group, a medium-low, medium-high and high exposure group. Due to little variation in the distribution of job demands and work pressure scores, the median score was categorized as the medium exposure category, while scores above and below the median were assigned high and low exposure status respectively.

2.6 Workload Predictor Variables

Three measures of workload were included in the study. These were monthly, time-varying measures of departmental sicktime, overtime and work units (e.g. number of meals prepared, number of clinic visits, number of patient days). Data on departmental sicktime hours, overtime hours, and work units was extracted from hospital payroll and financial reports (sample reports are provided in Appendix 15) and entered into a database by the principal investigator. A description of the work units data by department is provided in Appendix 16.

2.6.1 New Study Variables in Workload Database

Departmental sicktime and overtime hours were calculated as a proportion of total paid hours per month. Departmental work units were calculated per full-time equivalent employee (based on a 37.5-hour workweek) by month. Sicktime and overtime proportions, and work units per employee were assigned to cohort members by their department and month of employment at the hospital. Proportions of departmental sicktime and overtime were categorized into quartile groups (low, medium-low, medium-high and high) based on the distribution of the variables in the study population over the four-year follow-up period. Work units/FTE ratios were plotted for each department and the median value categorized as usual workload. The remaining values below the median were categorized as below usual and very below usual workload levels by equally splitting the distribution between these two categories. Similarly, values above the median were split into above usual and very above usual categories. The 'very below usual' workload level was collapsed into the 'below usual' category due to low numbers. A total of four categories were used in the cohort analysis: below usual workload, usual (reference), above usual and very above usual workload. A summary of the data collection methods for the study is provided in Appendix 4.

2.7 Database Linkage

The employee database consisted of unique exposure records corresponding to person-months of observation for the 4020 included employees. OH&S incident reports of musculoskeletal symptoms and accepted compensation claims were linked to an employee exposure record by matching the unique employee identifiers between the musculoskeletal report and the employee record, and the date of the musculoskeletal episode with the start and end date of the employee exposure record. Biomechanical scores were assigned to employees by linking the occupation and department code of a biomechanical assessment to the occupation and department employment code of an employee exposure record. Scores for job control, job demand, work support and work pressure were linked to each employee exposure record by matching the categories of significant predictor variables in the work organization exposure matrix (i.e. age, sex, experience, supervisor and work group categories) with the same categories in the employee exposure record. Finally, workload measures were assigned to employees by linking the department code and month of the sicktime proportion, overtime proportion and work units/employee with the department code of employment and start date of an exposure record.

2.8 Data Analysis

2.8.1 Descriptive Analysis Methods

Means and percentages were calculated for categorical and continuous study variables to describe the health care study population. Musculoskeletal symptom and claim rates for the four-year study period were described by categorical study variables. Descriptive results were compared across the cohort and two sub-cohort populations, as well as between included and excluded employees. Additional cross-tabulations and correlation coefficients of study variables were computed to investigate possible confounding. Descriptive results are presented in Chapter III.

2.8.2 Uni-variable Regression Analysis Methods

The risk for work-related musculoskeletal symptoms and claims associated with predictor variables was calculated using Poisson regression in *Egret* (Statistics and Epidemiology Research Corporation, Seattle USA). Poisson regression models are appropriate for time related analysis of rare events (Frome and Checkoway 1985; Kuhn et al 1994). The cohort database was aggregated using *SPSS* (SPSS Inc, Chicago US) to derive count data for musculoskeletal outcomes per person-months of follow-up by categories of predictor variables. The independent variables of interest were job control, work support, job demands, work pressure; and departmental sicktime, overtime and work units/FTE. The effect of increasing age, sex, fewer years of experience, more recent previous symptoms, and higher upper-body and lower-body biomechanical factors were also analyzed independently.

Using Poisson regression, the numerator count of musculoskeletal symptoms or claims, with the denominator of person-months of observation, were regressed against each of the predictor variables. It was a priori hypothesized that the risk of musculoskeletal symptoms and claims would increase with low job control, low work support, high job demands, high work pressures and high levels of workload. Reference categories for individual variables (age <30 years, experience > 10 years, no prior symptoms or symptoms more than two years ago), biomechanical factors (scores ≤ 2 representing one factor present for less than half the work day) and work organization variables (high levels of control and support, and low levels of demands, pressures and workload) were selected as the hypothesized lowest risk group for each predictor variable. Regression models and tests for trend were completed for the entire cohort population and again for the sub-cohorts defined by sicktime/overtime data and work units data. Uni-variable results are presented in Chapter IV.

2.8.3 Multi-Variable Analysis Methods

Individual predictor variables (age, sex, and years of experience) were entered first into Poisson regression models. Biomechanical predictor variables (upper and lower-body scores) were then added to the models, followed by the work organization predictor variables (job control/job demands or work support/work pressure). For the sub-cohort populations, the workload variables for departmental sicktime, overtime and work units were subsequently added to the models. The variable 'time since last symptom' was a relatively novel way of controlling for previous musculoskeletal history and was added last to all of the models to understand its affect on the other variables. The addition of interaction terms (control*demand, support*pressure, and biomechanical categories*work organization levels) was used to test for effect modification. Models failed to converge with interaction terms and stratified analyses were completed to investigate the effect of work organization factors on musculoskeletal outcomes for employees with high verses low biomechanical exposures and vice versa. The analytical procedures were followed for each of the four musculoskeletal outcomes of interest (upper or lower-body musculoskeletal symptoms, and upper or lower-body compensation claims). However, analysis of compensation outcomes was not completed for the work units sub-cohort due to limited statistical power.

Based on high correlation coefficients between the upper and lower-body biomechanical scores, the score for upper-body biomechanical factors was only added to models seeking to explain upper-body musculoskeletal outcomes, as was the score for lower-body biomechanical factors to models seeking to explain lower-body musculoskeletal outcomes. Similarly, job control was entered into separate analyses from work support, as was job demands from work pressure, due to high correlation coefficients between these pairs of variables (Appendix 17). The variables of sicktime, overtime and work units were entered into separate models as measures of the same construct of workload.

2.9 Ethics

All research protocols were reviewed in advance by the University of British Columbia's Research and Ethics Committee, the hospital's Research and Ethics Committee and the hospital's Freedom of Information and Protection of Privacy Officer. In particular, permission to download or extract hospital data, to link hospital databases and to conduct on-site biomechanical assessments of employees was approved by the various research and ethical approval bodies. Unique identifiers were removed from the final cohort database following the data linkage procedure.

Chapter III Description of Health Care Study Population

3.1 Health Care Workers

The cohort of 4020 health care workers was comprised of 3186 women (79%) and 834 men (21%). Employees were followed an average of 3.1 years during the study period. The mean age at start of follow-up was 36.8 years (range 18 to 71 years). Experience ranged from one month to 42 years, with an average of 7.8 years (sd=6.6) at the hospital at the time of entry into the study. On average, employees worked 4.2 years (sd=5.3) in an occupation before moving to another occupation within the hospital (e.g. nurse in intensive care department moving to the emergency department, or a care aide moving to a unit co-ordinator position). Differences between men and women for demographic variables were not statistically significant ($p>0.05$) with the exception of years of experience in an occupation (Table 3).

Table 3: Mean Age, Follow-up time and Experience of Health Care Workers

Variable	Cohort Population	Female Cohort Members	Male Cohort Members
Number of workers (% of total)	4020	3186 (79%)	834 (21%)
Mean in years:			
Age at entry into cohort	36.8	37.0	36.5
Average length of follow-up	3.1	3.1	3.1
Average years of experience at the hospital, at entry into cohort	7.8	7.9	7.5
Average years of experience in a hospital occupation	4.2	4.3*	3.7*

*statistically different between females and males ($p<0.05$)

Almost half of the cohort population (44%) worked in a direct care occupation such as a nurse, care aide, or therapist. The majority of women worked in direct care or clerical occupations, while most men worked in support services (e.g. housekeeping) or direct care occupations (Figure 2).

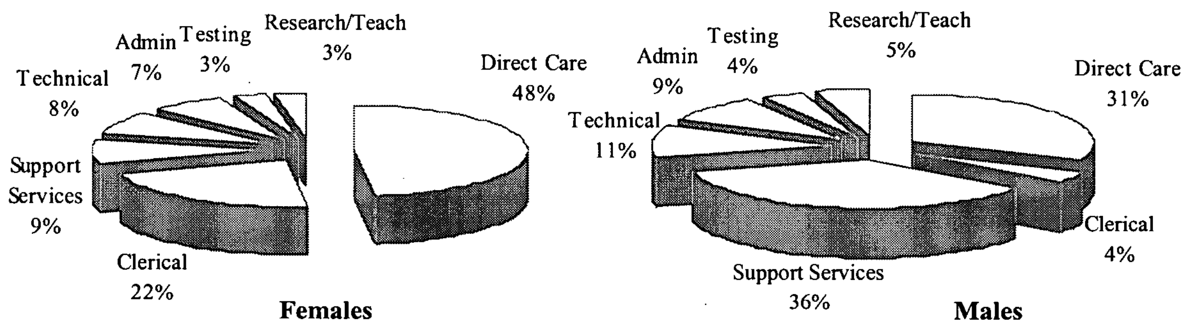


Figure 2: Percentage of Health Care Workers by Occupation and Sex

3.1.1 Excluded Health Care Workers

A total of 126 employees were excluded from the cohort and 140 physicians/students were ineligible. Excluded and ineligible employees were younger and less experienced than the cohort population (Table 4). The lower mean values were understandable given 37% of the ineligible employees were students and 19% were excluded because they were employed less than one month. There was also an over-representation of women in the excluded group and an under-representation among ineligible employees.

Table 4: Age, Sex and Experience of Included, Excluded and Ineligible Health Care Workers

Variable	Cohort Population (Included)	Excluded Workers	Ineligible Workers
Total number of workers	4020	126	140
% Female	79%	89%	68%
Mean Age	36.8	32.7	27.9
Average years of experience at the hospital	7.8	2.0	1.3
Average years of experience in a hospital occupation	4.2	1.7	1.1

The distribution of excluded employees by occupation, other than students and physicians, was consistent with the overall population as approximately half worked in direct care occupations (49%). Only employees in research and teaching occupations were over represented among excluded employees (15%), compared to the study population (4%).

3.2 Musculoskeletal Outcomes among Health Care Workers

A total of 1262 occupational health and safety reports, or 33% of all reports filed between January 1992 and December 1995, were defined as a musculoskeletal episode. Slightly more than half of all episodes (54%) resulted in lower-body musculoskeletal symptoms, 35% upper-body musculoskeletal symptoms and 11% involved both upper and lower-body symptoms (Table 5). Of the 1262 musculoskeletal episodes, 735 resulted in an accepted worker's compensation claim. Fifty-four percent were lower-body musculoskeletal claims, 34% upper-body claims, and 12% involved both the upper and lower-body.

Table 5: Number of Musculoskeletal Symptoms (OH&S Reports) and Accepted Compensation Claims among Health Care Workers in the Study Population (n=4020) from 1992 – 1995

	1262 Musculoskeletal Episodes (OH&S Reports)	
↙	↓	↘
687 (54%) Lower-body Musculoskeletal Symptoms	440 (35%) Upper-body Musculoskeletal Symptoms	135 (11%) Both Lower and Upper-body Musculoskeletal Symptoms
	↓	
	735 Musculoskeletal Compensation Claims	
↙	↓	↘
398 (54%) Lower-body Compensation Claims	250 (34%) Upper-body Compensation Claims	87 (12%) Both Lower and Upper-body Compensation Claims

Episodes involving both the upper and lower-body were counted in each category separately. As a result, the descriptive and cohort analyses investigated 822 lower-body musculoskeletal symptoms and 575 upper-body musculoskeletal symptoms, for a total of 1397 symptoms. Similarly, the descriptive and cohort analyses investigated 485 lower-body compensation claims and 337 upper-body compensation claims, for a total of 822 claims.

Seven hundred and eighty-two employees (20% of the study population) reported the 1262 musculoskeletal episodes during the follow-up period. Approximately 35% of the 782 employees reported at least 2 and as many as 7 musculoskeletal episodes. Fifteen percent of the study population reported at least one lower-body musculoskeletal symptom and 11% an upper-body symptom. Compensation claims occurred less frequently with 7% and 9% of the study population having at least one upper-body or lower-body compensation claim respectively during the four-year follow-up period.

3.2.1 Description of Health Care Workers with Musculoskeletal Symptoms and Claims

The percentage of upper-body musculoskeletal symptoms (83%) and compensation claims (82%) experienced by females was slightly higher than the proportion of females in the overall study population (79%), while the percentage of lower-body symptoms (77%) and claims (75%) was slightly lower. Age at time of symptoms reported to the OH&S system or acceptance of a compensation claim (mean of 39 years) was identical to the overall mean age for all health care workers during the four-year study period. Compared to the entire study population, employees at the time of a lower-body musculoskeletal symptom or claim were employed, on average, one year less at the hospital (6.7 to 6.9 years verses 7.8 years), and a half a year less in their occupation (3.8 verses 4.2 for the population). The mean age and experience of employees with symptoms or claims was not statistically different from the mean age and experience of the overall cohort population ($p>0.05$).

The overall rate of musculoskeletal symptoms among health care workers in the study population between 1992 and 1995 was 8.9 symptoms per 1000 person-months of observation, and that for compensation claims 5.8 claims per 1000 person-months (Table 6). Lower-body musculoskeletal symptoms and claims occurred at a higher rate than upper-body musculoskeletal outcomes. Employees in the youngest (<30 years) and oldest (>50 years) age categories tended to have the lower rates of musculoskeletal problems during the study period. Women had higher upper-body rates and males higher lower-body rates. Employees with the most experience, both in the hospital and their occupation, consistently reported the lowest rates of musculoskeletal morbidity. The rate of musculoskeletal symptoms and claims increased consistently with higher levels of biomechanical factors (Table 6). Results from further sub-analyses indicate that the pattern of risk by age, experience, occupation and biomechanical exposure was the same between men and women (results not shown).

Employees in security, housekeeping and direct care occupations had the highest rates of both upper and lower-body outcomes (Table 6). Employees in administrative, clinical and research/teaching occupations had the lowest rates. With the exception of security guards, clerical workers and technicians (non-patient services), all occupations had higher rates of lower-body musculoskeletal morbidity than upper-body rates.

Rates of musculoskeletal symptoms and claims increased as levels of job control and work support decreased (Table 6). Conversely, rates tended to decrease with more time pressures, and peaked with medium levels of job demands. A sub-analysis by gender indicated that the rate of upper-body symptoms among males increased steadily with higher job demands.

Table 6: Rates of Upper and Lower-body Symptoms and Claims by Predictor Variables, 1992-1995

	Rates per 1000 Person-Months				
	All Symptoms or Claims	**Upper-body Symptoms**	**Upper-body Claims**	**Lower-body Symptoms**	**Lower-body Claims**
Overall Rate	8.9	4.0	2.4	5.8	3.4
Age					
<30	8.3	3.5	1.8	5.7	3.5
30-39	9.1	4.3	2.7	5.9	3.4
40-49	9.3	4.3	2.4	6.0	3.5
50-59	9.2	4.2	2.7	5.6	3.5
60+	4.0	1.7	1.2	2.6	1.4
Sex					
F	8.8	4.2	2.5	5.6	3.2
M	9.2	3.3	2.1	6.6	4.2
Years at Hosp					
>20	6.4	3.2	1.7	3.8	2.0
11-20	8.7	4.6	2.7	5.3	3.0
6-10	9.7	4.6	2.7	5.9	3.5
2-5	9.8	4.0	2.4	7.0	4.2
<2	7.2	3.0	1.8	4.9	2.8
Years in Job					
>20	5.0	1.5	0.4	4.4	1.9
11-20	7.2	3.8	1.9	4.6	2.5
6-10	8.3	4.4	2.8	4.7	2.6
2-5	9.5	4.1	2.3	6.3	3.7
<2	9.3	4.1	2.6	6.1	3.8
Biomechanical	Upper Lower				
Low	4.8 2.8	2.1	1.2	1.9	1.0
Medium	10.4 6.4	4.7	2.6	4.6	2.6
High	11.0 14.6	5.3	3.6	9.0	5.4
Very High	na 15.1	na	na	10.3	6.3
Job Control					
High	4.2	1.7	0.8	2.9	1.4
Medium-High	8.9	3.5	1.6	6.1	3.5
Medium-Low	10.2	4.8	2.9	6.8	4.1
Low	10.5	5.2	3.5	6.2	3.9
Work Support					
High	5.1	2.1	1.0	3.3	1.5
Medium-high	8.0	4.0	2.3	5.1	3.0
Medium-low	9.1	4.0	2.2	6.2	3.7
Low	12.0	5.4	3.5	7.4	4.7
Job Demands					
Low	8.5	3.8	2.2	5.0	3.2
Medium	10.0	4.4	2.5	6.6	3.9
High	5.0	2.9	1.8	3.0	1.6
Work Pressure					
Low	10.3	4.9	2.9	6.5	4.2
Medium	1.0	4.4	2.5	6.7	3.9
High	3.8	2.1	1.3	2.3	1.1

3.3 Biomechanical Factors among Health Care Workers

The biomechanical scores for all health care occupations included in the cohort ranged from 0 to 9 (mean=3.7) for the upper-body and 0 to 14 (mean=4.6) for the lower-body (Figure 3). Twenty percent of occupations held by cohort members during the follow-up period had upper-body biomechanical scores greater than 5, signalling occupations at risk for musculoskeletal problems due to biomechanical factors (Figure 5). Forty-three percent of occupations held by cohort members during the follow-up period had lower-body biomechanical scores greater than 5.

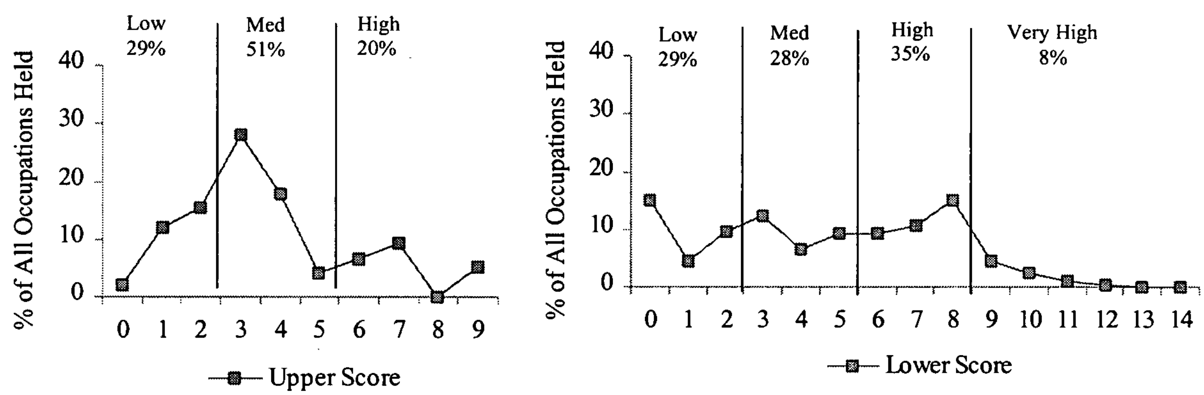


Figure 3: Distribution of Upper and Lower-body Biomechanical Scores for all Occupations held by Health Care Workers (n=6186) from 1992-1995 and Percentage of Jobs Categorized as Low to High Risk

Using analysis of variance, mean biomechanical scores were found to be statistically different across age, sex, experience and occupation categories (Table 7). Younger employees and males had somewhat higher scores than older employees and females. Security, housekeeping and care aide workers had the highest mean scores for lower-body biomechanical factors, while dietary, housekeeping, and laboratory workers had the highest mean scores for upper-body biomechanical factors.

Table 7: Mean Upper and Lower-body Biomechanical Scores for Health Care Workers by Age, Sex, Experience and Occupation

Variable		Upper Biomechanical Mean Score	Lower Biomechanical Mean Score
Overall Cohort Population		3.7	4.6
Range		0-9	0-14
Age+	<30	4.3	4.5
	30-39	3.8	4.6
	40-49	3.5	4.6
	50-59	3.4	4.6
	60+	3.5	4.7
Sex*	Females	3.5	4.4
	Males	4.4	5.4
Years in Hospital*	>20	3.7	4.0
	11-20	3.5	5.1
	6-10	3.7	4.7
	2-5	3.9	4.7
	<2	3.4	4.0
Years in Occupation*	>20	3.8	4.0
	11-20	3.7	5.0
	6-10	3.4	4.5
	2-5	3.6	4.6
	<2	3.8	4.6
Occupation Group*			
Housekeeping		7.0	8.0
Security		3.0	8.0
Direct Care Non RN		2.9	7.2
Physical Plant		5.6	7.1
Dietary		8.6	6.1
Direct Care RN		2.8	6.0
Technician-Non Patient Care		4.8	3.6
Technician-Patient Care		3.5	3.5
Therapies		1.6	3.4
Clerical		3.6	2.4
Supervisors		2.3	2.1
Clinical		1.1	1.5
Labs		5.7	1.2
Research/Teaching		1.3	0.8
Computer		4.0	0.4
Administration		1.0	0.1

+ upper mean scores statistically different across categories at 0.05 level – Anova analysis

* upper and lower mean scores statistically different across categories at 0.05 level – Anova analysis

3.4 Work Organization Factors among Health Care Workers

Job control, job demands, work support and work pressure scores were predicted from a random sample of health care workers (See Methods section 2.5). The scores are by definition related to predictors in the final regression models and mean scores are significantly different by age, sex, experience and occupation. As a result of applying these models to the whole cohort, we ended up with work organization characteristics as summarized in Table 8.

Job control and support scores increased with age and experience, while scores for job demands and work pressure decreased. Females had higher levels of work organization factors than males indicating, on average, more control, support, demands and pressures in their occupations. On average, workers in dietary, housekeeping and physical plant occupations had the lowest levels of job control and work support; while security officers, clerical workers and administrators had the highest levels of demands and time pressures.

Table 8: Mean Predicted Work Organization Scores for Health Care Workers between 1992 to 1995 by Age, Sex, Experience and Occupation

Descriptor	Mean Control Score	Mean Demand Score	Mean Support Score	Mean Pressure Score
Overall Population	65.2	32.8	5.1	6.0
Range of Scores	47.8-89.5	28.4-36.9	2.5-7.2	3.7-7.3
Age*				
<30	54.8	33.5	3.9	6.2
30-39	63.3	33.0	4.9	6.1
40-49	65.5	33.1	5.0	6.0
50-59	67.7	33.2	5.5	5.9
>60	71.9	29.4	5.4	5.0
Sex*				
Females	65.6	33.0	6.0	5.2
Males	63.5	32.6	5.8	4.5
Years at Hospital *				
>20	69.1	31.9	5.4	5.8
11-20	66.1	32.7	5.2	5.5
6-10	65.2	33.0	5.2	6.0
2-5	64.6	32.9	4.9	6.1
<2	64.2	33.0	4.8	6.1

Table 8 Continued

Descriptor	Mean Control Score	Mean Demand Score	Mean Support Score	Mean Pressure Score
Years in Occupation*				
>20	69.0	31.7	5.4	5.7
11-20	66.9	32.3	5.2	5.1
6-10	66.0	32.6	5.5	6.0
2-5	65.4	32.9	5.0	6.1
<2	64.1	33.1	4.9	6.1
Occupation Group*				
Dietary	54.6	32.0	3.6	5.8
Housekeeping	55.6	31.9	3.6	5.8
Physical Plant	56.6	31.6	3.5	5.8
Clerical	60.6	35.6	6.8	6.8
Security	61.3	36.4	4.7	5.8
Technical Patient	62.0	32.2	5.1	5.4
Technical NonPatient	62.1	32.5	4.9	5.9
Direct Care Non RN	62.8	31.8	5.2	5.1
Labs	63.1	32.1	5.1	5.8
Computer	66.9	32.2	4.8	5.9
Direct Care RN	67.8	32.1	5.2	5.9
Therapies	72.9	32.2	5.7	5.9
Clinical	73.8	32.0	5.8	5.9
Research/Teaching	75.8	32.3	5.2	6.6
Supervisors	78.3	35.4	6.4	6.5
Administration	82.7	35.2	6.4	6.6

* significant difference across categories at 0.05 level-Anova analysis

3.5 Sicktime/Overtime and Work Units Sub-Cohort Populations

3.5.1 Comparison of Sub-cohort Population to Overall Cohort Population

Generally, the sub-cohort defined by sicktime and overtime data was comparable to the overall cohort population with 94% of employees retained. Differences were observed, however, between the overall cohort population and sub-cohort population defined by work units data, given a loss of 37% of the original population (Table 9). The work units sub-cohort had an over-representation of female workers and workers in direct care occupations. There were no employees representing physical plant, security, technical non-patient services and computer services. Employees in the work units sub-cohort also tended to be more experienced both in years at the hospital and in their occupation. Only minor differences were observed across the three populations for biomechanical and work organization scores.

Table 9: Comparison of Demographic, Biomechanical and Work Organization Values For Health Care Workers by Cohort and Sub-cohort Populations

Variable	Cohort Population	Sick/Over Sub-cohort Population	Work Units Sub-cohort Population
Total number of employees	4020	3769	2525
Total person-months	142,269	126,877	66,158
% Female	79%	79%	85%
Mean in Years			
Length of follow-up	3.1	3.1	3.3
Age, entry into cohort	36.8	36.8	36.5
Age over entire study period	39.1	39.1	39.1
Years in position	4.2	4.3	4.7
Years at hospital	7.2	8.0	8.2
% of Cohort and Sub-cohort Population by Occupation Group			
Direct Care	44.4%	45.1%	62.4%
Clerical	18.3%	17.1%	13.3%
Support Services	15.0%	15.9%	7.3%
Technicians	8.4%	8.3%	5.5%
Administration	7.1%	6.7%	5.4%
Patient Testing	3.7%	3.9%	4.9%
Other	3.2%	3.0%	1.1%
Mean Biomechanical Score			
Lower-body Biomechanical	4.6	4.7	4.8
Upper-body Biomechanical	3.7	3.7	3.5
Mean Work Organization Scores			
Job Control	65.2	65.1	65.7
Work Support	5.1	5.1	5.2
Job Demand	32.8	32.8	32.7
Work Pressure	6.0	6.0	5.9

3.5.2 Comparison of Musculoskeletal Symptoms and Claims across Study Populations

The distribution of upper and lower-body musculoskeletal symptoms and compensation claims among the sicktime/overtime sub-cohort populations did not differ in any substantial way from the overall study population (Table 10). However, a higher proportion of females had musculoskeletal symptoms and compensation claims in the work units sub-cohort population compared to the overall cohort. Employees in the same sub-cohort population also tended to be younger and slightly more experienced at the time of a musculoskeletal outcome (Table 10).

Table 10: Comparison of Demographic Characteristics for Health Care Workers at the Time of Musculoskeletal Symptoms (OH&S Reports) or Start of a Compensation Claim, 1992-1995

	Upper-body Musculoskeletal Symptoms			Upper-body Musculoskeletal Claims		
	Overall Cohort Population	**Sicktime/ Overtime Sub-cohort**	**Work Units Sub-cohort**	**Overall Cohort Population**	**Sicktime/ Overtime Sub-cohort**	**Work Units Sub-cohort**
Total Number	575	528	283	337	307	151
% of Total*	41%	41%	40%	41%	41%	39%
% Reported by Females	83%	84%	91%	82%	84%	91%
Mean Age and Experience at Time of Symptoms or Claim						
Age	39.1	39.0	38.5	39.3	39.0	37.8
Years at Hospital	7.8	7.8	8.0	7.8	7.8	8.0
Years in Job	4.3	4.3	4.3	3.8	3.8	3.6

	Lower-body Musculoskeletal Symptoms			Lower-body Musculoskeletal Claims		
	Overall Cohort Population	**Sicktime/ Overtime Sub-cohort**	**Work Units Sub-cohort**	**Overall Cohort Population**	**Sicktime/ Overtime Sub-cohort**	**Work Units Sub-cohort**
Total Number	822	760	432	485	445	232
% of Total*	59%	59%	60%	59%	59%	61%
% reported by females	77%	77%	87%	75%	75%	86%
Mean Age and Experience at Time of Symptoms or Claim						
Age	38.8	38.8	38.1	38.8	38.6	37.8
Years at Hospital	6.9	7.1	7.0	6.7	6.9	6.8
Years in Job	4.1	4.2	4.3	3.8	3.8	3.6

*Total number of symptoms 1992-1995: 1397 overall cohort; 1153 sicktime/overtime sub-cohort; and 715 work units sub-cohort. Total number of claims from 1992-1994: 822 for overall cohort; 752 for sicktime/overtime sub-cohort; 383 for work units sub-cohort

Rates of musculoskeletal outcomes by occupation were somewhat different within the work units sub-cohort compared to the overall population (Table 11). Most noticeable was a decreased rate of lower-body outcomes among housekeeping employees, and an increased rate of lower-body outcomes among administration, research/teaching and clinical personnel.

Table 11: Rates of Upper and Lower-body Musculoskeletal Symptoms and Claims Among Health Care Workers by Occupation Group across Study Populations, 1992-1995

	Upper-body Musculoskeletal Symptoms			Upper-body Musculoskeletal Claims		
	Overall Cohort Population	Sicktime/ Overtime Sub-cohort	Work Units Sub-cohort	Overall Cohort Population	Sicktime/ Overtime Sub-cohort	Work Units Sub-cohort
			Rates per 1000 person-months			
Overall Rate	4.0	4.3	4.3	2.4	2.5	2.3
Rate by Occupation Group						
Security	16.4	14.8	--	13.9	12.1	--
Housekeeping	9.7	9.5	5.9	6.5	6.3	5.9
Care Non RNs	6.8	7.3	7.2	4.1	4.5	4.8
Care-RNs	4.4	4.5	4.7	2.2	2.2	2.2
Dietary	5.0	5.2	4.2	3.4	3.5	2.5
Physical Plant	4.3	3.7	--	3.0	2.3	--
Therapies	2.8	3.3	3.6	1.2	1.4	1.1
Supervisors	2.9	2.8	2.6	1.4	1.3	1.1
Techs-Care	2.5	2.7	2.9	1.3	1.3	1.2
Computer	1.5	1.7	--	0.7	0.9	--
Labs	1.6	1.7	1.6	1.2	1.4	1.2
Clerical	2.5	2.4	4.0	1.7	1.6	2.5
Tech-NonCare	2.1	2.1	--	1.0	1.0	--
Administration	0.4	0.6	0.0	0.2	0.3	0.0
Clinical	0.3	0.3	0.0	0.3	0.3	0.0
ResearchTeach	0.0	0.0	0.0	0.0	0.0	0.0

	Lower-body Musculoskeletal Symptoms			Lower-body Musculoskeletal Claims		
	Overall Cohort Population	Sicktime/ Overtime Sub-cohort	Work Units Sub-cohort	Overall Cohort Population	Sicktime/ Overtime Sub-cohort	Work Units Sub-cohort
			Rate per 1000 person-months			
Overall Rate	5.8	6.1	6.5	3.4	3.6	3.5
Rate by Occupation Group						
Security	12.6	10.8	--	10.1	8.1	--
Housekeeping	11.1	11.5	3.0	7.5	7.6	3.0
Care Non RN	8.9	9.4	9.2	6.3	6.8	6.5
Care RN	8.1	8.1	8.6	4.4	4.3	4.2
Dietary	5.9	6.2	5.9	4.0	4.1	3.6
Physical Plant	6.0	6.5	--	4.3	4.7	--
Therapies	4.9	5.4	5.7	1.9	1.9	2.1
Supervisors	4.3	3.7	2.8	2.1	2.1	1.4
Techs-Care	3.4	3.5	3.4	1.9	1.9	1.5
Computer	3.0	3.5	--	1.5	1.7	--
Labs	2.7	3.1	3.3	1.6	1.9	2.0
Clerical	2.2	2.3	3.1	1.1	1.1	1.2
Tech-NonCare	1.8	1.9	--	0.8	0.9	--
Administration	1.1	1.4	3.6	0.4	0.6	3.6
Clinical	1.1	0.9	2.6	0.8	0.9	2.6
ResearchTeach	0.5	0.6	1.7	0.5	0.6	1.7

3.5.3 Description of Workload Measures

The workload measures of departmental sicktime and overtime as a proportion of total paid hours per month, and departmental work units per full-time employee per month, were unique to the sub-cohort populations. The amount of sicktime that an employee was exposed to in their department during any month of follow-up was, on average, 4.2% of total paid hours. The distribution of sicktime proportions for all employees during the four year follow-up period was somewhat normally distributed with the exception of an extended 'right tail' for sicktime greater than 10% of total paid hours and 5% of follow-up time associated with no sicktime. On average, the amount of overtime that an employee was exposed to in their department during any month of follow-up was 0.8% of total paid hours. The distribution of departmental overtime proportions for all employees during follow-up was highly skewed with 22% of follow-up time associated with no overtime and another 30% associated with less than 0.5% of total paid hours.

Work units were department specific and a description of this variable is limited to the categorical variable (e.g. usual level, above usual level) for meaningful comparisons. Overall, 35% of the follow-up time for all employees was categorized as an above usual level of work units/FTE and 12% as very above usual (Table 12), compared to the median or mean number of work units/FTE per department over the four year period.

The mean proportion of sicktime and overtime that employees were exposed to during any given month of follow-up did not differ significantly across categories of age (range 4.0 to 4.3% of total paid hours) or years of experience (range 0.7 to 0.9 of total paid hours). Males were exposed to statistically higher proportions of both sicktime (4.9%) and overtime (1.0%) in their departments than were females (4.6% and 0.9% respectively). The mean age, years of experience, and the proportion of males and females, was not significantly different across categories of exposure to work units/FTE. Employees working in housekeeping and security occupations were exposed, on average, to higher levels of sicktime and overtime in their departments than were employees in other occupations (Table 12). Employees in dietary departments worked more often during 'above usual' levels of work units/FTE than employees in other occupations over the follow-up period.

Table 12: Mean Proportion of Sicktime and Overtime Exposure Per Month and Percentage of Time Exposed to Work Units by Health Care Occupation Group, 1992-1995

	Hours		**Work Units/FTE Categories**			
	Sicktime	**Overtime**	**Below Usual**	**Usual**	**Above Usual**	**Very Above**
	Mean Proportion of Total Paid Hours in Department/Month		% of Total Follow-up time			
Overall for Population	4.2	0.8	13.6	39.3	34.8	12.4
Occupation Group*						
Housekeeping	6.4	0.2	20.0	27.5	41.8	10.6
Care Non RN	5.4	0.8	12.3	37.1	42.3	8.4
Direct Care RN	5.2	1.1	11.3	42.0	37.6	9.1
Dietary	5.0	0.8	13.9	29.1	32.5	24.5
Supervisors	4.7	1.0	12.5	40.9	33.7	12.9
Security	4.6	3.4	--	--	--	--
Physical Plant	4.5	0.7	--	--	--	--
Clerical	4.4	1.2	14.8	39.3	31.1	14.9
Laboratory	4.0	0.4	17.9	36.1	27.8	18.3
Clinical	3.9	0.2	15.1	48.7	22.8	13.4
Therapies	3.9	0.6	18.2	34.6	29.2	18.0
Research/Teach	3.6	0.5	25.6	39.5	26.9	7.9
Technical Care	3.6	1.9	20.1	36.5	25.5	17.8
TechNonPatient	3.4	1.4	--	--	--	--
Administration	2.7	0.5	15.7	34.8	29.8	19.7
Computer	2.3	1.1	--	--	--	--

*Mean proportions were significantly different across occupation groups-Anova analysis

3.5.4 Rates of Musculoskeletal Symptoms and Claims by Workload Measures

The rate of musculoskeletal symptoms and claims demonstrated a consistent pattern of increased risk with working during higher levels of sicktime within a department (Table 13). Despite the lowest rates of musculoskeletal outcomes among employees working during periods of low overtime, those working during period of medium-low overtime tended to have the highest rates. Rates of lower-body musculoskeletal symptoms and claims tended to increase with exposure to more departmental work units per employee. Rates were inconsistent across categories of work units per employee for upper-body outcomes.

Table 13: Rates of Upper and Lower-body Musculoskeletal Symptoms and Claims among Health Care Workers by Workload Levels, 1992 – 1995

	Rates of Musculoskeletal Symptoms and Claims per 1000 Person-Months			
	Upper-body Symptoms	Upper-body Claims	Lower-body Symptoms	Lower-body Claims
Level of Departmental Sicktime as a Proportion of Total Paid Hours				
Low	1.7	1.4	3.4	2.6
Medium-Low	2.7	2.1	5.3	4.1
Medium-High	4.2	2.8	7.6	5.0
High	5.7	3.5	8.0	5.1
Level of Departmental Overtime as a Proportion of Total Paid Hours				
Low	2.7	2.0	4.6	3.3
Medium-Low	4.1	2.8	6.8	4.9
Medium-High	4.0	2.2	6.8	4.3
High	3.4	2.6	6.1	4.3
Level of Departmental Work Units Per Employee				
Below Usual	3.7	2.1	4.8	2.5
Usual	4.0	2.1	6.4	3.4
Above Usual	5.2	2.7	7.0	3.6
Very Above	3.5	2.2	7.4	4.7

3.6 Investigation of Correlation among Potential Predictor Variables

Pearson correlation coefficients were calculated to identify highly correlated variables that could not be entered together in regression models, and to investigate potential confounders. Interpretation of the correlation coefficients is based on the categorical variables, which were used in the cohort analysis. Reference is made to continuous variables if differences exist between the two correlation analyses.

3.6.1 Overall Cohort Population

Medium (0.3 to 0.6) and high (>0.6) correlation coefficients between predictor variables are summarized in Table 14. A complete table of all correlation coefficients can be found in Appendix 17. High correlation coefficients were only observed between work organization factors. Increased job control was positively correlated with increased work support (0.70), and increased job demands with increased work pressure (0.72).

Biomechanical scores were negatively correlated with work organization factors. In other words, higher biomechanical risks were associated with lower levels of job control and work support, but also lower levels of job demands and work pressures. Coefficients ranged from –0.31 to –0.52. As expected, there was a medium positive correlation between increasing age and years of experience (0.36). Other medium correlation coefficients between variables included increasing age with more control (0.32), increasing age with less pressure (-0.37), less support among men (-0.35) and less pressure with increasing experience (-0.35). All other correlation coefficients between variables were below +/-0.30. These relationships between variables were present in the analysis of continuous measures with two notable exceptions (Table 14). Less control (-0.64) and less support (-0.62) were highly correlated with continuous measures of upper-body biomechanical factors.

3.6.2 Sub-cohort Populations

The workload variables for sicktime and overtime as a proportion of total paid hours were not strongly associated with any of the other variables in the sub-cohort population (Appendix 17). The strongest correlation was between increasing levels of departmental sicktime and higher levels of exposure to biomechanical factors (0.21). All other correlations were below +/- 0.1. The variable of work units/FTE was weakly associated with all other variables. Correlation coefficients were in the +/- 0.06 range. Only minor differences were observed in correlations coefficients for all study variables when compared across the three cohort and sub-cohort populations, as highlighted in bold in Table 14.

Table 14: High and Medium Correlation Coefficients between Categorical Predictor Variables by Study Population

Legend: High = >0.60 correlation coefficient
Medium = 0.3 to 0.6 coefficient
Low = <0.30 correlation coefficient
Bold highlighting indicates differences between overall Cohort and sub-cohorts populations

Variables	Overall Cohort	Sicktime/Overtime Sub-cohort	Work Units Sub-cohort
Control – Support	High +	High +	High +
Demand – Pressure	High +	High +	High +
Age – Years Position	Med +	Med +	Med +
Age – Control	Med +	Med +	Med +
Age – Pressure	Med -	**Low -**	**Low -**
Age – Support	Low +	**Med +**	**Med +**
Sex – Support	Med -	Med -	Med -
Years Position – Pressure	Med -	Med -	Med -
Years Position – Support	Low +	Low +	**Med +**
Lower Biomechanical – Support	Med -	Med -	**Low -**
Lower Biomechanical–Demands	Med -	Med -	Med -
Lower Biomechanical-Pressure	Med -	Med -	Med -
Upper Biomechanical–Control	Med -	Med -	Med -
Upper Biomechanical – Support	Med -	Med -	Med -
Different Correlation's Found with Continuous Variables			
Age – Support	Med +		
Upper Biomechanical – Control	High -	High -	
Upper Biomechanical – Support	High -	High -	

Chapter IV Work Organization Factors and Musculoskeletal Morbidity: Results of Uni-variable Analyses

4.1 Results for Upper-body Musculoskeletal Symptoms and Compensation Claims

4.1.1 Influence of Work Organization Predictor Variables on Upper-body Symptoms

The unadjusted risk ratios for upper-body musculoskeletal symptoms associated with individual, biomechanical and work organization variables are illustrated in Figure 4 and are tabulated in Appendix 18. The risk of upper-body musculoskeletal symptoms among health care workers was associated with adverse work organization conditions. Unadjusted risk ratios increased significantly from '1' among workers with high levels of job control and work support to 3.17 (95% CI=2.28, 4.40) among those with low control and to 2.54 (95% CI=1.83, 3.51) among those with low support. The risk associated with low control was higher than any other independent association observed between predictor variables and upper-body outcomes. The directionality of the association between upper-body symptoms and higher levels of job demands and work pressure was opposite that predicted. Only the decreased risk of upper-body symptoms among workers with high work pressure (RR=0.42, 95% CI=0.31, 0.58) was significantly different from those with low pressure.

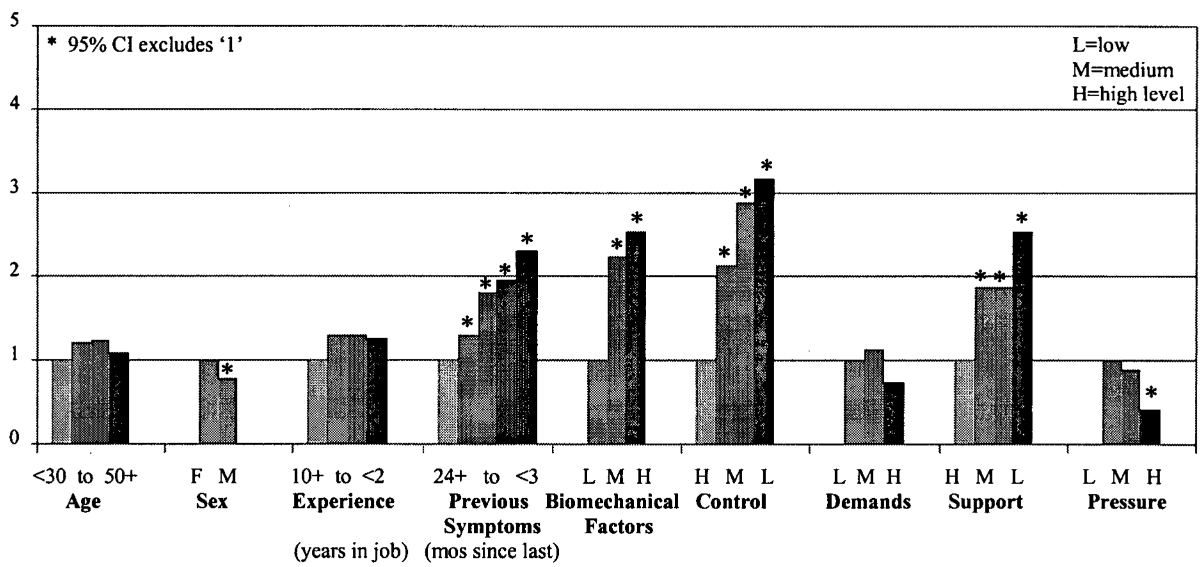


Figure 4: Unadjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Overall Cohort and Control/Demand Variables

4.1.2 Influence of Individual and Biomechanical Variables on Upper-body Symptoms

Independent associations were also found for individual and biomechanical factors (Figure 4). The risk of upper-body musculoskeletal symptoms was significantly decreased among males (RR=0.79, 95% CI=0.63, 0.93). Risk ratios increased steadily and significantly from '1' among workers with no prior symptoms during the follow-up period to 2.31 (95% CI=1.78, 3.00) among those with previous symptoms within the last 3 months. More than a two-fold increased risk of upper-body musculoskeletal symptoms was observed for high levels of exposure to biomechanical factors (RR=2.54, 95% CI=1.95, 3.31). Although the risk of upper-body symptoms was elevated for employees over the age of 30 years and those with less than 10 years in their occupations, risk ratios were not significantly different from the reference group of employees under 30 years of age and those with more than 10 years in their job.

4.1.3 Sub-analysis of Workload Variables and Upper-body Musculoskeletal Symptoms

The independent effect of departmental sicktime and overtime on the risk of upper-body musculoskeletal symptoms, as well as the effect of the other predictor variables among the sicktime/overtime sub-cohort population, are illustrated in Figure 5 and are tabulated in Appendix 18. The findings suggest that higher workload levels may be associated with an elevated risk of upper-body musculoskeletal symptoms. Unadjusted risk ratios increased significantly across quartiles of exposure to departmental sicktime with a two-fold increased risk (RR=1.97, 95% CI=1.52, 2.56) among those working during periods of high sicktime. Risk ratios were significantly and consistently elevated across quartiles of exposure to departmental overtime (RR range 1.30 to 1.51) compared to periods of no overtime. Findings for the individual, biomechanical and other work organization factors (control, support, demands and pressure) were consistent between the analysis for the sicktime/overtime sub-cohort (Figure 5) and that of the overall cohort (Figure 4).

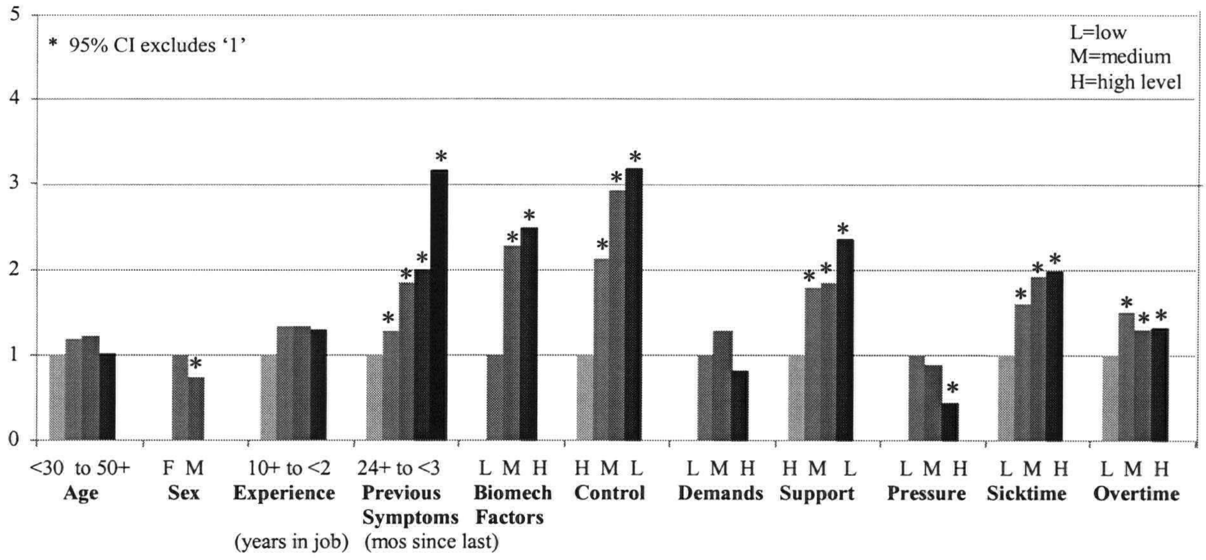


Figure 5: Unadjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort

Unadjusted risk ratios for upper-body musculoskeletal symptoms were not significantly elevated for employees working during periods of above usual levels of work units compared to median levels (Figure 6). Also, previously observed patterns of risk for individual and biomechanical factors were not found among the work units sub-cohort. In particular, high levels of biomechanical factors (RR=1.00, 95% CI=0.62, 1.63) and high levels of work support (RR=1.47, 95% CI=0.88, 2.44) were no longer significantly associated with an increased risk of upper-body musculoskeletal symptoms.

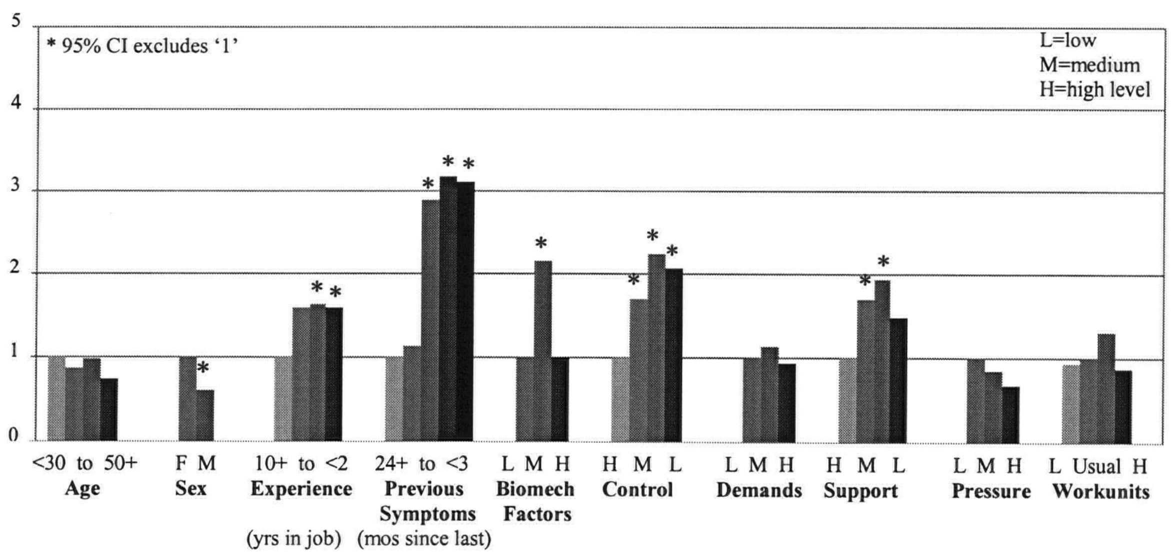


Figure 6: Unadjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Work Units Sub-cohort

4.1.4 Sub Analysis of Upper-body Musculoskeletal Compensation Claims

The independent effect of individual, biomechanical and work organization factors on the risk of an upper-body compensation claim was comparable to the findings for symptoms, except the strength of association was notable higher for compensable outcomes (Figure 7). In particular, risk ratios increased four-fold associated with low job control (RR=4.41, 95% CI=2.77, 7.02) and three-fold with low work support (RR=3.43, 95% CI=2.17, 5.14). Distinct from the findings for upper-body musculoskeletal symptoms, the risk of upper-body musculoskeletal claims was significantly elevated for less than 10 years of experience in an occupation (RR range 1.63 to 1.74).

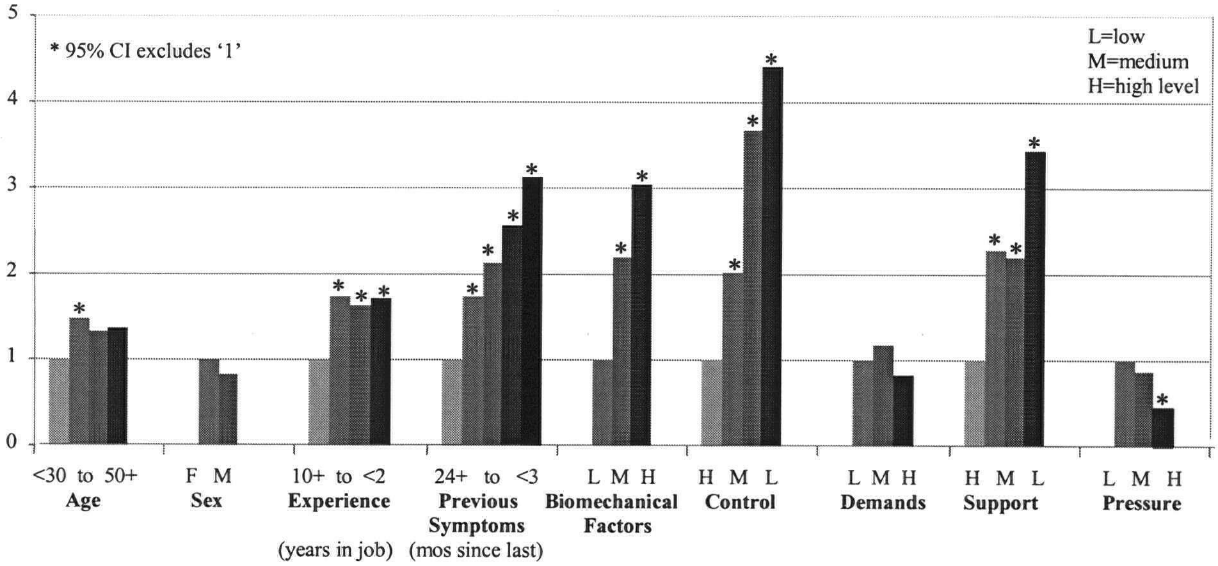


Figure 7: Unadjusted Risk Ratios for Upper-body Musculoskeletal Claims: Overall Cohort

4.2 Results for Lower-body Musculoskeletal Symptoms and Claims

4.2.1 Influence of Work Organization Variables on Lower-body Musculoskeletal Symptoms

The unadjusted risk ratios for lower-body musculoskeletal symptoms associated with individual, biomechanical and work organization factors are shown in Figure 8 and tabulated in Appendix 18. Adverse work organization conditions were associated with the risk of lower-body musculoskeletal symptoms at the uni-variable level of analysis. Risk ratios increased from '1' among workers with high levels of job control or support to 2.14 (95% CI=1.65, 2.77) for those with low control and to 2.20 (95% CI=1.69, 2.87) for those with low support. While the risks increased in a dose-response relationship with lower levels of support, the risks for control were homogenous across exposure quartiles. Contrary to the hypothesized direction of effect, employees working with high job demands (RR=0.60, 95% CI=0.41, 0.87) or work pressures (RR=0.35, 95% CI=0.26, 0.47) had a significant decreased risk of symptoms.

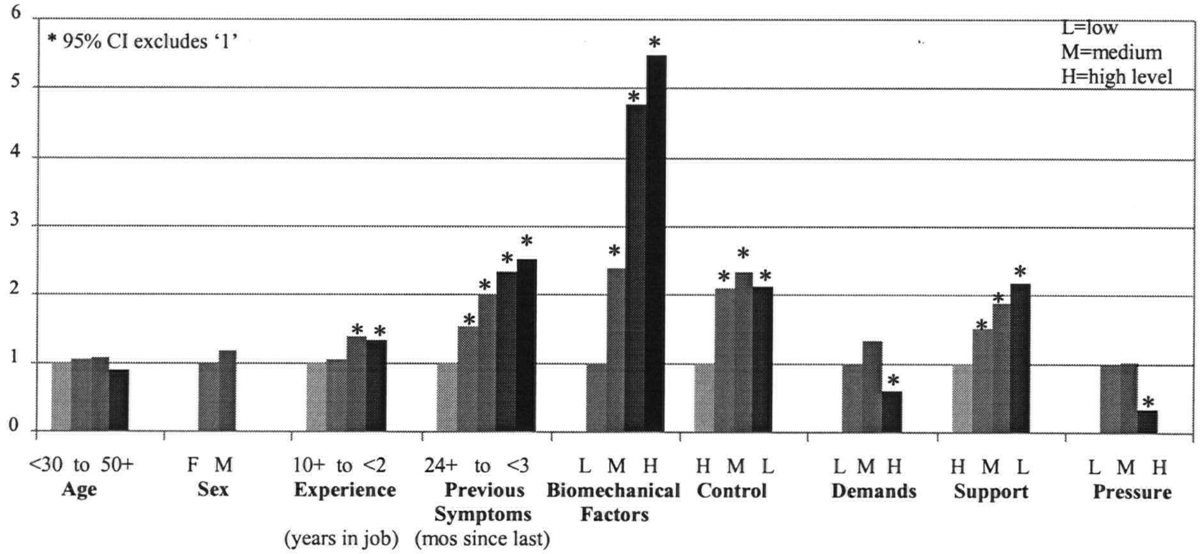


Figure 8: Unadjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Overall Cohort

4.2.2 Influence of Individual and Biomechanical Variables on Lower-body Symptoms

The findings for the other predictor variables suggest that job experience, previous musculoskeletal symptoms and biomechanical factors are important predictor variables for lower-body musculoskeletal symptoms (Figure 9). Less than 5 years in an occupation was associated with a significant 30% increased risk of lower-body musculoskeletal symptoms compared to employees with more than 10 years in a job. Employees who experienced a prior symptom less than three months ago had an elevated risk of 2.52 (95% CI=2.02, 3.15) compared to those with no prior symptoms during the follow-up period. Compared to workers with low levels of exposure to biomechanical factors, workers with very high levels had a five-fold increased risk of developing a musculoskeletal symptom (RR=5.48, 95% CI=4.10, 7.31). The risk associated with biomechanical factors was higher than any other independent association observed between predictor variables and lower-body musculoskeletal outcomes. Age and sex did not appear to be associated with the risk of lower-body musculoskeletal symptoms.

4.2.3 Sub-analyses of Workload Variables and Lower-body Musculoskeletal Symptoms

The risk of lower-body musculoskeletal symptoms was associated with higher workload levels defined by department sicktime and overtime (Figure 9 and Appendix 18). Unadjusted risk ratios increased consistently from '1' for employees working during periods of low departmental sicktime to 2.36 (95% CI=1.89, 2.94) for those working during periods of high sicktime. Risk ratios across the three exposure quartiles for departmental overtime, relative to no overtime, were more modest and homogeneous ranging from 1.30 to 1.47. Findings for lower-body musculoskeletal symptoms were consistent between the sicktime/overtime sub-cohort population (Figure 9) and that of the overall cohort (Figure 8). Elevated risks were observed among employees in the sicktime/overtime sub-cohort for higher levels of exposure to biomechanical factors, recent previous symptoms and less than five years in an occupation. No differences were observed between males and females or across different age categories, as found in the overall cohort.

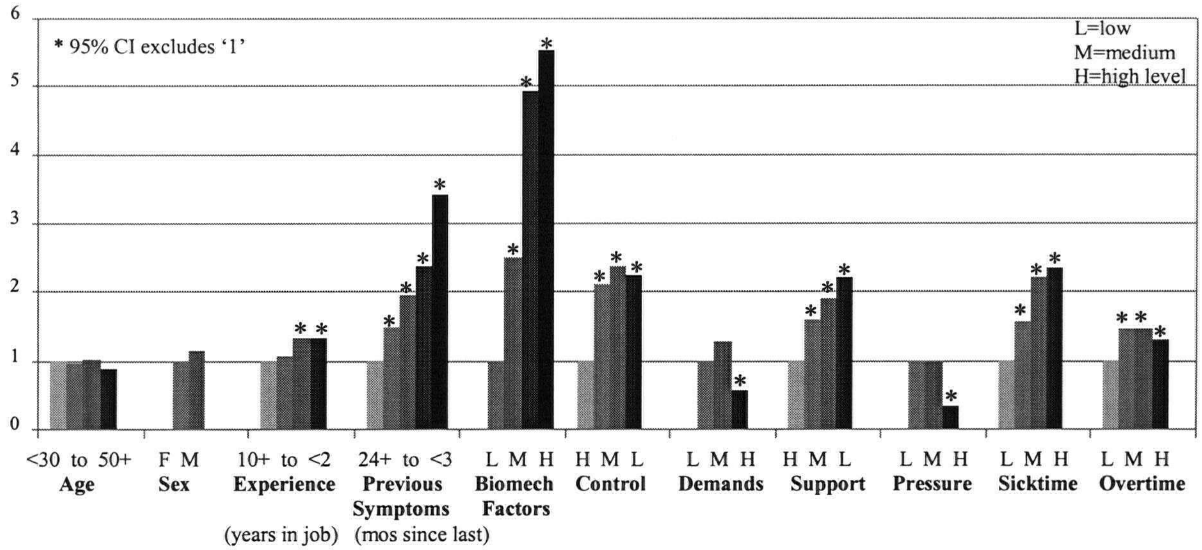


Figure 9: Unadjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort

Working during periods of above usual levels of work units per employee, compared to median levels, was not associated with a significant elevated risk of lower-body musculoskeletal symptoms (Figure 10). Unadjusted risk ratios ranged from 1.08 to 1.17 and confidence intervals included '1' for all exposure categories. Differences were observed in the patterns of risk associated with individual and biomechanical factors between the work units sub-cohort and the overall cohort population (Figure 8). The highest risk ratios for lower-body musculoskeletal symptoms among members of the work units sub-cohort were observed for medium levels of control, medium levels of support and 4-6 months since previous symptoms, compared to low levels and less than 3 months among the overall cohort. Also different was a loss of statistical significance for risks associated with low control and high demands.

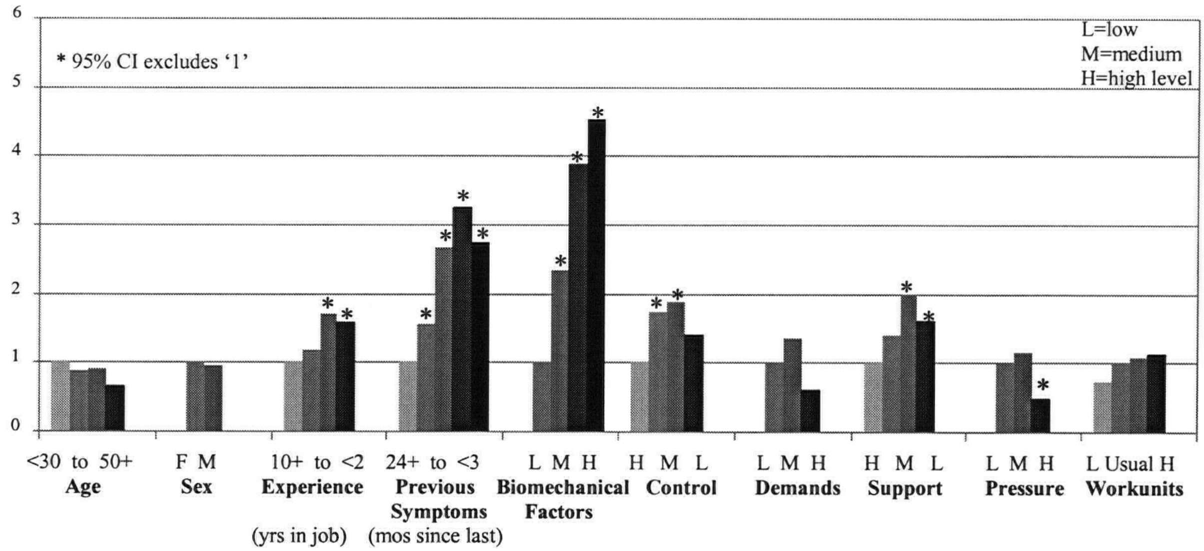


Figure 10: Unadjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Work Units Sub-cohort

4.2.4 Sub-analysis of Lower-body Musculoskeletal Compensation Claims

The findings for lower-body compensable outcomes were comparable to previous findings for lower-body musculoskeletal symptoms (Figure 11). Unadjusted risk ratios for lower-body compensation claims were significantly elevated for low levels of job control and work support, and significantly decreased with high levels of demands and pressures. Risks also increased significantly with less experience, less time since previous symptoms and higher levels of exposure to biomechanical factors. Age continued to show no association with the risk of lower-body outcomes. Different was a significant elevated risk of a lower-body compensation claim for males (RR=1.30, 95% CI=1.06, 1.60).

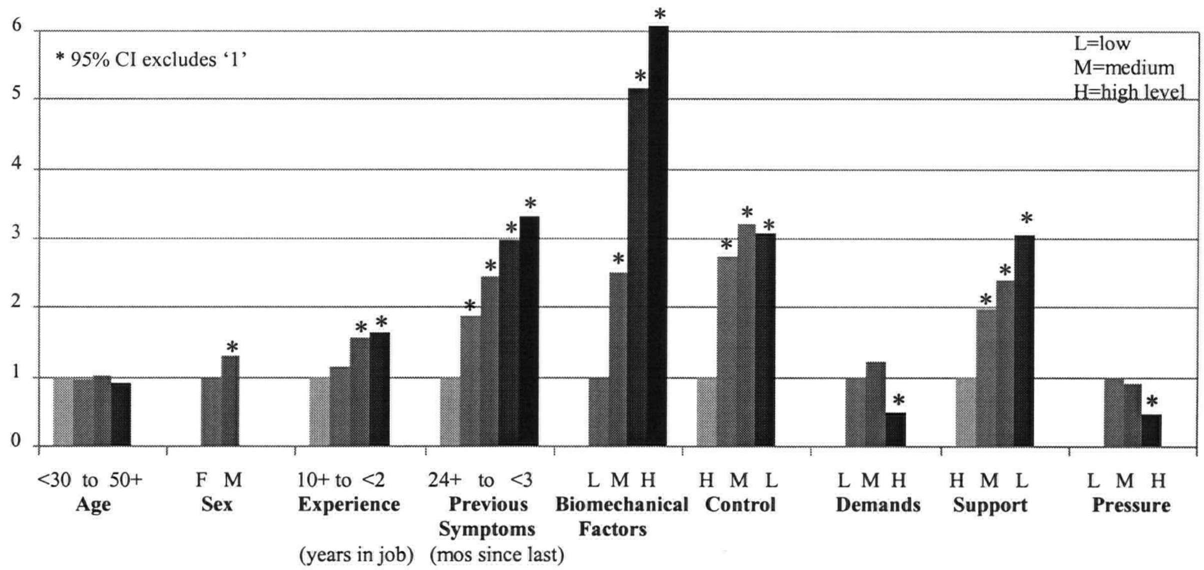


Figure 11: Unadjusted Risk Ratios for Lower-body Musculoskeletal Claims: Overall Cohort

4.3 Trend Analysis

Significant, positive linear trends were observed between the risk of upper and lower-body outcomes and less time since previous symptoms, higher levels of biomechanical factors, periods of higher sicktime, lower levels of job control and lower levels of work support (See table of results in Appendix 19). The positive trend for control and support did not persist in the work units sub-cohort population. A positive linear trend was also observed with less time in an occupation for all outcomes except upper-body symptoms. The risk of musculoskeletal outcomes demonstrated a significant negative trend with higher demands and pressures. This negative trend did not persist in the work units sub-cohort. The risk of upper or lower-body musculoskeletal outcomes across categories of increasing age, overtime and work units/employee failed to show a significant linear trend in any of the study populations.

Chapter V Work Organization Factors and Musculoskeletal Morbidity: Results of Multi-variable Analyses

5.1 Results for Upper-body Musculoskeletal Symptoms and Claims

The findings for upper-body musculoskeletal symptoms from the multi-variable analyses aimed at reducing confounding are shown in Figures 12 and 13. Tables of risk ratios with 95% confidence intervals are provided in Appendix 20.

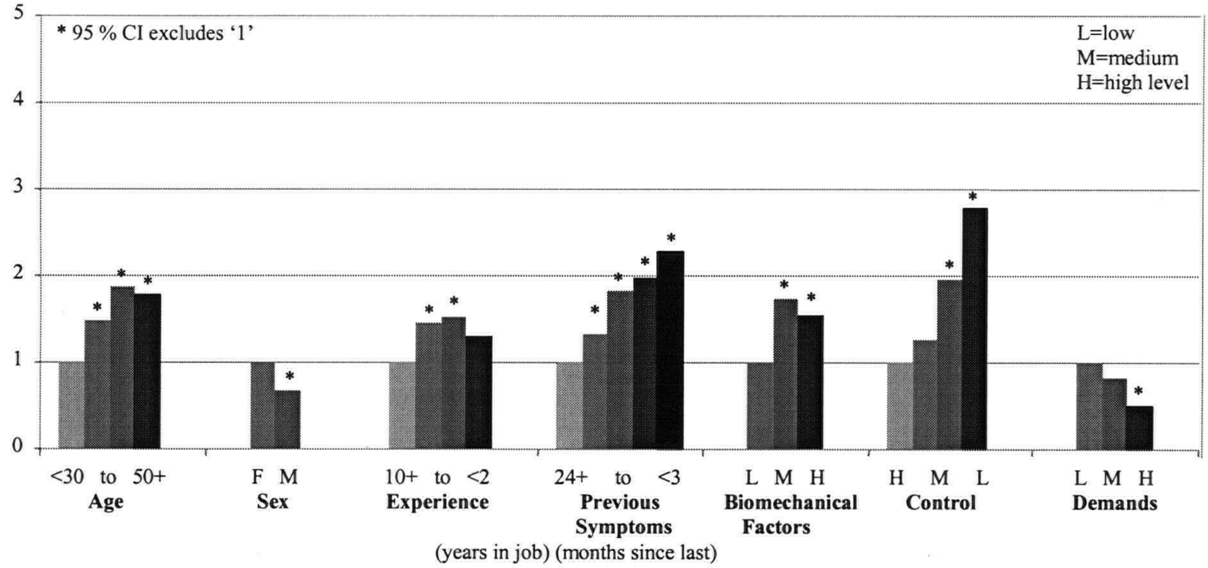


Figure 12: Adjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Overall Cohort and Control/Demand Variables

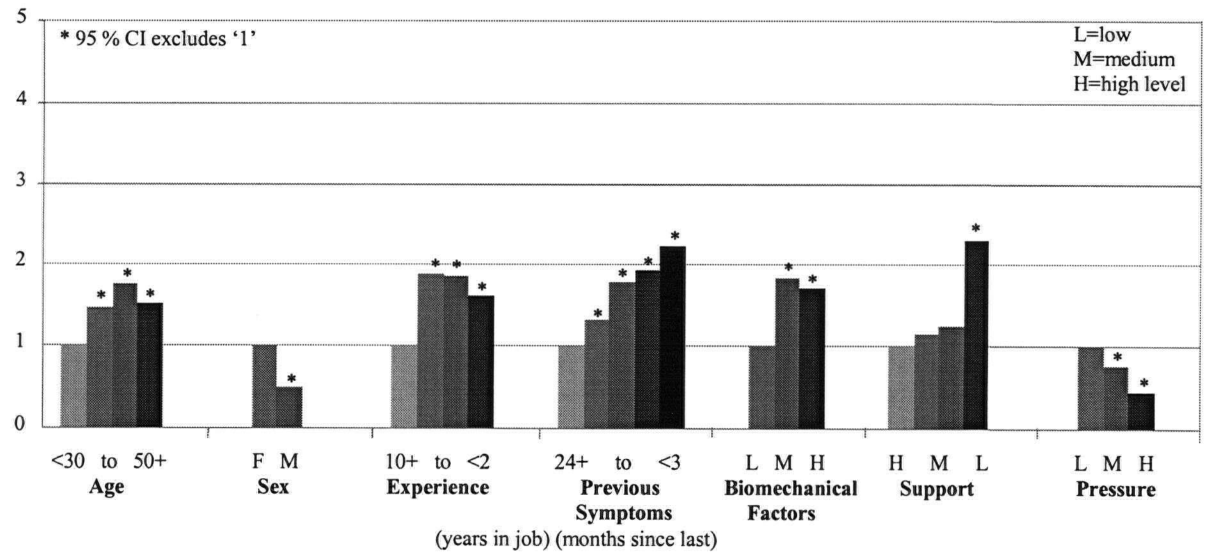


Figure 13: Adjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Overall Cohort and Support/Pressure Variables

5.1.1 Influence of Work Organization Variables on Upper-body Musculoskeletal Symptoms

Independent associations between upper-body musculoskeletal symptoms and work organization factors remained in the multi-variable models (Figures 12 and 13). Compared to employees with high job control, risk ratios increased in a dose-response fashion across exposure quartiles to 2.78 (95% CI=1.87, 4.12) among those with low control. Risks were marginally elevated for the medium quartiles of work support relative to the high support quartile, but jumped significantly to 2.31 (95% CI=1.51, 3.51) for that of low support. The findings also suggested a decreased risk of upper-body musculoskeletal symptoms associated with high levels of job demands (RR=0.50, 95% CI=0.30, 0.87) and work pressures (RR=0.55, 95% CI=0.33, 0.63). Interaction terms for work organization and biomechanical factors failed to converge in the final models for both upper-body and lower-body musculoskeletal outcomes.

5.1.2 Influence of Individual and Biomechanical Variables on Upper-body Symptoms

All individual and biomechanical factors were significantly associated with the risk of upper-body musculoskeletal symptoms in the multi-variable models adjusted for control/demands (Figures 12) and that for support/pressure (Figure 13). Risk ratios associated with individual and biomechanical variables remained relatively unchanged when the support and pressure variables were substituted for the control and demands variables.

Male health care workers had a significant decreased risk of upper-body musculoskeletal symptoms (RR=0.49, 95% CI=0.37, 0.64) compared to female workers in the final models. Risk ratios also increased in a dose-response fashion from '1' for employees with no prior symptoms to 2.29 (95% CI=1.76, 1.99) among those with symptoms in the past 3 months. Significant increased risk ratios were observed for exposure to higher levels of biomechanical factors, up to 1.84 (95% CI=1.42, 2.37) in the model adjusted for support and pressure. Significant associations emerged between upper-body musculoskeletal symptoms and the variables of age and experience in the multi-variable models.

Less than 10 years of experience was associated with as much as a 90% increased risk of symptoms (95% CI=1.29, 2.73), compared to those with more than 10 years of experience. Risk ratios increased significantly from '1' among employees in their 20s, peaked among those in their 40s (RR=1.88, 95% CI=1.45, 2.45) and dropped slightly among employees over the age of 50 years.

5.1.3 Sub-analysis of Workload Variables and Upper-body Musculoskeletal Symptoms

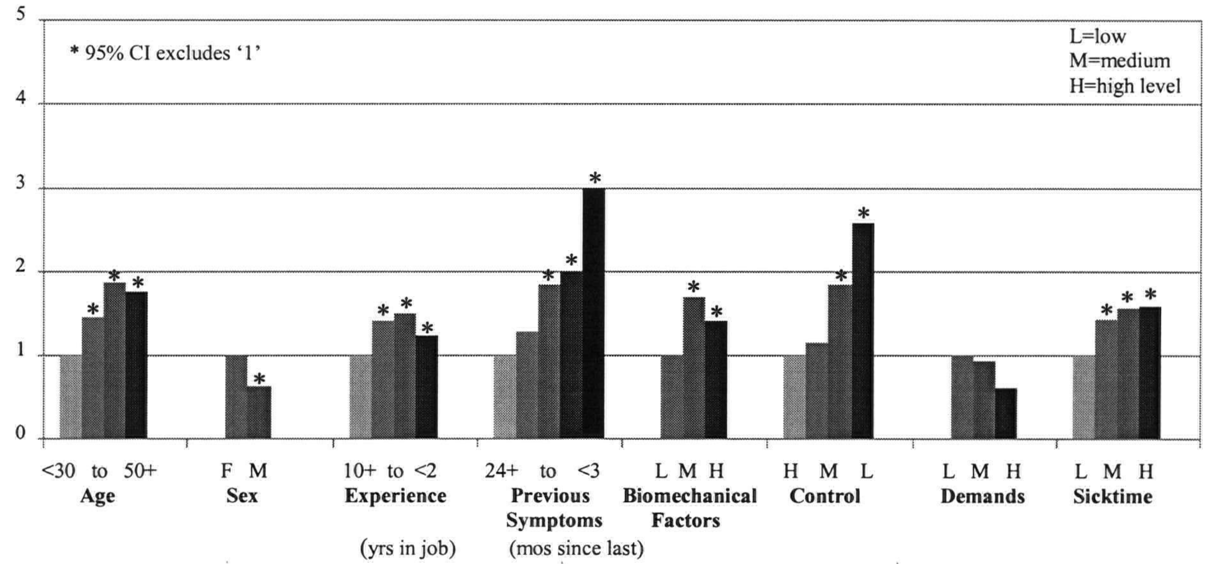


Figure 14: Adjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort and Control/Demand Variables

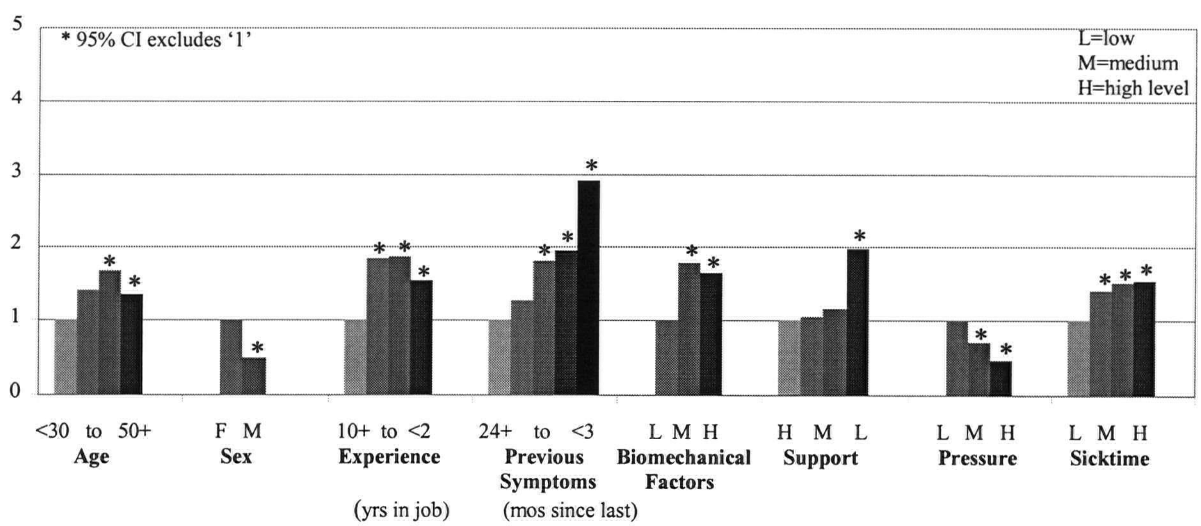


Figure 15: Adjusted Risk Ratios for Upper-body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort and Support/Pressure Variables

Only the workload measure of departmental sicktime, not overtime or work units/employee, was a significant predictor of upper-body musculoskeletal symptoms in the multi-variable models (Figures 14 and 15). Compared to employees working during periods of low department sicktime, risk ratios increased significantly to 1.50 (95% CI 1.22, 2.07) among those working during high exposure periods. Elevated risk ratios for overtime observed at the uni-variable level of analysis did not remain in the models adjusted for confounders (RR range 1.13 to 1.28).

There were few important differences between the sicktime/overtime sub-cohort and the overall cohort in terms of the magnitude or significance of risks associated with predictor variables. However, there were notable differences between the work units sub-cohort and the overall cohort (See Table A38 in Appendix 20). Although recency of previous symptoms remained a significant predictor of risk, the dose-response relationship was no longer apparent among the work units sub-cohort population. Also, high levels of biomechanical factors were associated with a decreased risk of upper-body musculoskeletal symptoms and significant risks were refined to only the lowest level of control and support, and the medium level work pressure.

5.1.4 Sub-analysis of Upper-body Musculoskeletal Compensation Claims

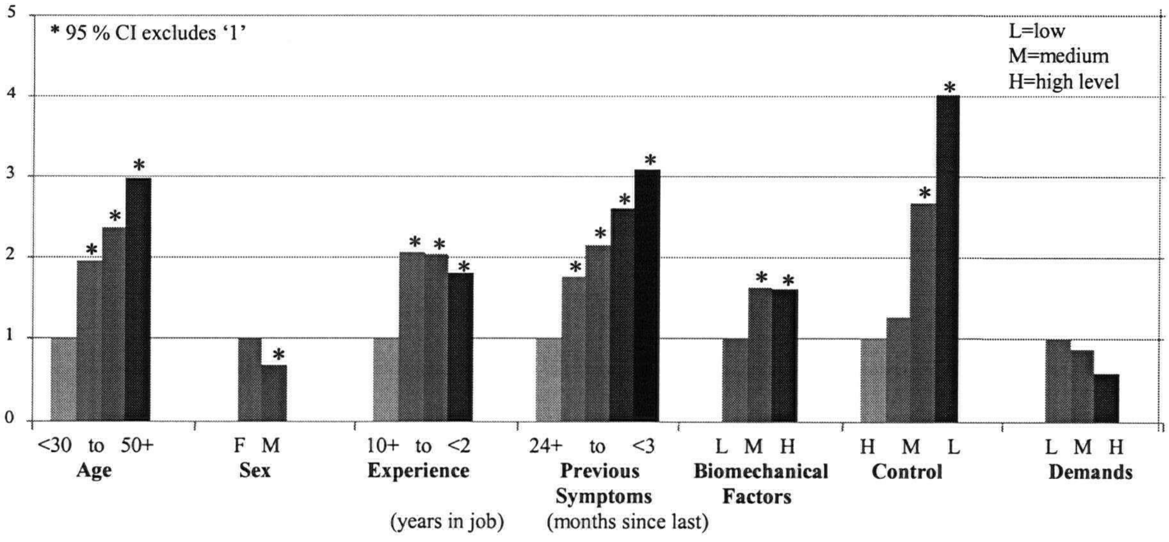


Figure 16: Adjusted Risk Ratios for Upper-body Musculoskeletal Claims: Overall Cohort and Control/Demand Variables

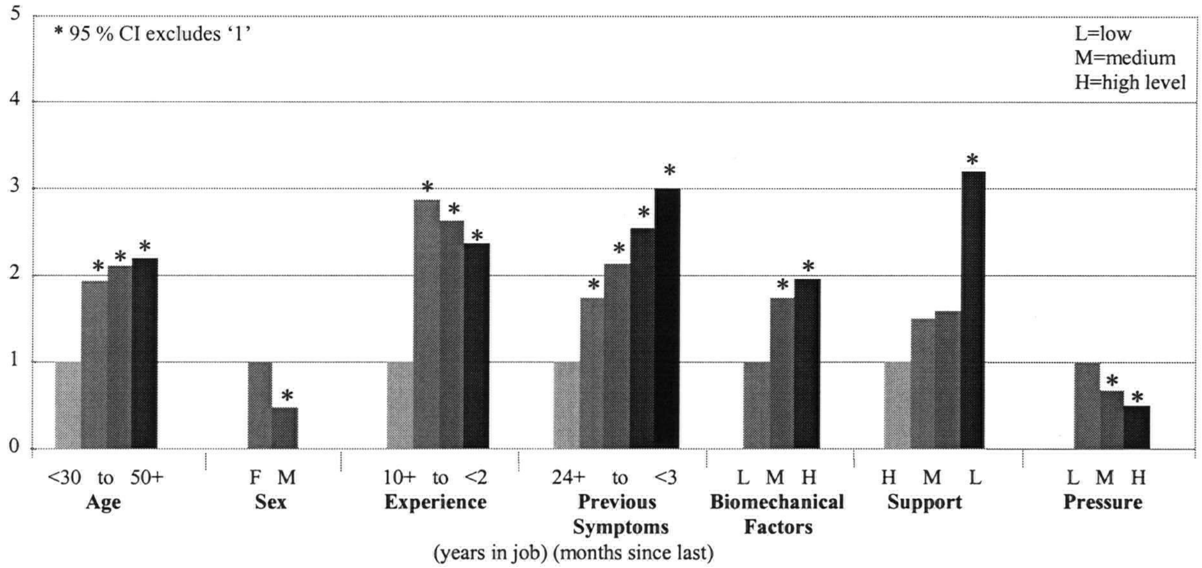


Figure 17: Adjusted Risk Ratios for Upper-body Musculoskeletal Claims: Overall Cohort and Support/Pressure Variables

The final multi-variable models for upper-body musculoskeletal compensation claims (Figures 16 and 17, Appendix 21) demonstrated the same pattern of risks with individual, biomechanical and work organization predictor variables as observed in the previous multi-variable analysis of upper-body musculoskeletal symptoms (Figures 14 and 15). However, the magnitude of association was higher for compensation claims. In particular, employees with low levels of work support and job control experienced a three-fold (95% CI=1.80, 5.67) and four-fold (95% CI=2.34,6.95) increased risk of compensable upper-body musculoskeletal outcomes. Also, the risk of an upper-body musculoskeletal compensation claims increased in a dose-response relationship from '1' among employees working during periods of low departmental sicktime to 1.90 (95% CI=1.35, 2.68) among those working during periods of high sicktime.

Findings further support a multi-factorial model of upper-body musculoskeletal compensation claims as risk ratios increased significantly with age, less than 10 years experience, less time since previous claim, and higher biomechanical factors. Males also had a significant decreased risk of upper-body musculoskeletal compensation claims. Again, the magnitude of association between upper-body compensation outcomes and individual and biomechanical variables was notable higher than those observed for upper-body symptoms. In particular, employees over the age of 50 years (RR=2.97, 95% CI=1.94, 4.64), those with less than 10 years of experience (RR=2.86, 95% CI=1.70, 4.81) and those with a recent history of symptoms (RR=3.04, 95% CI=2.17, 4.38) experienced approximate three-fold increased risks of a compensable upper-body musculoskeletal outcome.

5.2 Results for Lower-body Musculoskeletal Symptoms and Claims

The findings for lower-body musculoskeletal symptoms from the multi-variable analyses aimed at reducing confounding are shown in Figures 18 and 19. Tables of risk ratios with 95% confidence intervals are provided in Appendix 22.

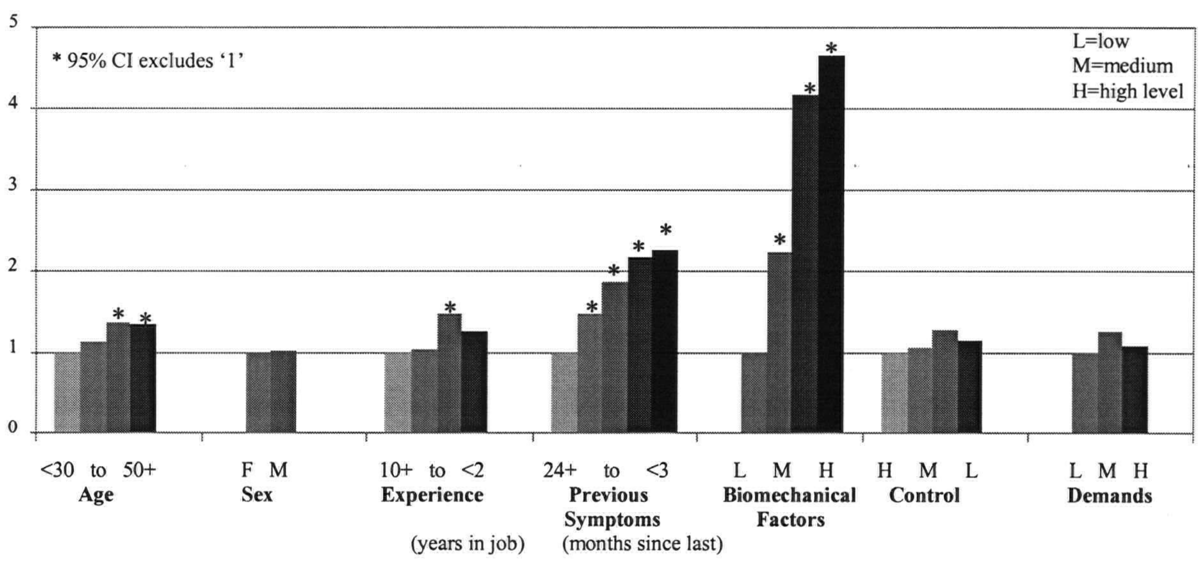


Figure 18: Adjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Overall Cohort and Control/Demand Variables

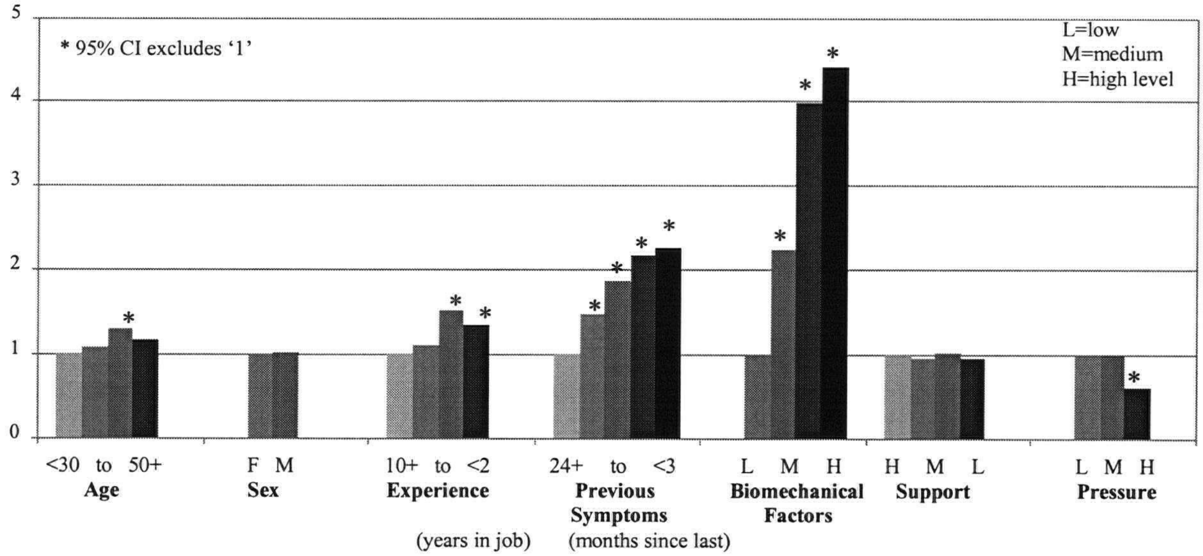


Figure 19: Adjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Overall Cohort and Support/Pressure Variables

5.2.1 Influence of Work Organization Variables on Lower-body Musculoskeletal Symptoms

The findings from the multi-variable models suggest that the risk of lower-body musculoskeletal symptoms was not related to adverse work organization conditions defined by low control, low support or high demands (Figures 18 and 19). Only workers with high levels of work pressure had a significantly different risk from the reference group with low work pressure, albeit a decreased risk (RR=0.61, 95% CI=0.44, 0.85). Elevated risk ratios observed at the independent level of analysis did not remain in the models adjusted for biomechanical factors, suggesting these factors may be important confounders in the association between work organization and lower-body musculoskeletal morbidity (Appendix 24 and Appendix 25).

5.2.2 Influence of Individual and Biomechanical Variables on Lower-body Symptoms

Individual and biomechanical factors remained significant predictors of lower-body musculoskeletal symptoms in the final multi-variable models adjusted for control/demand (Figures 18) and for support/pressure (Figure 19). Adjusted risk ratios increased in a step-wise gradient from '1' for workers with no prior musculoskeletal symptoms during the follow-up period to 2.26 (95% CI=1.80, 2.84) among those with symptoms in the past 3 months. Employees with very high levels of exposure to biomechanical factors had more than a four-fold increased risk of lower-body symptoms (RR=4.65, 95% CI=3.39, 6.39) compared to those with low levels of exposure. Employees with less than 5 years of experience also had elevated risk ratios for lower-body musculoskeletal symptoms (RR range 1.27 to 1.53) compared to the reference group with more than 10 years experience. Risk ratios increased as employees aged, peaking among those in their 40s (RR=1.36, 95% CI=1.10, 1.69) and dropping somewhat among those over 50 years. Male health care workers did not have significantly different rates of lower-body musculoskeletal symptoms than female workers.

5.2.3 Sub-analysis of Workload Variables and Lower-body Musculoskeletal Symptoms

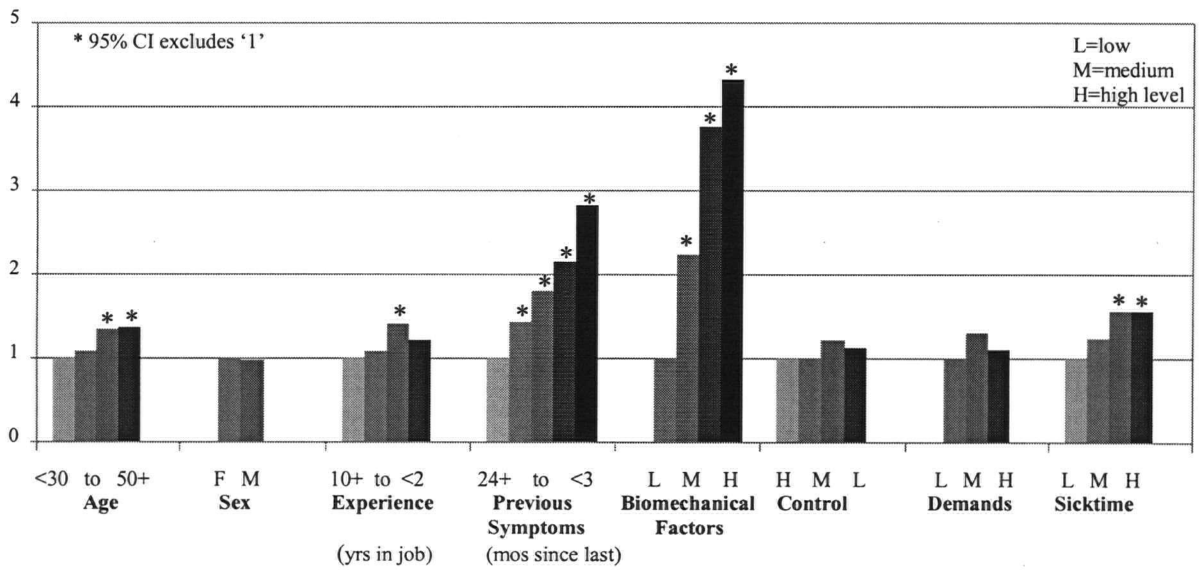


Figure 20: Adjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort and Control/Demand Variables

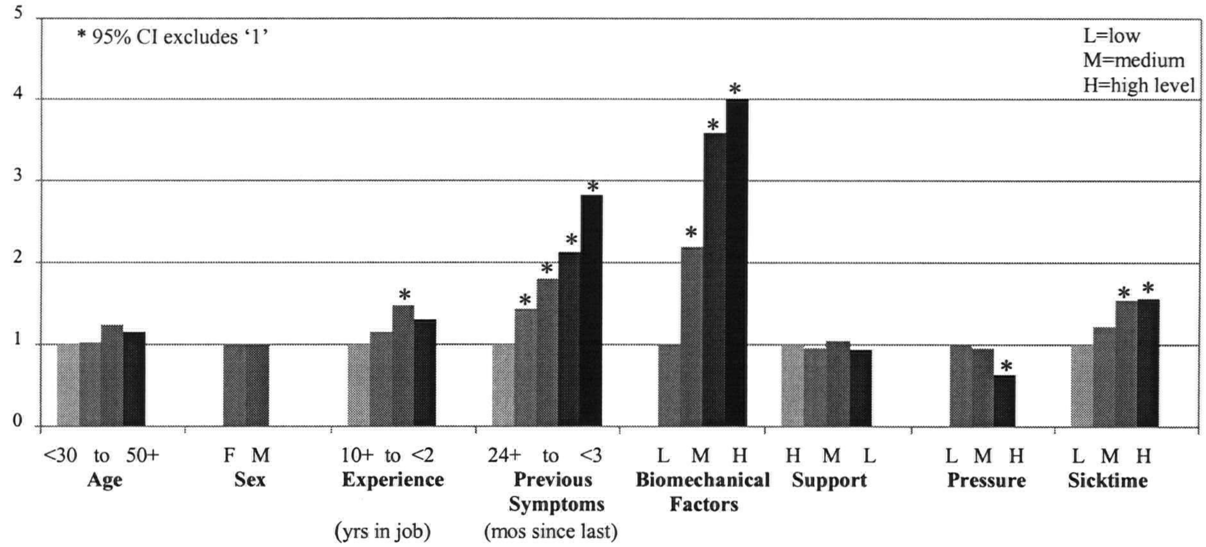


Figure 21: Adjusted Risk Ratios for Lower-body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort and Support/Pressure Variables

Elevated risk ratios for lower-body musculoskeletal symptoms were found for employees working during periods of higher departmental sicktime, but not overtime or work units/FTE (Figures 20 and 21). Risk ratios significantly increased in a step-wise gradient across quartiles of exposure to departmental sicktime, with a 50% increased risk (95% CI=1.22, 2.07) observed for employees working during the periods with the highest sicktime. Risk ratios remained relatively unchanged across increasing levels of departmental overtime (RR range 1.16 to 1.19) or work units per FTE (RR range 1.04 to 1.23). Elevated risks associated with higher levels of overtime observed at the independent level of analysis did not remain in the multi-variable models after adjusting for biomechanical factors (See Appendix 25 for a comparison of uni-variable and multi-variable results).

Overall, risks for lower-body musculoskeletal symptoms associated with the individual, biomechanical and other work organization predictor variables among the sicktime/overtime sub-cohort are consistent with those of the overall cohort. However, there were notable differences between the work units sub-cohort and the overall cohort (See Table A40 in Appendix 22). Age was no longer significantly associated with an increased risk of lower-body musculoskeletal symptoms nor was high work pressure with a decreased risk of symptoms. Risks associated with increasing levels of biomechanical factors were notably smaller in magnitude among the work units sub-analyses.

5.2.4 Sub-analysis of Lower-body Musculoskeletal Compensation Claims

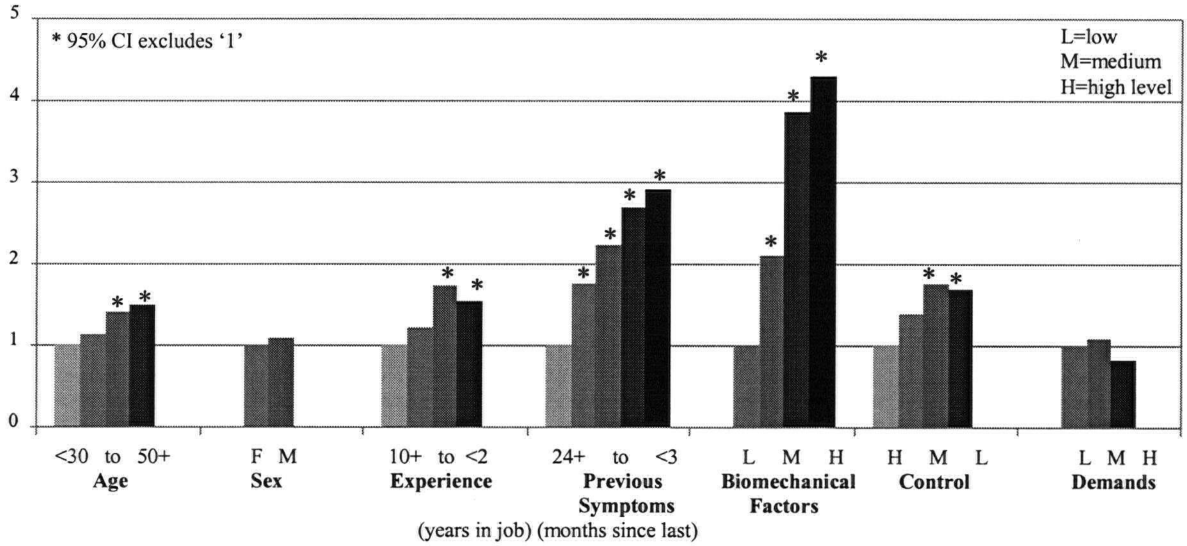


Figure 22: Adjusted Risk Ratios for Lower-body Musculoskeletal Claims: Overall Cohort and Control/Demand Variables

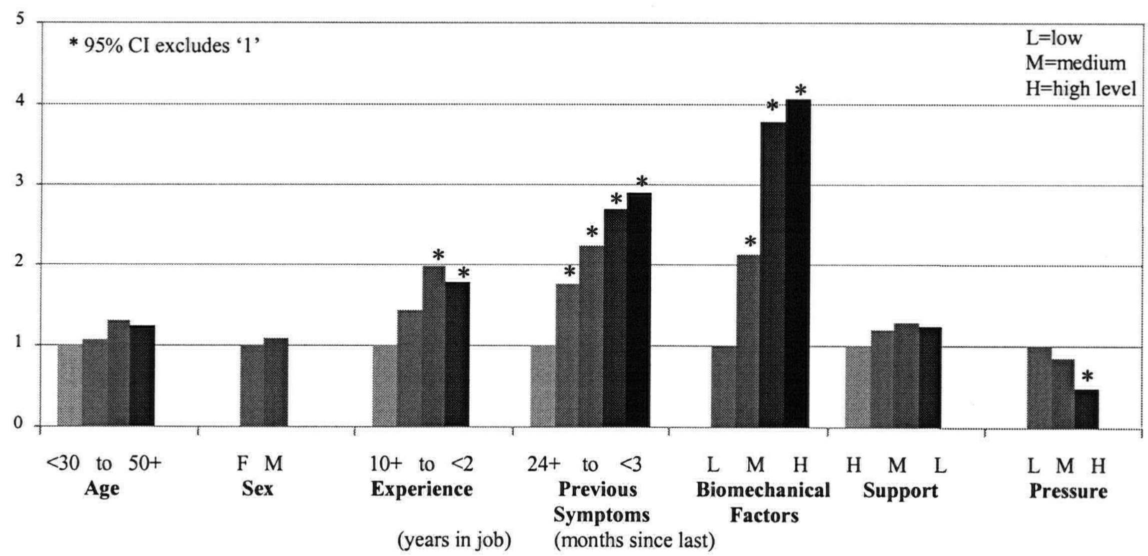


Figure 23: Adjusted Risk Ratios for Lower-body Musculoskeletal Claims: Overall Cohort and Support/Pressure Variables

The final multi-variable models for lower-body musculoskeletal compensation claims (Figures 22 and 23, Appendix 23) demonstrated the same pattern of risks with individual, biomechanical and work organization predictor variables as observed in the previous analysis of lower-body musculoskeletal symptoms (Figures 18 and 19), with one notable exception. Low (RR=1.77, 95% CI=1.20, 2.61) and medium-low levels (RR=1.60, 95% CI=1.12, 2.53) of job control were significant predictors of compensable lower-body outcomes in the multi-variable models. Otherwise, risk ratios increased significantly with higher levels of sicktime, with age, less than 5 years of experience, less time since previous symptoms and higher levels of exposure to biomechanical factors, as observed in the models for the overall cohort. Similarly, risk ratios for lower-body musculoskeletal claims were not significantly different between males and females, or across levels of support, demands and overtime.

5.3 Additional Analyses to Investigate Multiple Events, Confounding, Collinearity and Effect Modification

5.3.1 Multiple Events

Additional analyses were conducted to investigate the effect of including multiple events in the regression models, as well as the effect of the variable 'time since last symptoms' to account for multiple events. The multi-variable analyses were re-run for a) first upper-body or lower-body event only, censoring all subsequent events and ignoring the variable 'time since last symptom'; b) first event only between 1993 to 1995, including the variable 'time since last symptom' for a prior symptom in 1992; and c) multiple events between 1993 and 1995 for all employees who were injury free in 1992, including the variable 'time since previous symptoms'. In all cases, the results were consistent with the multi-variable results described above for individual, biomechanical and work organization factors. The one exception was a significant elevated risk of a lower-body musculoskeletal symptom with low job control in the analysis completed for employees who were injury free in 1992.

5.3.2 Potential Sources of Confounding

Multi-variable models were constructed by first adding individual variables to the model, followed by the biomechanical factors, the work organization variables, and then the workload variables where applicable (Tables with changes in risk ratios following the addition of variables to the models are presented in Appendix 24). For upper-body outcomes, the addition of work organization variables strengthened the effect of risks associated with individual predictor variables, but weakened the effect of biomechanical variables. This suggests that work organization factors are likely to be important confounders in the association between upper-body outcomes and biomechanical factors, and that of individual variables. The addition of the work organization factors had very little effect on individual or biomechanical factors in the models for lower-body outcomes. The subsequent addition of workload measures to all models had little effect on the risk of upper-body or lower-body outcomes associated with individual, biomechanical or the other work organization factors. However, a decreased effect of departmental sicktime and the loss of an effect with departmental overtime from the unadjusted to adjusted models suggests that biomechanical factors may be important confounders for these workload measures.

5.3.3 Collinearity

To investigate collinearity among the study variables, results were compared with and without possibly related variables in the multi-variable models. The findings for individual, biomechanical and work organization predictor variables were consistent with the results described above in the multi-variable regression models. The exception was the emergence of low control as a significant predictor of lower-body musculoskeletal symptoms in the model without adjustment for biomechanical factors (RR up to 2.11 for low control). Also, the risk of an upper-body musculoskeletal event associated with job control was notable higher in the model without biomechanical factors (RR up to 3.72 for low control), and vice versa (RR up to 2.77 for high biomechanical factors).

5.3.4 Effect Modification

Since the regression models failed to converge with interaction terms, stratified multi-variable analyses were conducted to investigate the effects of biomechanical factors on the risk of musculoskeletal events among employees with high verses low job control; the effect of job control among employees with high verses low biomechanical factors; and the effect of departmental sicktime among employees stratified by levels of control and biomechanical factors. The findings were consistent with the final multi-variable results with a few notable exceptions. The findings suggest that departmental sicktime may be of more significance for upper-body outcomes among employees with low job control, and job control for lower-body outcomes among employees with low biomechanical factors. Risk ratios for upper-body outcomes associated with departmental sicktime did not remain significantly elevated among employees with high job control (RR from 0.82 to 1.03). For lower-body musculoskeletal outcomes, job control emerged as a significant predictor among employees stratified for low biomechanical factors (RR up to 2.27). Also, risk ratios were notable higher (up to a two-fold increased risk) for upper-body events associated with department sicktime among employees with high biomechanical factors, and conversely for lower-body events among employees with low biomechanical factors.

Chapter VI Discussion

Concerns regarding the prevalence and burden of musculoskeletal disorders among health care workers have focused attention on identifying important risk factors for prevention. Studies have largely examined individual factors and more recently ergonomic or biomechanical factors. While risks associated with these factors are founded, they may not represent a complete picture of the multi-factor nature of work-related musculoskeletal morbidity. Indeed, individual and ergonomic factors have not explained all occurrences of musculoskeletal events, nor have individual and ergonomic interventions always been successful in the prevention of occurrences. Although, some studies have demonstrated encouraging results (Yassi et al 1995; Gundewall et al 1993). As a consequence, characteristics pertaining to the way in which work is organized have gained attention as potential risk factors. As early at 1973, Magora showed that work organization factors were linked with musculoskeletal disorders. More recent reviews of the literature conclude there is evidence of such a relationship (Bongers et al 1993; Burdorf and Sorock 1997; Lagerström et al, 1998). However, the difficulty in determining the importance of work organization factors are inconsistency of findings, a lack of cohort studies, a reliance on self-reported or perceived measures of biomechanical factors, and single point estimates of work organization exposures. The present cohort study was designed to investigate the relationship between work organization factors and rates of upper and lower-body musculoskeletal symptoms and accepted compensation claims among health care workers while addressing some of the preceding methodological limitations.

6.1 Influence of Work Organization Factors on Musculoskeletal Morbidity

During this study's four-year follow-up period, health care workers with low job control and low work support, as well as high workload related to departmental sicktime, had a significant elevated risk of upper-body musculoskeletal symptoms and claims in multi-variable models adjusted for individual and biomechanical factors. The risk associated with low control was higher than any other independent association observed between predictor variables and upper-body musculoskeletal outcomes, with a three-fold increased risk observed for symptoms and a four-fold increased risk for compensation claims. High workload due to departmental sicktime was associated with an increased risk of lower-body musculoskeletal symptoms and claims, and low job control with that of compensation claims. As much as a two-fold increased risk was observed for high workload levels. The independent effect of control and support on lower-body musculoskeletal symptoms did not remain in the final models after adjusting for the effect of biomechanical factors. Working during periods of higher departmental overtime and work units/employee were not found to be associated with an elevated risk of musculoskeletal outcomes in the final models. Contrary to the hypothesized direction of effect, a decreased risk of musculoskeletal outcomes was observed for high levels of job demands and work pressure. Only the risk associated with high work pressure remained significantly different from those with low pressure in the final models.

Table 15 summarizes the study findings for work organization factors and compares them to findings from the literature. The weight of the evidence for an association between work organization factors and musculoskeletal outcomes was often conflicting in the literature and the present findings help to clarify evidence for job control, work support and workload among health care workers. Findings for job demands or work pressure are paradoxical.

Table 15: Summary of Findings for Work Organization Factors

++ Evidence of an increased risk for musculoskeletal outcomes, consistent across studies and/or demonstrating a dose response relationship
+ Evidence of an increased risk for musculoskeletal outcomes
- No evidence of an increased risk for musculoskeletal outcomes
+/- Conflicting evidence
* Evidence based on 3 or fewer studies

Study Variable	Evidence from Cross-sectional Studies	Evidence from Case-Control/ Cohort	Evidence from Cross-sectional Studies	Evidence from Case-Control/ Cohort	Evidence from Present Study
Upper-body Musculoskeletal Outcomes					
Low Job Control	+		+/-		++
Low Work Support	+/-	+*	+/-		+
High Demand/Press	+	+*	+/-		-
High Workload Levels	+/-	+	+/-		+ Dept Sicktime - Dept Overtime - Workunits/FTE
Lower-body Musculoskeletal Outcomes					
Low Job Control	+/-	+/-	+/-		+ claims - symptoms
Low Work Support	+/-	+/-	+		-
High Demand/Press	+	+/-	+/-		-
High Workload	+/-	+/-	+/-	+/-	+ Dept Sicktime - Dept Overtime - Workunits/FTE

6.1.1 Job Control and Work Support

The present findings are consistent with other studies that have identified low job control and/or low work support as important variables associated with musculoskeletal morbidity in multi-variable models adjusted for confounders. Previous studies have found upper and lower-body musculoskeletal outcomes associated with measures of social support in a ten-year cohort study of Finnish workers (Leino and Hänninen 1995); low control in national surveys of Dutch workers over ten years (Houtman et al 1994); low control and support in a survey study of salespeople (Skov et al 1996); support and skill discretion among newspaper workers (Polanyi et al 1997); low job control among telecommunication workers (Hoekstra et al, 1994); insufficient support in a case-control study of health care workers (Josephson et al 1998); poor social relations among hospital staff (Bru et al, 1996); and low control and supervisor support among nursing personnel (Lagerström et al 1995).

Employee's ability to influence how they perform work tasks is considered important to their health and safety while on the job (Karasek and Theorell 1990; Amick 1992), and includes such things as participation in decisions that impact them directly, ability to pace work, control over work hours and problem solving opportunities. Similarly, supervisor and co-worker support are workplace resources that can affect worker health and safety, and include such things as co-worker help in completing job tasks or a supervisor's understanding of time requirements to complete a job. As potential determinants of health and safety, a lack of job control or work support are sources of strain that can influence musculoskeletal morbidity. Stressful work conditions due to low control or support may result in physiological consequences such as muscle tension or the exacerbation of existing physical strain (Theorell et al 1991; Ursin et al 1988; Waersted and Westgaard 1991). Low control or support could also moderate the relationship with biomechanical factors by influencing levels of exposure (Hagberg et al 1995), altering work behaviours (Eakin and MacEachen 1998), or producing psychological consequences such as mental fatigue or altered perceptions (Cioffi 1996; Sauter and Swanson 1996). The current study did not delineate the mechanisms by which job control, or work support were related to musculoskeletal morbidity. Further study, using more advanced statistical techniques such as structural equation modelling, is warranted to understand whether they are independent or modifying variables (Sauter and Swanson 1996; Gerr et al 1996).

It should be pointed out that findings from other studies were often conflicting for measures of control or support (Dehlin and Berg 1977; Pot et al 1987; Theorell et al 1991; Magni et al 1990), including cohort studies (Bergenudd and Nilsson 1988; Viikari-Juntura et al 1991; 1994; Riihimäki et al 1989) and studies in the health care sector (Johansson 1995; Ready et al 1993; Smedley et al 1997). Clearly, further study of work organization characteristics, particularly among health care populations, is warranted to build upon and clarify the evidence to date. Given the methodological strengths of the present study and the magnitude of associations, it seems justifiable that the results reflect some impact of job control and work support on musculoskeletal morbidity among health care workers.

6.1.2 Job Demands or Work Pressure

Unexpectedly, negative or null associations were found in the current study between higher job demands, work pressures, and rates of upper and lower-body musculoskeletal outcomes. These findings contradict the balance of evidence from other studies that have found positive associations between musculoskeletal outcomes and high job demands or work pressures (Sauter et al 1983; Pot et al 1987; Hales et al 1994; Houtman et al 1994; Holmström et al 1992; Skov et al 1996; Polanyi et al 1997), including cohort studies (Krause et al 1998; Ferreira et al 1997). Most of these studies controlled for the potential confounding effect of physical workload. Evidence for the effect of job demands and work pressures was contradictory in health care studies (Josephson et al 1998; Kamwendo et al 1991; Lagerström et al, 1995; Josephson et al 1998; Ahlberg-Hultén et al 1995). The lack of a positive association in the present study may be attributable to several reasons.

The majority of previous studies used self-reported measures of job demands and work pressures. Perhaps individual perceptions of demands and pressures are the important elements of job stress leading to morbidity, and not the demands and pressures associated with an occupation, as measured in the current study. The study population of health care workers also demonstrated very little variability in job demand and work pressure scores, even though the breadth of occupations was greater than that included in previous health care studies. Work on the Job Content Questionnaire has shown the demands sub-scale to be associated with poorer sensitivity and specificity (Theorell et al 1998). The ability to discern differences in demands between work environments and occupations in a health care setting might be limited using the current survey instrument. As a result, there may not have been enough variability in the job demand measure, compared to other work organization factors, to detect a relationship.

Scores for demands and pressures may be acting as a surrogate for something unmeasured in the study. Part-time employees, for example, may have higher job demands due to a shorter workday or work week within which to complete job requirements, but a decreased risk of musculoskeletal morbidity due to reduced work hours. Work by Steffy and Jones (1990) found part-time hospital workers experience greater strain than full-time workers, and working status has been identified as a risk factor for musculoskeletal problems in some studies (Fuortes et al 1994; Bru et al 1996). This may explain the decreased risk of musculoskeletal morbidity among the high demand exposure group. Retrospective data on employment status was not available for the health care study population.

An inverse relationship for high demands and pressures observed in the current study has been reported in the cardiovascular morbidity literature (Johnson et al 1996; Albright et al 1992; Theorell et al 1998). It has also been found in studies on musculoskeletal outcomes (Hemingway et al 1997), including a study among health care workers (Josephson et al 1998). It is possible that high job demands has a different meaning among certain populations (Hemingway et al 1997). High demands may indicate highly variable work among health care workers and, as a positive work organization characteristic, offer some protection from job strain or biomechanical exposures leading to musculoskeletal symptoms and claims. The findings correspond to the review by Schnall et al (1994) in which 17 of 25 studies found significant associations between job control and cardiovascular outcomes, whereas associations with job demands were significant in only 8 of 23 studies. More recent studies confirm that job control may be the more important job strain factor related to mortality and morbidity (Amick et al 1999; Bosma et al 1997).

6.1.3 Workload Measures

The current study differentiated the mental demands and pressures of work from more objective workload measures. Levels of sicktime and overtime per total paid hours, and work units per employee were used as measures of the amount of departmental work to be completed within four-week periods. In the present study, increased risks were associated with working during periods of higher departmental sicktime, but not overtime or work units/employee, in the final models. Previous studies using measures of overtime have found inconsistent results for musculoskeletal outcomes, including a positive association (Krause et al 1998; Bergqvist et al 1995), a negative association (Svensson and Andersson 1983; Hales et al 1994) and no association (Daltroy et al 1991; Ferreira et al 1997). No studies were found that investigated the influence of departmental overtime, verses individual levels of overtime, as in the current study.

Contrary to the current findings, studies using comparable measures to that of work units per employee found patient-staff ratios or staffing levels associated with lower-body musculoskeletal morbidity (Larese and Fiorito 1994; Stubbs et al 1981), and units of productivity associated with upper-body outcomes (Kilbom and Persson 1987; Schibye et al 1995). Still others have found no association with staffing levels (Heap 1987) or the number of sonography procedures (Vanderpool et al 1993). No studies were found using a comparable measure to that of departmental sicktime.

Higher departmental sicktime translates into an increased number of work tasks to be completed by employees who must compensate for absent co-workers. It also represents an unplanned increase in workload. The current findings for higher levels of departmental sicktime suggest that an unexpected surge in workload may be an important element of work organization associated with the risk of musculoskeletal outcomes. Studies have documented increased risks of upper-body outcomes with surges in workload (Hales et al 1994), and that of lower-body outcomes with unforeseen events (Engels et al 1996). Hale and Sauter (1992), in a review of the literature, identified surges in workload as one of seven factors associated with upper-body musculoskeletal disorders among telecommunication workers.

One might expect that higher work units/employee, representing a surge in workload, would also be a significant predictor of morbidity. The results related to the work units sub analyses must be interpreted with caution. First, the work units sub-cohort only had statistical power of 50% to detect a relative risk of 1.5 associated with this factor, if that was the true RR (Appendix 3). Second, data were only available for a limited number of employees resulting in statistically significant demographic differences between the overall cohort and work units sub cohort (Chapter III). Finally, the sub-cohort was defined by the availability of work units data on a select group of homogeneous departments, primarily nursing and testing/laboratory occupations. As a result there was less variability in the exposure variables, limiting the ability to detect differences.

Results from the sub-cohort defined by sicktime and overtime data can be interpreted with more confidence, as there were few differences from the overall cohort and sufficient statistical power. The lack of a significant association with overtime is understandable given the hypothesized importance of a surge or unexpected increase in workload. Overtime translates into more work due to a longer working day, not necessarily an increased rate of work or an unexpected surge in workload. The combination of an increase in the rate of work and the unanticipated surge in workload may be important factors in the casual pathway of workload, job strain and musculoskeletal morbidity.

Alternatively, it could be argued that the temporal relationship between workload and musculoskeletal outcomes is made unclear using the surrogate measure of sicktime levels within a department. Musculoskeletal symptoms may in fact be the cause of higher sicktime levels within a department over a four-week period, providing an alternate explanation for the positive association between outcomes and sicktime levels. Further analysis of the data using survival analysis and cumulative workload exposures leading up to a musculoskeletal outcome will help to delineate the temporal pathways.

6.1.4 Differences Between Upper and Lower-body Musculoskeletal Morbidity

Overall, the strongest factors influencing upper-body musculoskeletal outcomes were previous symptoms and low job control, while previous symptoms and biomechanical factors were the predominant predictors of lower-body musculoskeletal outcomes. Results from the present study are in agreement with other studies that have found work organization factors more strongly associated with upper-body musculoskeletal outcomes than with those of the lower-body studies (Bongers et al 1993; Marras et al 1993, Svebak et al 1991; Westgaard and Jansen 1992). Johansson's study of home care workers (1995), for example, reported physical workload as the main effect for lower-body musculoskeletal symptoms, while physical workload and work organization factors were of equal importance to upper-body musculoskeletal symptoms. Several studies (Dehlin and Berg 1977; Linton 1990; Linton and Kamwendo 1989; Magora 1973; Svensson and Andersson 1989), including cohort studies (Svensson and Andersson 1983; Bigos et al 1991), have found no association between some work organization factors and lower-body musculoskeletal outcomes after adjusting for biomechanical factors. In the current study, the independent effect of control, support and overtime on lower-body musculoskeletal symptoms did not remain in the final models that adjusted for biomechanical factors.

It should be noted that other researchers have found strong associations between work organization factors and lower-body musculoskeletal outcomes in well-designed studies that adjusted for biomechanical factors (Kerr 1998; Hemingway et al 1997; Hughes et al 1997). A review 29 cohort studies on risk factors for back disorders (Hoogendoorn et al 1998), of which 12 were classified as high quality, found strong evidence for work support and, when studies were combined, strong evidence for job content and job control. In support of these studies, we found that low job control was associated with an elevated risk of lower-body compensation claims.

The more consistent findings for work organization factors and upper-body musculoskeletal outcomes emphasize the complex relationships between work organization factors and musculoskeletal morbidity. The job stress imposed by low control and low support may result in tension in the upper-body musculature, but not lower-body musculature, increasing the risk of musculoskeletal symptoms selectively. Alternatively, the modification of exposure to biomechanical risks through control or support may be different for the upper-body musculature than for the lower-body. Manual materials handling and patient lifting are major risk factors for the lower-body; while repetition, awkward postures and forceful gripping are major risk factors for the upper-body. High levels of supervisor support during a patient lift, for example, may not mediate the wear and tear on the lower-body musculature when completing this physically demanding task. Whereas the support from a supervisor to take a break while typing, may mediate the cumulative effect of repetition on the upper-body musculature. Perhaps control and support are resources that mediate cumulative exposure to biomechanical risk factors commonly associated with the upper-body, but have no effect on exposure to single overexertion incidents more commonly associated with the lower-body (although lower-body risks can also be cumulative due to awkward postures or low level lifting over time). It is interesting to note that while no relationship was seen for lower-body musculoskeletal symptoms and job control in the final multi-variable models, there was an elevated risk of a lower-body compensation claim with low control. These findings suggest that low job control may play an important role in more severe lower-body disability associated with compensation and emphasizes again the complex inter-relationships between biomechanical, work organization and musculoskeletal outcomes.

6.1.5 Collinearity and Effect Modification

Since demographic variables were used to predict work organization factors, it is possible that the work organization predictors are an exact linear combination of the demographic variables included in the final multi-variable models. This situation may also exist between demographic variables such as age and years of experience, as well as between work organization factors and biomechanical variables. Incremental increases in biomechanical factors may, for example, correspond with incremental increases in job demands. Collinearity between variables can distort the true magnitude of the association of these variables with the musculoskeletal outcomes. To investigate collinearity among the study variables, results were compared across analyses with and without possibly related variables. The results suggest that collinearity may exist between biomechanical factors and job control. Low job control emerged as a significant predictor of lower-body musculoskeletal symptoms in the multi-variable model without adjustment for biomechanical factors. The risk of upper-body musculoskeletal symptoms associated with job control was notable higher in the model without biomechanical factors, and vice versa.

While the etiologic mechanisms are not clearly understood, some researchers have suggested that work organization factors may not be predictors of musculoskeletal outcomes, but rather predictors or effect modifiers of biomechanical factors. Stratified analyses were conducted to investigate the joint effects of biomechanical and work organization factors on musculoskeletal events. The findings were consistent with the final results, with two notable exceptions. Low job control appears as a risk factor for lower-body events when in combination with low biomechanical factors, but has no effect when biomechanical loads are high. Again, perhaps this supports the suggestion that job control is important for cumulative exposures to biomechanical factors such as low level lifting over time but not important for single overexertion exposures such as patient lifting. Also, departmental sicktime primarily appears to be a risk factor for upper-body events when in combination with low control. An unexpected increase in workload due to absent employees may only be important to upper-body musculoskeletal morbidity when employees cannot alter their work tasks or schedules to address the surge in workload.

6.2 Multi-factorial Nature of Musculoskeletal Morbidity

The results for work organization factors did not occur independently but as part of multi-variable models that controlled for potential confounders. Results from the final models suggest that work organization factors are part of a multi-factor model of musculoskeletal morbidity that includes individual and biomechanical risk factors. In final models, the risk of musculoskeletal symptoms and claims was consistently elevated with less time since a previous musculoskeletal symptom and exposure to higher levels of biomechanical factors. There was also evidence of a relationship with increasing age and fewer years in an occupation, although the evidence was less consistent for lower-body musculoskeletal outcomes. A difference in rates between males and females was observed for upper-body musculoskeletal outcomes. This is consistent, for the most part, with the evidence from the literature (Table 16). The results for individual and biomechanical factors are discussed in more detail in the following sections.

Table 16: Summary of Findings for Individual and Biomechanical Factors

++ Evidence of an increased risk for musculoskeletal outcomes, consistent across studies and/or demonstrating a dose response relationship
+ Evidence of an increased risk for musculoskeletal outcomes
- No evidence of an increased risk for musculoskeletal outcomes
+/- Conflicting evidence

	NON-HEALTH CARE SECTOR		HEALTH CARE SECTOR		
Study Variable	**Evidence from Cross-sectional Studies**	**Evidence from Case-control/ Cohort Studies**	**Evidence from Cross-sectional Studies**	**Evidence from Case-control/ Cohort Studies**	**Evidence from the Present Study**
Upper-body Musculoskeletal Outcomes					
Increasing Age	+/-	+	+	+	+
Females	+	+	+/-		+
Experience	+/-	+/-	+/-		+
Previous Symptoms	+	+	+	+	++
Biomechanical Factors	++	++	++	++	+
Lower-body Musculoskeletal Outcomes					
Age	+	+/-	+	+/-	+/-
Sex	+/-	+/-	-	-	-
Experience	+/-	+/-	+/-	+/-	+/-
Previous Symptoms	+	++	++	++	++
Biomechanical Factors	++	++	++	++	++

6.2.1 Influence of Individual Variables

Age

In the final adjusted models, risk ratios for upper-body musculoskeletal symptoms and claims increased significantly with age, peaking among employees aged 40-49 years and decreasing slightly among those over the age of 50. Older employees had as much as a two-fold increased risk of upper-body musculoskeletal symptoms and a three-fold increased risk of a compensation claim. The same pattern of risk was evident for lower-body musculoskeletal morbidity, but risks were only significantly different from '1' for employees over the age of 40 years.

The overall pattern of increasing risk of musculoskeletal morbidity with age and a slight drop in the oldest age group has been observed previously among Canadian (Liira et al 1996), American (Deyo and Tsui-Wu 1987), Japanese (Kuwashima et al 1997), Belgian (Skovron et al 1994), and Dutch workers (Houtman et al 1994). This pattern has also been reported among health care workers (Videman et al 1984; Pope 1989; Larese and Fiorito 1994; Ono et al 1995; Smedley et al 1997).

The less consistent and qualified findings for lower-body outcomes are supported by a recent review of studies on back disorders (Burdorf and Sorock 1997). Burdorf and Sorock found 12 studies with a positive association for age, 15 studies with no association and 3 studies with a negative association. The 12 studies with a positive association consistently found the prevalence of back disorders increased with age and fell slightly among the oddest age group. Health care studies are equally inconsistent with some documenting a positive association between age and lower-body outcomes (Videman et al 1984), others a negative association (Molumphy et al 1985) and still others no association (Lagerström et al 1995).

The ageing process and ability to tolerate physical stress on the musculoskeletal system are believed to play a role in an increased prevalence of musculoskeletal morbidity (Hagberg et al 1995). The cumulative exposure to risk factors with age also means that older employees are more likely to sustain health outcomes than younger employees, and that age may be acting as a surrogate measure for these other exposures (Hagberg et al 1992; Morgenstern et al 1991). Separating the biological effect from the occupational exposure effect is difficult. However, the age effect persisted in the current study after controlling for length of employment in current occupation.

Why a drop in risk among the oldest age groups? Senior employees may be more likely or able to move to another occupation with conditions less aggravating to musculoskeletal problems. Maturity may also mean that employees are more experienced in dealing with high risk work conditions, perhaps accounting for some of the decline in risk among this age group. Alternatively, the rate of musculoskeletal morbidity in the oldest age group could be biased by early retirement to alleviate musculoskeletal discomfort.

Sex

There is no evidence that the risk for lower-body musculoskeletal outcomes was different between male and female workers in the current study. Elevated risks of lower-body compensation claims among men did not remain in the final models after adjustment for biomechanical factors. Studies on lower-body outcomes have found comparable rates between men and women (Liira et al 1996; Skovron et al 1994; Zwerling et al 1993), including studies in the health care sector (Larese and Fiorito 1994; Molumphy et al 1985). A review of 40 studies on back pain found little evidence of a difference between men and women (Burdorf and Sorock 1997). Likewise, a study of back-related compensation claims among New York workers reported no difference between men and women for

18 occupations including care aides, licensed practical nurses, therapists, pharmacists, radiology technicians, laboratory technicians, nursing assistants and registered nurses (Jensen 1986).

In the present study, males had a 50% decreased risk of upper-body musculoskeletal morbidity. Studies on upper-body musculoskeletal disorders have consistently identified a higher prevalence of musculoskeletal outcomes among women across different industries, countries and study designs (Polanyi et al 1997; Bergqvist et al 1995; Bernard et al 1994; Ohlsson et al 1989; Ekberg et al 1994; English et al 1995; Leino and Hänninen 1995; Tanaka et al 1995). Women have traditionally been assigned to work requiring less physical force such as manual handling, but more repetitive movements such as data entry. When these biomechanical exposures are accounted for, some studies report no difference between male and female workers (Hagberg et al 1992; Silverstein et al 1986). Gender differences did persist in the current study for upper-body musculoskeletal morbidity after adjusting for biomechanical factors. Exposure to home tasks is a possible explanation for a higher prevalence of musculoskeletal problems among women. Most studies, however, have not identified home exposures as significant factors related to work-related musculoskeletal morbidity among health care workers (Ahlberg-Hultén et al 1995; Venning et al 1987; Ready et al 1993; Josephson et al 1998; Niedhammer et al 1994).

Burt (1998), in a recent review of gender and upper-body musculoskeletal disorders, provides an alternative explanation for observed differences between men and women. She concluded that differences in anthropometry change the nature of the fit between the worker and the work environment for women in the same jobs as men, resulting in increased risk of musculoskeletal morbidity. Workstations and equipment are often designed to male anthropometric standards, which may exclude a significant portion of working women. As a result, women adopt awkward postures or higher forces in order to compensate. While the current study controlled for biomechanical risks, the risks were based on occupation not individual exposures. Differences between a male and female worker completing the same job may have been missed and could explain the gender difference in the current study. The lack of a difference between men and women for the lower-body is understandable in this context given that many of the lower-body biomechanical risks in the health care sector have less to do with workstation design and more to do with the physical demands of the task (i.e. patient lifting, manual handing of equipment, awkward postures during care activities).

Work Experience

In both the uni-variable and multi-variable analyses, the risk of lower-body musculoskeletal outcomes was elevated for health care workers with less than 5 years in their occupation, compared to those with the most experience (>10 years). The risk of upper-body outcomes was significantly elevated for those with less than 10 years of experience. Previous studies have found that upper-and lower-body musculoskeletal morbidity can occur more frequently within the first few years on the job (Bigos et al 1986; Krause et al 1998; Videman et al 1984; Heuer et al 1996; Silverstein et al 1987), including studies of health care workers (Yassi et al 1995; Molumphy et al 1985). Still many other studies report a positive relationship between musculoskeletal outcomes and years of experience, particularly for the upper-body (Bernard et al 1997; Holmström et al 1992; Schibye et al 1995; Lagerström et al 1995).

It is not clear whether the development of musculoskeletal problems among health care workers was related to a lack of experience performing work tasks, or that workers with less seniority were assigned more strenuous or stressful work tasks. The pattern of risk for occupational experience was also not uniformly associated with rates of musculoskeletal outcomes. Those with the least experience were not at the highest risk but rather those with 2-5 years or 6-10 years of experience. Also, elevated risks were not statistically significant across all categories of experience. This may be the result of opposing risk mechanisms associated with time in a position. Longer time places an employee at risk due to cumulative strain on the musculoskeletal system, while less time in a position places an employee at risk due to lack of training.

Previous Musculoskeletal Symptoms

Upper and lower-body morbidity rates, including outcomes serious enough to result in compensation claims, increased steadily and significantly with the recency of prior musculoskeletal episodes during the follow-up period. Previous history of musculoskeletal morbidity is one of the most reliable predictive factors for subsequent morbidity in musculoskeletal studies (vanPoppel et al 1998; Bigos et al 1992; Daltroy et al 1991; Hemingway et al 1997; Kerr 1998; Riihimäki et al 1989; Jonsson et al 1988; Mäkelä et al 1991). Health care studies similarly document the importance of previous incidents (Fuortes et al 1994; Rydén et al 1989; Harber et al 1994; Venning et al 1987; Estryn-Behar et al 1990) and the recency of incidents (Smedley et al 1995; Smedley et al 1997) as predictive variables.

Employees with a prior episode during the follow-up period and particularly a recent episode, may be predisposed to musculoskeletal disability due to underlying damage of the musculoskeletal system. The model of musculoskeletal morbidity proposed by Burdorf and colleagues (1997) states that if there is residual musculoskeletal pain, a worker is more likely to incur future musculoskeletal problems or disability. Multiple musculoskeletal episodes and the clinical course of musculoskeletal morbidity are a current topic of discussion in the literature (Von Korff 1994; Frank et al 1996). Multiple symptoms, as measured in the current study, may in fact measure the effect of one episode becoming aggravated over time rather than the effect of one event on an independent future event. This may explain the strong relationship observed between previous and current musculoskeletal symptoms. Further research that links occupational health and safety data with health care utilization data will provide better information on the clinical course of musculoskeletal morbidity and phases of morbidity.

For many chronic health outcomes, longitudinal studies may result in multiple incident cases in many of the study participants. Results may be biased due to failure to take into account the within subject correlation associated with multiple occurrences of the same health outcome. This does not justify discarding these events from consideration. In the current study, the variable 'time since previous symptoms' was included in the regression models to account for multiple musculoskeletal events among the same health care worker during the follow-up period. Additional analyses were conducted to investigate the effect of including multiple events and the 'time since' variable to account for these multiple events. The results were consistent with the final multi-variable results with the exception of a significant elevated risk of a lower-body outcome associated with low job control in the subsequent analysis of employees who were injury free in 1992.

6.2.2 Influence of Biomechanical Variables

The risk of upper and lower-body musculoskeletal morbidity increased with the number, frequency, magnitude and duration of biomechanical factors. The risk of lower-body musculoskeletal outcomes demonstrated a dose-response relationship with three-fold and four-fold increased risks associated with the highest levels of exposure to biomechanical factors. The risk of upper-body musculoskeletal morbidity was consistently elevated for the presence of at least one biomechanical factor for more than half of the workday.

The strong positive association between occupational biomechanical factors and musculoskeletal outcomes in the current study confirms previous occupational studies and reviews of the literature reporting similar relationships for lower-body outcomes (Bernard et al 1997; Stock 1991; Marras et al 1993), and upper-body outcomes (Chiang et al 1993; Osorio et al 1994; Andersen and Gaardboe

1993; Holmström et al 1992; Armstrong et al 1987; Silverstein et al 1987), as well as for musculoskeletal outcomes in the health care sector (Smedley et al 1995; Fuortes et al 1994; Engels et al 1996). Studies have also reported dose-response relationships and associations with composite biomechanical scores as in the current study. The risk of lower-body musculoskeletal morbidity was significantly associated with a physical workload index or combination of risk factors in a dose-response fashion after adjustment for confounders among Finnish (Heliövaara et al 1991), Dutch (Houtman et al 1994), Swedish (Bergenudd and Nilsson 1988) and Canadian workers (Liira et al 1996). Videman et al (1984) found physical demands classified as heavy, intermediate and light combinations of lifting, bending, rotation, standing, walking and sitting associated with low-back pain among nurses in a dose-response relationship. Although not observed in the present study, other studies on upper-body musculoskeletal outcomes have demonstrated dose-response relationships with biomechanical exposures (Ekberg et al 1994; Tola et al 1988; deKrom 1990). Punnett (1998) for example, in a study of automobile workers, documented a dose-response increase in prevalence ratios for upper-extremity disorders associated with low, moderate and high biomechanical exposure scores.

Biomechanical factors are widely recognized as exerting physical or mechanical forces in the body. These forces in turn contribute to pathological change in the musculoskeletal system (e.g. disc, ligament, muscle, bone, and cartilage) as excessive physical forces or the wear of prolonged physical demands exceed a worker's capacity to sustain them. Exposure that exceeds worker capabilities is a function of the presence, frequency, duration and magnitude of biomechanical forces on the body (Hagberg et al 1995).

6.3 Strengths and Limitations

The overall strength of this study lies in the methodological design. Work organization factors were investigated in a cohort design and as part of a multi-factor model that adequately controlled for biomechanical factors. Biomechanical factors were assessed by direct observation of employees by a trained observer, overcoming limitations of previous studies that relied on self-reports or job titles (Burdorf 1992; Kilbom 1994; Winkel and Westgaard 1992). The study sample was representative of the working population within the acute-care segment of the health care industry including all occupations, except physicians and students. It also provided much needed data on female workers with 79% cohort representation. Exposure status for work organization factors was based on data collected at three points in time over a four-year period and scores predicted from random sample survey responses. Workload measures were estimated with objective, quantitative data and assigned to cohort subjects by four-week exposure points. Consistency of findings using compensation claims data requiring medical confirmation of morbidity and incident reports of musculoskeletal symptoms, helped to address concerns regarding self-reported outcome measures and biases associated with different reporting systems. With the exception of the work-units sub-cohort, the study had sufficient power to detect associations between work organization factors and musculoskeletal morbidity. Overall, this study provided a stronger methodologically investigation of the role of work organization factors in work-related musculoskeletal morbidity than previous studies in the health care industry. However, the study does have its limitations.

6.3.1 Work Organization Exposures

Misclassification of work organization and biomechanical exposures, as well as work-related musculoskeletal morbidity, is a possibility in the current study. Data for the work organization job-exposure matrix was derived from self-reported assessments of work-related control, demand, support and pressure. As such, the work organization scores may have been influenced by individual employee attitudes (Chen and Spector 1991; Hurrell and Murphy 1992; Sauter and Murphy 1995). However, predicting work organization scores from three random samples of employees over a four-year time span helped to minimize the effect of misclassification due to individual differences, and, according to Josephson et al (1997), decreased the importance of individual biasing factors across occupational groups. Others have advocated for the imputation of scores as a means of reducing the subjective component of reported work organization characteristics (Schwartz et al 1988; Landsbergis et al 1995), and still others have constructed job-exposure matrices, similar to the present study, using occupation and individual characteristics (Johnson and Stewart 1993). Two studies in the cardiovascular literature found occupation-based measures of control and demand more predictive of cardiovascular outcomes, than that of self-reported measures (Theorell et al 1991; Netterstrom and Sjol 1991). However, imputation techniques can result in misclassification when within-occupation differences are ignored. The current imputation technique included significant individual variables such as age, sex and years of experience in the final regression models to account for some of individual differences within an occupation. From a prevention point of view, measuring work organization factors for groups may also be preferred for the development, implementation and evaluation of occupation and department-level interventions.

Both the Work Environment Scale (Insel and Moos 1974; Moos 1986) and the short version of the Job Content Questionnaire (Karasek 1979; Karasek and Theorell 1990), used to measure work organization factors, have been assessed in terms of reliability and validity. The WES was standardized on a sample of over 3,000 workers, including 1,600 from health care settings. It has been used in a large number of research projects to describe work settings and to compare the environments of subgroups within a workplace (Griffin et al 1989; Moos 1986). The demand/control dimensions measured by the JCQ have emerged as a dominant model to explain the relationship between job strain and worker health (Muntaner and O'Campo 1993). A recent analysis of the properties of the JCQ scales across 6 studies and 4 countries (Karasek et al 1998) found that the internal consistency of the scales tended to be similar across populations and between men and women, and that the sub-scales were reliable based on similarity in means, standard deviations, and correlations among the scales. Other studies have supported the ability of the model to predict health outcomes (Karasek et al 1981; Karasek et al 1988; Pieper et al 1989) with a few exceptions (Reed et al 1989).

Studies investigating the control-demand measurement have shown misclassification to be more severe for the measure of job demands than for job control or support (Johnson and Stewart 1993; Theorell et al 1998), and for the job demands measure to be less predictive when occupational groups are homogenous (Payne and Fletcher 1983; Spector 1987). Indeed, there was not as much variability in the demands and pressures variables among the health care worker population as would be desired. This limited variability could be one reason for the lack of a positive association between demands, pressures and musculoskeletal outcomes. Also, items from the work organization sub-scales were omitted in different years and for different union groups, particularly for the job demands sub-scale, further increasing the potential for misclassification. These sources of misclassification are likely to be non-differential so that the true relationship between musculoskeletal outcomes and work organization factors would have been underestimated.

Another limitation of the study is the use of transient exposures. In the current study, musculoskeletal events were registered when employees' work was interrupted and exposures linked to the date of this interruption. The clinical course of musculoskeletal morbidity has yet to be clearly delineated, and exposures at the time of reporting may not necessarily represent the exposures of importance in the development of pathological changes to the musculoskeletal system. Cumulative exposures to both biomechanical and work organization factors may be more important to musculoskeletal morbidity (House et al 1986). Further research on the current study population is planned to examine relationships between cumulative exposures and musculoskeletal morbidity.

6.3.2 Biomechanical Exposures

Musculoskeletal studies rely on job title and self-reports for assessment of biomechanical exposures more than direct observations or measurements (Winkel and Westgaard 1992). Self-reports and job titles have been challenged for their validity and reliability, and for misclassification of exposures (Rossignol and Baetz 1987; Burdorf and Laan 1991; Baty et al 1986; Uhl et al 1987; Armstrong et al 1989; Bernard et al 1994; Fransson-Hall et al 1995; Stubbs 1986; Wiktorin et al 1993; 1996). A review of 72 studies on low-back pain (Burdorf 1992) revealed that more than half relied on job title for assessment of biomechanical exposures. Fourteen studies or 19% of the sample used direct observations or measurements. A review of 39 studies on upper-body musculoskeletal disorders (Winkel and Westgaard 1992) revealed that only 25% assessed duration of exposure or amount of repetition. Since these aforementioned reviews, studies can be found that assess both upper-body and lower-body biomechanical factors in a more comprehensive manner (Norman et al 1998; Hughes et al 1997), including the use of observational (Ohlsson et al 1995; Faucett and Rempel, 1994; Punnett 1998; Punnett et al 1991) and direct measures (Kerr 1998).

The current study relied on direct observations of a sample of employees to assess biomechanical exposures for occupations in the health care population. Observational methods are preferred to self-reports as a feasible, albeit less precise alternative, to direct measurements (Burdorf 1995; Kilbom 1994). Several researchers have employed observational methods using samples of employees to assess biomechanical factors in studies of musculoskeletal outcomes (Bernard et al 1994; Punnett 1998). However, measurement of biomechanical factors by direct observation is still a potential source of exposure misclassification.

In the current study, the presence of a biomechanical exposure may have been easily discernible to the observer, but the ability to assess the frequency, duration and/or magnitude of exposure may have been more subjective. For example, an observer could objectively discern that repetition, hand force or trunk forward flexion were part of clerical, laboratory, and nursing occupations, but the frequency of repetition, amount of force, or degree of flexion was more subjective without direct measurement techniques. Also, the direct observations may have been biased to gross body movements resulting in more precise scoring of lower-body factors such as trunk flexion or pushing/pulling, and less precise scoring of the more finite biomechanics of the upper-body such as neck flexion and hand extension. Also, the speed of upper-body movements associated with typing, food service preparation or lab work made it difficult to accurately observe postures and duration of postures. Less precise measurement of upper-body risk factors may explain the lack of a dose-response relationship with upper biomechanical scores in the current study.

The period of observation may not have been representative of a typical workday. A risk factor that was present more than is usual during the observation period could have over-estimated the exposure, or vice versa. The assumption that risks were constant across individuals in the same occupation and constant across the four years of follow-up is an additional source of error. Variability of exposure between workers in the same occupation and intra-worker variability over the week, month or year were neglected. However, in a comparison of occupations, Burdorf (1992) found that the between-group variance accounted for more of the total variance in biomechanical postures than the within-worker or between-worker variance. Again, these sources of misclassification were likely random and underestimated the effect in the current study.

Direct observations were scored in the present study using OSHA's checklists for the upper and lower-body (Appendix 6). The development of the instrument was based on a comprehensive review of the literature, and factors included in the checklist demonstrated a consistent pattern of increased risk with musculoskeletal disorders in studies. The weighting of the frequency, duration and magnitude of these factors was similarly based on study findings (personal conversation with Barbara Silverstein 1996). The checklist was sensitive to differences in high and low risk groups in the present study, particularly for the lower-body musculoskeletal morbidity. Several other researchers have relied on scoring systems to assess exposure to biomechanical factors (Estryn–Behar et al 1990; Liira et al 1996; Schierhout et al 1993; Punnett 1998). Punnett (1998), in a recent paper, argued that there is a need for the development of biomechanical scoring instruments given the multi-factor nature of musculoskeletal disorders and the importance of assessing exposure to multiple biomechanical factors. She writes that a composite score provides a practical and feasible way to compare many jobs and avoid confounding by strongly correlated biomechanical exposures.

6.3.3 Musculoskeletal Outcomes

Another limitation of the current study is the reliance on incident reports and compensation claims data to ascertain musculoskeletal outcomes. Workers compensation reporting systems have been criticized for under reporting (Stout and Bell 1991; Schwartz 1987; Cummings et al 1989). The acceptance of a compensation claim is subject to definitions of morbidity that may exclude actual musculoskeletal outcomes not meeting the definitions. Reporting of incidents in a workplace has also been shown to be unreliable, under reported and incomplete (Silverstein et al 1997; Pollack and Keimig 1991). Reasons for registering with a workplace or compensation system could be biased by work organization factors such as supervisor relations. If employees with adverse work organization are less likely to report symptoms, the actual morbidity in the current hospital population could be far greater than observed and the association between work organization factors and morbidity may have been underestimated. The converse could also be true. It is not known whether reports of musculoskeletal episodes recorded by the occupational health and safety department, and registration with a compensation claim would be biased in the same way. The similar findings for both musculoskeletal symptoms and compensation outcomes among the health care study population suggests that these two systems were a valid source of musculoskeletal outcome data.

Criticism of self-reported outcomes to ascertain morbidity was addressed in the present study by replicating the analyses for symptoms resulting in a compensation claim. The acceptance of a compensation claim requires medical confirmation of morbidity. Findings were consistent between the two analyses, but relative risks were consistently higher for compensation outcomes. This is similar to the findings of Åstrand (1987) who found a tendency toward stronger associations for outcomes measured by physical examination than by self-reports.

The analysis of upper-limb, neck and shoulders outcomes together, and the analysis of lower-limb and all back outcomes combined may mask the effect of risk factors associated with specific types of disorders such as carpal tunnel syndrome or low-back pain. In the current study, it was hypothesized that work organization factors and the associated stress have general effects on the musculoskeletal system via biomechanical or job strain mechanisms, but future research may need to investigate this assumption by looking at specific disorders.

6.3.4 Survivor Bias

Inherent in this type of study is the potential for survivor bias and an underestimation of the association between predictor variables and musculoskeletal outcomes. Health care workers may leave the hospital setting because of musculoskeletal problems, or change to a job with conditions less aggravating to these problems. The results of the study could also be biased by the probability that leaving the hospital varied by level of work organization exposure. In other words, those with adverse work organization conditions may seek employment elsewhere more readily than those with positive work conditions. The retrospective nature of the study design and the reliance on secondary hospital data sources meant that follow-up of workers ceased when employees left the hospital.

6.3.5 Residual Confounding

The present analyses may not have taken into account all of the factors and complex relationships that influence work-related musculoskeletal morbidity. In particular, job status may be a confounder for both biomechanical and work organization exposures. Biomechanical exposures will have been overestimated for individuals who work part-time and underestimated for those who work 12-hour verses 8-hour shifts. Whereas the level of control or support at work may not be a function of hours worked, the level of job demands and pressures may be directly related to time components. Similarly, other factors such as smoking status (Liira et al 1996; Niedhammer et al 1994), job satisfaction (Bigos et al 1991; Holmström et al 1992) or monotonous work (Bru et al 1996; Leino and Hänninen 1995), that have been significantly associated with musculoskeletal outcomes in previous studies, were not included in the current study. Residual confounding from other unaccounted for variables may distort the true relationship between exposures and outcomes in the current study and explain negative or null associations for some work organization factors.

6.4 Summary

In summary, there is a need to conduct more research on work organization factors and their relative importance to the health of workers. Further investigation of the epidemiology of work-related musculoskeletal morbidity will benefit from longitudinal, multi-variable studies that appropriately measure work organization and biomechanical factors. Future studies can build upon the present study by investigating the cumulative effect of work organization factors, ascertaining musculoskeletal outcomes from data sources other than self-reports or compensation systems, linking with more detailed medical data on the clinical course of musculoskeletal episodes, and investigating the mechanisms by which work organization factors influence musculoskeletal morbidity. It is important to carry out such studies in sectors or occupations that are judged to be at high-risk for musculoskeletal outcomes such as health care.

6.5 Conclusions

The three main conclusions from this study are as follows:

- Adverse work organization factors were associated with an elevated risk of musculoskeletal outcomes among health care workers. Low job control, low work support and working during periods of high departmental sicktime were associated with an increased risk of both upper-body musculoskeletal symptoms and compensation claims. Working during periods of high departmental sicktime was associated with an increased risk of lower-body musculoskeletal symptoms and compensation claims, and low job control with that of compensation claims. Job control may be of more importance to the development of lower-body outcomes among workers with low biomechanical factors, and departmental sicktime to the development of upper-body outcomes among workers with low control. Levels of biomechanical factors may also modify the influence of departmental sicktime.

- Work-related musculoskeletal morbidity among health care workers was multi-factorial in nature. Elevated risks of both upper and lower-body musculoskeletal symptoms and claims were found among employees with recent previous musculoskeletal symptoms and with increasing exposure to biomechanical risk factors. In addition, the risk of upper-body and lower-body musculoskeletal outcomes tended to be elevated with increasing age and fewer years in an occupation, while the risk of upper-body musculoskeletal outcomes tended to be lower among male health care workers.

- Risk profiles among health care workers differed for upper-body and lower-body musculoskeletal morbidity. The magnitude of the association between upper-body musculoskeletal outcomes and predictor variables was greatest for low job control, while the magnitude of association between lower-body musculoskeletal outcomes and predictor variables was greatest for biomechanical factors.

The findings add to models of work stress by providing evidence of a link between adverse work organization conditions and musculoskeletal morbidity. The findings add to models of work-related musculoskeletal morbidity by providing evidence of adverse work organization factors as possible stimuli in the work environment that trigger a physiological process leading to musculoskeletal pain and symptoms.

The findings also build upon the literature by investigating the relationship between musculoskeletal outcomes and work organization factors in a longitudinal manner and as part of a multi-factor model that adequately controlled for biomechanical factors. The study also incorporated objective and time-varying measures of work organization factors.

Finally, the study identified specific work organization factors, as well as individual and biomechanical factors, of relevance to musculoskeletal prevention strategies within the health care sector.

6.6 Implications

Consideration of work organization factors is important not only to research and to understanding the relationships between these factors and health, but also to applied efforts to reduce job strain and improve the health of workers. In the health care sector, work-related musculoskeletal morbidity is the most common and costly occupational health and safety issue. Detailed, reliable data on the relative importance of individual, biomechanical and work organization risk factors, given a multi-factorial model of musculoskeletal morbidity, is of increasing importance in allocating limited resources, setting priorities and developing effective workplace prevention strategies. It is hoped that findings from this study will inform the development of effective prevention strategies and the allocation of resources to implement these strategies within the health care sector.

Most interventions in the health care sectors have focused on employee education and more recently ergonomics to prevent work-related musculoskeletal morbidity. The short-term or limited effect of education and ergonomics to date may stem from the lack of an integrated approach that recognizes the complex relationships and modifying effects of work organization factors. The current findings suggest that a combination of education, ergonomic and work organization interventions has the potential to be more effective in reducing musculoskeletal morbidity, and that the combination of interventions be weighted towards improving work organization conditions for reducing upper-body musculoskeletal morbidity, and weighted towards biomechanical for reducing lower-body morbidity. The results for adverse work organization factors provides evidence to seriously consider workplace interventions designed to increase possibilities for control over work activities, improve co-worker and supervisor support of employees during the completion of work tasks and provide additional resources during periods of high sicktime within a department.

Bibliography

Ahlberg-Hultén GK, Theorell T, Sigala F (1995). Social support, job strain and musculoskeletal pain among female health workers. Scandinavian Journal of Work Environment and Health, 21(6), 435-439.

Albright CL, Winkelby M, Ragland D, Fisher J, Syme SL (1992). Job strain and prevalence of hypertension in a biracial population of urban bus drivers. American Journal of Public Health, 82, 984-989.

Alfredsson L, Spetz CL, Theorell T (1985). Type of occupation and neat future hospitalization for myocardial infarction and some other diagnoses. International Journal of Epidemiology, 14(3), 378 - 388.

Amick BC, Smith MJ (1992). Stress, computer-based with monitoring and measurement systems: a conceptual overview. Applied Ergonomics, 23(1), 6-16

Amick MC, McDonough P, Pieper C (1999). Working life course job exposures and the risk of death: approximating cumulative psychosocial job exposures Work, Stress and Health: Organization of Work in a Global Economy Conference, Baltimore. March 11-13, 1999.

Andersen JH, Gaardboe O (1993). Musculoskeletal disorders of the neck and upper limb among sewing machine operators: a clinical investigation. American Journal of Industrial Medicine, 24(6), 689-700.

Andersen JH, Gaardboe O (1993). Prevalence of persistent neck and upper limb pain in a historical cohort of sewing machine operators. American Journal of Industrial Medicine, 24(6), 677–687.

Arad D, Ryan MD (1989). The incidence and prevalence in nurses of low back pain. The Australian Nurses Journal, 16(1), 44-48.

Armstrong TJ, Buckle P, Fine LJ, Hagberg M, Jonsson B, Kilbom A, Kuorinka IAA, Silverstein BA, Sjogaard G, Viikari-Juntura ERA (1993). A conceptual model for work-related neck and upper-limb musculoskeletal disorders. Scandinavian Journal of Work Environment and Health, 19(2), 73-84.

Armstrong TJ, Fine LJ, Goldstein SA, Lifshitz YR, Silverstein BA (1987). Ergonomic considerations in hand and wrist tendinitis. Journal of Hand Surgery, 12A(5), 830-837.

Armstrong TJ, Punnett L, Ketner P (1989). Subjective worker assessments of hand tools used in automobile assembly. American Industrial Hygiene Association Journal, 50(12), 639-645.

Armstrong TJ, Silverstein BA (1987). Upper-extremity pain in the workplace-role of usage in causality. Clinical Concepts in Regional Musculoskeletal Illness. Grune and Stratton, Inc, pp 333-351.

Arndt R (1987). Work pace, stress and cumulative trauma disorders. Journal of Hand Surgery, 12A(2 Pt 2), 866-869.

Aronsson G (1991). Dimensions of control as related to work organization, stress and health. In JV Johnson and G Johansson (eds), The Psychosocial Work Environment. Work Organization, Democratization and Health.. Baywood, New York.

Association of Workers Compensation Boards in Canada (1997). Worker's Compensation Industry Classifications, Assessment Rates and Experience Rating Programs in Canada, 1997. Mississauga, AWCBC. Document 97-200

Åstrand NE (1987). Medical, psychological, and social factors associated with back abnormalities and self-reported back pain: a cross-sectional study of male employees in a Swedish pulp and paper industry. British Journal of Industrial Medicine, 44(5), 327–336.

Åstrand NE, Isacsson S-O (1988). Back pain, back abnormalities, and competing medical, psychological, and social factors as predictors of sick leave, early retirement, labour turnover and mortality: a 22 year follow-up of male employees in a Swedish pulp and paper company. British Journal of Industrial Medicine, 45, 387-395.

Baker GA, Carlisle C, Riley M, Tapper J, Dewey M (1992). The Work Environment Scale: a comparison of British and North American nurses. Journal of Advanced Nursing, 17, 692-698.

Baty D, Buckle PN, Stubbs DA (1986). Posture recording by direct observation, questionnaire assessment and instrumentation: a comparison based on a recent field study. In Corlett N, Wilson J (eds). The ergonomics of working postures. London: Taylor and Francis.

Bergenudd H, Jonell O (1991). Somatic versus nonsomatic shoulder and back pain experience in middle age in relation to body build, physical fitness, bone mineral content, gamma-glutamyltransferase, occupational workload and psychosocial factors. Spine, 16(9), 1051-1055.

Bergenudd H, Nilsson B (1988). Back pain in middle age. Occupational workload and psychologic factors: an epidemiologic survey. Spine, 13(1), 58–60.

Bergqvist U (1984). Video display terminals and health. Scandinavian Journal of Work Environment and Health, 10(2), 68-77.

Bergqvist U, Wolgast E, Nilsson B, Voss M (1995a). Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. Ergonomics, 38(4), 763 - 776.

Bergqvist U, Wolgast E, Nilsson B, Voss M (1995b). The influence of VDT work on musculoskeletal disorders. Ergonomics, 38(4), 754–762.

Bernard B (1997). Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back. BP Bernard (ed). National Institute for Occupational Safety and Health DHHS (NIOSH) Publication No. 97-141. US Department of Health and Human Services: Cincinnati, Ohio.

Bernard B, Sauter S, Fine LJ (1993). Hazard evaluation and technical assistance report: Los Angeles Times, Los Angeles, CA. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 90–013–2277.

Bernard B, Sauter S, Fine LJ, Petersen M, Hales T (1994). Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. Scandinavian Journal of Work Environment and Health, 20(6), 417– 426.

Bigos SJ, Battié MC, Spengler DM, Fisher LD, Fordyce WE, Hansson TH, Nachemson AL, Wortley MD (1991). A prospective study of work perceptions and psychosocial factors affecting the report of back injury. Spine, 16(1), 1 - 6.

Bigos SJ, Battié MC, Spengler DM, Fisher LD, Fordyce WE, Hansson T, Nachemson AL, Zeh J (1992). A longitudinal, prospective study of industrial back injury reporting. Clinical Orthopaedics and Related Research, 279, 21-34.

Bigos SJ, Spengler DM, Martin NA, Zeh J, Fisher L, Nachemson A (1986). Back injuries in industry: a retrospective study. III. Employee-related factors. Spine, 11(3), 252–256.

Bigos SJ, Spengler DM, Martin NA, Zeh J, Fisher L, Nachemson A Wang MH (1986). Back injuries in industry: a retrospective study. II Injury factors. Spine, 11 (3), 246–251.

Bjelle A, Hagberg M, Michaelson G (1981). Occupational and individual factors in acute shoulder-neck disorders among industrial workers. British Journal of Industrial Medicine, 38, 356-363.

Bongers PM, deWinter CR, Kompier MAJ, Hildebrandt VH (1993). Psychosocial factors at work and musculoskeletal disease. Scandinavian Journal of Work Environment and Health, 19(5), 297-312.

Bork BE, Cook TM, Rosecrance JC, Engelhardt KA, Thomason ME, Wauford IJ, Worley RK (1996). Work-related musculoskeletal disorders among physical therapists. Physical Therapy, 76(8), 827-835.

Boshuizen HC, Bongers PM, Hulshof CTJ (1992). Self-reported back pain in fork-lift truck and freight-container tractor drivers exposed to whole-body vibration. Spine, 17, 59–65.

Bosma H, Marmot MG, Hemingway H, Nicholson AC, Brunner E, Stansfeld SA (1997). Low job control and risk of coronary heart disease in Whitehall II (prospective cohort) study. British Medical Journal, 314, 558-565.

Bovenzi M, Betta A (1994). Low-back disorders in agricultural tractor drivers exposed to whole body vibration and postural stress. Applied Ergonomics, 25, 231-241.

Bovenzi M, Zadini A (1992). Self-reported low back symptoms in urban bus drivers exposed to whole-body vibration. Spine, 17(9), 1048–1059.

Bru E, Mykletun RJ, Svebak S (1994). Assessment of musculoskeletal and other health complaints in female hospital staff. Applied Ergonomics, 25(2), 101-105.

Bru E, Mykletun RJ, Svebak S (1996). Work-related stress and musculoskeletal pain among female hospital staff. Work and Stress, 10(4), 309-321.

Burdorf A (1992). Exposure assessment of risk factors for disorders of the back in occupational epidemiology. Scandinavian Journal of Work, Environment and Health, 18, 1 - 9.

Burdorf A (1995). Reducing random measurement error in assessing postural load on the back in epidemiologic surveys. Scandinavian Journal of Work Environment and Health, 21(1), 15 - 23.

Burdorf A and Sorock G (1997). Positive and negative evidence of risk factors for back disorders. Scandinavian Journal of Work, Environment and Health, 23(4), 243-256.

Burdorf A, Laan J (1991). Comparison of methods for the assessment of postural load on the back. Scandinavian Journal of Social Medicine, 17, 425-429.

Burdorf A, Rossignol M, Fathallah F, Snook SH, Herrick RF (1997). Challenges in assessing risk factors in epidemiologic studies on back disorders. American Journal of Industrial Medicine, 32, 142-152.

Burt, S (1998). Gender and upper extremity musculoskeletal disorders: confounding with workplace risk factors. 3rd International Conference on Prevention of Work-Related Musculoskeletal Disorders, Helsinki, Finland. September 21-25, 1998

Cahill J, Landsbergis PA (1996). Job strain among post office mailhandlers. International Journal of Health Services, 26(4), 731-750.

Cannon LJ, Bernacki EJ, Walter SD (1981). Personal and occupational factors associated with carpal tunnel syndrome. Journal of Occupational Medicine, 23(4), 255-258.

Caplan RD, Cobb S, French JRP, Harrison RV, Pinneau SR (1975). Job demands and worker health. Washington, DC: Government Printing Office. US Department of Health Education and Welfare Publication No. (NIOSH) 75-160.

Carayon P (1995). Chronic effect of job control, supervisor support and work pressure on office worker stress. In Sauter SL, Murphy LR (eds), Organizational Risk Factors For Job Stress. American Psychological Association: Washington DC.

Carayon P, Yang C-L, Lim S-L (1995). Examining the relationship between job design and worker strain over time in a sample of office workers. Ergonomics, 38(6), 1199-1211.

Carlisle C, Baker GA, Riley M, Dewey M (2994). Stress in midwifery: A comparison of midwives and nurses using the Work Environment Scale. International Journal of Nursing Studies, 31(1), 13-22.

Cato C, Olson DK, Studer M (1989). Incidence, prevalence, and variables associated with low back pain in staff nurses. AAOHN, 37(8), 321-327.

Chen PY, Spector PE (1991). Negative affectivity as the underlying case of correlations between stressors and strain. Journal of Applied Psychology, 76, 398-407.

Chiang H, Ko Y, Chen S, Yu H, Wu T, Chang P (1993). Prevalence of shoulder and upper-limb disorders among workers in the fish-processing industry. Scandinavian Journal of Work Environment and Health, 19(2), 126–131.

Choi BCK, Levitsky M, Lloyd RD, Stones IM (1996). Patterns and risk factors for sprains and strains in Ontario, Canada 1990: an analysis of the workplace health and safety agency data base. Journal of Occupational and environmental Medicine, 38, 379-389.

Cioffi D (1996). Somatic interpretation in cumulative trauma disorders: A social cognitive analysis. In S Moon and S Sauter (eds), Beyond Biomechanics: Psychosocial Aspects of Musculoskeletal Disorders in Office Work. London: Taylor and Francis.

Cox S, Cox T, Thirlaway M (1982). Effects of simulated repetitive work on urinary catecholamine excretion. Ergonomics, 25, 1129-1141.

Cummings K, Maizlish N, Rudolph L, Dervin K, Ervin A (1989). Occupational disease surveillance: carpal tunnel syndrome. MMWR, 38, 485-489.

Cust G, Pearson JCG, Mair A (1972). The prevalence of low back pain in nurses. International Nurses Review, 19, 169.

Daltroy LH, Larson MG, Wright EA, Malspeis S, Fossel AH, Ryan J, Zwerling C, Liang MH (1991). A case-control study of risk factors for industrial low back injury: implications for primary and secondary prevention programs. American Journal of Industrial Medicine, 20, 505-515.

de Zwart BCH, Frings-Dresen MHW, van Dijk FJH (1995). Physical workload and the aging worker: a review of literature. International Archives of Occupational and Environmental Health, 68, 1-12.

Dehlin O, Berg S (1977). Back symptoms and psychological perception of work: a study among nursing aides in a geriatric hospital. Scandinavian Journal of Rehabilitative Medicine, 9, 61–65.

Dehlin O, Hedenrud B, Horal J (1976). Back symptoms in nursing aides in a geriatric hospital: an interview study with special reference to the incidence of low back symptoms. Scandinavian Journal of Rehabilitation Medicine, 8(2), 47-53.

deKrom MCT, Kester ADM, Knipschild PG, Spaans F (1990). Risk factors for carpal tunnel syndrome. American Journal of Epidemiology, 132(6), 1102–1110.

Deyo RA, Bass JE (1989). Lifestyle and low-back pain. The influence of smoking and obesity. Spine, 14(5), 501-506.

Deyo RA, Tsui-Wu YA (1987). Descriptive epidemiology of low-back pain and its related medical care in United States. Spine, 12, 327-333.

Eakin JM, McEachen E (1998). Health and the social relations of work: a study of the health-related experiences of employees in small workplaces. Sociology of Health and Illness, 20(6), 896-914.

Ekberg K, Bjorkqvist B, Malm P, Bjerre-Kiely B, Karlsson m, Axelson O (1994). Case control study of risk factors for disease in the neck and shoulder area. Occupational and Environmental Medicine, 51, 262-266.

Ekberg K, Karlsson M, Axelson O (1995). Cross-sectional study of risk factors for symptoms in the neck and shoulder area. Ergonomics, 38(5), 971 - 980.

Engels JA, van der Gulden JW, Senden TF, van't Hof B (1996). Work related risk factors for musculoskeletal complaints in the nursing profession: results of a questionnaire survey. Occupational and Environmental Medicine, 53(9), 636-41.

Engels JA, van der Gulden JWJ, Senden ThF, Hertog CAWM, Kolk JJ, Binkhorst RA. (1994). Musculoskeletal complaints and physical workload among the nursing staff in nursing-homes. Journal of Occupational Medicine, 36, 338-346.

English CJ, Maclaren WM, Court-Brown C, Hughes SPF, Porter RW, Wallace WA, Graves RJ, Pethick AJ, Soutar CA (1995). Relationship between upper limb soft tissue disorders and repetitive movements at work. American Journal of Industrial Medicine, 27(1), 75-90.

Estlander A-M, Takala E-P, Viikari-juntura E (1998). Do psychological factors predict changes in musculoskeletal pain? A prospective, two-year follow-up study of a working population. Journal of Occupational and Environmental Medicine, 40(5), 445-453.

Estryn-Behar M, Kaminski M, Peigne E, Maillard MK, Pelletier A, Berthier C, Delaporte MF, Paoli MC, Lerous JM (1990). Strenuous working conditions and musculo-skeletal disorders among female hospital workers. International Archives of Environmental Health, 62, 47 – 57.

Faucett J, Rempel D (1994). VDT-related musculoskeletal symptoms: interactions between work posture and psychosocial work factors. American Journal of Industrial Medicine, 26, 597-612.

Ferreira M, de Souza Conceição GM, Saldiva PHN (1997). Work organization is significantly associated with upper extremities musculoskeletal disorders among employees engaged in interactive computer-telephone tasks of an international back subsidiary in São Paulo, Brazil. American Journal of Industrial Medicine, 31, 468-473.

Feyer A-M, Williamson A, Mandryk J, de Silva I, Healy S (1992). Role of psychosocial risk factors in work-related low-back pain. Scandinavian Journal of Work Environment and Health, 18, 368-375.

Foppa I, Noack RH (1996). The relation of self-reported back pain to psychosocial, behavioral, and health-related factors in a working population in Switzerland. Social Science and Medicine, 43(7), 1119 - 1126.

Fox M, Dwyer DJ, Ganster DC (1993). Effects of stressful job demands and control on physiological and attitudinal outcomes in a hospital setting. Academy of Management Journal, 36(2), 289-318.

Frank J, Brooker A-S, Demaio S, Kerr M, Maetzel A, Shannon H, Sullivan T, Norman R, Wells R (1996). Disability resulting from occupational low back pain: Part II: What do we know about secondary prevention? A review of the scientific evidence on prevention after disability begins. Spine, 21(24), 2918-2929.

Frankenhaeuser M, Gardell B (1976). Overload and underload in working life: outline of a multidisciplinary approach. Journal of Human Stress, 2, 35-46.

Frankenhaeuser M, Johannsen G (1976). Task demand as reflected in catecholamine excretion and heart rate. Journal of human Stress, 2, 15-23.

Frankenhaeuser M, Johanssen G (1986). Stress at work: psychobiological and psychosocial aspects. International Review of Applied Psychology, 35, 287-299.

Frankenhaeuser M, Lundberg C, Forsman L (1980). Dissociation between sympathetic-adrenal and pituitary-adrenal responses to an achievement situation characterized by high controllability: comparison between Type A and Type B males and females. Biological Psychology, 10, 79-91.

Fransson-Hall C, Bystrom S, Kilbom A (1995). Self-reported physical exposure and musculoskeletal symptoms of the forearm-hand among automobile assembly-line workers. Journal of Occupational and Environmental Medicine, 37(9), 1136–1144.

Frome EL, Checkoway H (1985). Epidemiologic programs for computers and calculators: use of Poisson regression models in estimating incidence rates and ratios. American Journal of Epidemiology, 121, 309-323.

Fuortes LJ, Shi Y, Zhang M, Zwerling C, Schootman M (1994). Epidemiology of back injury in university hospital nurses from review of workers' compensation records and a case-control survey. Journal of Occupational Medicine, 36(9), 1022-1026.

Gardell B, Aronsson G, Barklof K (1982). The Working Environment for Local Public Transport Personnel. Report from the Swedish Work Environment Fund: Stockholm, Sweden. In G Aronsson (1989). Dimensions of control as related to work organization stress and health. International Journal of health Services, 19(3), 459-468.

Gerdle B, Brulin C, Elert J, Granlund B (1994). Factors interacting with perceived work related complaints in the musculoskeletal system among home care service personnel. Scandinavian Journal of Rehabilitation Medicine, 32 (Supplement), 51-58.

Gerr F, Marcus M, Ortiz DJ (1996). Methodological limitations in the study of video display terminal use and upper extremity musculoskeletal disorders. American Journal of Industrial Medicine, 29, 649-656.

Gibson ES (1994). Trying to explain the unexplainable: a conceptual model for low back disability. Annual Scientific Meeting Occupational and Environmental Medical Association Canada, Montreal, Canada.

Gomer F, Silverstein LD, Berg WK, Lassiter DL (1987). Changes in electromyographic activity associated with occupational stress and poor performance in the workplace. Human Factors, 29(20, 131-143.

Griffin P, Alcock D, Emmerson L, Quintero T (1989). Nurses' perceptions of their work environment: organizational change on an adolescent unit. Canadian Journal of Nursing Administration, 2, 19-23.

Gundewall B, Liljeqvist M, Hansson T (1993). Primary prevention of back symptoms and absence from work. Spine, 18(5), 587-594.

Hacker W (1994). Action regulation theory and occupational psychology. Review of German empirical research since 1987. The German Journal of Psychology, 18, 91-120.

Hagberg M, Morgenstern H, Kelsh M (1992). Impact of occupations and job tasks on the prevalence of carpal tunnel syndrome. Scandinavian Journal of Work Environment and Health, 18(6), 337– 345.

Hagberg M, Silverstein B, Wells R, Smith MJ, Hendrick HW, Carayon P, Perusse M (1995). Work Related Musculoskeletal Disorders (WMSDs): A Reference Book for Prevention. Taylor and Francis: London.

Hales TR, Bernard BP (1996). Epidemiology of work-related musculoskeletal disorders. Orthopedic Clinics of North America, 27(4), 679 – 709.

Hales TR, Sauter SL (1992). Hazard evaluation and technical assistance report: US West Communications, Phoenix, AZ; Minneapolis , MN; Denver, CO, Cincinnati, OH: US Department of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH Report NO HHE 89-299-2230.

Hales TR, Sauter SL, Peterson MR, Fine LJ, Putz-Anderson V, Schleifer LR, Ochs TT, Bernard BP (1994). Musculoskeletal disorders among visual display terminal users in a telecommunications company. Ergonomics, 37(10), 1603 - 1621.

Harber P, Billet E, Gutowski RN, SooHoo K, Lew M, Roman A (1985). Occupational low-back pain in hospital nurses. Journal of Occupational Medicine, 27, 518-524.

Harber P, Pena L, Hsu P, Billet E, Greer D, Kim K (1994). Personal history, training and worksite as predictors of back pain in nurses. American Journal of Industrial Medicine, 25, 519 - 526.

Harenstam A, Theorell T (1990). Cortisol elevation and serum γ-glutamyl transpeptidase in response to adverse job conditions: how are they interrelated? Biological Psychology, 31, 157-171.

Health Canada (1997). Economic Burden of Illness in Canada 1993. Health Canada: Ottawa, Ontario.

Health Sciences Centre (1996). Injury Statistics 1995/1996. Department of Occupational and Environmental Medicine, Community Health Sciences. Winnipeg, Manitoba.

Heap D (1987). Low back injuries in nursing staff. Journal of Social and Occupational Medicine, 37, 66-70.

Heliövaara M, Mäkelä M, Knekt P, Impivaara O, Aromaa A (1991). Determinants of sciatica and low back pain. Spine, 16(6), 608–614.

Hemingway H, Shipley MJ, Stansfeld S, Marmot M. (1997). Sickness absence from back pain, psychosocial work characteristics and employment grade among office workers. Scandinavian Journal of Work Environment and Health, 23(2), 121-129.

Heuer H, Klimmer F, Kylian H, Seeber A, Schmidt KH (1996). Musculoskeletal problems in bricklayers as a function of length of employment: the role of secondary selection by low-back pain. Work and Stress, 10(4), 322-335.

Hildebrandt VH, Bongers PM, Dul J, van Dijk FJ, Kemper HC (1996). Identification of high-risk groups among maintenance workers in a steel company with respect to musculoskeletal symptoms and workload. Ergonomics, 39(2), 232-242.

Hoekstra EJ, Hurrell JJ, Swanson NG (1994). Hazard evaluation and technical assistance report: Social Security Administration Teleservice Centers, Boston, MA; Fort Lauderdale, FL. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH Report No. 92–0382–2450.

Holmström EB, Lindell J, Moritz U (1992). Low back and neck/shoulder pain in construction workers: occupational workload and psychosocial risk factors. Part II: Relationship to neck and shoulder pain Spine, 17(6), 672–677.

Holmström EB, Lindell J, Moritz U (1992). Low back and neck/shoulder pain in construction workers: occupational workload and psychosocial risk factors. Part I: relationship to low back pain. Spine, 17(6), 663–671.

Holness DL, Beaton D, House RA (1998). Prevalence of upper extremity symptoms and possible risk factors in workers handling paper currency. Occupational Medicine, 48(4), 231-236.

Hoogendoorn WE, Bongers PM, Koes BW (1998). Systematic review of risk factors for back disorders. 3rd International Conference on Prevention of Work-Related Musculoskeletal Disorders, Helsinki, Finland. September 21-25, 1998.

House J, Strecher V, Metzner H, Robbins CA (1986). Occupational stress and health among men and women in the Tecumseh Community Health Study. Journal of Health and Social Behaviour, 27, 62-77.

House JS, Landis KR, Umberson D (1988). Social relationships and health. Science, 241, 540-545.

Houtman ILD, Bongers PM, Smulders PGW, Kompier MAJ (1994). Psychosocial stressors at work and musculoskeletal problems. Scandinavian Journal of Work Environment and Health, 20(2), 139-145.

Hughes RE, Silverstein BA, Evanoff BA (1997). Risk factors for work-related musculoskeletal disorders in an aluminium smelter. American Journal of Industrial Medicine, 32(1), 66-75

Hurrell JJ, Murphy LR (1992). Psychological job stress. In: ROM WN (ed). Environmental and occupational medicine (2nd edition). New York, NY: Little, Brown and Company.

Insel PM and Moos RH (1974). Work Environment Scale. Palo Alto, California: Consulting Psychologists Press.

Jensen RC (1986). Work-related back injuries among nursing personnel in New York. Proceedings of the Human Factors Society 30th Annual Meeting.

Jensen RC (1990). Back injuries among nursing personnel related to exposure. Applied Occupational and Environmental Hygiene, 5, 38–45.

Johansson G, Aronsson G, Lindstrom BO (1978). Social psychological and neuroendocrine stress reactions in highly mechanised work. Ergonomics, 21(8), 583-399.

Johansson JA (1995). Psychosocial work factors, physical workload and associated musculoskeletal symptoms among home care workers. Scandinavian Journal of Psychology, 36, 113-129.

Johansson JA, Rubenowitz S (1994). Risk indicators in the psychosocial and physical work environment for work-related neck, shoulder and low back symptoms: a study among blue- and white-collar workers in eight companies. Scandinavian Journal of Rehabilitation Medicine, 26, 131-142.

Johnson JV (1991). Collective control-strategies for survival in the workplace. In JV Johnson and G Johansson (eds), The Psychosocial Work Environment. Work Organization, Democratization and Health.. Baywood, New York.

Johnson JV, Hall EM (1988). Job strain, workplace social support and cardiovascular disease: a cross-sectional study of a random sample of Swedish workers. American Journal of Public Health, 78, 1336-1342.

Johnson JV, Stewart W (1993). Measuring work organization exposure over the life course with a job-exposure matrix. Scandinavian Journal of Work Environment and Health, 19, 21-28.

Johnson JV, Stewart W, Hall EM, Fredlund P, Theorell T (1996). Long-term psychosocial work environment and cardiovascular mortality among Swedish men. American Journal of Public Health, 86(3), 324-331.

Jonsson BG, Persson J, Kilbom A (1988). Disorders of the cervicobrachial region among female workers in the electronics industry: a two-year follow-up. International Journal of Industrial Ergonomics, 3(1), 1–12.

Josephson M, Lagerström M, Hagberg M and Wigaeus Hjelm E (1997). Musculoskeletal symptoms and job strain among nursing personnel: a study over a three year period. Occupational and Environmental Medicine, 54, 681-685.

Josephson M, Vingård E, MUSIC-Norrtälje Study Group (1998). Workplace factors and care seeking for low-back pain among female nursing personnel. Scandinavian Journal of Work Environment and Health, 24(6), 465-472.

Kamwendo K, Linton, SJ, Moritz U (1991). Neck and shoulder disorders in medical secretaries. Part I. Pain prevalence and risk factors. Scandinavian Journal of Rehabilitation Medicine, 23(3), 127–33.

Kamwendo K, Linton, SJ, Moritz U (1991). Neck and shoulder disorders in medical secretaries. Part II. Ergonomical work environment and symptom profile. Scandinavian Journal of Rehabilitation Medicine, 23(3), 135–142

Karasek R (1985). Job content questionnaire. Department of Industrial and Systems Engineering University of Southern California: Los Angeles.

Karasek RA (1979). Job demands, job decision latitude and mental strain: implications for job redesign. Administrative Science Quarterly, 24, 285-307.

Karasek R, Baker D, Marxer F, Ahlbom A, Theorell T (1981). Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. American Journal of Public Health, 71(7), 694 - 705.

Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B (1998). The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. Journal of Occupational Health Psychology, 3(4), 322-355.

Karasek RA, Gardell B, Lindell J (1987). Work and non-work correlates of illness and behaviour in male and female Swedish white-collar workers. Journal of Occupational Behaviour, 8(3), 187– 207.

Karasek R, Theorell T (1990). Healthy Work: Stress, Productivity and the Reconstruction of Working Life. Basic Books: Washington, USA.

Karasek R, Theorell T, Schwartz JE, Schnall PL, Pieper CF, Michela JL (1988). Job characteristics in relation to the prevalence of myocardial infarction in the US Health Examination Survey (HES) and the Health and Nutrition Examination Survey (HANES). American Journal of Public Health, 78(8), 910-918.

Kelsey JL, Githens PB, White AA, Holford TR, Walter SD, O'Connor T, Ostfeld Am, Weil U, Southwick WO, Calogero JA (1984). An epidemiologic study of lifting and twisting on the job and risk for acute prolapsed lumbar intervertebral disc. Journal of Orthaepedic Research, 2(1), 61-66.

Kelsey JL, Golden AL (1988). Occupational and workplace factors associated with low back pain. Occupational Medicine: State of the Art Reviews, 3(1), 7 - 16.

Kerr MS (1998). A case-control study of biomechanical and psychosocial risk factors for low-back pain reported in an occupational setting. PhD thesis, University of Toronto.

Kilbom Å (1994). Assessment of physical exposure in relation to work-related musculoskeletal disorders - what information can be obtained from systematic observations? Scandinavian Journal of Work Environment and Health, 20 (special issue), 30-45.

Kilbom A, Persson J (1987). Work technique and its consequences for musculoskeletal disorders. Ergonomics, 30(2), 273-279.

Klaber Moffett J, Hughes G, Griffiths P (1993). A longitudinal study of low back pain in student nurses. International Journal of Nursing Studies, 30(3), 197-212.

Knibbe JJ, Friele RD (1996). Prevalence of back pain and characteristics of the physical workload of community nurses. Ergonomics, 39(2), 186 – 198.

Kobayashi F, The Japan Work Stress and Health Cohort Study Group (1999). Job stress, depressive symptoms and sick absence in Japan. Work, Stress and Health: Organization of Work in a Global Economy Conference, Baltimore. March 11-13, 1999.

Krause N, Ragland DR, Fisher JM, Syme SL (1998), Psychosocial job factors, physical workload and incidence of work-related spinal injury: a 5 year prospective study of urban transit operators. Spine, 23(23), 2507-2516.

Kuhn L, Davidson LL, Durkin MS (1994). Use of Poisson regression and time series analysis for detecting changes over time in rates of child injury following prevention program. American Journal of Epidemiology, 140(10), 943 - 955.

Kuwashima A, Aizawa Y, Nakamura K, Taniguchi S, Watanabe M (1997). National survey on accidental low back pain in workplace. Industrial Health, 35, 187 – 193.

Lagerström M, Hansson T, Hagberg M (1998). Work-related low-back problems in nursing. Scandinavian Journal of Work Environment and Health, 24(6), 449-464.

Lagerström M, Wenemark M, Hagberg M, Wigaeus Hjelm E, the Moses Study Group (1995). Occupational and individual factors related to musculoskeletal symptoms in five body regions among Swedish nursing personnel. International Archives of Occupational and Environmental Health, 68, 27-35.

Landsbergis PA, Schnall PL, Warren K, Pickering TG, Schwartz JE (1994). Association between ambulatory blood pressure and alternative formulations of job strain. Scandinavian Journal of Work Environment and Health, 20, 349 - 363.

Landsbergis PA, Schnall PL, Warren K, Pickering TG, Schwartz JE (1999). The effect of job strain on ambulatory blood pressure in men: does it vary by age, hypertensive status, social support or socio-economic status? Work, Stress and Health: Organization of Work in a Global Economy Conference, Baltimore. March 11-13, 1999.

Landsbergis PA, Schnall PLL, Schwartz JE, Warren K, Pickering T (1995). Job strain, hypertension and cardiovascular disease: empirical evidence, methodological issues and recommendations for future research. In Sauter SL, Murphy LR (eds), Organizational Risk Factors for Job Stress. American Psychological Association: Washington, DC.

Larese F, Fiorito A (1994). Musculoskeletal disorders in hospital nurses: a comparison between two hospitals. Ergonomics, 37(7), 1205 - 1211.

Lee Y-H, Chiou W-K (1994). Risk factors for low back pain, and patient handling capacity of nursing personnel. Journal of Safety Research, 25(3), 135-145.

Leigh JP (1991). Employee and job attributes as predictors of absenteeism in a national sample of workers: the importance of health and dangerous working conditions. Social Science in Medicine, 33, 127-137

Leigh JP, Sheetz RM (1989). Prevalence of back pain among fulltime United States workers. British Journal of Industrial Medicine, 46, 651-657.

Leino P, Aro S, Hasan J (1987). Trunk muscle function and low back disorders: a ten-year follow-up study. Journal of Chronic Disease, 400(4), 289-296.

Leino PI, Hänninen V (1995). Psychosocial factors at work in relation to back and limb disorders. Scandinavian Journal of Work Environment and Health, 21(2), 134-142.

Liira JP, Shannon HS, Chambers LW, Haines TA (1996). Long-term back problems and physical work exposures in the 1990 Ontario Health Survey. American Journal of Public Health, 86(3), 382-387.

Lim S-Y, Sauter SL, Swanson NG (1997). Musculoskeletal disorders. In JM Stellman (ed), Encyclopaedia of Occupational Health and Safety. International Labour Office: Geneva, Switzerland.

Linton SJ (1990). Risk factors for neck and back pain in a working population in Sweden. Work and Stress, 4(1), 41-49.

Linton SJ, Kamvendo K (1989). Risk factors in the psychosocial work environment for neck and shoulder pain in secretaries. Journal of Occupational Medicine, 31(7), 609–613.

Lundberg U, Frankenhaeuser M (1980). Pituitary-adrenal and sympathetic-adrenal correlation of distress and effort. Journal of Psychosomatic research, 24, 125-130.

Lundberg U, Granqvist M, Hansson T, Magnusson M, Wallin L (1989). Psychological and physiological stress responses during repetitive work at an assembly line. Work & Stress, 3(2), 143-153.

Lundberg U, Kadefors R, Melin B, Palmerud G, Hassmen P, Engstrom M, Elfsberg Dohns I (1994). Psychophysiological stress and EMG activity of the trapezius muscle. International Journal of Behavioural Medicine, 1, 354-3700.

Lundberg U, Kadefors R, Melin B, Palmerud G, Hassmen P, Engstrom M, Elfsberg Dohns I (1994). Stress, muscular tension and musculoskeletal disorders. International Journal of Behavioural Medicine, 1, 354-370.

Magni G, Caldieron C, Rigatti-Luchini S, Merskey H (1990). Chronic musculoskeletal pain and depressive symptoms in the general population: an analysis of the 1st National Health and Nutrition Examination Survey data. Pain, 43, 299-307.

Magnusson ML, Pope MH, Wilder DG, Areskoug B (1996). Are occupational drivers at an increased risk for developing musculoskeletal disorders? Spine, 21(6), 710-7177.

Magora A (1973). Investigation of the relation between low back pain and occupation. IV. Physical requirements: bending, rotation, reaching, and sudden maximal effort. Scandinavian Journal of Rehabilitation Medicine, 5, 191–196.

Mäkelä M, Heliövaara M, Sievers K, Impivaara O, Knekt P, Aromma A (1991). Prevalence, determinants and consequences of chronic neck pain in Finland. American Journal of Epidemiology, 134(11), 1356-1367.

Mandel JH, Lohman W (1987). Low-back pain in nurses: the relative importance of medical history, work factors, exercise and demographics. Research in Nursing Health, 10, 165-170.

Marcus M, Gerr F (1996). Upper extremity musculoskeletal symptoms among female office workers: associations with video display terminal use and occupational psychosocial stressors. American Journal of Industrial Medicine, 29(2), 161–170.

Marras WS, Lavender SA, Leurgans SE, Rajulu SL, Allread WG, Fathallah FA, Ferguson SA (1993). The role of dynamic three-dimensional trunk motion in occupationally related low back disorders. Spine, 18, 617-628.

McAbee RR (1988). Nurses and back injuries: A literature review. AAOHN Journal, 36(5), 200-209.

Meijman TF, vanDormolen M, Herber RFM, Rongen H, Kuiper S (1995). Job strain, neuroendocrine activation and immune status. In Sauter SL, Murphy LR (eds), Organizational Risk Factors for Job Stress. American Psychological Association: Washington DC.

Moens G, Dohogne T, and Jacques P (1993). Prevalence of back pain among health care workers in Hagber M, Hofmann F, Stossel U and Westlander G (eds). Occupational Health for Health Care Workers. Landsberg: Ecomed.

Molumphy M, Unger B, Jensen GM, Lopopolo RB (1985). Incidence of work-related low back pain in physical therapists. Physical Therapy, 65, 482-486.

Moore A, Wells R, Ranney D (1991). Quantifying exposure in occupational manual tasks with cumulative trauma disorder potential. Ergonomics, 34(12), 1433-1453.

Moore B, vanSonnenberg, Casola G, Novelline RA (1994b). The relationship between back pain and lead apron use in radiologists. American Journal of Radiology, 158, 191-193.

Moore R, Mao Y, Zhang J, Clarke K (1997). Economic burden of illness in Canada, 1993. Ottawa, Health Canada.

Moos RH (1986). Work Environment Scale Manual (2nd editions). Palo Alto, California: Consulting Psychologists Press.

Mostardi R, Noe D, Kovacik M, Porterfield J (1992). Isokinetic lifting strength and occupational injury: a prospective study. Spine, 17(2), 189-193.

Muntaner C, O'Campo PJ (1993). A critical appraisal of the demand/control model of the psychosocial work environment: epistemological, social, behavioral and class considerations. Social Science and Medicine, 36(11), 1509 - 1517.

Murphy LR (1985). Individual coping strategies. In Cl Cooper and MJ Smith (eds), Job Stress and Blue-Collar Work. Chichester, England: John Wiley.

Netterstrom B, Sjol A (1991). Glycated haemglobin as an indicator of job strain. Stress Medicine, 7, 113-118.

Niedhammer I, Lert F, Marne M (1994). Back pain and associated factors in French nurses. International Archives of Occupational and Environmental Health, 66, 349-357.

Norman RW (1994). Occupational Injury: Is it a psychosocial or biomechanical issue? International Perspectives, 1, 44-47.

Norman R, Wells R, Neumann P, Frank J, Shannon H, Kerr M, Ontario Universities Back Pain Study (OUBUS) Group (1998). A comparison of peak vs. cumulative physical work exposure risk factors for the reporting of low back pain in the automotive industry. Clinical Biomechanics, 13, 561-573.

Occupational Health and Safety Administration (OSHA) (1995). Description of OSHA's Workplace Risk Factor Checklist (DRAFT). US Department of Labor: Washington, DC.

Oesterreich R, Volpert W (1986). Task analysis for work design on basis of action regulation theory. Ergonomic and Industrial Democracy, 7, 503-527.

Ohlsson K, Attewell R, Paisson B, Karlsson B, Balogh I, Johnsson B, Ahlm A, Skerfving S (1995). Repetitive industrial work and neck and upper limb disorders in females. American Journal of Industrial Medicine,27(5), 731–747.

Ohlsson K, Attewell R, Skerfving S (1989). Self-reported symptoms in the neck and upper limbs of female assembly workers. Scandinavian Journal of Work Environment and Health, 15(1), 75–80.

Ono Y, Lagerström M, Hagberg M, Linden A, Malker B (1995). Reports of work related musculoskeletal injury among home care service workers compared with nursery school workers and the general population of employed women in Sweden. Occupational and Environmental Medicine, 52, 686 – 693.

Osorio AM, Ames RG, Jones J, Castorina J, Rempel D, Estrin W, Thompson D (1994). Carpal tunnel syndrome among grocery store workers. American Journal of Industrial Medicine, 25(2), 229–245.

Owen BD (1986). Personal characteristics important to back injuries. Rehabilitation Nursing, 11, 12-16.

Payne RL, Fletcher B (1983). Job demands, supports and constraints as predictors of psychological strain among schoolteachers'. Journal of Vocational Behaviour, 22, 136-147.

Pieper C, LaCroix AZ, Karasek RA (1989). The relation of psychosocial dimensions of work with coronary heart disease risk factors: a meta-analysis of five United States data bases. American Journal of Epidemiology, 129 (3), 483-494.

Pietri F, Leclerc A, Boitel L, Chastang JF, Morcet JF, Blondet M (1992). Low back pain in commercial travellers. Scandinavian Journal of Work Environment and Health, 18, 52-58.

Pike I, Russo A, Berkowitz J, Baker JP, Lessoway VA (1997). The prevalence of musculoskeletal disorders among diagnostic medical sonographers. Journal of Diagnostic Medical Sonography, 13(5), 219-227.

Polanyi MF, Cole DC, Beaton DE, Chung J, Wells R, Abdolell M, Beech-Hawley L, Ferrier SE, Mondloch MC, Shields SA, Smith JM, Shannon HS (1997). Upper limb work-related musculoskeletal disorders among newspaper employees. American Journal of Industrial Medicine, 32(6), 620-628.

Pollack ES and Keimig DG, (1991). Counting Injuries and Illnesses in the Workplace; Proposals for a Better System. Washington, DC: National Academy Press.

Pope MH (1989). Risk indicators in low back pain. Annals of Medicine, 21, 387-392.

Pot F, Padmos P, Brouwers A (1987). Determinants of the VDU operator's well-being. In Knave B, Wideback PG (eds) Work with display units. Selected papers from the International Scientific Conference on Work with Display Units, Stockholm, Sweden, May 12–15, 1986. Amsterdam: Elsevier Science Publishers BV, 16–25.

Prezant B, Demers P, Strand K (1986). A cross-sectional descriptive questionnaire study of ergonomic stressors, back problems and training experience among nurses. Proceedings of the Annual Conference of the Human Factors Association Canada, 19th Annual Conference, Vancouver, British Columbia, 177-180.

Punnett L (1987). Upper extremity musculoskeletal disorders in hospital workers. The Journal of Hand Surgery, 12A (5 part 2), 858-862.

Punnett L (1998). Ergonomic stressors and upper extremity disorders in vehicle manufacturing: cross sectional exposure-response trends. Occupational Environmental Medicine, 55, 414-420.

Punnett L, Fine LJ, Keyserling WM, Herrin GD, Chaffin DB (1991). Back disorders and non-neutral trunk postures of automobile assembly workers. Scandinavian Journal of Work Environment and Health, 17(5), 337–346.

Punnett L, Robins JM, Wegman DH, Keyserling WM (1985). Soft tissue disorders in the upper limbs of female garment workers. Scandinavian Journal of Work Environment and Health, 11, 417-425.

Ready AE, Boreskie SL, Law SA, Russell R (1993). Fitness and lifestyle parameters fail to predict back injuries in nurses. Canadian Journal of Applied Physiology, 18(1), 80 - 90.

Reed DM, LaCroix AZ, Karasek RA, Miller DW and MacLean CA (1989). Occupational strain and the incidence of coronary heart disease. American Journal of Epidemiology, 129(3), 495-502.

Revicki DA, May HJ (1989). Organizational characteristics, occupational stress and mental health in nurses. Behavioural Medicine, 15, 30-36.

Revicki DA, Whitley TW (1995). Work-related stress and depression in emergency medicine residents. In Sauter SL, Murphy LR (eds), Organizational Risk Factors For Job Stress. American Psychological Association: Washington DC.

Revicki DA, Whitley TW, Landis SS, Allison AJ (1988). Organizational characteristics, occupational stress and depression in rural emergency medicine technicians. Journal of Rural Health, 4, 73-83.

Riihimäki H, Tola S, Videman T, Hänninen K (1989a). Low-back pain and occupation: a cross-sectional questionnaire study of men in machine operating, dynamic physical work and sedentary work. Spine, 14, 204-209.

Riihimäki H, Wickström G, Hänninen K, Luopajarvi T (1989). Predictors of sciatic pain among concrete reinforcement workers and house painters: a five-year follow-up. Scandinavian Journal of Work Environment and Health, 15(6), 415– 423.

Rissler A (1977). Stress reactions at work and after work during a period of quantitative overload. Ergonomics, 20, 13-16.

Rossignol M, Baetz J (1987). Task-related risk factors for spinal injury: validation of a self-administered questionnaire on hospital employees. Ergonomics, 30, 1531-1540.

Rydén LA, Molgaard CA, Bobbitt S, Conway J (1989). Occupational low-back injury in a hospital employee population: an epidemiologic analysis of multiple risk factors of a high-risk occupational group. Spine, 14, 315–320.

Sauter SL, Gottlieb MS, Jones KC, Dodson VN, Rohrer KM (1983). Job and health implications of VDT use: initial results of the Wisconsin-NIOSH study. Communication of the ACM, 26(4), 284–294.

Sauter SL, Murphy LR (eds) (1995). Organizational risk factors for job stress. American Psychological Association: Washington DC.

Sauter SL, Swanson NG (1996). An ecological model of musculoskeletal disorders in office work. In Moon S, Sauter S (eds). Beyond Biomechanics: Psychosocial Aspects of Musculoskeletal Disorders in Office Work. London, England: Taylor and Francis.

Sauter SL, Swanson NG (1996). Psychological aspects of musculoskeletal disorders in office work. In Moon S, Sauter S (eds). Psychosocial Factors and Musculoskeletal Disorders. London, England: Taylor and Francis.

Schibye B, Skov T, Ekner D, Christiansen J, Sjogaard G (1995). Musculoskeletal symptoms among sewing machine operators. Scandinavian Journal of Work Environment and Health, 21, 427–434.

Schierhout GH, Myers JE, Bridger RS (1993). Musculoskeletal pain and workplace ergonomic stressors in manufacturing industry in South Africa. International Journal of Industrial Ergonomics, 12, 3-11.

Schnall PL, Landsbergis PA, Baker D (1994). Job strain and cardiovascular disease. Annual Review of Public Health, 15, 381–411.

Schnall PL, Landsbergis PA, Warren K, Pickering TG, Schwartz JE (1999). The effect of job strain on ambulatory blood pressure in men: results of six years of follow-up. Work, Stress and Health: Organization of Work in a Global Economy Conference, Baltimore. March 11-13, 1999.

Schnall PL, Pieper C, Schwartz JE, Karasek RA, Schlussel Y, Devereauz RB, Ganau A, Alderman M, Warren K, Pickering TG (1990). The relationship between 'job strain', workplace diastolic blood pressure, and left ventricular mass index: results of a case-control study. JAMA, 263, 1929-1935.

Schwartz E (1987). Use of workers' compensation claims for surveillance of work-related illness-New Hampshire January 1986-March 1987. MMWR, 36, 713-720.

Schwartz JE, Pieper CF, Karasek RA (1988). A procedure for linking psychosocial job characteristics data to health surveys. American Journal of Public Health, 78, 904-909.

Silverstein BA, Fine LJ, Armstrong TJ (1986). Hand and wrist cumulative trauma disorders in industry. British Journal of Industrial Medicine, 43(11), 779–784.

Silverstein BA, Fine LJ, Armstrong TJ (1987). Occupational factors and the carpal tunnel syndrome. American Journal of Industrial Medicine, 11(3), 343– 358.

Silverstein BA, Stetson DS, Keyserling WM, Fine LJ (1997). Work-related musculoskeletal disorders: comparison of data sources for surveillance. American Journal of Industrial Medicine, 31, 600-608.

Skov T, Borg V, Orhede E (1996). Psychosocial and physical risk factors for musculoskeletal disorders of the neck, shoulders, and lower back in salespeople. Occupational and Environmental Medicine, 53, 351-356.

Skovron ML, Mulvihill MN, Sterling RC, Nordin M, Tougas G, Gallagher M, Speedling EJ (1987). Work organization and low back pain in nursing personnel. Ergonomics 30(2), 359-366.

Skovron ML, Szpalski M, Nordin M, Melot C, Cukier D (1994). Sociocultural factors and back pain: a population based study in Belgian adults. Spine, 19(2), 129-137.

Smedley J, Egger P, Cooper C, Coggon D (1995). Manual handling activities and risk of low back pain in nurses. Occupational and Environmental Medicine, 52, 160-163.

Smedley J, Egger P, Cooper C, Coggon D (1997). Prospective cohort study of predictors of incident low back pain in nurses. British Medical Journal, 314, 1225-1228.

Smedley J, Insjip H, Cooper C, Coggon D (1998). Natural history of low back pain: a longitudinal study of nurses. Spine, 23(22), 2422-2426.

Smith MJ, Carayon-Sainfort PC (1989). A balance theory of job design for stress reduction. International Journal of Industrial Ergonomics, 4, 67-79.

Sommerich CM, McGlothlin JD, Marras WS (1993). Occupational risk factors associated with soft tissue disorders of the shoulder: a review of recent investigations in the literature. Ergonomics 36(6), 697-717.

Spector PE (1987). Interactive effects of perceived control and job stressors on affective reactions and health outcomes for clerical workers. Work and Stress, 1, 155-162.

Statistics Canada, Labour Division (1992). Work Injuries 1989-1991. Ottawa, Ontario.

Steffy BD, Jones JW (1990). Differences between full-time and part-time employees in perceived role strain and work satisfaction. Journal of Organizational Behaviour, 11, 321-329.

Stobbe TJ, Plummer RW, Jensen RC, Attfield MD (1988). Incidence of low back injuries among nursing personnel as a function of patient lifting frequency. Journal of Safety Science, 19, 21-28.

Stock SR (1991). Workplace ergonomic factors and the development of musculoskeletal disorders of the neck and upper limbs: a meta -analysis. American Journal of Industrial Medicine, 19, 87 - 107.

Stout N, Bell C (1991). Effectiveness of source documents for identifying fatal occupational injuries: A synthesis of studies. American Journal of Public Health, 81, 725-728.

Stubbs DA (1986). Back pain and its relationship to manual handling. In Morrison D, Hartley L, Kemp D (eds), Trends in the Ergonomics of Work. Proceedings of the 23rd Annual Conference of the Ergonomics Society of Australia, 118–128.

Stubbs DA, Buckle PW, Hudson MP, Rivers PM, Worringham CJ (1983). Back pain in the nursing profession. I. Epidemiology and pilot methodology. Ergonomics, 26(8), 755-765.

Stubbs DA, Rivers PM, Hudson MP, Worringham CJ (1981). Back pain research. Nursing Times, May 14, 857-858.

Svebak S, Ursin H, Endresen I, Hjelmen AM, Apter MJ (1991). Back pain and the experience of strain, efforts and moods. Psychology and Health, 5, 307-314.

Svensson H, Andersson GBJ (1983). Low- back pain in 40- to 47-year old men: work history and work environment factors. Spine, 8, 272–276.

Svensson H, Andersson GBJ (1989). The relationship of low-back pain, work history and work environment, and stress: a retrospective cross-sectional study of 38- to 64-year old women. Spine, 14(5), 517–522.

Tanaka S, McGlothlin DJ (1993). A conceptual quantitative model for prevention of work related carpal tunnel syndrome (CTS). International Journal of Industrial Ergonomics, 11, 181-193.

Tanaka S, Wild DK, Seligman PJ, Halperin WE, Behrens VJ, Putz-Anderson V (1995). Prevalence of work-related carpal tunnel syndrome among U.S. workers: analysis of the occupational health supplement data of 1988 National Health Interview Survey. American Journal of Industrial Medicine, 27(4), 451–470.

Tattersall AJ, Farmer EW (1995). The regulation of work demands and strain. In Sauter SL, Murphy LR (eds), Organizational Risk Factors For Job Stress. American Psychological Association: Washington DC.

Theorell T, deFaire U, Johnson J, Hall E, Perski A, Stewart W (1991). Job strain and ambulatory blood pressure profiles. Scandinavian Journal of Work Environment and Health, 16, 74-79.

Theorell T, Harms-Ringdahl K, Ahlberg- Hultén G, Westin B (1991). Psychosocial job factors and symptoms from the locomotor system: a multicausal analysis. Scandinavian Journal of Rehabilitation Medicine, 23(3), 165–173.

Theorell T, Nordemar R, Michélsen H, Stockholm Music I Study Group (1993). Pain thresholds during standardized psychological stress in relation to perceived psychosocial work situation. Journal of Psychosomatic Research, 37(3), 299-305.

Theorell T, Tsutsumi A, Hallquist J, Reuterwall C, Higstedt C, Fredlund P, Emlund N, Johnson JV, SHEEP Study Group (1998). Decision latitude, job strain and myocardial infarction: a study of working men in Stockholm. American Journal of Public Health, 88(3), 382-388.

Tola S, Riihimäki H, Videman T, Viikari-Juntura E, Hänninen K (1988). Neck and shoulder symptoms among men in machine operating, dynamic physical work and sedentary work. Scandinavian Journal of Work Environment and Health, 14(5), 299–305.

Tsai SP, Gilstrap EL, Cowles SR, Waddell LC, Ross CE (1992). Personal and job characteristics of musculoskeletal injuries in an industrial population. Journal of Occupational Medicine, 34(6), 606-612.

Uchino BN, Cacioppo JT, Kiecolt-Glaser JK (1996). The relationship between social support and physiological processes: a review with emphasis on underlying mechanisms and implications for health. Psychological Bulletin, 119(3), 488-531.

Uhl JE, Wilkinson WE, Wilkinson CS (1987). Aching backs? A glimpse into the hazards of nursing. AAOHN Journal, 35(1), 13–17.

Unden A-L, Orth-Gomer K, Elofsson S (1991). Cardiovascular effects of social support in the work place: twenty-four hour ECG monitoring of men and women. Psychosomatic Medicine, 53, 50-60.

Ursin H, Endersen I, Ursin G (1988). Psychological factor and self-reports of muscle pain. European Journal of Applied Physiology, 57, 282-290.

van Poppel MNM, Koes BW, Deville W, Smid T, Bouter LM (1989). Risk factors for back pain incidence in industry. 3rd International Conference on Prevention of Work-Related Musculoskeletal Disorders, Helsinki, Finland. September 21-25, 1998.

Vanderpool HE, Friis EA, Smith BS, Harms KL (1993). Prevalence of carpal tunnel syndrome and other work-related musculoskeletal problems in cardiac sonographers. Journal of Occupational Medicine, 35(6), 604-610.

Veazie MA, Landen DD, Bender TR, Amandus HE (1994). Epidemiologic research on the etiology of injuries at work. Annual Review of Public Health, 15, 203-221.

Venning PJ, Walter SD, Stitt LW (1987). Personal and job related factors that are determinants of incidents of back injuries among nursing personnel. Journal of Occupational Medicine, 29, 820 - 825.

Videman T, Nurminen T, Tola S, Kuorinka I, Vanharanta H, Troup JDG (1984). Low-back pain in nurses and some loading factors of work. Spine, 9(4), 400–404.

Viikari-Juntura E, Riihimäki H, Tola S (1994). Neck trouble in machine operating, dynamic physical work and sedentary work: A prospective study on occupational and individual risk factors. Journal of Clinical Epidemiology, 47, 1411-1422.

Viikari-Juntura EJ, Vuori J, Silverstein B, Kalimo R, Kuosma E, Videman T (1991). A life-long prospective study on the role of psychosocial factors in neck-shoulder and low back pain. Spine, 16, 1056–1061.

Volpert W (1982). The model of the hierarchichal-sequential organization of action. In W Hacker, W Volpert, M von Cranach (eds), Cognitive and Motivational Aspects of Action. Amsterdam: North Holland.

Von Korff M (1994). Studying the natural history of back pain. Spine, 19(18S), 2041S-2046S.

Waddell G (1992). Biopsychosocial analysis of low back pain. Bailliere's Clinical Rheumatology, 6(3), 523-557.

Waersted M, Westgaard RH (1991). Working hours as a risk factor in the development of musculoskeletal complaints. Ergonomics 34(3), 265 - 276.

Westerling D, Jonsson B (1980). Pain from the neck-shoulder region and sick leave. Scandinavian Journal of Social Medicine, 8, 131-136.

Westgaard RH, Jansen T (1992). Individual and work-related factors associated with symptoms of musculoskeletal complaints II: different risk factors among sewing machine operators. British Journal of Industrial Medicine, 49, 154-162.

Westgaard RH, Jensen C, Kansen K (1993). Individual and work-related risk factors associated with symptoms of musculoskeletal complaints. International Archives of Occupational and Environmental Health, 64, 405 - 413.

Wickström G, Pentti J (1998). Occupational factors affecting sick leave attributed to low-back pain. Scandinavian Journal of Work, Environment and Health, 24(2), 145-152. (abstract)

Wiktorin C, Karlqvist L, Winkel J (1993). Validity of self-reported exposures to work postures and manual materials handling. Scandinavian Journal of Work Environment and Health, 19, 208-214.

Winkel J, Westgaard R (1992a). Occupational and individual risk factors for shoulder-neck complaints. International Journal of Industrial Ergonomics, 10, 1–20.

Winkel J, Westgaard R (1992b). Occupational and individual risk factors for shoulder-neck complaints. Part II: the scientific basis (literature review) for the guide. International Journal of Industrial Ergonomics, 10, 85–104.

Workers' Compensation Board of British Columbia (1996). Focus Report: Health Care Industry. WCB of BC: Richmond, BC.

Workers' Compensation Board of British Columbia (1998). Statistics for subclass 0626 1994-1998.

World Health Organization (1985). Identification and Control of Work Related Diseases. WHO Technical Report Series 714, Geneva.

Yassi A, Khokhar J, Tate R, Cooper J, Snow C, Vallentyne S (1995a). The epidemiology of back injuries in nurses at a large Canadian tertiary care hospital: implications for prevention. Occupational Medicine, 45(4), 215-220.

Yassi A, Sprout J, Tate R (1996). Upper limb repetitive strain injuries in Manitoba. American Journal of Industrial Medicine, 30, 461–472.

Yassi A, Tate R, Cooper JE, Snow C, Vallentyne S, Khokhar JB (1995b). Early intervention for back-injured nurses at a large Canadian tertiary care hospital: an evaluation of the effectiveness and cost benefits of a two-year pilot project. Occupational Medicine, 45(4), 209-214.

Zwerling C, Ryan J, Schootman M (1993). A case-control study of risk factors for industrial low back injury. The utility of preplacement screening in defining high-risk groups. Spine, 18(9), 1242-1247.

Appendix 1: Summary of Findings for Musculoskeletal Risk Factors: Review of Studies in the Health Care Sector

Table A17: Summary of Findings for Risk Factors Associated with Lower-body Musculoskeletal Outcomes: Review of Health Care Studies

Study	Lower-body Outcome	Population	Physical Demands Assessment	Control	Demands/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Symptoms	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Job Title/Work Area
Ahlberg Hultén 1995	Self-reported back pain	Nurses and nurses aides	Department	+	+	∅	+				∅		+		∅			∅						∅
Arad Ryan 1986	Self-reported back pain	Nurses	Self-reported lifts						+		-						+	+						
Bork et al 1996	Self-reported back pain	Physical therapists	Self-reported stressors									F							+					
Bru et al 1994, 1996	Self-reported musculo pain	21 hospital depart's	Perceived ergonomic load		+	+				+	+							+						
Cato et al 1989	Self-reported low back pain	Nurses	Self-reported factors				+				∅		+		+	∅	∅	∅	+					
Cust et al 1973	Self-reported low back pain	Nurses	Nursing speciality								+						∅	+	+					+
Dehlin et al 1976, 1977	Self-reported back symptoms	Nursing aides	Self-reported lifts			-	∅		+									+						
Engels et al 1996	Self-reported back complaints	Nurses	Self-reported physical demands		+			∅			∅	∅	∅				∅	∅	+	+			–	
Estryn-Behar et al 1990	Self-report and clinical back pain	Female hospital staff	Posture and lifting index-self reported								+/-	∅	∅	+		∅		+	+	+				
Feyer et al 1992	Self-reported low back pain	Nurses							∅															

Table A17 Continued:

Study	Lower-body Outcome	Population	Physical Demands Assessment	Control	Demands/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Symptoms	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Job Title/Work Area
Gerdle et al 1994	Self-reported musculo complaints	Home care personnel	Self-reported ergonomic factors			+			+		+		∅			+		∅						
Harber et al 1985	Self-reported low back pain	Nurses	Self-reported physical demands																					
Jensen 1985, 1986	Back injury reports	Nurses, LPNs, aides	Occupational title									∅							+					+
Johansson et al 1995	Self-reported low back symptoms	Home care workers	Self-reported physical demands	∅	∅	+				∅									+	+	∅			
Kamwendo et al 1991a/b	Self-reported back pain	Medical secretaries	Self-reported hrs of typing plus direct observations	+	∅	+				+														
Knibbe et al 1996	Self-reported back pain	Community nurses, aides	Self-report and observation																					
Lagerström et al 1995	Self-reported low back pain	Nursing personnel	Ward and occupation	∅	∅	+					∅				∅	+	∅							+
Larese and Fiorito 1994	Self-report and physical exam of back pain	Nurses	Department classification					+			+	∅	+					+	+	+				

Table A17 Continued:

Study	Lower-body Outcome	Population	Physical Demands Assessment	Control	Demands/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Symptoms	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Job Title/Work Area
Lee & Chiou 1994	Self-reported low back pain	Nurses	Simulated patient handling								+		+				∅		+				+	
Mandel & Lohman 1987	Self-reported low back pain	Nurses	Work area											+					+					∅
Molumphy et al 1985	Self-reported low back pain	Physical therapists	Self-reported postures								-	∅	-	+				-	+	+				+
Moore et al 1991	Self-reported back pain	Radiologists	Hrs of lead apron use																					
Ono et al 1995	Injury reports of musculo injury	Home care workers	Incident reports of physical factors								+							+	+					
Owen 1986	Incident reports	Nurses	Self-reports of lifting style								+		+		+	+		+						
Pike et al 1997	Self-reported musculoskeletal pain	Sono-graphers	Self-reported physical demands																					
Prezant et al 1986	Self-reported back problems	Nurses	Work area, reports of lifting practices								∅	∅					∅	∅	∅					+
Skovron et al 1987	Self-reported low back pain	Nursing personnel	Job category and self-reports of lifts	∅		-					-							-	∅					∅

Table A17 Continued:

Study	Lower-body Outcome	Population	Physical Demands Assessment	Control	Demands/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Symptoms	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Job Title/Work Area
Smedley et al 1995	Self-reported low back pain	Nurses	Self-reported lifting activities				+					∅		+		-	+		+					
Stobbe et al 1988	Injury reports	Nursing personnel	Expert assessment of lifting										+						+					∅
Stubbs et al 1983	Self-reported pain	Nurses	Self-reported risk factors								+							+						
Videman et al 1984	Self-reported low back pain	Nurses	Self-reported physical demands								+		-					+	+	+				+
Case-control/Cohort Studies																								
Fuortes et al 1994	Comp. Claims	Nurses	Self-reported physical demands					+			∅	F					+		+	+			+	+
Harber et al 1994	Self-report and interview of back pain	Nurses	Self-reported physical demands					+ / ∅						+					∅					∅
Heap 1987	Incident report and clinical exam-low back injuries	Nursing staff	Self-reported physical demands								∅	∅		+			∅							∅
Josephson et al 1997	Self-reported musculoskeletal symptoms	Nursing personnel	Self-reported perceived exertion				+				+				∅			+						+

Table A17 Continued:

Study	Lower-body Outcome	Population	Physical Demands Assessment	Control	Demands/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Symptoms	Smoking Status	Fitness/Strength	Anthropometry	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Job Title/Work Area
Josephson et al 1998	Medical reports and clinical exams of LBP	Hospital and home care aides	Self-report and expert assessment	+	Ø	+	Ø	+		Ø	+							+	Ø	+				
Klaber Moffett et al 1993	Self-report and physical exam of LBP	Nursing students														+	+							
Mostardi et al 1992	Injury reports	Nurses												Ø		Ø								
Niedham-mer et al 1994	Self-reported pain	Nurses	Self-reported physical demands				Ø				+/-				+	Ø	Ø	+						
Ready et al 1993	Incident reports of back injury	Nurses	Nursing unit category						+				Ø	+	+	Ø	Ø							Ø
Rydén et al 1989	Incident reports	Hospital employees	Report of physical factors											+	Ø	Ø	Ø							
Smedley et al 1997	Self-reported low back pain	Nurses	Self-reported lifting activities				Ø				Ø			+			Ø		+					
Venning et al 1987	Self-reported back injury	Nursing personnel	Job category and self-reports								Ø	Ø	Ø	+			Ø		+					+
Yassi et al 1995	Incident reports	Nurses	Incident report of physical factors								-	Ø	-						+					+

Table A18: Summary of Findings for Risk Factors Associated with Upper-body Musculoskeletal Outcomes: Review of Health Care Studies

Study	Upper-body Outcome	Population	Physical Demands Assessment	Control	Demand/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Injury	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Forces	Job Title/Work Area
Ahlberg-Hultén 1995	Self-reported neck shoulder pain	Nurses and nurses aides	Department classification	∅		∅	∅				∅		∅		∅										∅
Bork et al 1996	Self-reported neck shoulder pain	Physical therapists	Self-reported physical stressor									F							+					+	+
Bru et al 1994, 1996	Self-reported neck shoulder pain	21 hospital depart's	Perceived ergonomic load		+					+	∅							+							
Dehlin et al 1976, 1977	Self-reported neck shoulder pain	Nursing aides	Self-reported lifts			∅	∅		∅									∅							
Engels et al 1994	Self-reported arm neck complaints	Nurses	Direct observation Perceived Heart rate		+			+			+	∅	+				∅		+	+		∅			
Gerdle et al 1994	Self-reported musculo complaints	Home care personnel	Self-reported ergonomic factors			+			+		+		∅			+		∅							

Table A18 Continued:

Study	Upper-body Outcome	Population	Physical Demands Assessment	Control	Demand/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Injury	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Forces	Job Title/Work Area
Johansson et al 1995	Self-reported neck shoulder symptoms	Home care workers	Self-reported physical demands	∅	+	∅													+	+	+				
Kamwendo et al 1991a/b	Self-reported neck/shoulder pain	Medical secretaries	Self-reported hrs of typing plus direct observations	+	+		+	+		∅	+		+									+			
Lagerström et al 1995	Self-reported neck/shoulder pain	Nursing personnel	Ward and occupation	+/-	+	+/-					+				∅	+	∅								∅
Linton et al 1989	Self-reported neck/shoulder pain	Medical secretaries																							
Ono et al 1995	Injury reports of musculo injury	Home care workers	Incident reports of physical factors								+								+						
Prezant et al 1986	Self-reported neck problem	Nurses	Work area, reports of lifting practices								+														

Table A18 Continued:

Study	Upper-body Outcome	Population	Physical Demands Assessment	Control	Demand/Pressure	Support	Stress/Strain	Workload	Job satisfaction	Monotony	Age	Sex	Experience	Previous Injury	Smoking Status	Fitness/Strength	Anthropometric	Physical Demands	Lifting/Heavy Load	Awkward Postures	Repetition	Vibration	Static Postures	Forces	Job Title/Work Area
Punnett 1987	Survey and exam of upper-body symptoms	Female hospital workers	Job category								+		+												+
Vanderpool et al 1993	Self-reported upper-body symptoms	Sonographers	Self-reported physical demands					∅			∅	M	∅			∅				+				+	
Case-control/Cohort Studies																									
Josephson et al 1997	Self-reported musculoskeletal symptoms	Nursing personnel	Self-reported perceived exertion				+	∅			+							+							+
Niedhammer et al 1994	Self-reported neck pain	Nurses	Self-reported physical demands				+				+			+		∅	∅								

Appendix 2: Factors Associated with Musculoskeletal Morbidity - Results of Focus Groups

Focus groups were organized with three acute care hospitals in British Columbia, as part of a workshop on musculoskeletal prevention. Focus groups consisted of 21 to 33 employees with representatives invited to participate from all major departments and occupations in the hospital (i.e. nursing, housekeeping, dietary, administration, laboratories, clerical), as well as union, management and occupational health and safety committee representatives. The focus groups were asked to respond to one question: 'What do you think are the factors related to musculoskeletal problems in your workplace?'.

Table A19: Results of Focus Groups with Health Care Workers: 'What do you think are the factors related to musculoskeletal problems in your workplace?'

Responses	Hospital A	Hospital B	Hospital C	Identified by All Three
Individual Factors				
Attitudes toward work	X	X	X	Attitudes
Ageing population	X	X	X	Age
Strength and fitness levels	X			
Obesity		X		
Safety practices/training for new people	X		X	Work experience
Senior workers – hard to change practices, 'always done this way'		X		
Conflict resolution	X			
Problem solving skills		X		
Previous musculoskeletal problem		X		
Hard to return to work if injured			X	
Home/work balance		X	X	
Different norms and customs			X	
Ergonomics/Biomechanical Factors				
Safe equipment	X		X	
Physical environment-design	X	X	X	Awkward Postures
Physical loads	X	X	X	Physical Load
Physically difficult tasks	X			
Safe work procedures	X	X	X	Unsafe Tasks
Pace of work – repetition		X		
Physical workload		X	X	

Table 19A Continued

Responses	Hospital A	Hospital B	Hospital C	Identified by All Three
Work Organization Factors				
High patient/staff ratios	X			Workload
Cut-backs – having to do more with fewer staff		X		
More chronic patients = increased workload due to rapid turnover			X	
Not enough time to get things done	X			Demands/Pressure
Asking workers to do more and more		X		
Working fast to get things/unsafe		X		
Not enough time to get help, equipment			X	
Management commitment	X		X	Support
Team spirit/workplace culture	X			
Lack of communication		X		
Supervisor Relationship/Feedback		X		
No more supervisors in some areas			X	
Front-line flexibility	X			Control
Involvement in decisions		X		
Lack of problem solving opportunities			X	
Incident reporting /follow-up		X	X	
Facility and industry changes-regionalization, amalgamations		X	X	
Work clarity – unclear expectations/direction			X	
Work schedules – shift work			X	
Low morale			X	

Appendix 3: Power Calculations

Power calculations were completed using *EpiInfo*.

Calculations are based on a 1:1 ratio of unexposed (lower two quartiles of employees by work organization scores and workload factors) to exposed (upper two quartiles of employees by work organization and workload factors), and a 50% increase in the risk of an upper-body musculoskeletal outcomes among the exposed, given .2% of the exposed population has an upper-body outcomes during the follow-up period. The calculations were completed for the incidence of an upper-body outcome, as the least frequent of the outcomes to be analyzed in the study. The estimate of the incidence of an upper-body injury among health care workers was based on injury statistics from another large Canadian hospital (Health Sciences Centre, 1995). This hospital reported 159 upper-body exertion injuries per 9,326,410 paid hours between April 1995 to March 1996, or 1.7 injuries per 100,000 paid hours or 2.5 injuries per 1000 person months. This is similar to the incidence of upper-body musculoskeletal claims in the current study of 2.4 claims per 1000 person months.

The overall cohort population (n=142,269 person-months) has sufficient power at the .80 level to detect a 50% increase in the risk of musculoskeletal morbidity between exposed (low control/support, high demand/pressure) and non-exposed with 95% confidence. The sicktime/overtime sub-cohort population (n=126,877) has sufficient power at the .80 level to detect a 50% increase in the risk of musculoskeletal morbidity between exposed (exposure to high sicktime/overtime) and non-exposed with 95% confidence. The work units sub-cohort population (n=66,158) does not have sufficient power at the .80 level to detect a 50% higher risk of musculoskeletal morbidity between exposed (exposure to high work units/FTE) and non-exposed with 95% confidence. The current sample size is sufficient to detect a 50% increase at the .80 level with 75% confidence or at the .50 level of power with 95% confidence.

Table A20: Power Calculations

Conf.	Power	Unex:Exp	Disease in Exposed	Risk Ratio	Odds Ratio	Sample Size Unexp.	Sample Size Exposed	Person-months (n) Total	**Study Populations Overall**	**Sick/Over**	**WorkUnits**
95.00 %	80.00 %	1:1	0.20 %	1.50	1.50	63,316	63,316	126,632	**142,269**	**126,877**	**66,158**
90.00 %	"	"				50,510	50,510	101,020			
95.00 %	"	"				63,316	63,316	126,632			
99.00 %	"	"				92,742	92,742	185,484			
99.90 %	"	"				134,188	134,188	268,376			
95.00 %	80.00 %	"				63,316	63,316	126,632			
"	90.00 %	"				83,742	83,742	167,484			
"	95.00 %	"				102,848	102,848	205,696			
"	99.00 %	"				144,153	144,153	288,306			
"	80.00 %	4:1				150,620	37,655	188,275			
"	"	3:1				121,569	40,523	162,092			
"	"	2:1				92,486	46,243	138,729			
"	"	1:2				48,646	97,293	145,939			
"	"	1:3				43,728	131,185	174,913			
"	"	1:4				41,260	165,042	206,302			

```
Formula   : m' = Sq{c(a/2)*Sqrt[(r+1)*PQ]-c(1-b)*Sqrt[r*P1Q1+P2Q2]}
                 /(r*Sq[P2-P1])
            m = .25m'*Sq{1+Sqrt[1+2*(r+1)/(m'r*Abs[P2-P1])]}
```

Reference : Fleiss, "Statistical Methods for Rates and Proportions", 2nd Ed., Wiley,1981, pp. 38-45.

Appendix 4: Summary of Data Collection Methods and Study Databases

Table A21: Summary of Data Collection Methods and Study Databases

Study Variable	Data Source/ Instrument	Collection Methods	Additional Information	Data Fields
Denominator Data - person-months	Hospital Employee Records	Data downloaded into ASCII file by hospital personnel	Hospital maintains a personnel record for all jobs held by paid employees	Unique identifier Sex Date of birth Job start date Regular start date[4] Casual start date Separation date Occupation code Department code
Numerator Data - musculoskeletal symptoms and claims	Hospital Incident Reporting System	Data downloaded into ASCII file by principal investigator	Hospital maintains database of reported occupational health and safety incidents	Unique identifier First name Last name Sex Union Date of birth Department code Occupation code Incident Description Incident type[5] Incident date Incident code Claim type[6] Days lost
Demographic Data • Age, • Sex, • Years in Job	Hospital Employee Records	Data downloaded into ASCII file by hospital personnel	Hospital maintains a record for all jobs held by employees	See Demographic Data
Biomechanical factors	OSHA checklist for upper and lower-body	Direct observation of employees at work by trained observed	Completed for all unique occupations included in the cohort	Occupation code Department code Scores 12 upper risks Scores 17 lower risks
Work Organization Factors • Control • Demands • Support • Pressure	Hospital survey database (JCQ and WES scales)	Data copied from Hospital SPSS data files	Hospital administered a survey to a random sample of employees in '91, '93 and '94	Age Sex Occupation group Union Supervisor status Years experience 9 pressure items 8 support items) 7 control items 3 demand items
Workload Factors • Sicktime • Overtime • Work units	Hospital finance reports • sicktime/ overtime • work units	Data inputted from hard copy reports into two Excel spreadsheets by principal investigator	Hospital maintains reports of sicktime, overtime, and work units by department for 4 week periods	Department code Sick hours Overtime hours Total paid hours FTEs Total work units

[4] Regular start date and casual start date refer to the first date of employment at the hospital by employment status (i.e. permanent or temporary). These dates remain the same in all records for the same employee and are used by the HR department for seniority purposes.

[5] An incident type could be coded for one of the following: a) struck or contacted by, b) struck against or contact with, c) caught in, on between repetitive movement, d) slip/fall from same level, e) overexertion weight, f) overexertion effort, g) material handling, h) machine involvement, or i) tool - hand, power.

[6] A claim type is defined is a) a hazardous situation, b) a first aid injury or c) a worker's compensation claim.

Appendix 5: Sample of Hospital OH&S Incident Report Form

INCIDENT REPORT

OCCUPATIONAL HEALTH AND SAFETY DEPARTMENT		
NO INJURY ☐ HAZARDOUS SITUATION	INJURY ☐ TREATMENT ☐ NO TREATMENT	W.C.B. CLAIM ☐ HEALTH CARE ☐ LOST TIME

LAST NAME	FIRST NAME	SEX	MARITAL STATUS	AREA CODE	PHONE NO.	DATE OF BIRTH DAY MONTH YEAR

ADDRESS (NP. STREET, APT)	CITY/TOWN	PROV	POSTAL CODE	DEPARTMENT/UNIT	LOCAL/PAGER

DATE OF EMPLOYMENT DAY MONTH YEAR	OCCUPATION AT TIME OF THE INJURY AND YEARS OF EXPERIENCE	LANGUAGE SPOKEN	SOCIAL INSURANCE NO.
	YRS. EXP.		

D/M/Y OF INCIDENT	TIME OF DAY	D/M/Y REPORTED	TIME OF DAY	STAFF CLASSIFICATION	UNION AFFILIATION	STUDENT	SCHOOL AFFILIATION

MEDICAL PERSONNEL STAFF ☐ RESIDENT ☐ INTERN ☐ UBC STAFF ☐ OTHER ☐ _

STATE EXACTLY WHAT WAS THE SEQUENCE OF EVENTS LEADING UP TO THE INCIDENT, WHERE INCIDENT OCCURRED.
WHAT EMPLOYEE WAS DOING, SIZE, WEIGHT AND TYPE OF EQUIPMENT OR MATERIALS INVOLVED ETC. STATE ALL INJURIES INDICATING LEFT OR RIGHT IF APPLICBLE

SIGNATURE OF PERSON REPORTING INCIDENT　　SIGNATURE OF DEPT. HEAD OR SUPERVISOR

NAMES AND ADDRESSSES OF WIRNTESSES OR PERSONS HAVING KNOWLEDGE OF THE INCIDENT
1. ______
2. ______

CHECK OF STATEMENT THAT BEST DESCRIBE TYPE OF INCIDENT (ONLY NE CAN BE CHECKED)
- ☐ STRUCK OR CONTACTED BY
- ☐ STRUCK AGAINST CONTACT WITH
- ☐ CAUGHT IN, ON OR BETWEEN
- ☐ REPETITIVE MOVEMENT
- ☐ SLIP/FALL FROM SAME LEVEL
- ☐ OVEREXERTION – WEIGHT
- ☐ OVEREXERTION – EFFORT
- ☐ EXPOSURE (CHEMICAL/RADIATION)
- ☐ SHARPS INJURY (NEEDLE/LACERATION)
- ☐ UNKNOWN
- ☐ MATERIAL HANDLING
- ☐ FOREIGN MATTER IN EYE
- ☐ VEHICLE, CAR, TRUCK, FORKLIFT
- ☐ CONTACT BY TEMPERTURE EXTREMES
- ☐ ELECTRICAL CONTACT
- ☐ MACHINE INVOLVEMENT
- ☐ TOOL, HAND, POWER
- ☐ SPLASH (BLOOD/BODY FLUIDS)*
- ☐ EXPOSURE (PULMONARY TUBERCULOSIS)**
- ☐ EXPOSURE (INFECTIOUS DISEASE)
- ☐ OTHER (PLEASE EXPLAIN)

* COMLETE EP088 ** COMPLETE 939B

WHAT CONDITIONS CONTRIBUTED TO THE INCIDENT. NNUMBER ALL CONTRIBUTING CAUSES IN ORDER OF IMPORTANC
- ☐ OPERATING WITHOUT AUTHORITY
- ☐ FAILURE TO SECURE OR WARN
- ☐ WORKING AT UNSAFE SPEED
- ☐ UNSAFE EQUIPMENT
- ☐ UNSAFE LOADING, PLACING, MIXING ETC.
- ☐ UNSAFE POSITION OR POSTURE
- ☐ WORKING/OVING OR DANGEROUS EQUIPMENT
- ☐ DISTRACTING, TEASING WILFUL MISCONDUCT
- ☐ FAILURE TO USE PERSONAL PROTECTIVE EQUIP
- ☐ WHEELED EQUIPMENT OPERATION
- ☐ NOT GUARDED OR IMPROPERLY GUARDED
- ☐ PATIENT ACTION
- ☐ SHARPS
- ☐ FIRE, EXPLOSION, ATMOSPHERIC HAZARD
- ☐ HAZARDOUS PERSONAL ATTIRE
- ☐ UNSAFE DESIGN OR ARRANGEMENT
- ☐ HAZARDOUS METHOD OR PROCEDURE
- ☐ OUTSIDE HAZARDOUS CONDITION
- ☐ VISITOR/CRIMINAL ACTION
- ☐ OTHER (PLEASE EXPLAIN)

EXPLANATION OF CAUSES ______

DETAILS OF PROPERTY DAMAGE ______

ACTIONS TO PREVENT INCIDENT RECURRENCE – MARK WITH ✓ THOSE ACTIONS TAKEN TO PREVENT RECURRENCE. MARK WITH (P) OTHER CORRECTIVE ACTIONS DECIDED UPON OR PLANNED BUT NOT YET CARRIED OUT. MORE THAN ONE ITEM MANY APPLY
- ☐ REINSTRUCITON OF PERSON INVOLVED
- ☐ INSTALLATION OF GUARD OR EQUIPMENT
- ☐ EQUIPMENT REPAIR OR REPLACEMENT
- ☐ IMPROVED PERSONAL PROTECTIVE EQUIP.
- ☐ IMPROVED PROCEDURE
- ☐ REASSESS JOB SAFETY
- ☐ CLEAN UP WORK AREA
- ☐ DSCIPLINE OF PERSONS INVOLVED
- ☐ REFERRAL FOR ERGONOMIC EVALUATION
- ☐ WORK ORGER SUBMITTED
- ☐ REFERRAL TO IINDUSTRIAL HYGIENE
- ☐ PROCEDURE CHANGED TO INCLUDE PPE
- ☐ ORDER JOB SAFETY ANALYSIS DONE
- ☐ OTHER
- ☐ CHECK WITH MANUFACTURER

DESCRIBE ACTIONS TAKEN TO PREVENT RECURRENCE ______

SIGNATURE OF DEPT. HEAD OR SUPERVISOR

SPECIFY INJURY AND TREATMENT GIVEN

DID WORKER ATTEND OR INTEND TO SEE A PHYSICIAN OR QUALIFEID PRACTITIONER? IF YES, NAME AND ADDRESS

TO YOUR KNOWLEDGE, HAS THE EMPLOYEE HAD APREVIOUS SIMIALR DISABILITY YES ☐ NO ☐

VISITED OH&S ______ EMERGENCY PHYSICIAN ______ PERSONAL PHYSICIAN ______

ACTION TAKEN ☐ BE SENT HOME (SAME DAY ONLY) ☐ UNDERTAKE REGULAR DUTIES
☐ MODIFIED DUTIES ☐ REMAIN OFF WORK FOR DAYS

SIGNATURE OF FIRST AID ATTENDANT

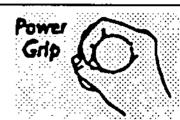
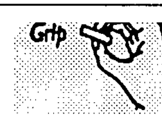
Appendix 6: OSHA Checklists for Upper and Lower-body Risk Factors

Upper Extremity Risk Factors - A

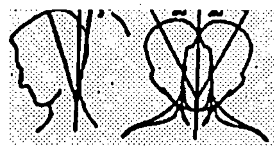
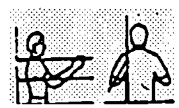
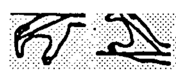
Date: ____________________
Job: ____________________
Department: ____________________
Employee: ____________________
Analyst: ____________________
Comments: ____________________

Task (Est Time, Hours)	Risk Factor	Est Time/Risk Factor (Hours)

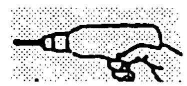
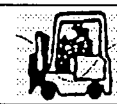
Upper Extremity Risk Factors Scores — Page 1

A	B		C	D	E	F	
			TIME			SCORE	
RISK FACTOR CATEGORY	**RISK FACTOR**	Is the risk factor present	2 to 4 hours	4 to 8 hours	8+ hours add 0.5 per hour		Comments
Repetition (Finger, Wrist, Elbow Shoulder or Neck Motions	**1. Similar Motions Performed Every Few Seconds** *Motions or motion patterns that are repeated every 15 seconds or less; includes steady pace , as in data entry*		1	3			
Hand Force (Repetitive or Static)	**1. Grip More Than 10 Pound Load**  **Holding an object weighing more than** *10\pounds or squeezing hard with hand such as gripping and lifting a 10 pound bag of sugar*		1	3			
	2. Pinch More Than 2 Pounds  **Pinch force of 2+ pounds as in the pinch used** *To open small binder clip with the tips of Fingers*		2	3			
	3. Fingers *Low force prolonged grip such as click & drag tasks with a computer mouse, deboning with a knife, or handling items at a grocery checkout. Do not count with power or pinch grips.*		1	2			

Upper Extremity Risk Factors Scores — Page 2

A	B		C	D	E	F	
			TIME			SCORE	
RISK FACTOR CATEGORY	RISK FACTOR	Is the risk factor present	2 to 4 hours	4 to 8 hours	8+ hours add 0.5 per hour		Comments
Awkward Postures	**1. Neck Bend** *Bending neck to either side more than 20°, bending neck forward more than 20° as in viewing items on a desk or bending neck backward more than 5°* 		1	3			
	2. Shoulder: Unsupported Arm *Arm is unsupported during precision finger work* Or (if both are present then only score one)  **2a. Shoulder: Elbow Above Mid-Torso Height** *Elbow is away from the body (>=45° torso-elbow)*		2	3			
	3. Rapid Forearm Rotation *Rotating the forearm or resisting rotation from a tool. An example of forearm rotation is using a manual screwdriver.* Or (if both are present then only score one) **3a. Extremely Flexed Elbow** For example, working with hands close to the eyes		1	2			
	4. Wrist: Bend/Deviate ***Consider wrist bends that involve more than 20°*** *of flexion (bending the wrist palm down) or more than 30° of extension (bending the wrist back).* *Consider extreme deviation toward the thumb or little finger.* 		2	3			
Contact Stress	**1. Hard/Sharp Objects Dig Into Skin** Unpadded or unrounded surfaces that dig into the palm, wrist, elbow, armpit or fingers, such as ring handled scissors. Or, (if both are present then only score one) **1a. Using the Palm of the Hand as a Hammer**		1	2			

Upper Extremity Risk Factors Scores — Page 3

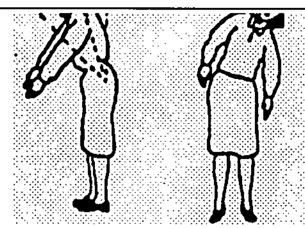
A	B		C	D	E	F	
				TIME		SCORE	
RISK FACTOR CATEGORY	RISK FACTOR	Is the risk factor present	2 to 4 hours	4 to 8 hours	8+ hours add0.5 per hour		Comments
Vibration	**1. Localized Vibration** (Without Vibration Dampening)  *Vibration from contact between the hands and a Vibrating object, such as a power tool*		1	3			
	2. Sitting on Vibrating Surface (Without Vibration Dampening) 		1	2			
Environment	**1. Cold Temperature** *Hands exposed to air temperature of less than 50°F*		0	1			
Work Organization	**1. No Control Over Work Pace, Insufficient Breaks** *Five factors to consider: 1. Machine paced 2. Piece rate 3. Electronic monitoring 4. Daily deadlines 5. Workers with fixed or awkward postures (static or precision work) do not get frequent short breaks (micropauses)* Enter 2 if one factor is present, or enter 3 if two or more factors are present						
TOTAL UPPER EXTREMITY SCORE FOR CHECKLIST A (SUM OF PAGES 1, 2, AND 3)							

Back and Lower Extremity Risk Factors - B

Date: ____________________
Job: ____________________
Department: ____________________
Employee: ____________________
Analyst: ____________________
Comments: ____________________

Task (Est Time, Hours)	Risk Factor	Est Time/Risk Factor (Hours)

Back and Lower Extremity Risk Factors Scores Page 1

A	B		C	D	E	F	
			TIME			SCORE	
RISK FACTOR CATEGORY	RISK FACTOR	Is the risk factor present	2 to 4 hours	4 to 8 hours	8+ hours add0.5 per hour		Comments
Awkward Postures (Repetitive or Static)	1. Side Bending, Mild Bending of Torso More Than 20° But less Than 45° 		1	3			
	2. Severe Forward Bending of Torso More than 45°		2	3			

DO NOT CITE OR QUOTE

Back and Lower Extremity Risk Factors Scores — Page 2

A	B		C	D	E	F	
			TIME			SCORE	
RISK FACTOR CATEGORY	**RISK FACTOR**	Is the risk factor present	2 to 4 hours	4 to 8 hours	8+ hours add0.5 per hour		Comments
Awkward Postures (Repetitive or Static) ***Continued***	**3. Backward Bending of Torso** *Greater than 10 degrees*		1	2			
	4. Twisting Torso *Shoulders turned at least 20 degrees*		2	3			
	5. Prolonged Sitting Without Adequate Back Support *Back is not firmly supported by a back rest for an extended period*		1	2			
	6. Inadequate Foot Support While Seated		0	1			
	7. Standing Stationary, with little or not walking ***Stand in one place (on assembly line or check stand) without sit/stand option or walking***		0	1			
	8. Kneeling/Squatting		2	3			
	9. Repetitive Ankle Extension/Flexion *Using a foot pedal to start or stop a machine cycle* ***(as in sewing machine operators).***		1	2			
Contact Stress	**1. Hard/Sharp Objects Dig Into Skin** *Contact using the leg such as the seat digging into the back of the legs or, pressure against the thigh, knee or shins from equipment or the workplace*		1	2			
	2. Using the Knee as a Hammer or Kicker		2	3			

DO NOT CITE OR QUOTE

Back and Lower Extremity Risk Factors Scores — Page 3

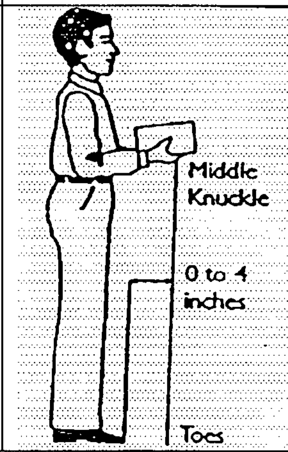
A	B		C	D	E	F	
			TIME			SCORE	
RISK FACTOR CATEGORY	RISK FACTOR	Is the risk factor present	2 to 4 hours	4 to 8 hours	8+ hours add0.5 per hour		Comments
Vibration	**1. Sitting on Vibrating Surface** *(Without Vibration Dampening)* 		1	2			
Push/Pull	**1. Moderate Load** *Moderate Loads = 20 pounds of initial force needed to push/pull* *An object such as a shopping cart loaded with five* *40-pound bags of dog food (200 pounds)*		1	2			
	2. Heavy Load *Heavy load = 50 pounds of initial force needed push/pull* *Object such as a two-drawer full file cabinet* *Across a carpeted floor*		2	3			
Work Organization	**1. No Control Over Work Pace, Insufficient Breaks** *Five factors to consider: 1. Machine paced 2. Piece rate* *3. Electronic monitoring 4. Daily deadlines* *5. Workers with fixed or awkward postures (static or precision work) do not get frequent short breaks (micropauses)* Enter 2 if one factor is present, or enter 3 if two or more factors are present						
MANUAL HANDLING SCORE (FROM CHECKLIST C)							
PATIENT HANDLING SCORE (FROM CHECKLIST D)							
TOTAL BACK AND LOWER EXTREMITY SCORE (SUM OF BOTH PAGES 1 AND 2)							

Manual Handling (10 Pounds or More) - C

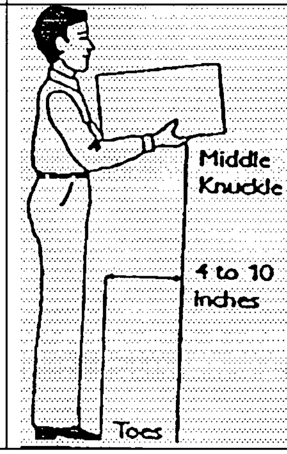
STEP 1
Determine if the Lift is Near, Middle or Far (Body to Hands)

- Use an average horizontal distance if a lift is made every 10 minutes or less.
- Use the largest horizontal distance if more than 10 minutes pass between lifts.

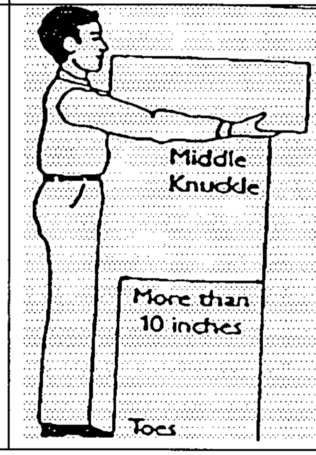
NEAR LIFT



MIDDLE LIFT



FAR LIFT



STEP 2 Find the Lifting Zone And Estimate the Weight Lifted (Pounds)	NEAR LIFT		MIDDLE LIFT		FAR LIFT	
	DANGER ZONE	More than 51 lb 5 Points*	DANGER ZONE	More than 35 lb 6 Points	DANGER ZONE	More than 28 lb 6 Points
- use an average weight if a lift is made every 10 minutes or less - use the heaviest weight if more than 10 minutes pass between lifts	CAUTION ZONE	17 to 51 lb 3 Points	CAUTION ZONE	12 to 35 lb 3 Points	CAUTION ZONE	10 to 28 lb 3 Points
- Counter 0 in the total score if the weight is less than 10 lbs	SAFE ZONE	Less Than 17 lb 0 Points	SAFE ZONE	Less Than 12 lb 0 Points	SAFE ZONE	Less Than 10 lb 0 Points

* if lifts are performed more than 15 times per shift, use 6 points

STEP 2 SCORE	(enter 0, 3, 5, 6)	

STEP 3 Determine the Points for Other Risk Factors	FACTOR	OCCASIONAL LIFTS PERFORMED FOR 1 HOUR OR LESS IN TOTAL PER SHIFT	LIFTS PERFORMED FOR MORE THAN 1 HOUR IN TOTAL PER SHIFT
- use occasional lifts if more than 10 minutes pass between lifts	Twist torso during lift	1	1
	Lift one-handed	1	2
- use the more than 1 hour points if the risk factor occurs with most lifts and lifting is performed for more than 1 hour	Lift unstable loads (people, liquids, or loads that shift around or have unequal weight distribution)	1	2
	Lift between 1 to 5 times per minute	1	1
	Lift more than 5 times per minute	2	3
	Lift above the shoulder	1	2
	Lift below the knuckle	1	2
	Carry objects farther than 30 feet	2	3
	Lift while seated or kneeling	1	2
STEP 3 SCORE			
TOTAL SCORE (add scores from steps 2 and 3. Enter total score on Checklist B)			

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Patient/Resident Handling Checklist - D

	SCORE	
RISK FACTOR/CONDITION	**NO**	**YES**
Lift or transfer totally dependent patient/resident		6
Lifting from the floor (patient/resident totally or partially dependent)		6
Patient/resident partially dependent? Consider factors below and check or circle as appropriate:		
Transfer Type/Tasks		
Lateral transfer		
Bed to chair or chair to bed		
Chair to Chair		
Repositioning in bed or chair		
If at least one of the above is checked as yes, score 4 and continue checking		4
Environment (bed, toilet, shower area, etc.)		
Limited access (such as restricted toileting or bathing area)		2
Obstructions (such as shower curbs, room furnishing, IV tubing or catheters)		2
Slippery surfaces (such as wet floors in bathing areas)		2
Uneven surfaces (such as wheelchair to bed or wheelchair and toilet)		2
Worker Factors		
Twelve or more lifts or transfers per shift		1
Carrying three or more feet		1
Twisting/bending torso (such as when lifting a patient from a geri-chair)		2
Patient/Resident Factors		
Unpredictable behaviour or combative patient		2
Cognitive impairment		2
Special medical conditions (such as burns, skin tears or stroke)		1
Little ability to assist in transfer		2
TOTAL SCORE (Record the score on Checklist B)		

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Appendix 7: Hospital Survey – Description of Sampling Strategy and Response Rates

Legend: BCNU = British Columbia Nurses Union
HEU = Hospital Employees Union
HSA = Health Services Association

Table A22: Stratified Sample of Hospital Employees and Response Rates for June 1991 Survey

	Number of Employees by Union (% of Total Population)	Number in Survey Sample (% of Total Sample)	Number of Respondents (Response Rate for Union)
BCNU	982 (61%)	244 (61%)	163 (67%)
HEU		Not Included in 1991 Survey Population	
HSA	449 (28%)	112 (28%)	87 (78%)
Non Contract	153 (10%)	40 (10%)	29 (73%)
TOTAL	1597 (100%)	400 (100%)	281 (70%)

Table A23: Stratified Sample of Hospital Employees and Response Rates for May 1993 Survey

	Number of Employees by Union (% of Total Hosp. Population)	Number in Survey Sample (% of Total Sample)	Number of Respondents (Response Rate for Union)
BCNU	1050 (37%)	133 (29%)	102 (77%)
HEU	1170 (41%)	170 (37%)	105 (62%)
HSA	470 (16%)	94 (20%)	74 (79%)
Non Contract	169 (6%)	67 (14%)	38 (57%)
TOTAL	2850 (100%)	464 (100%)	319 (69%)

Table A24: Stratified Sample of Hospital Employees and Response Rates for May 1994 Survey

	Number of Employees by Union (% of Total Hospital Population)	Number in Survey Sample (% of Total Sample)	Number of Respondents (Response Rate for Union)
BCNU	1050 (37%)	133 (30%)	82 (62%)
HEU	1100 (39%)	162 (36%)	97 (60%)
HSA	470 (17%)	82 (18%)	68 (83%)
Non Contract	188 (7%)	72 (16%)	55 (76%)
Total	2808 (100%)	449 (100%)	312 (67%)

Appendix 8: Healthy Hospitals Project Survey (JUNE, 1991)

HEALTHY HOSPITALS PROJECT

SURVEY
JUNE, 1991

INSTRUCTIONS

This survey is a first step in our Healthy Hospitals Project. It is aimed at getting your ideas about what it is like to work at XXX Hospital. The survey is designed to:

1. Get an overall picture of opinions and attitudes at XXX Hospital.
2. Let us chart our progress.

The survey will be re-administered each year to see how opinions and attitudes have changed at XXX Hospital.

There are no right or wrong answers to the survey questions. The best answer is ALWAYS just what you think.

Your answers are STRICTLY CONFIDENTIAL! No one in the hospital will see your completed survey. No one at the Hospital will know how you personally answered any questions. PLEASE DO NOT PUT YOUR NAME ON THIS SURVEY.

****

BACKGROUND INFORMATION ON YOU........

Please circle the appropriate number in each category below.....

GENDER
1. Female   2. Male

YEARS OF EMPLOYMENT AT HOSPITAL
1. Less than 2 years
2. 2-5 years
3. 6-10 years
4. 11-20 years
5. 20 years or more

DEPARTMENT: ______________________________
YEARS IN PRESENT POSITION: ______________________________
YEARS OF EXPERIENCE IN THIS PROFESSION: ____________________

NUMBER OF CHILDREN
1. No children
2. 1 child
3. 2 or 3 children
4. 4 or more children

ARE YOU A......
1. Supervisor
2. Non-supervisor

BASIC EDUCATION:
1. High School
2. College Program
3. University Program
4. Other ____________________

DO YOU...
1. Live alone
2. Live with someone

DO YOU HAVE A PET
1. Yes
2. No

AGE:
1. Less than 25 years of age
2. 25-34 years
3. 35-44 years
4. 45-54 years
5. 55 or more

NURSING EDUCATION:
1. RN Diploma
2. LPN Diploma
3. BN; BScN
4. Post Baccalaureate Nursing Program
5. Other: ____________________

CURRENT JOB STATUS
1. Permanent full-time
2. Permanent part-time
3. Casual or temporary employee

USUAL # OF HOURS PER SHIFT: ____________________

USUAL SHIFTS
1. Days only
2. Evenings only
3. Night only
4. Rotating: days/evenings
5. Rotating: days/nights
6. Three shift rotation
7. Other: ____________________

NUMBER OF OVERTIME HOURS IN LAST MONTH: __________

WORK AREA:

1. Direct Patient Care
    a. Critical Care
    b. Emergency
    c. 45-54 years
    d. 55 or more
    e. Obstetrics
    f. Operating Room
    g. Paediatrics
    h. Psychiatry
    i. Surgery
2. Research
3. Education
4. Management
5. Other: ____________________

UNION:

1. BCNU
2. HEU
3. HSA
4. Other: ____________________
5. Non Union

EACH STATEMENT BELOW IS FOLLOWED BY A 7 POINT SCALE. READ EACH STATEMENT CAREFULLY. PLACE THE LETTER 'N' (NOW) ABOVE THE POINT ON THE SCALE TO REFLECT HOW STRONGLY YOU AGREE ABOUT THE STATEMENT NOW. ANSWER AS HONESTLY AS YOU CAN AND TRY NOT TO BE INFLUENCED BY THE OPINION OF OTHERS. THEN, ON THE SAME SCALE PLACE THE LETTER 'F' (FUTURE) BELOW THE SCALE TO INDICATE WHERE YOU WOULD LIKE TI TO BE IN THE FUTURE.

1. Getting your work done on time is important here

   |____|____|____|____|____|____|
   1 2 3 4 5 6 7
   Very Dissatisfied — Very Satisfied

2. In doing your work it is important to follow the rules very closely.

   |____|____|____|____|____|____|
   1 2 3 4 5 6 7
   Very Dissatisfied — Very Satisfied

3. We are encouraged to try new approaches

   |____|____|____|____|____|____|
   1 2 3 4 5 6 7
   Very Dissatisfied — Very Satisfied

4. If small mistakes are made, they are tolerated by management

   |____|____|____|____|____|____|
   1 2 3 4 5 6 7
   Very Dissatisfied — Very Satisfied

5. I do the same thing day after day

   |____|____|____|____|____|____|
   1 2 3 4 5 6 7
   Very Dissatisfied — Very Satisfied

6. I have the authority decisions in my work

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

7. Management takes an interest in how we feel about changes

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

8. Management and union relationships are positive

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

9. The vast majority of decisions are made by the senior managers

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

10. The orientation program for new employees is very good

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

11. The hospital is only concerned about the work we do, not the employee

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

12. Managers encourage good people to move on to better positions

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

13. We people I work with are experts in their fields

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

14. Being part of the hospital is important to me

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

15. The people I work with do things together socially

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

16. There is a lot of cooperation between departments

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

17. It takes a long time for a new employee to feel at home here.

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

18. The employees here are very much alike

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

19. Senior management is overly involved in my daily work.

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

20. Everybody here is very aware of the need to save money

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

21. We have relatively strict rules about how people should dress

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

22. People here take their work seriously

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

23. We are encouraged to have fun at work

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

24. It is important to be punctual at meeting here

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

25. We go out of our way to meet our patient□s needs

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

26. It is more important that we follow regulations than make exceptions for patients

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

27. We change our rules depending on the needs of our patients

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

28. Getting the paper work done is extremely important around here

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

29. We rarely question the rules and procedures here

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

30. People here place a lot of emphasis on formal educational qualifications

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

31. People here are clear about how they can contribute to the organization□s overall success

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

32. The committee system at the hospital is very effective

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

33. I am well informed about changes and events taking place within my department

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

34. We provide high quality patient care in my area

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

35. Nurses have a positive image at the hospital

1	2	3	4	5	6	7
Very Dissatisfied						Very Satisfied

SHARED GOVERNANCE IS THE FOUNDATION OF THE HOSPITAL□S MANAGEMENT PHILOSOPHY. SHARED GOVERNANCE MEANS MAKING DECISIONS IN A COLLEGIAL AND COLLABORATIVE FRAMEWORK, BY FOSTERING OPENNESS AND ACCESSIBILITY. IN YOUR OPINION, WHERE IS THE HOSPITAL AT THIS STAGE? RATE YOUR AGREEMENT WITH THE STATEMENTS BELOW. ONCE AGAIN, PLEASE PLACE THE LETTER 'N' (NOW) ABOVE THE POINT IN THE SCALE TO REFLECT HOW STRONGLY YOU AGREE WITH THE STATEMENT NOW, AND PLACE AN 'F' (FUTURE) BELOW THE SCALE TO SHOW WHERE YOU WOULD LIKE TO BE IN THE FUTURE.

36. I understand the principles and practice of shared governance

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

37. I believe shared governance is important for patient care at the hospital

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

38. I see strong support for shared governance at the hospital

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

39. Shared governance is currently practices at the hospital

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

40. I am able to practice shared governance at the hospital

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

PLEASE THINK ABOUT THE MESSAGES YOU RECEIVE FROM THE ATTITUDES AND BEHAVIOURS OF YOUR MANAGERS AND SUPERVISORS AT WORK. ON THIS 7 POINT SCALE, PLEASE INDICATE THE EXTENT TO WHICH YOU AGREE OR DISAGREE WITH EACH OF THE FOLLOWING STATEMENTS. ONCE AGAIN, PLEASE PLACE THE LETTER 'N' (NOW) ABOVE THE POINT IN THE SCALE TO REFLECT HOW STRONGLY YOU AGREE WITH THE STATEMENT NOW, AND PLACE AN 'F' (FUTURE) BELOW THE SCALE TO SHOW WHERE YOU WOULD LIKE TO BE IN THE FUTURE.

40. 41. I count around here

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

41. I am taken seriously around here

|____|____|____|____|____|____|
1 2 3 4 5 6 7
Very Dissatisfied — Very Satisfied

42. I am important around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

43. I am trusted around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

44. There is faith in me around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

45. I can make a difference around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

46. I am valuable around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

47. I am helpful around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

48. I am efficient around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

49. I am cooperative around here

|___|___|___|___|___|___|
1 2 3 4 5 6 7
Very Dissatisfied ... Very Satisfied

PLEASE CIRCLE THE NUMBER THAT MOST ACCURATELY REPRESENTS YOUR FEELINGS............

50. I plan to work at my present job for as long as possible

|______|______|______|
1 2 3 4
Strongly Disagree ... Strongly Agree

51. I will probably spend the rest of my career in this job or the jobs that it leads to in this hospital

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

52. Even if this job does not meet all of my expectations, I will not quit

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

53. Under no circumstances would I leave my present job

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

54. I plan to keep this job for at least two or three years

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

55. Knowing what I know now, I would take this same job with no hesitation

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

56. If I was counselling someone on choice of a profession, I would encourage them to become a nurse

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

57. I would recommend this hospital to someone else as a good place to work

1 — 2 — 3 — 4
Strongly Disagree … Strongly Agree

HOW SATISFIED ARE YOU WITH THE FOLLOWING ASPECTS OF YOUR CURRENT JOB? PLEASE CIRCLE THE NUMBER THAT APPLIES.

58. Hours that you work

1 — 2 — 3 — 4 — 5
Very Dissatisfied … Very Satisfied

59. Flexibility in scheduling your hours

1 — 2 — 3 — 4 — 5
Very Dissatisfied … Very Satisfied

60. Opportunity to work straight days

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

61. Opportunity for part-time work

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

62. Weekends off per month

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

63. Flexibility in scheduling your weekends off

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

64. Parental leave time

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

65. Child care facilities

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

66. Your immediate supervisor

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

67. Your nursing peers

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

68. The physicians you work with

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

69. The delivery of care method used on your unit (e.g. functional, team, primary)

|_____|_____|_____|_____|
1 2 3 4 5
Very Dissatisfied ... Very Satisfied

70. Opportunities for social contact at work

1	2	3	4	5
Very Dissatisfied				Very Satisfied

71. Opportunities for social contact with your colleagues after work

1	2	3	4	5
Very Dissatisfied				Very Satisfied

72. Opportunities to interact professionally with other disciplines

1	2	3	4	5
Very Dissatisfied				Very Satisfied

73. Opportunities to interact with faculty of the School of Nursing

1	2	3	4	5
Very Dissatisfied				Very Satisfied

74. Opportunities to belong to department and institutional committees

1	2	3	4	5
Very Dissatisfied				Very Satisfied

75. Control over what goes on in your work setting

1	2	3	4	5
Very Dissatisfied				Very Satisfied

76. Opportunities for career advancement

1	2	3	4	5
Very Dissatisfied				Very Satisfied

77. Recognition for your work from supervisors

1	2	3	4	5
Very Dissatisfied				Very Satisfied

78. Recognition of your work from peers

1	2	3	4	5
Very Dissatisfied				Very Satisfied

79. Amount of encouragement and positive feedback

1	2	3	4	5
Very Dissatisfied				Very Satisfied

80. Opportunities to participate in nursing research

1	2	3	4	5
Very Dissatisfied				Very Satisfied

81. Opportunities to write and publish

1	2	3	4	5
Very Dissatisfied				Very Satisfied

82. Your amount of responsibility

1	2	3	4	5
Very Dissatisfied				Very Satisfied

83. Your control over work conditions

1	2	3	4	5
Very Dissatisfied				Very Satisfied

84. Your participation in organizational decision making

1	2	3	4	5
Very Dissatisfied				Very Satisfied

85. The amount of floating to other areas that you are asked to do

1	2	3	4	5
Very Dissatisfied				Very Satisfied

86. Your workload

1	2	3	4	5
Very Dissatisfied				Very Satisfied

87. The type and number of support personnel (e.g. unit clerks, porters, physios, pharmacists) available to you

1	2	3	4	5
Very Dissatisfied				Very Satisfied

88. The senior management team

1	2	3	4	5
Very Dissatisfied				Very Satisfied

89. The amount of inservice education/training provided in your unit/area

1	2	3	4	5
Very Dissatisfied				Very Satisfied

90. The quality and content of inservice education/ training on your unit/area

1	2	3	4	5
Very Dissatisfied				Very Satisfied

91. The amount of orientation provided to new staff

1	2	3	4	5
Very Dissatisfied				Very Satisfied

92. The quality of orientation provided to new staff

1	2	3	4	5
Very Dissatisfied				Very Satisfied

93. The opportunity for advanced/continuing education

1	2	3	4	5
Very Dissatisfied				Very Satisfied

94. The opportunity to teach patients

1	2	3	4	5
Very Dissatisfied				Very Satisfied

95. The opportunity to teach students

1	2	3	4	5
Very Dissatisfied				Very Satisfied

96. The opportunity for career development

1	2	3	4	5
Very Dissatisfied				Very Satisfied

THE FOLLOWING STATEMENTS RELATE TO YOUR WORK ENVIRONMENT. PLEASE CIRCLE THE NUMBER THAT REPRESENTS YOUR LEVEL OF AGREEMENT WITH THE STATEMENTS.

97. The work is really challenging

1	2	3	4
Strongly Disagree			Strongly Agree

98. People go out of their way to help a new employee feel comfortable

1	2	3	4
Strongly Disagree			Strongly Agree

99. Supervisors tend to talk down to employees

1	2	3	4
Strongly Disagree			Strongly Agree

100. Few employees have any important responsibilities

1	2	3	4
Strongly Disagree			Strongly Agree

101. People pay a lot of attention to getting work done

1	2	3	4
Strongly Disagree			Strongly Agree

102. There is constant pressure to keep working

1	2	3	4
Strongly Disagree			Strongly Agree

103. Things are sometimes pretty disorganized

1	2	3	4
Strongly Disagree			Strongly Agree

104. There□s a strict emphasis on following policies and regulations

1	2	3	4
Strongly Disagree			Strongly Agree

105. Doing things in a different way is valued

1	2	3	4
Strongly Disagree			Strongly Agree

106. It sometimes gets too hot

1	2	3	4
Strongly Disagree			Strongly Agree

107. There□s not much group spirit

1	2	3	4
Strongly Disagree			Strongly Agree

108. The atmosphere is somewhat impersonal

1	2	3	4
Strongly Disagree			Strongly Agree

109. Supervisor usually compliment an employee who does something well

1	2	3	4
Strongly Disagree			Strongly Agree

110. Employees have a great deal of freedom to do as they like

1	2	3	4
Strongly Disagree			Strongly Agree

111. There□s a lot of time wasted because of inefficiencies

1	2	3	4
Strongly Disagree			Strongly Agree

112. There always seems to be an urgency about everything

1	2	3	4
Strongly Disagree			Strongly Agree

113. Activities are well-planned

1	2	3	4
Strongly Disagree			Strongly Agree

114. People can wear wild looking clothing while on the job if they want

1	2	3	4
Strongly Disagree			Strongly Agree

115. New and different ideas are always being tried out

1	2	3	4
Strongly Disagree			Strongly Agree

116. The lighting is extremely good

1	2	3	4
Strongly Disagree			Strongly Agree

117. A lot of people seem to be just putting in time

1	2	3	4
Strongly Disagree			Strongly Agree

118. People take a personal interest in each other

1	2	3	4
Strongly Disagree			Strongly Agree

119. Supervisors tend to discourage criticisms from employees

1 Strongly Disagree	2	3	4 Strongly Agree

120. Employees are encouraged to make their own decisions

1 Strongly Disagree	2	3	4 Strongly Agree

121. Things rarely get 'put off till tomorrow

1 Strongly Disagree	2	3	4 Strongly Agree

122. People can afford to relax

1 Strongly Disagree	2	3	4 Strongly Agree

123. Rules and regulations are somewhat vague and ambiguous

1 Strongly Disagree	2	3	4 Strongly Agree

124. People care expected to follow set rules in doing their work

1 Strongly Disagree	2	3	4 Strongly Agree

125. This place would be one of the first to try out a new idea

1 Strongly Disagree	2	3	4 Strongly Agree

126. Work space is awfully crowded

1 Strongly Disagree	2	3	4 Strongly Agree

127. People seem to take pride in the organization

1 Strongly Disagree	2	3	4 Strongly Agree

128. Employees rarely do things together after work

1 Strongly Disagree	2	3	4 Strongly Agree

129. Supervisors usually give full credit to ideas contributed by employees

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

130. People can use their own initiatives to do things

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

131. This is a highly efficient, work-oriented place.

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

132. Nobody works too hard

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

133. The responsibilities of supervisors are clearly defined

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

134. Supervisors keep a rather close watch on employees

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

135. Variety and change are not particularly important

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

136. This place has a stylish and modern appearance

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

137. People put quite a lot of effort into what they do

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

138. People who are generally frank about how they feel

|___|___|___|
1 2 3 4
Strongly Disagree — Strongly Agree

139. Supervisors often criticize employees over minor things

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

140. Supervisors encourage employees to rely on themselves when a problem arises

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

141. Getting a lot of work done is important to people

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

142. There is no time pressure

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

143. The details of assigned jobs are generally explained to employees

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

144. Rules and regulations are pretty well enforced

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

145. The same methods have been used for quite a long time

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

146. The place could stand some new interior decorations

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

147. Few people ever volunteer

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

148. Employees often eat lunch together

|_________|_________|_________|
1 2 3 4
Strongly Disagree — Strongly Agree

149. Employees generally do not try to be unique and different

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

150. There□s an emphasis on work before play

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

151. It is very hard to keep up with your work load

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

152. Employees are often confused about exactly what they are supposed to do

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

153. Supervisors are always checking on employees and supervise them very closely

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

154. New approaches to things are rarely tried

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

155. The colours and decorations make the place warm and cheerful to work in

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

156. It is quite a lively place

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

157. Employees who differ greatly from the others in the organization don□t get on well

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

158. Supervisors expect far too much from employees

|________|________|________|
1 2 3 4
Strongly Disagree — Strongly Agree

159. Employees are encouraged to learn things even if they are not directly related to the job

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

160. Employees work very hard

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

161. You can take it easy and still get your work done

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

162. Supervisors do not often give in to employee pressure

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

163. Things tend to stay just about the same

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

164. It is rather drafty at times

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

165. It's hard to get people to do any extra work

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

166. Employees often talk to each other about their personal problems

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

167. Employees discuss their personal problems with supervisors

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

168. Employees function fairly independently of supervisors

1 Strongly Disagree — 2 — 3 — 4 Strongly Agree

169. People seem to be quite inefficient

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

170. There are always deadlines to be met

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

171. Rules and policies are constantly changing

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

172. People often have to work overtime to get their work done

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

173. Supervisors encourage employees to be neat and orderly

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

174. If employees come in late, they can make it up by staying late

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

175. Things always seem to be changing

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

176. The rooms are well ventilated

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

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

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

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

1 Strongly Disagree | 2 | 3 | 4 Strongly Agree

179. Employees are expected to conform rather strictly to the rules and customs

1 2 3 4
Strongly Disagree — Strongly Agree

180. There is a fresh, novel atmosphere about the place

1 2 3 4
Strongly Disagree — Strongly Agree

181. The furniture is usually well-arranged

1 2 3 4
Strongly Disagree — Strongly Agree

182. The work is usually very interesting

1 2 3 4
Strongly Disagree — Strongly Agree

183. Often people make trouble by talking behind others' backs

1 2 3 4
Strongly Disagree — Strongly Agree

184. Supervisors really stand up for their people

1 2 3 4
Strongly Disagree — Strongly Agree

185. Supervisors meet with employees regularly to discuss their future work goals.

1 2 3 4
Strongly Disagree — Strongly Agree

186. There□s a tendency for people to come to work late

1 2 3 4
Strongly Disagree — Strongly Agree

187. People often have to work

1 2 3 4
Strongly Disagree — Strongly Agree

188. There is enough time to get the job done

1 2 3 4
Strongly Disagree — Strongly Agree

189. I am not asked to do an excessive amount of work

1	2	3	4
Strongly Disagree			Strongly Agree

190. My job involves a lot of repetitive work

1	2	3	4
Strongly Disagree			Strongly Agree

191. My job requires that I learn new things

1	2	3	4
Strongly Disagree			Strongly Agree

192. My job requires a high level of skill

1	2	3	4
Strongly Disagree			Strongly Agree

193. My job requires me to be creative

1	2	3	4
Strongly Disagree			Strongly Agree

194. My job is very hectic

1	2	3	4
Strongly Disagree			Strongly Agree

195. I have support from my co-workers to do my job

1	2	3	4
Strongly Disagree			Strongly Agree

196. On the line to the right, please make a mark at the point that you thin best represents your health and vitality

Poor Health |..| Very Healthy

THE END

Appendix 9: Work Organization Items included in Hospital Survey by Year and Union

Table A25: Work Organization Items included in Hospital Survey by Year and Union

Legend: BCNU = British Columbia Nurses Union
HEU = Hospital Employees Union
HSA = Health Services Association

JOB CONTENT QUESTIONNAIRE (Karasek 1979; Karasek & Theorell 1990)	1991 Hospital Survey			1993 Hospital Survey				1994 Hospital Survey			
	BCNU	HSA	NON	BCNU	HSA	HEU	NON	BCNU	HSA	HEU	NON
Job Control – Skill Discretion Items											
1. My job requires that I learn new things	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. My job involves a lot of repetitive work	✓	✓	✓	✓	✓	✓	✓	X	X	X	X
3. My job requires me to be creative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. My job requires a high level of skill	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
5. I get to do a variety of different things on my job	X	X	X	X	X	X	X	X	X	X	X
6. I have an opportunity to develop my own special abilities	X	X	X	X	X	X	X	X	X	X	X
Job Control – Decision Authority Items											
7. My job allows me to make a lot of decisions on my own	X	X	X	X	X	X	X	X	X	X	X
8. I have very little freedom to decide how I do my work	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9. I have a lot of say about what happens on my job	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Job Demands Items											
10 and 11. My job is very hectic (combination of original items on working very fast and very hard)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12. I am not asked to do an excessive amount of work	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
13. I have enough time to get the job done	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14. I am free from conflicting demands that others make	X	X	X	X	X	X	X	X	X	X	X

Table A25 Continued:

WORK ENVIRONMENT SCALE (Insel & Moos 1974; Moos 1986)	1991 Hospital Survey			1993 Hospital Survey				1994 Hospital Survey			
	BCNU	HSA	NON	BCNU	HSA	HEU	NON	BCNU	HSA	HEU	NON
Work Pressure Items											
1. There is constant pressure to keep working	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
2. There always seems to be an urgency about everything	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. People cannot afford to relax	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Nobody works too hard	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
5. There is no time pressure	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
6. It is very hard to keep up with your work load	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7. You can take it easy and still get your work done	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
8. There are always deadlines to meet	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9. People often have to work overtime to get their work done	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
Work Support Items											
1. Supervisors tend to talk down to employees	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Supervisors usually compliment an employee who does something well	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Supervisors tend to discourage criticisms from employees	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Supervisors usually give full credit to ideas contributed by employees	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Supervisors often criticize employees over minor things	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6. Employees generally feel free to ask for a raise	X	X	X	X	X	X	X	X	X	X	X
7. Supervisors expect far too much from employees	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
8. Employees discuss their personal problems with supervisors	✓	✓	✓	✓	✓	X	✓	✓	✓	X	✓
9. Supervisors really stand up for their people	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Appendix 10: Formulae for Job Content Questionnaire and Work Environment Scales

A10.1 Formulae for calculation of Job Control and Job Demands scores:

Job Control = {[learn new things + requires creativity + high skill level + develop own abilities + (5-repetitive work)] * 2} + {[allows own decisions +lot of say + (5 – little decision freedom)] * 4}

Job Demands = {[(work hard + work fast) * 3]} + {[15 – (no excessive work + enough time + conflicting demands] * 2}

The formulae were adapted to adjust for three job control and one job demands question that were never included in the survey and to weight survey items appropriately as follows:

Job Control = {[(learn new things + requires creativity + high skill level) + (5 – repetitive work)] * 3} + {[(lot of say + (5 – little decision freedom)] * 6}

Job Demands = [(work hectic) * 6] + {[10 - (no excessive work + enough time)] * 3}

A10.2 Formulae for calculation of Work Pressure and Work Support scores:

Work Pressure = constant pressure + urgency to everything + cannot relax + nobody works too hard + no time pressure + hard to keep up + can get work done + always deadlines + frequent overtime

Work Support = employees talked down to + employee compliments + criticisms discouraged + full credit for ideas + employees criticized + free to ask for raise + supervisors expect too much + able to discuss personal problems + supervisors stand up for employees

Formulae were adjusted for missing questions, including the one work support item never asked on the survey, and to appropriately weight survey items as follows:

Work Pressure for HEU employees = 9/4 * (urgency to everything + cannot relax + hard to keep up + always deadlines)

Work Support for HEU employees = 9/6 * (employees talked down to + employee compliments + criticisms discouraged + full credit for ideas + employees criticized + supervisors stand up for employees)

Work Support for All Other Employees = 9/8 * (employees talked down to + employee compliments + criticisms discouraged + full credit for ideas + employees criticized + supervisors expect too much + able to discuss personal problems + supervisors stand up for employees)

Appendix 11: Summary of Non-Respondents and Omitted Items in Hospital Survey for Work Organization Factors

Table A26: Summary of Non-Respondents and Omitted Items in Hospital Survey

JOB CONTENT QUESTIONNAIRE (Karasek 1979; Karasek and Theorell 1990)	**Non-respondents**	**Item Omitted**
Job Control – Skill Discretion Items	**(n)**	**(n)**
1. My job requires that I learn new things	6	
2. My job involves a lot of repetitive work	3	299[7]
3. My job requires me to be creative	5	
4. My job requires a high level of skill		
Job Control – Decision Authority Items		
8. I have very little freedom to decide how I do my work	16	
9. I have a lot of say about what happens on my job	9	
Job Demands Items		
10 and 11. My job is very hectic	8	
12. I am not asked to do an excessive amount of work	5	199[8]
13. I have enough time to get the job done	3	
WORK ENVIRONMENT SCALE (Insel and Moos 1974; Moos 1986)		
Work Pressure Items		
1. There is constant pressure to keep working	6	199
2. There always seems to be an urgency about everything	13	
3. People cannot afford to relax	16	
4. Nobody works too hard	5	199
5. There is no time pressure	4	199
6. It is very hard to keep up with your work load	8	
7. You can take it easy and still get work done	11	199
8. There are always deadlines to be met	11	
9. People often have to work overtime to get their work done	9	199
Work Support Items		
1. Supervisors tend to talk down to employees	12	
2. Supervisors usually compliment an employee who does something well	17	
3. Supervisors tend to discourage criticisms from employees	24	
4. Supervisors usually give full credit to ideas contributed by employees	25	
5. Supervisors often criticize employees over minor things	27	
7. Supervisors expect far too much from employees	19	199
8. Employees discuss their personal problems with supervisors	28	199
9. Supervisors really stand up for their people	21	

[7] Not Asked in 1994
[8] Not asked of Hospital Employee Union in 1993 or 1994

Appendix 12: Summary of Methods to Replace Missing and Non-Respondent Data Fields for Work Organization Items

Table A27: Summary of Methods to Replace Missing and Non-Respondent Data Fields in Hospital Survey Database of Work Organization Items

JOB CONTENT QUESTIONNAIRE (Karasek 1979; Karasek & Theorell 1990)	**Status**	**Replacement Strategy**
Job Control Items		Non-respondents to items were replaced with mean value (See Table A33)
My job involves a lot of repetitive work	Missing for all unions in 1994	Replaced with mean value from 1993 by union and supervisor status
My job requires a high level of skill	Missing for HEU in 1993 and 1994	Predicted from non-HEU respondents to this item. Model=1.8 +(0.3 *item 1)+(0.2*item 3)
I get to do a variety of different things on my job I have an opportunity to develop my own special abilities My job allows me to make a lot of decisions on my own	Missing all years all unions	Left missing (Formulae for job control weighted for missing items)
Job Demands Items		Non-respondents to items were replaced with mean values (See Table A33)
I am not asked to do an excessive amount of work	Missing for HEU in both 1993 and 1994	Predicted from non-HEU respondents to this item. Model=1.5+(-0.2*item10)+(0.6*item13)
I am free from conflicting demands that others make	Missing all years all unions	Left missing (Formulae for job control weighted for missing items)

Table A27 Continued

WORK ENVIRONMENT SCALE (Insel & Moos 1974; Moos 1986)	**Status**	**Replacement Strategy**
Work Pressure Items		Non-respondents to items were replaced with mean value (See Table A33)
There is constant pressure to keep working Nobody works too hard There is no time pressure You can take it easy and still get your work done People often have to work overtime to get their work done	Missing for HEU in 1993 and 1994	Left missing (Formulae for job control weighted for missing items)
Work Support Items		Non-respondents to items were replaced with mean value (See Table A33)
Employees generally feel free to ask for a raise	Missing all years, all unions	Left missing (Formulae for job control weighted for missing items)
Supervisors expect far too much from employees Employees discuss their personal problems with supervisors	Missing for HEU in 1993 and 1994	

Table A28: Replacement of Missing Cells for Non Respondents with Mean Values by Significant Demographic Variables

JOB CONTENT QUESTIONNAIRE	Missing Cells for Non Respondents Replaced with Mean Values by the Following Significant Demographic Variables:					
Job Control – Skill Discretion	**Age**	**Sex**	**Experience**	**Union**	**Supervisor**	**Job Area**
1 My job requires that I learn new things	X			X	X	X
2 My job involves a lot of repetitive work				X	X	X
3 My job requires me to be creative	X			X	X	X
4 My job requires a high level of skill		X	X	X	X	
Job Control – Decision Authority						
8 I have very little freedom to decide how I do my work		X		X	X	X
9 I have a lot of say about what happens on my job	X		X	X	X	X
Job Demands						
10 My job requires working very fast 11 My job requires working very hard		X			X	X
12 I am not asked to do an excessive amount of work	X	X		X	X	
13 I have enough time to get the job done	X	X		X	X	X
WORK ENVIRONMENT SCALE						
Work Pressure						
1 There is constant pressure to keep working		X		X		X
2 There always seems to be an urgency about everything			X			
3 People cannot afford to relax			X		X	X
4 Nobody works too hard						X
5 There is no time pressure		X				X
6 It is very hard to keep up with your work load	X			X	X	
7 You can take it easy and still get your work done	X					X
8 There are always deadlines to be met				X	X	X
9 People often have to work overtime to get their work done	X		X	X		X
Work Support						
1 Supervisors tend to talk down to employees				X	X	
2 Supervisors compliment employee who does something well	X		X	X	X	X
3 Supervisors tend to discourage criticisms from employees	X	X			X	X
4 Supervisors give full credit to ideas contributed by employees		X	X		X	X
5 Supervisors often criticize employees over minor things		X		X		
7 Supervisors expect far too much from employees						
8 Employees discuss their personal problems with supervisors	X	X			X	X
9 Supervisors really stand up for their people		X			X	X

Appendix 13: Description of Job Area Variable in Hospital Survey

Table A29: Description of Job Area Variable in Hospital Survey

UNION	Description of Job Areas Included in Survey by Union	Reconciliation of Job Areas Across Union into 7 Areas as Follows:	Creation of New Variable for Regression Analysis: 21 Unique Combinations of Union* 7 Job Areas
Hospital Employee Union	Clerical Food Service Housekeeping Laundry Maintenance Trades Stores Patient Care Patient Care Technical Miscellaneous Supervisor Other	1. Clerical 2. Support Services " " " " " 3. Direct Patient Care 4. Patient Care Testing 5. Technical Services 6. Administration 7. Other	HEU * 7 Job Categories:
British Columbia Nurses Union	Critical Care Emergency Medical/Surgical Rehabilitation Obstetrics Operating Room Paediatrics Renal Psychiatry Ambulatory Care/Clinics Management Supervisor Research Education Other	3. Direct Patient Care " " " " " " " " " 6. Administration " 7. Other " "	BCNU * 3 job categories:
Health Services Association	Direct Patient Care Patient – Testing/Technical Non Patient- Professional/Tech Management Supervisor Other	3. Direct Patient Care 4. Patient Care Testing 5. Technical Services 6. Administration " 7. Other	HSA * 5 categories:
Non Contract	Direct Patient Care Patient – Testing/Technical Non Patient- Professional/Tech Clerical Management Other	3. Direct Patient Care 4. Patient Care Testing 5. Technical Services 1. Clerical 6. Administration 7. Other	Non Contract *6 job categories

Appendix 14: Final Predictive Models for Work Organization Factors

Table A30: Final Predictive Models for Work Organization Factors

Work Organization Factor	Predictive Variables	Final Model
Job Control	Intercept	69.86+
	Supervisor Status	6.95* Supervisor+
	Work Group	-6.03*HEU Direct Care +
		6.22*HSA Direct Care+
		-12.2*HEU Patient Testing+
		-3.12*HSA Patient Testing+
		-5.81* HEU Technical Services+
		-4.14*HSA Technical Services +
		-12.2 *HEU Support Services +
		-8.64*HEU Clerical +
		9.67*Non Clerical +
		5.45*BCNU Administration +
		7.46* Non Administration +
		6.79 * BCNU Other +
		-5.78*HEU Other +
		11.18 * Non Other +
	Age	-9.81* Age < 25 +
		-3.89* Age 25–34 +
		-2.32 * Age 35-44 +
		5.19 * Age >55
Job Demands	Intercept	32.29 +
	Supervisor Status	3.51 * Supervisor +
	Work Group	4.02 * HEU Clerical +
		4.59 * HEU Other +
	Age	-3.92 * Age >55 years
Work Support	Intercept	5.00 +
	Supervisor	1.27 * Supervisor +
	Sex	0.45 * Female +
	Years in Job	0.41 * 6-10 Years in Job +
	Work Group	0.70*HSA Direct Care +
		-1.32*HEU Support Services +
	Age	-1.21* Age <25 +
		-0.45*Age 25-34 +
		-0.41* Age 35 – 44
Work Pressure	Intercept	5.97 +
	Supervisor Status	0.76 * Supervisor +
	Years in Job	-0.74 * 10-20 Years in Job +
	Work Category	-0.67*HEU Direct Care +
		-0.66*HSA Patient Testing +
		0.90*HEU Clerical +
		1.34*NON Clerical +
		0.90*BCNU Other +
	Age	0.83 * age >55

Appendix 15: Sample of Reports for Sicktime, Overtime and Work Units Data

REVENUE AND EXPENSE REPORT

COST CENTRE LEVEL

FOR FISCAL PERIOD 13 ENDED MARCH 31, 1995

HOSPITAL:	001	OPERATING FUND – REVENUE, EXPENSE AND STATISTICS
DIVISION:	012	PATIENT SERVICES
DEPARTMENT:	111	LABORATORIES
COST CENTRE:	XXX	XXXXXXXXXX

ACTUAL	BUDGET	VARIANCE	DESCRIPTION
0.0	207.0	207.0	HOURS-MEDICAL STENO
201.9	0.0	-201.9	HOURS-CLERK IV
201.9	207.0	5.1	TOTAL HOURS -HEU
198.1	186.7	-11.4	HOURS-HEAD TECHNICIAN
422.5	374.1	-48.4	HOURS-TECHNICIAN V
84.1	85.3	1.2	HOURS-TECHNICIAN IV
581.3	779.0	197.7	HOURS-TECHNICIAN III
2,0001.4	1,565.7	-435.7	HOURS-TECHNICIAN II
982.8	1,432.1	449.3	HOURS-TECHNICIAN I
4,270.2	4,422.9	152.7	TOTAL HOURS –HSA
0.0	0.0	0.0	HOURS – PROGRAMMER ANALYST
0.0	0.0	0.0	TOTAL HOURS – NON UNION
4,472.10	4,629.9	157.8	TOTAL PAID HOURS
			F.T.E.'S
22.9	23.7	.8	AVERAGE HOURLY RATE
26.7	26.5	-.21	VARIANCE DUE TO HOURS
			VARIANCE DUE TO RATE
11,998.00	9,074.0	2,924.0	WORKLOAD UNITS-EMERGENCY TESTS
55,420.00	49,887.1	5,532.9	WORKLOAD UNITS-INPATIENT TESTS
40,902.00	42,706.9	-1,804.9	WORKLOAD UNITS-OUTPATIENT TESTS
15,454.00	8,186.3	7,267.7	WORKLOAD UNITS-REFERRRED IN
43,872.0	49,906.9	-6,034.9	WORKLOAD UNITS – QUALITY CONTROL
167,646.0	169,761.2	7,884.8	TOTAL WEIGHTED WORKLOAD UNITS
37.5	34.5	3.0	# OF WORKLOA D UNITS/PAID HOUR
12,248.0	10,553.4	1,694.6	EXAMS-INPATIENT
5,299.0	5,030.1	268.9	EXAMS-OUTPATIENT
1,536.0	1,084.9	451.1	EXAMS-OUTPATIENT REFERRED IN
8,204.0	7,939.7	264.3	EXAMS-QUALITY CONTROL
8.0	9.9	-1.9	EXAMS-INPATIENT REFERRED OUT
23.0	19.7	3.3	EXAMS-OUTPATIENT REFERRED
2,597.0	2,564.4	32.6	EXAMS-EMERGENCY
29,915.0	27,202.1	2,712.9	TOTAL EXAMS

HOURS REPORT
COST CENTRE LEVEL
FOR FISCAL PERIOD 13 ENDED MARCH 31, 1995

HOSPITAL:		001	OPERATING FUND – REVENUE, EXPENSE AND STATISTICS
DIVISION:		012	PATIENT SERVICES
DEPARTMENT:	111	LABORATORIES	
COST CENTRE:	XXX	XXXXXXXXXX	

ACTUAL	BUDGET	VARIANCE	DESCRIPTION
0.00	0.00	0.00	REGULAR HOURS
0.00	0.00	0.00	VACATION HOURS
0.00	0.00	0.00	SICKTIME HOURS
0.00	0.00	0.00	STATUTORY HOLIDAY HOURS
0.00	0.00	0.00	TRAINING HOURS
0.00	0.00	0.00	OTHER HOURS
0.00	0.00	0.00	TOTAL HOURS
0.00	0.00	0.00	OVERTIME HOURS
0.00	0.00	0.00	TOTAL

Appendix 16: Description Work Units Data Collected by Hospital Department

Table A31: Description of Work Units Data Collected by Hospital Department

Department	Type of Work Units Data
Medical Records	Admissions And Discharges
Admitting	
Cardiac Angiography	Cases
Linen	Kilograms Laundry
Nutrition Services	Meal Days
Nursing Units (n=22)	Patient Days
Cafeteria	Staff Meal Days
Clinics (n=13)	Visits
Post Anaesthetic Recovery Room	Visits
Emergency	
Operating Room	
Ambulatory Care	
Psychiatric Out - Patients	
Medical Short Stay	
Renal Dialysis Unit	
Nutrition Clinical Services	
Patient Testing Areas (n=7)	Workload Units*
Laboratory Areas (n=7)	
Therapy Departments (n=5)	
Nursing Units (n=7)	

*Note: Workload Units were calculated by a Provincial Government Formula that weights the type of service provided by the number employees and amount of time required to complete the service.

Appendix 17: Pearson Correlation Coefficients

Table A32: Correlation Coefficients for Categorical Variables: Overall Cohort Population

	↑Age	Sex	↑ Years in Job	↑ Time Previous Symptom	↑ Lower Biomech-anical	↑ Upper Biomech-anical	↑ Control	↑ Demand	↑ Pressure	↑ Support
↑ Age	**1.00**	-0.03	0.36	0.11	-0.01	-0.08	0.32	-0.21	-0.37	0.25
Sex		**1.00**	-0.06	-0.01	0.08	0.11	-0.09	-0.05	-0.07	-0.35
↑ Years In Job			**1.00**	0.18	-0.03	0.02	0.14	-0.14	-0.35	0.26
↑ Time Previous Symptom				**1.00**	-0.07	-0.01	0.06	0.01	-0.00	0.10
↑ Lower Biomech-anical					**1.00**	0.28	-0.24	-0.35	-0.37	-0.31
↑ Upper Biomech-anical						**1.00**	-0.52	-0.16	-0.16	-0.47
↑ Control							**1.00**	-0.14	0.02	0.70
↑ Demand								**1.00**	0.72	0.16
↑ Pressure									**1.00**	0.10
↑ Support										**1.00**

Table A33: Correlation Coefficients for Categorical Variables: Sicktime/Overtime Sub-cohort

	↑Age	Sex	↑Years in Job	↑ Time Previous Symptom	↑ Lower Biomechanical	↑ Upper Biomechanical	↑ Control	↑ Demand	↑ Pressure	↑ Support	↑ Sick time Prop.*	↑ Over time Prop.*
↑ Age	**1.00**	-0.03	0.36	0.11	-0.02	-0.09	0.33	-0.21	-0.25	0.37	-0.01	-0.08
Sex		**1.00**	-0.05	-0.01	0.09	0.12	-0.11	-0.05	-0.08	-0.35	0.05	0.01
↑ Years in Job			**1.00**	0.20	0.02	0.01	0.15	-0.14	-0.34	0.26	-0.00	-0.00
↑ Time Previous Symptom				**1.00**	-0.08	-0.02	0.07	0.02	0.00	0.11	-0.04	0.03
↑ Lower Biomech-anical					**1.00**	0.28	-0.24	-0.35	-0.36	-0.33	0.25	0.11
↑ Upper Biomech-anical						**1.00**	-0.53	-0.14	-0.14	-0.48	0.16	-0.02
↑ Control							**1.00**	-0.13	0.02	0.71	-0.14	-0.05
↑ Demand								**1.00**	0.72	0.16	-0.09	0.01
↑ Pressure									**1.00**	0.11	-0.09	-0.03
↑ Support										**1.00**	-0.13	0.05
↑ Sicktime Prop.*											**1.00**	0.09
↑Overtime Prop.*												**1.00**

Table A34: Correlation Coefficients for Categorical Variables: Work units Sub-cohort

	↑Age	Sex	↑ Years in Job	↑ Time Previous Symptom	↑ Lower-Biomechanical	↑ Upper-Biomechanical	↑ Control	↑ Demand	↑ Pressure	↑ Support	↑ Work Units/FTE
↑ Age	**1.00**	-0.06	0.38	0.14	-0.02	-0.04	0.35	-0.22	-0.26	0.40	0.009
Sex		**1.00**	-0.08	0.00	0.05	0.03	-0.06	-0.04	-0.07	-0.34	0.007
↑ Years in Job			**1.00**	0.27	0.01	0.03	0.20	-0.13	-0.31	0.32	0.009
↑ Time Previous Symptom				**1.00**	-0.11	0.01	0.06	0.03	-0.01	0.12	-0.03
↑ Lower Biomech-anical					**1.00**	0.15	-0.08	-0.36	-0.34	-0.22	-0.002
↑ Upper Biomech-anical						**1.00**	-0.43	-0.11	-0.12	-0.35	0.06
↑ Control							**1.00**	-0.21	-0.04	0.66	-0.03
↑ Demand								**1.00**	0.72	0.09	-0.004
↑ Pressure									**1.00**	0.07	-0.01
↑ Support										**1.00**	-0.02
↑ Work Units /FTE											**1.00**

Appendix 18: Uni-variable Analyses

Table A35: Unadjusted Risk Ratios for Upper-body Musculoskeletal Symptoms and Claims

		Upper-Body Musculoskeletal Symptoms			Upper-Body Claims	
		Overall Cohort	Sick/Overtime Sub-cohort	Work Units Sub-cohort	Overall Cohort	Sick/Overtime Sub-cohort
		Unadjusted RR (95% CI)			Unadjusted RR (95% CI)	
Age	<30	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
(Years)	30-39	1.22 (0.96, 1.55)	1.19 (0.93, 1.53)	0.88 (0.64, 1.21)	1.48 (1.07, 2.04)*	1.44 (1.03, 2.01)*
	40-49	1.24 (0.97, 1.59)	1.23 (0.95, 1.59)	0.98 (0.71, 1.37)	1.33 (0.95, 1.87)	1.32 (0.92, 1.87)
	≥ 50	1.09 (0.81, 1.46)	1.02 (0.75, 1.39)	0.75 (0.49, 1.14)	1.36 (0.93, 1.99)	1.22 (0.81, 1.84)
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.79 (0.63, 0.93)*	0.73 (0.58, 0.92)*	0.60 (0.39, 0.90)*	0.83 (0.63, 1.10)	0.71 (0.52, 0.97)*
Years	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
in Job	6-10	1.31 (0.94, 1.84)	1.33 (0.93, 1.89)	1.59 (0.97, 2.59)	1.74 (1.09, 2.79)*	1.79 (1.08, 2.95)*
	2-5	1.30 (0.98, 1.73)	1.34 (0.99, 1.81)	1.62 (1.04, 2.50)*	1.63 (1.08, 2.46)*	1.72 (1.10, 2.68)*
	<2	1.27 (0.96, 1.69)	1.29 (0.96, 1.74)	1.59 (1.03, 2.47)*	1.72 (1.15, 2.59)*	1.80 (1.17, 2.79)*
Time Since	**>24**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Previous	13-24	1.31 (1.04, 1.66)*	1.28 (1.01, 1.62)*	1.14 (0.84, 1.53)	1.74 (1.26, 2.38)*	1.67 (1.21, 2.30)*
Symptoms	7-12	1.80 (1.42, 2.29)*	1.84 (1.44, 2.34)*	2.89 (2.05, 4.07)*	2.13 (1.53, 2.97)*	2.16 (1.55, 3.02)*
(months)	3-6	1.96 (1.46, 2.62)*	2.00 (1.50, 2.68)*	3.18 (2.07, 4.87)*	2.57 (1.75, 3.77)*	2.61 (1.78, 3.84)*
	<3	2.31 (1.78, 3.00)*	3.16 (2.33, 4.29)*	3.10 (2.06, 4.64)*	3.12 (2.21, 4.40)*	4.20 (2.81, 6.26)*
Upper	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Biomech.	Medium	2.24 (1.77, 2.84)*	2.27 (1.77, 2.92)*	2.16 (1.58, 2.95)*	2.20 (1.60, 3.01)*	2.22 (1.59, 3.11)*
Score	High	2.54 (1.95, 3.31)*	2.49 (1.88, 3.30)*	1.00 (0.62, 1.63)	3.05 (2.17, 4.29)*	3.03 (2.11, 4.36)*
Job	**High**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Control	Med-High	2.14 (1.50, 3.04)*	2.13 (1.47, 3.09)*	1.69 (1.06, 2.69)*	2.03 (1.21, 3.39)*	2.10 (1.19, 3.69)*
	Med-Low	2.89 (2.10, 3.99)*	2.91 (2.07, 4.09)*	2.25 (1.46, 3.48)*	3.67 (2.32, 5.79)*	4.11 (2.48, 6.81)*
	Low	3.17 (2.28, 4.40)*	3.18 (2.24, 4.50)*	2.06 (1.27, 3.34)*	4.41 (2.77, 7.02)*	4.80 (2.88, 8.01)*
Job	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Demands	Medium	1.14 (0.79, 1.65)	1.28 (0.85, 1.93)	1.12 (0.65, 1.92)	1.17 (0.71, 1.91)	1.48 (0.83, 2.65)
	High	0.74 (0.49, 1.13)	0.81 (0.51, 1.29)	0.93 (0.50, 1.72)	0.83 (0.48, 1.44)	1.02 (0.54, 1.93)
Work	**High**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Support	Med-High	1.87 (1.33, 2.61)*	1.78 (1.26, 2.52)*	1.69 (1.08, 2.65)*	2.28 (1.42, 3.67)*	2.10 (1.28, 3.42)*
	Med-Low	1.88 (1.36, 2.58)*	1.84 (1.33, 2.56)*	1.94 (1.27, 2.97)*	2.20 (1.39, 3.47)*	2.19 (1.37, 3.49)*
	Low	2.54 (1.83, 3.51)*	2.35 (1.68, 3.28)*	1.47 (0.88, 2.44)	3.43(2.17, 5.14)*	3.17 (1.98, 5.08)*
Work	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Pressure	Medium	0.89 (0.74, 1.07)	0.88 (0.72, 1.07)	0.85 (0.65, 1.11)	0.87 (0.68, 1.11)	0.87 (0.67, 1.12)
	High	0.42 (0.31, 0.58)*	0.43 (0.31, 0.59)*	0.67 (0.44, 1.00)	0.46 (0.31, 0.68)*	0.46 (0.30, 0.69)*
Sicktime	**Low**		**1.00**			**1.00**
Prop. in	Med-Low		1.59 (1.21, 2.09)*			1.46 (1.00, 2.13)
Depart.	Med-High		1.91 (1.49, 2.46)*			1.99 (1.42, 2.79)*
	High		1.97 (1.52, 2.56)*			2.43 (1.73, 3.41)*
Overtime	**Low**		**1.00**			**1.00**
Prop. in	Med-Low		1.51 (1.19, 1.92)*			1.41 (1.03, 1.92)*
Depart.	Med-High		1.30 (1.01, 1.69)*			1.11 (0.79, 1.57)
	High Low		1.32 (1.03, 1.69)*			1.30 (0.95, 1.78)
Work	**Usual**			**1.00**		
Units/	Below			0.93 (0.63, 1.38)		
FTE	Above			1.30 (1.00, 1.69)		
	Very Above			0.87 (0.57, 1.32		

*** 95% CI excludes 1**

Table A36: Unadjusted Risk Ratios for Lower-body Musculoskeletal Symptoms and Claims

Variable	Category	Lower-Body Musculoskeletal Symptoms: Overall Cohort	Lower-Body Musculoskeletal Symptoms: Sicktime/Overtime Sub-cohort	Lower-Body Musculoskeletal Symptoms: Work Units Sub-cohort	Lower-Body Claims: Overall Cohort	Lower-Body Claims: Sicktime/Overtime Sub-cohort
		Unadjusted Rate Ratios (95% CI)			Unadjusted Rate Ratios (95% CI)	
Age (years)	<30	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.04 (0.86,1.26)	0.96 (0.79, 1.17)	0.89 (0.69, 1.14)	0.97 (0.76, 1.25)	0.90 (0.70, 1.16)
	40-49	1.06 (0.87,1.29)	1.02 (0.83, 1.26)	0.92 (0.70, 1.20)	1.01 (0.78, 1.31)	0.92 (0.70, 1.20)
	≥ 50	0.90 (0.71,1.15)	0.89 (0.70, 1.14)	0.65 (0.46, 0.93)	0.91 (0.67, 1.23)	0.86 (0.63, 1.18)
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	1.17 (0.99, 1.37)	1.15 (0.97, 1.36)	0.96 (0.72, 1.26)	1.30 (1.06, 1.60)*	1.30 (1.05, 1.61)*
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.05 (0.78, 1.42)	1.07 (0.79, 1.46)	1.18 (0.77, 1.79)	1.16 (0.77, 1.74)	1.17 (0.77, 1.79)
	2-5	1.37 (1.08, 1.74)*	1.32 (1.03, 1.70)*	1.71 (1.21, 2.42)*	1.56 (1.12, 2.17)*	1.50 (1.06, 2.13)*
	<2	1.34 (1.06, 1.70)*	1.34 (1.04, 1.71)*	1.58 (1.11, 2.24)*	1.64 (1.18, 2.27)*	1.64 (1.17, 2.31)*
Time Since Previous Symptoms (months)	**>24**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	13-24	1.53 (1.25, 1.86)*	1.50 (1.23, 1.83)*	1.57 (1.25, 1.98)*	1.87 (1.42, 2.45)*	1.82 (1.39, 2.39)*
	7-12	2.00 (1.63, 2.46)*	1.95 (1.59, 2.41)*	2.66 (1.98, 3.58)*	2.44 (1.85, 3.23)*	2.37 (1.79, 3.14)*
	3-6	2.36 (1.85, 3.00)*	2.37 (1.87, 3.02)*	3.25 (2.28, 4.64)*	2.97 (2.16, 4.08)*	2.97 (2.16, 4.09)*
	<3	2.52 (2.02, 3.15)*	3.42 (2.64, 4.43)*	2.76 (1.93, 3.94)*	3.31 (2.47, 4.45)*	4.42 (3.15, 6.20)*
Lower Biomech-anical Score	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	2.41 (1.85, 3.15)*	2.50 (1.89, 3.32)*	2.35 (1.63, 3.38)*	2.51 (1.76, 3.59)*	2.59 (1.77, 3.80)*
	High	4.78 (3.74, 6.09)*	4.92 (3.79, 6.38)*	3.88 (2.75, 5.46)*	5.17 (3.73, 7.16)*	5.39 (3.80, 7.65)*
	Very High	5.48 (4.10, 7.31)*	5.53 (4.07, 7.51)*	4.55 (3.08, 6.72)*	6.08 (4.10, 8.81)*	6.05 (4.02, 9.09)*
Job Control	**High**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High	2.11 (1.61, 2.75)*	2.10 (1.58, 2.78)*	1.74 (1.23, 2.47)*	2.74 (1.86, 4.03)*	2.63 (1.74, 3.97)*
	Med-Low	2.36 (1.84, 3.02)*	2.38 (1.83, 3.09)*	1.89 (1.35, 2.64)*	3.22 (2.24, 4.63)*	3.23 (2.19, 4.74)*
	Low	2.14 (1.65, 2.77)*	2.24 (1.70, 2.94)*	1.42 (0.96, 2.09)	3.08 (2.12, 4.49)*	3.24 (2.18, 4.82)*
Job Demands	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	1.32 (0.96, 1.83)	1.28 (0.91, 1.79)	1.35 (0.85, 2.14)	1.23 (0.82, 1.84)	1.18 (0.77, 1.80)
	High	0.60 (0.41, 0.87)*	0.57 (0.38, 0.85)*	0.61 (0.35, 1.08)	0.49 (0.30, 0.80)*	0.47 (0.28, 0.79)*
Work Support	**High**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High	1.52 (1.15, 2.00)*	1.59 (1.19, 2.12)*	1.42 (0.98, 2.05)	1.97 (1.33, 2.91)*	1.89 (1.26, 2.85)*
	Med-Low	1.87 (1.44, 2.41)*	1.91 (1.46, 2.50)*	1.98 (1.41, 2.78)*	2.39 (1.65, 3.45)*	2.34 (1.59, 3.42)*
	Low	2.20 (1.69, 2.87)*	2.23 (1.69, 2.94)*	1.61 (1.08, 2.40)*	3.04 (2.09, 4.43)*	2.97 (2.01, 4.39)*
Work Pressure	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	1.02 (0.87, 1.19)	0.99 (0.84, 1.17)	1.15 (0.92, 1.43)	0.92 (0.75, 1.13)	0.88 (0.72, 1.09)
	High	0.35 (0.26, 0.47)*	0.34 (0.25, 0.46)*	0.48 (0.32, 0.72)*	0.27 (0.18, 0.40)*	0.26 (0.17, 0.40)*
Sicktime Prop. Depart.	**Low**		**1.00**			**1.00**
	Med-Low		1.57 (1.23, 2.00)*			1.63 (1.16, 2.28)*
	Med-High		2.23 (1.80, 2.77)*			2.50 (1.85, 3.38)*
	High		2.36 (1.89, 2.94)*			3.39 (2.52, 4.56)*
Overtime Prop. Depart.	**Low**		**1.00**			**1.00**
	Med-Low		1.46 (1.19, 1.79)*			1.54 (1.18, 2.00)*
	Med-High		1.47 (1.19, 1.81)*			1.48 (1.12, 1.95)*
	High		1.30 (1.06, 1.61)*			1.28 (0.97, 1.69)
Work Units/FTE	**Usual**			**1.00**		
	Below			0.74 (0.53, 1.04)		
	Above			1.08 (0.87, 1.35)		
	Very Above			1.14 (0.85, 1.53)		

* 95% CI excludes 1

Appendix 19: Trend Analyses

Table A37: Uni-variable Risk Ratios for Trend: Upper-body Musculoskeletal Symptoms and Claims

	Upper-Body Musculoskeletal Symptoms			Upper-Body Compensation Claims	
Variable	Overall Cohort	Sick/Over Sub-cohort	Work Units Sub-cohort	Overall Cohort	Sick/Over Sub-cohort
	Unadjusted Risk Ratio (95% CI)			Unadjusted Risk Ratio (95% CI)	
Age	1.03 (0.94, 1.12)	1.01 (0.93, 1.11)	0.94 (0.83, 1.07)	1.06 (0.95, 1.18)	1.04 (0.92, 1.16)
Sex	0.79 (0.63, 0.98)*	0.73 (0.58, 0.92)*	0.60 (0.39, 0.90)*	0.83 (0.63, 1.10)	0.71 (052, 0.97)*
Years in Job	1.05 (0.97, 1.14)	1.05 (0.97, 1.15)	1.10 (0.98, 1.24)	1.12 (1.01, 1.25)*	1.13 (1.01, 1.27)*
Time Since Previous Symptoms	1.23 (1.16, 1.31)*	1.31 (1.23, 1.40)*	1.40 (1.29, 1.53)*	1.30 (1.21, 1.40)*	1.39 (1.27, 1.51)*
Upper Biomech. Score	1.52 (1.35, 1.71)*	1.50 (1.32, 1.69)*	1.14 (0.95, 1.37)	1.67 (1.43, 1.95)*	1.66 (1.41, 1.95)*
Job Control	1.36 (1.25, 1.48)*	1.36 (1.25, 1.49)*	1.24 (1.09, 1.40)*	1.55 (1.38, 1.74)*	1.58 (1.39, 1.78)*
Job Demands	0.78 (0.65, 0.92)*	0.79 (0.66, 0.95)*	0.91 (0.70, 1.19)	0.83 (0.66, 1.03)	0.85 (0.67, 1.08)
Work Support	1.27 (1.16, 1.38)*	1.24 (1.14, 1.36)*	1.12 (0.98, 1.27)	1.36 (1.21, 1.53)*	1.35 (1.19, 1.52)*
Work Pressure	0.71 (0.62, 0.81)*	0.71 (0.62, 0.81)*	0.82 (0.68, 1.00)	0.72 (0.61, 0.86)*	0.72 (0.61, 0.86)*
Sicktime Prop. in Department		1.23 (1.14, 1.33)*			1.33 (1.20, 1.48)*
Overtime Prop. in Department		1.06 (0.99, 1.14)			1.05 (0.95, 1.16)
Work Units/FTE			1.04 (0.93, 1.16)		

*95% CI excludes '1'

Table A38: Uni-variable Risk Ratios for Trend: Lower-body Musculoskeletal Symptoms and Claims

	Lower-Body Musculoskeletal Symptoms			Lower-Body Compensation Claims	
Variable	Overall Cohort	Sick/Over Sub-cohort	Work Units Sub-cohort	Overall Cohort	Sick/Over Sub-cohort
	Unadjusted Risk Ratio (95% CI)			Unadjusted Risk Ratio (95% CI)	
Age	0.98 (0.91, 1.05)	0.98 (0.91, 1.05)	0.90 (0.82, 1.00)	0.98 (0.89, 1.07)	0.96 (0.87, 1.06)
Sex	1.17 (0.99, 1.37)	1.15 (0.97, 1.36)	0.96 (0.72, 1.26)	1.30 (1.06, 1.60)*	1.30 (1.05, 1.61)*
Years in Job	1.10 (1.03, 1.18)*	1.10 (1.02, 1.18)*	1.15 (1.04, 1.27)*	1.17 (1.07, 1.28)*	1.17 (1.06, 1.29)*
Time Since Previous Symptoms	1.26 (1.20, 1.32)*	1.34 (1.27, 1.41)*	1.35 (1.26, 1.45)*	1.32 (1.24, 1.41)*	1.41 (1.32, 1.52)*
Lower Biomech. Score	1.78 (1.65, 1.91)*	1.77 (1.63, 1.91)*	1.61 (1.45, 1.78)*	1.82 (1.65, 2.01)*	1.82 (1.64, 2.01)*
Job Control	1.20 (1.12, 1.28)*	1.21 (1.13, 1.30)*	1.09 (0.98, 1.20)	1.29 (1.18, 1.41)*	1.32 (1.20, 1.45)*
Job Demands	0.67 (0.58, 0.78)*	0.66 (0.57, 0.77)*	0.70 (0.56, 0.87)*	0.62 (0.52, 0.75)*	0.62 (0.51, 0.76)*
Work Support	1.26 (1.17, 1.36)*	1.25 (1.16, 1.35)*	1.19 (1.07, 1.32)*	1.35 (1.22, 1.48)*	1.35 (1.22, 1.49)*
Work Pressure	070 (0.63, 0.78)*	0.70 (0.62, 0.78)*	0.82 (0.71, 0.96)*	0.65 (0.56, 0.74)*	0.64 (0.55, 0.74)*
Sicktime Prop. in Depart.		1.32 (1.23, 1.41)*			1.48 (1.36, 1.62)*
Overtime Prop. in Depart.		1.07 (1.01, 1.14)*			1.06 (0.98, 1.15)
Work Units/FTE			1.05 (0.96, 1.14)		

*95% CI excludes '1'

Appendix 20: Multi-variable Results: Upper-body Musculoskeletal Symptoms

Table A39: Adjusted Risk Ratios for Upper-body Musculoskeletal Symptoms by Predictor Variables across Study Population

Variable		OVERALL COHORT Control/Demand	OVERALL COHORT Support/Pressure	SICK/OVER SUB-COHORT Control/Demand	SICK/OVER SUB-COHORT Support/Pressure	WORK UNITS SUB-COHORT Control/Demand	WORK UNITS SUB-COHORT Support/Pressure
		Adjusted Risk Ratio (95% CI)		Adjusted Risk Ratio (95% CI)		Adjusted Risk Ratio (95% CI)	
Age	<30	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
(years)	30-39	1.48 (1.17, 1.89)*	1.47 (1.15, 1.88)*	1.45 (1.13, 1.86)*	1.41 (1.09, 1.83)*	1.03 (0.73, 1.43)	0.96 (0.68, 1.35)
	40-49	1.88 (1.45, 2.45)*	1.76 (1.35, 2.30)*	1.88 (1.43, 2.47)*	1.69 (1.28, 2.23)*	1.48 (1.02, 2.14)*	1.26 (0.86, 1.83)
	≥ 50	1.79 (1.26, 2.55)*	1.53 (1.08, 2.15)*	1.76 (1.22, 2.55)*	1.37 (0.95, 1.97)	1.15 (0.67, 1.98)	1.03 (0.61, 1.75)
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.68 (0.54, 0.85)*	0.49 (0.37, 0.64)*	0.62 (0.49, 0.79)*	0.48 (0.36, 0.63)*	0.60 (0.39, 0.91)*	0.48 (0.29, 0.80)*
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.45 (1.02, 2.05)*	1.88 (1.29, 2.73)*	1.42 (0.98, 2.04)	1.85 (1.25, 2.75)*	1.63 (0.98, 2.72)	2.22 (1.27, 3.90)*
	2-5	1.52 (1.12, 2.06)*	1.86 (1.35, 2.57)*	1.49 (1.08, 2.05)*	1.87 (1.33, 2.63)*	1.54 (0.97, 2.44)	1.87 (1.15, 3.02)*
	<2	1.30 (0.96, 1.77)	1.61 (1.17, 2.23)*	1.23 (0.89, 1.70)	1.56 (1.11, 2.20)*	1.12 (0.69, 1.81)	1.35 (0.82, 2.23)
Time Since	**>24**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Previous	13-24	1.33 (1.05, 1.69)*	1.32 (1.04, 1.67)*	1.28 (1.01, 1.63)*	1.27 (1.00, 1.62)	1.17 (0.86, 1.59)	1.16 (0.86, 1.58)
Symptoms	7-12	1.82 (1.42, 2.32)*	1.79 (1.40, 2.28)*	1.85 (1.44, 2.36)*	1.82 (1.42, 2.33)*	2.99 (2.08, 4.28)*	2.94 (2.05, 4.21)*
(months)	3-6	1.98 (1.47, 2.66)*	1.94 (1.44, 2.60)*	2.00 (1.49, 2.69)*	1.96 (1.46, 2.64)*	3.26 (2.10, 5.07)*	3.22 (2.07, 5.00)*
	<3	2.29 (1.76, 2.99)*	2.23 (1.71, 2.91)*	3.00 (2.19, 4.11)*	2.91 (2.12, 3.98)*	3.08 (2.03, 4.67)*	3.03 (1.99, 4.60)*
Upper	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Biomech. Score	Medium	1.74 (1.34, 2.27)*	1.84 (1.42, 2.37)*	1.69 (1.28, 2.24)*	1.80 (1.37, 2.36)*	1.75 (1.23, 2.47)*	1.72 (1.23, 2.41)*
	High	1.55 (1.13, 2.13)*	1.71 (1.24, 2.35)*	1.41 (1.00, 1.98)	1.66 (1.18, 2.33)*	0.73 (0.43, 1.23)	0.87 (0.51, 1.47)
Job Control/	**High**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Work Support	Med-High	1.27 (0.86, 1.88)	1.16 (0.81, 1.66)	1.15 (0.76, 1.74)	1.07 (0.74, 1.55)	1.04 (0.61, 1.76)	1.28 (0.79, 2.05)
	Med-Low	1.96 (1.36, 2.84)*	1.25 (0.86, 1.83)	1.85 (1.24, 2.74)*	1.16 (0.78, 1.71)	1.63 (0.96, 2.74)	1.53 (0.90, 2.60)
	Low	2.78 (1.87, 4.12)*	2.31 (1.51, 3.51)*	2.59 (1.70, 3.95)*	1.98 (1.27, 3.08)*	2.33 (1.33, 4.08)*	2.03 (1.03, 3.97)*
Job Demand	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
/Work Pressure	Med	0.82 (0.51, 1.29)	0.75 (0.60, 0.93)*	0.94 (0.57, 1.56)	0.71 (0.57, 0.90)*	0.71 (0.34, 1.47)	0.71 (0.53, 0.96)*
	High	0.51 (0.30, 0.87)*	0.45 (0.33, 0.63)*	0.60 (0.34, 1.06)	0.47 (0.33, 0.66)*	0.58 (0.26, 1.30)	0.73 (0.47, 1.14)
Sicktime	**Low**			**1.00**	**1.00**		
Proportion in	Med-Low			1.43 (1.09, 1.89)*	1.40 (1.06, 1.85)*		
Depart.	Med-High			1.57 (1.21, 2.03)*	1.53 (1.18, 1.98)*		
	High			1.59 (1.22, 2.07)*	1.56 (1.20, 2.03)*		
Overtime	**Low**			**1.00**	**1.00**		
Proportion in	Med-Low			1.28 (1.00, 1.63)	1.26 (0.99, 1.61)		
Depart.	Med-High			1.15 (0.88, 1.49)	1.13 (0.87, 1.47)		
	High			1.27 (0.98, 1.64)	1.26 (0.97, 1.62)		
Work	**Usual**					**1.00**	**1.00**
Units/FTE	Below					1.03 (0.70, 1.52)	1.04 (0.70, 1.54)
	Above					1.27 (0.97, 1.65)	1.26 (0.97, 1.65)
	Very Above					0.94 (0.62, 1.42)	0.94 (0.62, 1.43)

Appendix 21: Multi-variable Results: Upper-body Musculoskeletal Claims

Table A40: Adjusted Risk Ratios for Upper-body Musculoskeletal Compensation Claims by Predictor Variables across Study Populations

Variable		Overall Cohort: Control/ Demand Model	Overall Cohort: Support/ Pressure Model	Sicktime/Overtime Sub-Cohort: Control/ Demand Model	Sicktime/Overtime Sub-Cohort: Support/ Pressure Model
		Adjusted Risk Ratio (95% CI)		Adjusted Risk Ratio (95% CI)	
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.96 (1.41, 2.71)*	1.93 (1.38, 2.69)*	1.89 (1.35, 2.65)*	1.82 (1.29, 2.58)*
	40-49	2.36 (1.66, 3.36)*	2.11 (1.47, 3.02)*	2.35 (1.63, 3.40)*	2.01 (1.38, 2.92)*
	≥ 50	2.97 (1.90, 4.64)*	2.20 (1.41, 3.44)*	2.82 (1.77, 4.50)*	1.86 (1.16, 3.00)*
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.67 (0.50, 0.90)*	0.47 (0.34, 0.67)*	0.57 (0.41, 0.78)*	0.41 (0.29, 0.60)*
Years in Job	**>10 yrs**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	2.06 (1.27, 3.34)*	2.86 (1.70, 4.81)*	1.99 (1.19, 3.32)*	2.89 (1.66, 5.02)*
	2-5	2.04 (1.32, 3.15)*	2.62 (1.66, 4.13)*	1.99 (1.25, 3.16)*	2.69 (1.65, 4.37)*
	<2	1.80 (1.17, 2.77)*	2.36 (1.50, 3.71)*	1.70 (1.07, 2.70)*	2.34 (1.44, 3.80)*
Time Since Previous Symptoms (months)	**>24 mos**	**1.00**	**1.00**	**1.00**	**1.00**
	13-24	1.77 (1.28, 2.43)*	1.74 (1.27, 2.40)*	1.68 (1.21, 2.32)*	1.65 (1.20, 2.28)*
	7-12	2.16 (1.54, 3.02)*	2.12 (1.51, 2.97)*	2.15 (1.53, 3.01)*	2.10 (1.50, 2.95)*
	3-6	2.60 (1.76, 3.84)*	2.54 (1.72, 3.76)*	2.57 (1.74, 3.79)*	2.51 (1.70, 3.71)*
	<3	3.09 (2.17, 4.38)*	3.01 (2.12, 4.27)*	3.87 (2.57, 5.83)*	3.74 (2.48, 5.63)*
Upper Biomech. Score	**Low**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	1.62 (1.15, 2.29)*	1.74 (1.24, 2.43)*	1.50 (1.04, 2.17)*	1.66 (1.16, 2.39)*
	High	1.61 (1.07, 2.42)*	1.95 (1.29, 2.95)*	1.43 (0.98, 2.21)	1.85 (1.18, 2.88)*
Job Control/ Work Support	**High**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High	1.27 (0.73, 2.22)	1.49 (0.91, 2.46)	1.18 (0.64, 2.19)	1.30 (0.77, 2.18)
	Med-Low	2.67 (1.59, 4.48)*	1.59 (0.94, 2.69)	2.80 (1.59, 4.94)*	1.46 (0.85, 2.52)
	Low	4.03 (2.34, 6.95)*	3.19 (1.80, 5.67)*	3.95 (2.17, 7.20)*	2.73 (1.49, 5.00)*
Job Demands /Work Pressure	**Low**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	0.86 (0.47, 1.55)	0.67 (0.51, 0.89)*	1.08 (0.54, 2.13)	0.62 (0.46, 0.84)*
	High	0.58 (0.30, 1.15)	0.51 (0.33, 0.77)*	0.75 (0.35, 1.62)	0.49 (0.31, 0.77)*
Sicktime Proportion in Depart.	**Low**			**1.00**	**1.00**
	Med-Low			1.33 (0.91, 1.94)	1.29 (0.88, 1.89)
	Med-High			1.59 (1.13, 2.25)*	1.54 (1.09, 2.17)*
	High			1.90 (1.35, 2.68)*	1.84 (1.30, 2.60)*
Overtime Proportion in Department	**Low**			**1.00**	**1.00**
	Med-Low			1.20 (0.87, 1.64)	1.19 (0.87, 1.62)
	Med-High			1.02 (0.72, 1.45)	1.01 (0.71, 1.43)
	High			1.34 (0.96, 1.85)	1.34 (0.96, 1.85)

* 95 % CI excludes

Appendix 22: Multi-variable Results: Lower-body Musculoskeletal Symptoms

Table A41: Adjusted Risk Ratios for Lower-body Musculoskeletal Symptoms by Predictor Variables across Study Populations

		OVERALL COHORT		SICK/OVERTIME SUB-COHORT		WORKUNITS SUB-COHORT	
Variable	**Category**	**Control/Demand**	**Support/Pressure**	**Control/Demand**	**Support/Pressure**	**Control/Demand**	**Support/Pressure**
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.14 (0.94, 1.39)	1.09 (0.90, 1.33)	1.08 (0.88, 1.32)	1.02 (0.83, 1.25)	1.01 (0.77, 1.32)	0.95 (0.73, 1.24)
	40-49	1.36 (1.10, 1.69)*	1.30 (1.05, 1.61)*	1.34 (1.07, 1.67)*	1.25 (1.00, 1.56)	1.21 (0.89, 1.64)	1.14 (0.84, 1.53)
	≥ 50	1.35 (1.01, 1.80)*	1.18 (0.89, 1.57)	1.36 (1.01, 1.83)*	1.15 (0.86, 1.54)	0.90 (0.57, 1.42)	0.88 (0.57, 1.36)
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	1.02 (0.86, 1.21)	1.02 (0.84, 1.25)	0.98 (0.82, 1.17)	1.01 (0.82, 1.25)	0.88 (0.66, 1.17)	1.00 (0.71, 1.39)
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.05 (0.77, 1.43)	1.10 (0.79, 1.54)	1.08 (0.79, 1.48)	1.15 (0.82, 1.63)	1.08 (0.70, 1.66)	1.15 (0.71, 1.84)
	2-5	1.48 (1.14, 1.91)*	1.53 (1.17, 2.02)*	1.41 (1.08, 1.84)*	1.48 (1.11, 1.97)*	1.61 (1.12, 2.33)*	1.61 (1.09, 2.38)*
	<2	1.27 (0.98, 1.64)	1.34 (1.02, 1.77)*	1.22 (0.93, 1.59)	1.31 (0.98, 1.74)	1.17 (0.80, 1.71)	1.18 (0.79, 1.77)
Time Since Previous Symptoms (months)	**>24**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	13-24	1.47 (1.20, 1.79)*	1.47 (1.20, 1.79)*	1.43 (1.17, 1.75)*	1.43 (1.17, 1.75)*	1.53 (1.20, 1.93)*	1.52 (1.20, 1.93)*
	7-12	1.87 (1.52, 2.31)*	1.87 (1.52, 2.30)*	1.81 (1.47, 2.24)*	1.81 (1.46, 2.23)*	2.43 (1.78, 3.31)*	2.42 (1.77, 3.29)*
	3-6	2.18 (1.71, 2.79)*	2.18 (1.71, 2.79)*	2.15 (1.68, 2.75)*	2.14 (1.68, 2.74)*	2.92 (2.02, 4.22)*	2.91 (2.02, 4.21)*
	<3	2.26 (1.80, 2.84)*	2.26 (1.80, 2.84)*	2.82 (2.16, 3.68)*	2.82 (2.16, 3.68)*	2.38 (1.65, 3.44)*	2.38 (1.65, 3.43)*
Lower-body Biomechanical Score	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	2.23 (1.69, 2.95)*	2.23 (1.69, 2.94)*	2.25 (1.67, 3.04)*	2.19 (1.63, 2.95)*	2.12 (1.44, 3.10)*	2.06 (1.41, 3.01)*
	High	4.18 (3.19, 5.48)*	3.97 (3.04, 5.18)*	3.77 (2.81, 5.06)*	3.58 (2.67, 4.79)*	3.26 (2.23, 4.76)*	3.17 (2.17, 4.63)*
	Very-High	4.65 (3.39, 6.39)*	4.41 (3.22, 6.05)*	4.32 (3.08, 6.06)*	3.99 (2.84, 5.58)*	3.89 (2.53, 5.98)*	3.69 (2.40, 5.67)*
Job Control/ Work Support	**High**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High	1.07 (0.80, 1.43)	0.95 (0.71, 1.27)	0.99 (0.72, 1.35)	0.96 (0.71, 1.30)	1.03 (0.70, 1.52)	1.11 (0.76, 1.63)
	Med-Low	1.28 (0.98, 1.67)	1.03 (0.77, 1.37)	1.22 (0.92, 1.63)	1.04 (0.77, 1.42)	1.16 (0.81, 1.68)	1.23 (0.83, 1.81)
	Low	1.15 (0.86, 1.53)	0.96 (0.70, 1.31)	1.12 (0.83, 1.52)	0.93 (0.67, 1.30)	1.08 (0.71, 1.63)	0.94 (0.58, 1.52)
Job Demands /Work Pressure	**Low**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	1.26 (0.85, 1.88)	0.99 (0.82, 1.20)	1.30 (0.86, 1.97)	0.96 (0.78, 1.17)	0.95 (0.52, 1.74)	0.99 (0.76, 1.29)
	High	1.08 (0.68, 1.70)	0.61 (0.44, 0.85)*	1.11 (0.69, 1.79)	0.62 (0.44, 0.88)*	0.86 (0.42, 1.74)	0.80 (0.50, 1.28)
Sicktime Proportion in Department	**Low**			**1.00**	**1.00**		
	Med-Low			1.24 (0.97, 1.58)	1.21 (0.95, 1.55)		
	Med-High			1.56 (1.24, 1.95)*	1.55 (1.24, 1.93)*		
	High			1.57 (1.25, 1.98)*	1.56 (1.24, 1.96)*		
Overtime Proportion in Department	**Low**			**1.00**	**1.00**		
	Med-Low			1.16 (0.94, 1.42)	1.14 (0.93, 1.40)		
	Med-High			1.19 (0.96, 1.48)	1.16 (0.94, 1.44)		
	High			1.15 (0.93, 1.43)	1.12 (0.90, 1.39)		
Work Units/FTE	**Usual**					**1.00**	**1.00**
	Below					0.86 (0.62, 1.21)	0.87 (0.62, 1.22)
	Above					1.04 (0.84, 1.30)	1.05 (0.84, 1.30)
	Very Above					1.21 (0.90, 1.62)	1.23 (0.92, 1.66)

* 95% CI excludes '1'

Appendix 23: Multi-variable Results: Lower-body Musculoskeletal Claims

Table A42: Adjusted Risk Ratios for Lower-body Musculoskeletal Compensation Claims by Predictor Variables by Study Populations

		OVERALL COHORT		SICK/OVER SUB COHORT	
Variable	**Category**	**Control/Demand Model**	**Support/Pressure Model**	**Control/Demand Model**	**Support/Pressure Model**
		Adjusted Risk Ratio (95% CI)		Adjusted Risk Ratio (95% CI)	
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.13 (0.88, 1.46)	1.06 (0.82, 1.36)	1.05 (0.81, 1.37)	0.97 (0.75, 1.26)
	40-49	1.42 (1.08, 1.87)*	1.31 (1.00, 1.73)	1.30 (0.98, 1.74)	1.17 (0.87, 1.55)
	≥ 50	1.49 (1.03, 2.17)*	1.25 (0.87, 1.80)	1.40 (0.95, 2.06)	1.11 (0.76, 1.62)
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	1.09 (0.88, 1.36)	1.08 (0.84, 1.40)	1.06 (0.84, 1.32)	1.08 (0.82, 1.41)
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.21 (0.80, 1.85)	1.43 (0.91, 2.25)	1.22 (0.79, 1.88)	1.48 (0.92, 2.35)
	2-5	1.75 (1.23, 2.48)*	1.97 (1.36, 2.85)*	1.62 (1.12, 2.34)*	1.90 (1.29, 2.79)*
	<2	1.55 (1.10, 2.20)*	1.79 (1.24, 2.58)*	1.44 (1.00, 2.08)	1.73 (1.18, 2.54)*
Time Since Previous Symptoms (months)	**>24**	**1.00**	**1.00**	**1.00**	**1.00**
	13-24	1.77 (1.35, 2.33)*	1.76 (1.34, 2.32)*	1.71 (1.30, 2.25)*	1.69 (1.29, 2.23)*
	7-12	2.25 (1.69, 2.98)*	2.24 (1.69, 2.97)*	2.13 (1.60, 2.84)*	2.12 (1.59, 2.82)*
	3-6	2.70 (1.95, 3.73)*	2.69 (1.94, 3.72)*	2.59 (1.87, 3.58)*	2.57 (1.85, 3.55)*
	<3	2.91 (2.16, 3.93)*	2.90 (2.15, 3.92)*	3.51 (2.48, 4.96)*	3.50 (2.47, 4.95)*
Lower body Biomechanical Score	**Low**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	2.11 (1.45, 3.06)*	2.13 (1.47, 3.08)*	2.12 (1.42, 3.16)*	2.07 (1.39, 3.09)*
	High	3.87 (2.70, 5.53)*	3.78 (2.65, 5.39)*	3.36 (2.27, 4.98)*	3.27 (2.21, 4.84)*
	Very High	4.31 (2.84, 6.53)*	4.07 (2.69, 6.15)*	3.86 (2.46, 6.05)*	3.49 (2.23, 5.46)*
Job Control/ Work Support	**High**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High	1.40 (0.93, 2.13)	1.19 (0.79, 1.79)	1.25 (0.80, 1.95)	1.08 (0.70, 1.65)
	Med-Low	1.77 (1.20. 2.61)*	1.28 (0.85, 1.94)	1.64 (1.08, 2.49)*	1.18 (0.77, 1.82)
	Low	1.69 (1.12, 2.55)*	1.24 (0.80, 1.93)	1.58 (1.02, 2.44)*	1.09 (0.68, 1.72)
Job Demands /Work Pressure	**Low**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium	1.09 (0.66, 1.80)	0.85 (0.67, 1.08)	1.09 (0.64, 1.84)	0.78 (0.60, 1.00)
	High	0.82 (0.45, 1.49)	0.47 (0.30, 0.72)*	0.86 (0.46, 1.61)	0.46 (0.29, 0.74)*
Sicktime Proportions in Department	**Low**			**1.00**	**1.00**
	Med-Low			1.27 (0.90, 1.79)	1.25 (0.89, 1.77)
	Med-High			1.71 (1.25, 2.33)*	1.71 (1.25, 2.33)*
	High			2.19 (1.61, 2.98)*	2.21 (1.62, 3.00)*
Overtime Proportions in Department	**Low**			**1.00**	**1.00**
	Med-Low			1.20 (0.92, 1.57)	1.19 (0.91, 1.55)
	Med-High			1.21 (0.91, 1.60)	1.17 (0.88, 1.55)
	High			1.15 (0.87, 1.53)	1.11 (0.84, 1.48)

* 95 % CI excludes '1'

Appendix 24: Potential Sources of Confounding

All models were built by first adding the individual predictor variables, followed by the biomechanical variable, and then the work organization variables. The variable 'time since previous symptom' was added last to the model to understand the effect of adjusting for this novel measure. Changes in risk ratios for upper-body morbidity with the addition of groups of predictor variables are illustrated in tables A49 to A51 and for lower-body morbidity in tables A52 to A54.

Table A43: Change in Risk Ratios for Upper-body Musculoskeletal Symptoms by Addition of Predictor Variables to Multi-Variable Models: Overall Cohort

Variable	Category	Individual Variables	Plus Biomechanical Variable	Plus Work Organization Variables		Plus Time Since Previous Symptoms Variable	
				Control/ Demand Model	Support/ Pressure Model	Control/ Demand Model	Support/ Pressure Model
Age (years)	<30	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.21	1.32*	1.43*	1.41*	1.48*	1.47*
	40-49	1.32*	1.47*	1.79*	1.69*	1.88*	1.76*
	≥ 50	1.21	1.35	1.68*	1.44*	1.79*	1.53*
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.78*	0.73*	0.67*	0.47*	0.68*	0.49*
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.33	1.42*	1.41	1.86*	1.45*	1.88*
	2-5	1.38*	1.50*	1.49*	1.84*	1.52*	1.86*
	<2	1.38*	1.51*	1.45*	1.80*	1.30	1.61*
Upper-body Biomechanic Score	**Low**		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium		2.30*	1.76*	1.85*	1.74*	1.84*
	High		2.80*	1.52*	1.67*	1.55*	1.71*
Job Control/ Work Support	**High**			**1.00**	**1.00**	**1.00**	**1.00**
	Med-High			1.29	1.17	1.27	1.16
	Med-Low			2.02*	1.29	1.96*	1.25
	Low			2.90*	2.47*	2.78*	2.31*
Job Demands / Work Pressure	**Low**			**1.00**	**1.00**	**1.00**	**1.00**
	Medium			0.82	0.74*	0.82	0.75*
	High			0.49*	0.43*	0.51*	0.45*
Time Since Previous Symptoms (months)	**>24**					**1.00**	**1.00**
	13-24					1.33*	1.32*
	7-12					1.82*	1.79*
	3-6					1.98*	1.94*
	<3					2.29*	2.23*

* 95% CI excludes '1'.

Table A44: Change in Risk Ratios for Upper-body Musculoskeletal Symptoms by Addition of Predictor Variables to Multi-Variable Models: Sicktime/Overtime Sub-cohort

		Individual Variables	Plus Biomechanical Variable	Plus Work Organization Variables		Plus Sicktime and Overtime Variables		Plus Time Since Previous Symptoms Variable	
Variable	Category			Control/ Demand Model	Support/ Pressure Model	Control/ Demand Model	Support/ Pressure Model	Control/ Demand Model	Support/ Pressure Model
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.21	1.28*	1.39*	1.37*	1.38*	1.35*	1.45*	1.41*
	40-49	1.30*	1.45*	1.80*	1.65*	1.79*	1.62*	1.88*	1.69*
	≥ 50	1.13	1.27	1.66*	1.32	1.66*	1.30*	1.76*	1.37
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.72*	0.68*	0.61*	0.44*	0.61*	0.45*	0.62*	0.48*
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.34	1.43	1.41	1.90*	1.39	1.86*	1.42	1.85*
	2-5	1.39*	1.53*	1.51*	1.90*	1.49*	1.89*	1.49*	1.87*
	<2	1.37*	1.50*	1.43*	1.81*	1.42*	1.80*	1.23	1.56*
Upper-body Biomech. Score	**Low**		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium		2.34*	1.82*	1.93*	1.72*	1.83*	1.69*	1.80*
	High		2.77*	1.49*	1.71*	1.40*	1.61*	1.41	1.66*
Job Control/ Work Support	**High**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High			1.22	1.09	1.16	1.08	1.15	1.07
	Med-Low			1.95*	1.21	1.89*	1.19	1.85*	1.16
	Low			2.91*	2.26*	2.70*	2.13*	2.59*	1.98*
Job Demands / Work Pressure	**Low**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium			0.92	0.72*	0.95	0.72*	0.94	0.71*
	High			0.51*	0.42*	0.56*	0.44*	0.60	0.47*
Sicktime Proportion in Department	**Low**					**1.00**	**1.00**	**1.00**	**1.00**
	Medium-Low					1.43*	1.40*	1.43*	1.40*
	Medium-High					1.60*	1.55*	1.57*	1.53*
	High					1.65*	1.61*	1.59*	1.56*
Time Since Previous Symptoms (months)	**>24**							**1.00**	**1.00**
	13-24							1.28	1.27
	7-12							1.85*	1.82*
	3-6							2.00*	1.96*
	<3							3.00*	2.91*

* 95% CI excludes '1'

Table A45: Change in Risk Ratios for Upper-body Musculoskeletal Symptoms by Addition of Predictor Variables to Multi-Variable Models: Work Units Sub-cohort

		Individual Variables	Plus Biomechanical Variable	Plus Work Organization Variables		Plus Sicktime and Overtime Variables		Plus Time Since Previous Symptoms Variable	
				Control/ Demand Model	Support/ Pressure Model	Control/ Demand Model	Support/ Pressure Model	Control/ Demand Model	Support/ Pressure Model
Variable	**Category**								
Age (years)	<30	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	0.89	0.86	0.95	0.89	0.94	0.89	1.03	0.96
	40-49	1.06	1.06	1.37	1.20	1.36	1.18	1.48*	1.26
	≥ 50	0.86	0.87	1.05	0.97	1.04	0.95	1.15	1.03
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.58*	0.62*	0.58*	0.45*	0.57*	0.45*	0.60*	0.48*
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.61	1.67*	1.70*	2.31*	1.69*	2.29*	1.63	2.22*
	2-5	1.67*	1.69*	1.64*	1.96*	1.63*	1.96*	1.54	1.87*
	<2	1.64*	1.65*	1.55	1.85*	1.54	1.84*	1.12	1.35*
Upper-body Biomech. Score	**Low**		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium		2.17*	1.85*	1.84*	1.80*	1.80*	1.75*	1.72*
	High		1.05	0.70	0.81	0.70	0.82	0.73	0.87*
Job Control/ Work Support	**High**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High			1.07	1.30	1.06	1.31	1.04	1.28
	Med-Low			1.66	1.57	1.66	1.56	1.63	1.53
	Low			2.35*	2.23*	2.34*	2.21*	2.33*	2.03*
Job Demands / Work Pressure	**Low**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium			0.72	0.74	0.73	0.74	0.71	0.71*
	High			0.51	0.65	0.52	0.66	0.58	0.73
Work Units/FTE	**Usual**					**1.00**	**1.00**	**1.00**	**1.00**
	Below Usual					1.00	1.01	1.03	1.04
	Above Usual					1.26	1.25	1.27	1.26
	Very Above					0.95	0.95	0.94	0.94
Time Since Previous Symptoms (months)	**>24**							**1.00**	**1.00**
	13-24							1.17	1.16
	7-12							2.99*	2.94*
	3-6							3.26*	3.22*
	<3							3.08*	3.03*

* 95% CI excludes '1'

Table A46: Change in Risk Ratios for Lower-body Musculoskeletal Symptoms by Addition of Predictor Variables to Multi-Variable Models: Overall Cohort

		Individual Variables	Plus Biomechanical Variable	Plus Work Organization Variables		Plus Time Since Previous Symptoms Variable	
Variable	**Category**			**Control/ Demand Model**	**Support/ Pressure Model**	**Control/ Demand Model**	**Support/ Pressure Model**
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.08	1.07	1.10	1.05	1.14	1.09
	40-49	1.15	1.23	1.29*	1.24	1.36*	1.30*
	≥ 50	1.03	1.09	1.25	1.10	1.35*	1.18*
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	1.15	1.00	1.00	1.00	1.02	1.02
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.05	1.02	1.02	1.08	1.05	1.10*
	2-5	1.38*	1.47	1.46*	1.52*	1.48*	1.53*
	<2	1.36*	1.44	1.42*	1.51*	1.27	1.34*
Lower-Biomech. Score	**Low**		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium		2.44*	2.28*	2.27*	2.23*	2.23*
	High		4.89*	4.42*	4.16*	4.18*	3.97*
	Very High		5.53	4.89*	4.62*	4.65*	4.41*
Job Control/ Work Support	**High**			**1.00**	**1.00**	**1.00**	**1.00**
	Med-High			1.07	0.95	1.07	0.95
	Med-Low			1.30	1.04	1.28	1.03
	Low			1.15	0.97	1.15	0.96
Job Demands /Work Pressure	**Low**			**1.00**	**1.00**	**1.00**	**1.00**
	Medium			1.27	0.99	1.26	0.99
	High			1.07	0.60*	1.08	0.61*
Time Since Previous Symptoms (months)	**>24**					**1.00**	**1.00**
	13-24					1.47*	1.47*
	7-12					1.87*	1.87*
	3-6					2.18*	2.18*
	<3					2.26*	2.26*

* 95% CI excludes '1'

Table A47: Change in Risk Ratios for Lower-body Musculoskeletal Symptoms by Addition of Predictor Variables to Multi-Variable Models: Sicktime/Overtime Sub-cohort

		Individual Variables	Plus Biomechanical Variable	Plus Work Organization Variables		Plus Sicktime and Overtime Variables		Plus Time Since Previous Symptoms Variable	
Variable	**Category**			**Control/ Demand Model**	**Support/ Pressure Model**	**Control/ Demand Model**	**Support/ Pressure Model**	**Control/ Demand Model**	**Support/ Pressure Model**
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	1.00	1.01	1.04	0.98	1.03	0.98	1.08	1.02
	40-49	1.11	1.21	1.29*	1.21	1.28*	1.20	1.34*	1.25*
	≥ 50	1.02	1.09	1.27	1.09	1.27	1.08	1.36*	1.15
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	1.13	0.97	0.96	0.98	0.96	0.99	0.98	1.01
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.09	1.06	1.06	1.15	1.06	1.14	1.08	1.15
	2-5	1.34*	1.43*	1.42*	1.50*	1.41*	1.49*	1.41*	1.48*
	<2	1.36*	1.44*	1.41*	1.53*	1.41*	1.52*	1.22	1.31
Lower-body Biomech. Score	**Low**		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium		2.53*	2.35*	2.30*	2.31*	2.24*	2.25*	2.19*
	High		5.05*	4.52*	4.27*	4.04*	3.80*	3.77*	3.58*
	Very High		5.58*	4.94*	4.57*	4.59*	4.22*	4.32*	3.99*
Job Control/ Work Support	**High**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High			1.04	0.99	0.98	0.96	0.99	0.96
	Med-Low			1.29	1.09	1.24	1.05	1.22	1.04
	Low			1.20	0.99	1.12	0.93	1.12	0.93
Job Demands /Work Pressure	**Low**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium			1.28	0.96	1.32	0.96	1.30	0.96
	High			1.05	0.59*	1.10	0.60*	1.11	0.62*
Sicktime Proportion in Department	**Low**					**1.00**	**1.00**	**1.00**	**1.00**
	Medium-Low					1.23	1.21	1.24	1.21
	Medium-High					1.57*	1.55*	1.56*	1.55*
	High					1.61*	1.60*	1.57*	1.56*
Time Since Previous Symptoms (months)	**>24**							**1.00**	**1.00**
	13-24							1.43*	1.43*
	7-12							1.81*	1.81*
	3-6							2.15*	2.14*
	<3							2.82*	2.82*

* 95% CI excludes '1'

Table A48: Change in Risk Ratios for Lower-body Musculoskeletal Symptoms by Addition of Predictor Variables to Multi-Variable Models: Work Units Sub-cohort

		Individual Variables	Plus Biomechanical Variable	Plus Work Organization Variables		Plus Sicktime and Overtime Variables		Plus Time Since Previous Symptoms Variable	
Variable	**Category**			**Control/ Demand Model**	**Support/ Pressure Model**	**Control/ Demand Model**	**Support/ Pressure Model**	**Control/ Demand Model**	**Support/ Pressure Model**
Age (years)	**<30**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	30-39	0.93	0.93	0.95	0.89	0.95	0.89	1.01	0.95
	40-49	1.02	1.09	1.14	1.07	1.14	1.08	1.21	1.14
	≥ 50	0.78	0.80	0.82	0.82	0.83	0.82	0.90	0.88
Sex	**Female**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Male	0.91	0.86*	0.86	0.97	0.85	0.98	0.88	1.00
Years in Job	**>10**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	6-10	1.13	1.10	1.10	1.15	1.11	1.15	1.08	1.15
	2-5	1.63*	1.69*	1.68*	1.66*	1.69*	1.66*	1.61*	1.61*
	<2	1.51*	1.54*	1.53*	1.53*	1.54	1.53*	1.17	1.18
Lower-body Biomech. Score	**Low**		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium		2.40*	2.27*	2.22*	2.26*	2.21*	2.12*	2.06*
	High		3.95*	3.67*	3.57*	3.64*	3.55*	3.26*	3.17*
	Very High		4.75*	4.36*	4.16*	4.34*	4.14*	3.89*	3.69*
Job Control/ Work Support	**High**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Med-High			1.04	1.13	1.04	1.13	1.03	1.11
	Med-Low			1.18	1.24	1.18	1.24	1.16	1.23
	Low			1.06	0.94	1.05	0.93	1.08	0.94
Job Demand/ Work Pressure	**Low**			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Medium			0.94	1.02	0.94	1.02	0.95	0.99
	High			0.83	0.80	0.83	0.80	0.86	0.80
Work Units/FTE	**Usual**					**1.00**	**1.00**	**1.00**	**1.00**
	Below Usual					0.85	0.86	0.86	0.87
	Above Usual					1.05	1.05	1.04	1.05
	Very Above					1.25	1.27	1.21	1.23
Time Since Previous Symptoms (months)	**>24**							**1.00**	**1.00**
	13-24							1.53*	1.52*
	7-12							2.43*	2.42*
	3-6							2.92*	2.91*
	<3							2.38*	2.38*

* 95% CI excludes '1'

Appendix 25: Comparison of Uni-Variable and Multi-Variable Results

Findings were consistent between the unadjusted and adjusted models of upper and lower-body morbidity for the effect of previous history, biomechanical risks and the workload measures of sicktime and work units. Differences were observed for gender, age, experience and the work organization factors related to control, demand, support and pressures.

A25.1 Upper-body Musculoskeletal Symptoms and Claims

Age and less than 10 years of experience, insignificant in unadjusted models of upper-body outcomes, were significant predictors of upper-body symptoms in multi-variable models. Conversely, more overtime, significant in unadjusted models, did not remain significant in the adjusted models. Significant elevated risk ratios associated with medium and low levels of control and support were refined to low levels in the adjusted models while significant risk ratios associated with high work pressure were expanded to include medium levels.

Table A49: Comparison of Uni-variable and Multi-variable Results for Upper-body Musculoskeletal Symptoms and Claims by Study Population
↑ = Increased risk across all categories (unless otherwise specified)
↓ = Decreased risk across all categories (unless otherwise specified)
Change in Multi-variable Results Highlighted in Bold

	Upper-body Musculoskeletal Symptoms						**Upper-body Compensation Claims**			
Variable	**Overall Cohort**		**Sick/Overtime Sub-cohort**		**Work Units Sub-cohort**		**Overall Cohort**		**Sick/Overtime Sub-cohort**	
	Uni	**Multi**	**Uni**	**Multi**	**Uni**	**Multi**	**Uni**	**Multi**	**Uni**	**Multi**
Age	-	↑	-	↑	-	-	↑ 30s	↑	↑ 30s	↑
Sex	↓	↓	↓	↓	↓	↓	-	↓	↓	↓
Yrs in Job	-	↑	-	↑	↑	↑	↑	↑	↑	↑
Previous Symptoms	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Biomech. Factors	↑	↑	↑	↑	↑ Med	↑ Med	↑	↑	↑	↑
Control	↑	**↑ M/L**	↑	**↑ M/L**	↑	↑	↑	**↑ M/L**	↑	**↑ M/L**
Demands	-	**↓ High**	-	-	-	-	-	-	-	-
Support	↑	**↑ Low**	↑	**↑ Low**	↑	**↑ Low**	↑	**↑ Low**	↑	**↑ Low**
Pressure	↓ High	↓	↓ High	↓	--	**↓ Med**	↓ High	↓	↓ High	↓
Sicktime Proportion	NA	NA	↑	↑	NA	NA	NA	NA	↑	**↑ High**
Overtime Proportion	NA	NA	↑	--	NA	NA	NA	NA	↑ Med	--
WorkUnits / FTE	NA	NA	NA	NA	-	-	NA	NA	NA	NA

A25.2 Lower-body Musculoskeletal Symptoms and Claims

Age, insignificant by itself, emerged as a significant predictor of lower-body outcomes among employees aged 40-49 years in some but not all multi-variable models. Males, at an elevated risk for compensable lower-body outcomes, were not significantly different from females in any of the adjusted models. A significant increased risk of lower-body outcomes with less than 10 years experience was refined to those with less than 5 years in the multi-variable analysis. Significant elevated risks associated with control and support at the uni-variable level disappeared in the multi-variable models of lower-body symptoms. High demands, associated with a decreased risk of lower-body outcomes at the uni-variable level, also disappeared in the multi-variable models. An increased risk of morbidity with increasing levels of sicktime at the uni-variable level was refined to the highest levels of sicktime in the multi-variable models while significant elevated risks associated with overtime disappeared in the adjusted models.

Table A50: Comparison of Uni-variable and Multi-variable Results for Lower-body Musculoskeletal Symptoms and Claims by Study Population
↑ = Increased risk across all categories (unless otherwise specified)
↓ = Decreased risk across all categories (unless otherwise specified)
Changes in Multi -variable Results Highlighted in Bold

	Lower-body Musculoskeletal Symptoms						**Lower-body Compensation Claims**			
	Overall Cohort		**Sick/Overtime Sub-cohort**		**Work Units Sub-cohort**		**Overall Cohort**		**Sick/Overtime Sub-cohort**	
Variable	**Uni**	**Multi**	**Uni**	**Multi**	**Uni**	**Multi**	**Uni**	**Multi**	**Uni**	**Multi**
Age (yrs)	-	**↑40+**	-	**↑40+**	-	-	-	**↑40+**	-	-
Sex	-	-	-	-	-	-	↑M	-	↑M	-
Yrs in Job	↑	**↑<5**	↑	**↑2-5**	↑	**↑2-5**	↑	**↑<5**	↑	**↑<5**
Previous Symptoms	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Biomech. Factors	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Control	↑	-	↑	-	↑	-	↑	-	↑	**↑M/L**
Demands	↓High	-	↓High	-	-	-	↓High	-	↓High	-
Support	↑	-	↑	-	↑	-	↑	-	↑	**↑Low**
Pressure	↓High	↓High	↓High	↓High	↓High	-	↓High	↓High	↓High	↓High
Sicktime Proportion	NA	NA	↑	**↑High**	NA	NA	NA	NA	↑	**↑High**
Overtime Proportion	NA	NA	↑	--	NA	NA	NA	NA	↑	--
Work Units/ FTE	NA	NA	NA	NA	-	-	NA	NA	NA	NA