Workplace Psychosocial Factors and Musculoskeletal Disorders: A Discussion Paper

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Introduction

Recent evidence suggests that injury rates are decreasing in most compensation jurisdictions. In British Columbia, the overall number of accepted lost-time claims dropped from 79,428 in 1994 to 71,602 in 1996, a decline of almost 10% over the past few years (Association of Workers' Compensation Boards of Canada, 1997). Embedded within this substantial reduction in overall claims, was a similar, and perhaps even slightly stronger downward trend for sprain and strain injuries, the most common type of work-related musculoskeletal disorder (WMSD). The number of accepted lost-time sprain and strain injuries in British Columbia fell from 40,467 in 1994 to 35,043 in 1996, a drop of 13% over three years (Association of Workers' Compensation Boards of Canada, 1997).

How have these dramatic results come about? What is driving these downward trends? A number of speculative arguments can be put forward to explain the apparent declines: they might simply be misleading statistical artefacts, since lower numbers of claims do not necessarily mean lower injury rates; they could be the result of a business cycle effect, where lower claims rates are observed during times of higher unemployment (a similar reduction in claims occurred between 1982 and 1984); they may be the consequence of changes in compensation policy that could, for example, either discourage potential claimants through lower benefit levels, or encourage the availability of modified work, which in turn, could result in fewer lost-time claims; or they might also represent genuine reductions in injury rates, which are perhaps indicative of either the changing nature of work, as discussed by Ostry in a companion paper in
this volume, or the dividends that have begun to accrue from investments in workplace prevention programs, such as those with a focus on ergonomic improvements.

Throughout this recent period of reductions in overall claims, disorders of the musculoskeletal system have steadfastly maintained their rank as the most common occupational injury, consistently representing about half of all claims filed, even after accounting for the recent drop in the number of claims (Association of Workers' Compensation Boards of Canada, 1997). WMSD’s are also believed to account for well over half of all the direct compensation costs paid out (Frank, Kerr, Brooker, et al. 1996). Clearly there is a case to be made for singling these injuries out for special attention. The substantial burden of illness attributable to WMSD’s, including the immense financial, personal and societal costs associated with them, has provided the rationale for extensive research into the underlying causes of these disorders and the disability that often accompanies them (Frank, Kerr, Brooker, et al. 1996).

This paper will summarize the current state of research into the workplace “causes” of these conditions (etiologic research). While not negating the role of the physical demands of work, this review is intended to highlight a need for the recognition of the additional contribution that other workplace factors can have (see Norman and Wells, this volume). In particular, this summary is intended to provide an understanding of the factors contributing to the onset of the most common musculoskeletal conditions encountered in the workplace, with a special focus presented on recent developments involving research on the psychosocial work environment. This paper is deliberately structured to convey some sense of the relative importance of the different types of
risk factors found to be associated with WMSD’s, as determined by the weight of the current scientific evidence available on the topic. The review also highlights the potential for reducing injury rates (i.e. primary prevention) through intervention programs that attempt to change the workplace psychosocial environment. Finally, in addition to fostering a broader understanding of the underlying causes of the disorders and the possibilities for their prevention, this review is presented to highlight the need for more workplace-based research, including in particular, the development of new, practical tools that can better measure the most important aspects of the work environment thought to be associated with the onset of WMSD’s.

**Overall Scope of the Paper**

The most frequently occurring musculoskeletal disorders, which consist primarily of sprain and strain problems of the back, neck, shoulder and arm (including the wrist), are often caused by or aggravated by workplace factors, hence the commonly used acronym, WMSD, for work-related musculoskeletal disorders (Hagberg, Silverstein, Wells, et al. 1995). While all of these conditions are also known to have non-work causes, such as sports and motor vehicle injuries, pregnancy, and certain congenital conditions such as scoliosis, this review will focus primarily on an examination of their work-relatedness, since this is of particular relevance to workers’ compensation. In addition to these work-related factors, it should be noted that a number of individual characteristics have also been examined in relation to WMSD’s, such as height, weight, age, etc. These will discussed briefly in the section on risk factors. Finally, it is recognized that organizational or firm level practices, such as the presence of a joint health and safety committee, or management commitment to safety, can also have an impact on employee health, including the
rate of lost-time injuries such as WMSD’s (Robson et al. 1998). However, for the sake of parsimony and focus, these factors, which have been reviewed elsewhere, will not be covered in this paper.

It is also important to note that this paper will not discuss the factors that contribute to disability or chronicity once the condition occurs (prognostic research). A distinction needs to be drawn between these two types of research since there can easily be confusion between what causes (or contributes to) these conditions, and what is more likely a consequence (or sequelae) of them. Consider for example, the study of a psychological variable such as depression as a risk factor for back pain. In many, if not most studies examining the causes of WMSD’s, the exposures (possible risk factors, like depression) and the outcomes (possible injuries, like back pain) are measured at the same point in time. This can possibly obscure cause-effect relationships by making it difficult to determine whether the depression precipitated the back pain (i.e. possibly a
risk factor) or whether it was a consequence of the pain (and thus possibly a prognostic factor). This overlap between the factors related to the etiology and prognosis of musculoskeletal conditions is illustrated in Figure 1. Since one of the aims of this overview is to highlight the potential for intervention programs aimed at modifying true risk factors (to prevent the occurrence of WMSD’s), recognizing a distinction between risk and prognostic factors is essential. It would not, for example, be very helpful or cost effective for a workplace to focus prevention efforts on trying to change something that ultimately turns out to be a consequence of injury, rather than an underlying cause for it. (This comment is not meant to negate the value of treatment programs or disability management, that necessarily focus on these consequences as part of secondary prevention efforts aimed at improving return to work and functional abilities markers. Rather, it is presented to indicate the paper’s focus on discussing factors related to preventing WMSD’s in the first place, rather than a discussion about the disability they can produce.)

**Risk Factors for Musculoskeletal Disorders**

*Background*

The etiologic research on WMSD’s has usually taken one of two general approaches (Frank, Kerr, Brooker, et al. 1996). In biomechanical studies, the underlying conceptual model implies that WMSD’s are the result of tissue damage and/or pain produced when a worker is exposed to physically demanding work. Problems can be the result of either high peak loads that can affect tissues directly, or repeated physical loading at lower levels that ultimately leads to a lowered pain tolerance in the exposed tissue (i.e. a threshold shift). The recent emphasis on psychosocial
research, the second general approach to WMSD studies, may have been instigated by a recognition that claims rates for WMSD’s have increased or remained persistently high in the face of widespread changes in workplaces that, over time, are believed to have eliminated most “heavy” work. This seeming contradiction has been understandably interpreted as a clear demonstration of the importance of factors over-and-above the physical demands of work in determining the onset of these disorders (Hadler, 1997). Only recently have studies begun to consistently adopt a more comprehensive approach to the issue by combining the key aspects from both the biomechanical and psychosocial perspectives.

It is worth noting that because of the confusion that can result when the term is inconsistently applied, the “catch-all” definition of psychosocial research described above - i.e. all things not overtly related to the physical demands of work - has not been particularly helpful in furthering our understanding of the issue. In the eyes of some, misuse of this term can lead to a notion that the emphasis is being shifted away from an objective analysis of the work being done towards a more subjective focus on who is doing the work. In this paper, the term psychosocial is used in reference to a wide range of work environment factors that are believed to be associated with the onset of WMSD’s, such as the control one has over the tasks of a job, the level of dissatisfaction with work, or the balance between the efforts and rewards associated with work. A distinction needs to be made between these more work-related psychosocial variables and psychological states, such as anxiety or depression, which are related more to the individual worker than they are to the work environment. As stated earlier, while, such factors are likely very important in determining recovery from the disorder once it has occurred, it can be argued that they are more
likely a consequence of WMSD’s, rather than a cause of the original problem (Bombardier, Kerr, Shannon, et al. 1994). Similarly, psychological “traits”, sometimes associated with particular health problems, are often overstated as causes and almost certainly less amenable to constructive intervention than work environment factors.

While the psychosocial and biomechanical rubrics may adequately describe the approaches to etiologic research, the risk factors for WMSD’s themselves are perhaps better described within four main categories (see Table 1): i) individual factors, such as a person’s height and weight, and smoking habits and personality traits; ii) physical (or biomechanical) factors, such as vibration, heavy lifting and awkward postures; iii) psychophysical factors, which refer to an individual’s perceptions about the physical demands of work, over and above what may have been measured in (ii); and iv) psychosocial factors, which describe elements of the work environment and the work-worker interface, such as job control and job satisfaction. In order to better represent the relative impact of the various risk factors on the overall incidence of WMSD’s, and thereby provide some context for the influence that psychosocial factors may be exerting, each of these four categories are reviewed below.

In addition to the four broad groups of factors in Table 1, which are typically measured at the individual level, there are firm or organizational level factors, such as the presence of a joint health and safety committee and the adoption of a “safety culture” that can affect the occurrence of injury. However, few if any studies have examined these factors in relation to WMSD’s specifically.
<table>
<thead>
<tr>
<th>Category</th>
<th>Example for low back pain</th>
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<tr>
<td>Individual characteristics and traits</td>
<td>Previous back pain is a strong predictor of who will develop it in the future</td>
</tr>
<tr>
<td>Physical (biomechanical)</td>
<td>Workers who report back pain found to have higher measured levels of lumbar spine forces (e.g. peak shear)</td>
</tr>
<tr>
<td>Psychophysical</td>
<td>Workers who self-rate physical demands of work to be excessive are more likely to report back pain</td>
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<tr>
<td>Psychosocial</td>
<td>Workers who report back pain also more likely to report negative workplace social environment (e.g. more conflicts, less pleasant atmosphere, etc.)</td>
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**Table 1: Categories of risk factors and examples from low back pain research.**
(See Kerr et al., 1998)

**Scope of the Review**

This brief review of risk factors summarizes the results of recent epidemiologic studies rather than case reports, laboratory studies, or expert opinion. While the evidence from these other sources should not be ignored, as it can contribute significantly to the hierarchy of evidence required to systematically establish causation, the ultimate test for the hypotheses these efforts develop is to try and link them to real workplace injury and exposure data, hence the reliance on epidemiologic studies (Egilman, Punnett, Hjelm, et al. 1996; Bombardier, Kerr, Shannon, et al. 1994). This review is also limited mainly to an examination of the exposures thought to be most relevant to occupational settings, particularly those with the potential for change through workplace interventions. Several general and more in-depth reviews of specific WMSD epidemiology are also available (Burdorf & Sorock, 1997; National Institute for Occupational Safety and Health,)
The purpose here is not to reproduce these extensive reviews of the medical and scientific literature, but rather to supplement them with a focus on recent developments, particularly in the field of psychosocial risk factor research. Because physical and psychosocial factors tend to be poorly defined and measured in most published WMSD studies, it is worth noting some recent articles that thoroughly review the methods and issues of concern for assessing risk factors in the workplace (Veazie, Landen, Bender, et al. 1994; Burdorf, Rossignol, Fathallah, et al. 1997; Winkel & Mathiassen 1994; Bongers, de Winter, Kompier, et al. 1993; Burdorf 1992).

As a final note, this paper presents a general set of risk factors that are applicable to the majority of musculoskeletal disorders encountered in the workplace, most of which could be categorized as soft tissue sprains and strains. In other words, rather than singling out specific conditions and then detailing the list of possible risk factors associated with each one, the risk factors presented are assumed to be applicable across the full group of disorders combined into the common and burdensome WMSD category. This is not to suggest that unique pairings of specific risk factors and musculoskeletal disorder do not exist - they undoubtely do, as with the association between compression of the intervertebral discs and the onset of low back pain (Norman, Wells, Neumann, et al. 1998). However, the extent of the overlap between the risk factors identified in
the published literature for the various WMSD sub-conditions, whether physical or psychosocial, was deemed sufficient enough to justify the “unified” approach taken here. A further advantage to this approach, apart from the obvious parsimony it affords, is the recognition of common threads between some of the underlying causes of these conditions, which could allow for the development of more broadly based intervention programs targeted at WMSD’s in general, rather than the splintering of programs along specific sub-condition lines.¹

¹The argument in favour of combining the major conditions together in the discussion of risk factors in this paper may seem somewhat simplistic. It is not meant to imply that a narrow range of exposures causes all cases of a wide range of conditions. Rather, it is meant to convey the idea that common themes are present in many of the risk factors and that exploring these themes in more detail could have potential benefits. Certain musculoskeletal disorders, especially the less common conditions, but also including some of those that are relatively common, like carpal tunnel syndrome or epicondylitis, may benefit from very specific prevention programs aimed at a narrow range of factors, such as specific hand tool re-design. The argument presented here is that to a broad-ranging program that recognizes the extensive overlap in the etiology of WMSD’s is most likely to effect the greatest change. For a more thorough discussion of the issues of the nature and burden of WMSD’s, including topics of staging and phasing of the major WMSD’s as well as factors of relevance to recovery from them, see the companion paper in this volume by Johnson et al.
**Individual Factors**

A number of individual risk factors (i.e. personal characteristics) have been studied, though very few have been clearly established as risk factors for WMSD’s. The strongest and most consistent association has been reported for prior occurrence of a WMSD, with somewhat less well established associations for age, obesity, smoking and gender (Garg & Moore, 1992; Kelsey & Golden, 1988; Riihimäki, 1991; Hildebrandt, 1987). The lack of a clear association with age is perhaps surprising, but may be the result of experience or seniority issues in the workplace confounding the relationship - i.e. older workers often do not have the same job demands as younger workers and are typically more risk averse and cautious (Hales & Bernard, 1996).

Females have been shown to have higher rates of most WMSD’s, but there is also evidence to suggest that this may be more of a reporting phenomenon, since the level of unreported symptoms is often higher among men (Polanyi, Cole, Beaton, et al. 1997; National Institute for Occupational Safety and Health, 1997). Although previous reporting of WMSD, especially for low back pain, is probably the most established of the individual factors examined, this association has sometimes been interpreted as representing an underlying personality trait, such as “compensation neuroses” or “hysteria” (Bigos, Battie, Spengler, et al. 1992; Frank, Pulcins, Kerr, et al. 1995)(Ford, 1997). However, it could also be indicative of a reduced threshold for injury or pain in tissues that have been repeatedly injured over time. Additionally, there is very little evidence supporting an association between the occurrence of WMSD and general fitness or muscular strength levels, the presence of pre-morbid x-ray abnormalities, or the presence of psychological disorders such as depression and anxiety (Gibson, 1988; Battie, Bigos, Fisher, et al. 1989; Battie, Bigos, Fisher, et al. 1989; Bigos, Battie, Spengler, et al. 1991). While some of the factors from this group, are
known to affect recovery time once someone has a WMSD, their role in the onset of these conditions remains to be established. As noted, few if any of these individual factors are readily modifiable, especially in the workplace, thus they may be of little use in prevention strategies specific to WMSD (Frank, Kerr, Brooker, et al. 1996).

**Physical Factors**

The evidence linking the physical demands of work with WMSD comes mostly from cross-sectional studies, such as surveys\(^2\) (Bombardier, Kerr, Shannon, et al. 1994). There are a number of concerns with the quality of such studies, over and above the difficulty of establishing a cause and effect pathway using such data (Leamon, 1994; Frank, Pulcins, Kerr, et al. 1995).

Taken individually, most of the published studies on WMSD provide only modest evidence of causation. However, the evidence from anyone one study is only part of the overall picture of what is known to contribute to the disorders (Egilman, Punnett, Hjelm, et al. 1996). Two observations support the conclusion that there is a causal relationship between musculoskeletal problems and workplace physical exposures: i) the consistency of the published evidence, whereby

\(^2\)Cross-sectional studies select subjects at a single point in time. Therefore, a mixture of people with chronic and acute WMSD’s are usually enrolled. This can make the results difficult to interpret since distinguishing between factors that cause a problem and factors that are a consequence of it is problematic. Prospective cohort studies, that follow a large number of healthy people (the cohort) can usually avoid this difficulty. However, their high cost, driven by their larger sample sizes, limits their use. They may also suffer from a problem of intervening changes between the time of measuring exposure and measuring outcome. These changes can severely cloud a relationship when current and past exposures differ strongly. Because of their lower cost and greater flexibility, cross-sectional studies, including case-control studies that compare a predetermined number of cases and comparison subjects, are the most common form of WMSD study, with the latter providing the more robust design for investigating causality. See Bombardier et al., 1994, for a more thorough discussion of etiologic study design options.
certain variables (such as heavy lifting, and whole body vibration) have been reported over many
different types of studies and study settings as being linked to WMSD; and ii) the strength of the
associations observed for more generalizable characteristics of the physical demands of work
which are objectively measurable, such as repetitive use and awkward postures (Hales & Bernard
1996). In a number of studies, the risk of developing a WMSD has been reported to be several
times higher for workers exposed to physically demanding work compared to those who have not
(National Institute for Occupational Safety and Health, 1997).

Some of the best evidence substantiating the link between workplace biomechanical exposures
and WMSD’s comes from recent studies that have used detailed, direct measurements of the
physical demands of work on each individual in the study, rather than using self-reported data or
the assignment of exposure status from group measures or crude categories like job title (Neer II
Punnett, Fine, Keyserling, et al. 1991). Based on these newer studies, and the existing body of
evidence from older studies, the best established risk factors for WMSD’s are reported to be:
posture, including awkward and prolonged postures, as well as bending, twisting and overhead
work; vibration of the whole body and the hand/arm region; and lifting, including high forces (i.e.
“heavy” lifts) as well as cumulative or repetitive forces. As has been suggested recently, some
variables in this list, may in fact be surrogate measures of more direct biomechanical forces
(Wells, Norman, Neumann, et al. 1997). For example, while heavy lifting has been identified in
many studies as a risk factor, it may in fact be just a risk marker for the high levels of disc
compression in the low back that result from the lifting process (Kerr, 1997). While certain
conditions, such as hand/arm vibration syndrome may have very specific risk factors, elsewhere there is considerable overlap in the physical demands of work that have been reported as risk factors for the major WMSD’s. As previously mentioned, such risk factor congruence could have practical implications for the scope of interventions aimed at preventing WMSD’s in the workplace, whereby an overall strategic approach to WMSD prevention programs might be used to complement injury-specific ones.

Most of the evidence for the physical demands of work has been provided by studies that did not control for the workplace psychosocial environment, thus the relative contribution of these respective factors is still unclear. However, the overall quality of recent studies and the strengths of the associations observed for physical demands factors appear to indicate that physical risks are contributing substantially to the occurrence of WMSD. It is also possible that in certain work environments, particularly those where exposure to heavy physical demands is common, these factors would in fact be the primary risk factors of concern, since the effects of psychosocial factors might be overshadowed in such conditions (Theorell, 1995). To better present the relative effects of the factors from these two major categories, the few studies that have attempted to simultaneously measure biomechanical and psychosocial risk factors are discussed later under the psychosocial rubric. It is worth stating here however, that these studies have generally found that the physical demands factors produced substantial increases in risk that were significantly, and more consistently associated with WMSD than psychosocial factors, again underscoring the link between WMSD’s and the physical demands of work.
Psychophysical Factors

The evidence in support of the relationship between WMSD’s and workers perceptions of the physical demands of the job comes mostly from laboratory studies of material handling, which have often not linked these perceptions to risk of injury (Snook, 1988). Despite this qualification, psychophysical data forms the cornerstone of existing lifting guidelines (Borg, 1982; Waters, Putz-Anderson, Garg, et al. 1993; Snook, 1978). Recent evidence that has demonstrated the importance of workers’ perceptions of the physical demands of work comes from a Canadian study of risk factors for low back pain among autoworkers, that found an independent contribution for the perceptions of job loading even when direct (“objective”) measurements of job demands were taken into account (Kerr, 1997). The findings of this study support a considerable body of earlier work reporting a link between the self-reported assessment of work load and WMSD (National Institute for Occupational Safety and Health, 1997). It is a unique finding however, in that the strength of the reported association, combined with the fact that the study statistically controlled for direct measures of the physical demands, imply that such information could have an important role to play in workplace interventions. These results also suggest that psychophysical assessment of work load is a more complex construct than simply a self-assessed perception of job-related physical demands. It is almost certainly affected by a number of other dimensions, possibly including such elements as pain and endurance thresholds, coping skills and job expectations, among other things.
**Psychosocial Factors**

The complex relationship that appears to exist between work-related psychosocial factors, such as the amount of job control available to a worker, and the physical demands of work they experience, such as spinal loading, make it difficult to reach definitive conclusions about their relative importance to the risk of developing WMSD’s. Bongers et al., in a thorough review of the literature on this topic, concluded that the “*studies do not present conclusive evidence due to high correlations between psychosocial factors and physical load and [because of the] difficulties in measuring dependent and independent variables*” (Bongers, de Winter, Kompier, et al. 1993b). A similar finding was reported more recently by the US National Institute of Occupational Safety and Health (National Institute for Occupational Safety and Health, 1997). Despite these qualifications, there appears to be growing research evidence pointing towards a link between certain psychosocial factors and WMSD’s, such as monotonous work, a poor workplace social environment, low job control, high perceived workload and time-pressure.

This conclusion has been reached based on the findings of a number of recent studies specifically designed to examine the role these factors might have in the onset of WMSD’s. For example, an analysis of routinely collected survey data in the Netherlands reported a significant association between psychosocial stressors (high work pace and lack of intellectual discretion) and musculoskeletal complaints after taking self-reported physical work stressors and worker characteristics into account (Houtman, Bongers, Smulders, et al. 1994). Similar results were obtained in the recent case-control study of back pain among autoworkers in Canada, where substantial effects were observed for negative perceptions of the work environment, low job
control and a perceived mismatch between one’s education and the job held, even after controlling for the directly measured physical demands of work, which were themselves strongly, and independently associated with back pain (Kerr, 1997). In this study, the relative contribution of the two types of factors to the risk of reporting back pain was reported to be roughly equivalent.

Further support for a link between psychosocial factors and soft-tissue musculoskeletal problems at work comes from two recent studies of major newspapers in the US and Canada, involving non-production workers required to do extensive computer work on the job. Both of these studies reported independent associations between the presence of musculoskeletal symptoms and the physical and psychosocial aspects of work, most notably keyboard height and posture, and high psychological workload and low job control (Polanyi, Cole, Beaton, et al. 1997; Faucett & Rempel, 1994). The US study also examined the issue of possible interactions between physical and psychosocial risk factors, reporting that the effect of combined exposures was greater than might be expected based on the strengths of the independent associations for the separate factors.

Job dissatisfaction has also been examined as a psychosocial risk factor for WMSD. However, the published evidence in support of this association is weak and contradictory (Kerr, 1997; National Institute for Occupational Safety and Health, 1997; Bigos, Battie, Spengler, et al. 1991)(Krause et al., 1997). The Boeing Study of predictors for back injuries in airplane assembly workers is often cited to support the association between job-related psychosocial factors and WMSD’s (Bigos, Battie, Spengler, et al. 1991). The main finding of this prospective three-year follow-up study was that, apart from a prior history of back pain reports, worker dissatisfaction
with the job tasks was the only work-related risk factor associated with subsequent reporting of back pain. None of the variables assessing the physical demands of work significantly predicted who reported back pain. However, it is possible that the ability of this study to identify biomechanical risk factors was limited by misclassification error resulting from a reliance upon group-level biomechanical assessments to the study subjects, which were performed at once only, at baseline, often well before the worker developed back pain. It should also be noted that this study could predict only a small proportion of the observed cases even when all measured risk factors were combined (Bigos, Battie, Spengler, et al. 1992). Given these caveats, dissatisfaction with work, at least as measured in this study, does not appear to be a very strong risk factor for WMSD’s.

Finally, a number of new studies of risk factors for WMSD’s have been launched in Europe recently, that, like the Canadian study of low back pain in automobile workers, were specifically designed to address the relative contribution of biomechanical and psychosocial factors (see the Appendix for a description of the methods of these studies). The results of these studies have not yet been published, as most have not yet been completed. However, based on preliminary results

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3 Biomechanical data were collected for the Boeing study only for “job types” employing 20 or more workers. The remaining subjects were assigned the exposure values based on this site-specific job classification scheme. (See Bigos et al. 1992 for more information)
presented at international conferences, these studies once again seem to be demonstrating that both the psychosocial and the physical demands of work are important risk factors for WMSD’s. (Theorell, 1996; Bongers and Houtman, 1996) In particular, the variables assessing job control, psychological job demands and social support appeared to have the greatest association with WMSD’s, although, as concluded in the recent NIOSH review, there was some evidence indicating that the physical demands of work were having a stronger affect than the psychosocial ones (National Institute for Occupational Safety and Health, 1997).

**Risk Factor Summary**

Based on the available literature on the topic, the most well established risk factors for WMSD’s would be: a prior WMSD history; self-rated perceptions of the physical demands of work; heavy lifting or physically demanding or repetitive work; awkward postures; and vibration. Apart from the first two factors, all of the physical demands variables listed may in fact be surrogates for biomechanical forces in acting directly in the tissues. While the evidence is less compelling for the psychosocial factors, there is never the less increasing evidence that they have an independent contribution to the onset of WMSD’s. The most notable factors include limited job control, monotonous work, psychologically demanding work, and low workplace social support. There is also emerging evidence to suggest that an imbalance in the efforts and rewards associated with work may also be affecting the incidence of WMSD’s as well (Kerr et al., 1998).

While knowledge of risk factors for WMSD can be an important first step in the development of preventive and therapeutic interventions, it is worth noting that detailed knowledge of causal
mechanisms has not always been a prerequisite for action in terms of developing and implementing strategies for prevention. For example, while the exact mechanism for the relationship between smoking and lung cancer may not be entirely understood, smoking cessation campaigns have still been launched, and they have often had significant success in reducing smoking-related illness, including cancer and heart disease (Blair, 1995). The same potential for change could be argued as the rationale for interventions aimed at preventing musculoskeletal disorder in the workplace, since the exact mechanism linking injury with either the physical or psychosocial demands of work, are still not entirely known.

Causal Mechanisms for Psychosocial Risk Factors

It is relatively easy, because of everyday life experience with aches, pains, and physical activity, to imagine how physically demanding work could possibly result in a WMSD. It is not as simple to comprehend how the psychosocial work environment could be triggering these events as well. As might be expected, the body of evidence in support of the psychosocial model of WMSD etiology, as well as the theoretical and conceptual underpinnings of the model, are not nearly as well developed as they are for the biomechanical model (Bongers, de Winter, Kompier, et al. 1993b). One of the central contributing components of this model, and one that receives extensive attention from this study, has come from Karasek, with later modifications in conjunction with Theorell (Karasek & Theorell, 1990). Their demand-control-support model of work-related psychosocial stress has been widely studied, particularly for cardiovascular disease (CVD) outcomes in occupational settings (Reed, LaCroix, Karasek, et al. 1989; Karasek, Theorell, Schwartz, et al. 1988; Alfredsson, Karasek, & Theorell, 1983). It has only recently been extended

According to this model, job control combines elements of skill discretion, such as creativity, with elements of decision latitude, such as the freedom to make decisions about how work is done. Psychological demands are meant to address the concepts of work pace and cognitive demands, although there may be some concern with overlap of ratings of the physical demands of work (Kerr, 1997). Social support combines elements of the active encouragement and assistance of co-worker and supervisor in getting work done as well as the provision of a social environment conducive to work. In their model, shown in Figure 2, the people highest risk are those who have the least control over their job, have the highest demands, and receive the least amount of support from the workplace.
Research based on the Karasek-Theorell model has established a clear but modest association between CVD and the imbalance between the psychological demands of work, the degree of control available to the worker (presumably to modify these demands) and the workplace social support network available to mediate the demands (Theorell & Karasek, 1996). People working under “high strain” conditions, with high demand, low control and low social support, are at clinically significantly greater risk for CVD, even after adjusting for established risk factors such as smoking (Johnson, Stewart, Hall, et al. 1996). This has been very elegantly demonstrated recently in a study of CVD among the British civil service (Marmot et al., 1997). This study, based at Whitehall, first showed the existence of a strong gradient for CVD incidence according to civil service rank. The authors then reported that the proportion of the gradient observed that could be accounted for by traditional risk factors for CVD in a multivariate statistical model including smoking, obesity, physical inactivity and high cholesterol, was no greater than that which could be attributed to differences in job control between the occupational grades. In other words, the effect attributed to the psychosocial work environment, in the form of job control, persisted even after taking the individual risk factor differences into account. An equally impressive relationship is not yet as clearly established for musculoskeletal conditions, possibly because fewer studies have examined it, and possibly because the outcome is less clearly defined than CVD (Bongers, de Winter, Kompier, et al. 1993b).

One of the most recent developments in the field of workplace stress research, is a conceptual model by Siegrist that examines the perceived imbalance between the efforts and rewards
associated with work (Siegrist, 1996). In this model, Siegrist argues that the greatest risk to health is for people who experience “a mismatch between high costs spent and low gains received in occupational life”. Again, while this model has shown some promise in identifying work-related causes of stress, like the demand-control model, it has not been extensively used in studies of musculoskeletal outcomes. However, it is noteworthy that some body responses believed to be direct biomedical effects of stress, including changes in neuroendocrine responses such as cortisol and adrenaline/noradrenaline blood levels, may also ultimately affect several other body organs, including the muscles (e.g. the effects observed with the “fight-flight” response). This is a good indication that there may be parallel causal mechanisms for WMSD’s as for cardiovascular diseases, thus the likelihood for a generalizable effect for psychosocial work environment factors is high (Peter & Siegrist, 1997; Theorell, 1995).

As mentioned earlier, some of the controversy surrounding the acceptance of psychosocial variables as risk factors for WMSD’s may be the result of the difficulty in conceptualizing a causal mechanism. Recently, studies have begun to explore the biological mechanisms that may explain the association between WMSD’S and psychosocial stressors. Although the evidence is still very limited, there is some new research, particularly from electromyography (EMG) studies, indicating that direct biological effects of “stress” are possible on the musculoskeletal system (Theorell, 1995; Lundberg, Granqvist, Hansson, et al. 1989). Some of these effects are similar to those seen from biomechanical stressors (Lundberg, Kadefors, Melin, et al. 1994). - e.g. increased muscle tension - while others may be responses specific to psychological stressors - e.g. increased blood levels of cortisol or changes to the pain receptors (Theorell, Harms-Ringdahl, Ahlberg-Hulten, et al. 1991). It is also likely that some factors labelled as psychosocial variables
could have an indirect effect on WMSD risk by modifying exposure to biomechanical risk factors (either attenuating or amplifying these risk factors).

As shown in Figure 3, the possible injury mechanisms underlying the two main categories of risk factors for WMSD’s, may be the result of direct and/or indirect effects from exposure to either type of risk factor - psychosocial or biomechanical. The uncertainty surrounding these mechanisms, and the restrictions imposed by the rather narrow risk factor focus of much of the prior WMSD etiologic research, led to the broad-based approach to assessing workplace exposures that has been adopted by the more recent WMSD studies. It is hoped that the results of these new studies will help better clarify the relative importance of biomechanical and psychosocial workplace factors in the genesis of WMSD’s.
Review of the Potential for Interventions

While some intervention work has been done in trying to reduce or eliminate risk factors for WMSD’s, it has almost exclusively been directed towards either changing the workers themselves, often through behavioural or education programs, or changing the physical demands of work, such as with the introduction of lift-assists. However, as outlined in the companion piece by Norman and Wells (this volume), very few interventions have been properly evaluated in order to determine their effectiveness, particularly in relation to the costs and benefits, an important requirement for the broader uptake of any prevention program. Even fewer still have been specifically focused on changing the psychosocial work environment (Hurrell & Murphy, 1996).

Having stated these caveats on the quality and amount of the published research however, a comment is needed on understanding the difficulty faced in trying to demonstrate the scientific effectiveness of workplace interventions – i.e did a “package” achieve its desired effect(s) (Silverstein, 1992). Effectiveness of an intervention depends on a number of factors, only some of which can be controlled by the researchers: i) efficacy – e.g., safety glasses do prevent eye injury if properly used; ii) coverage - e.g., all workers were provided with safety glasses; iii) compliance - e.g., workers wore the glasses; and iv) measurement of outcome(s) - e.g., all eye injuries were recorded. Researchers must also contend with many extraneous factors that might influence effectiveness, such as economic disruptions in the workplace (e.g., layoffs), industrial engineering factors (product or processing changes), and labour-management problems (e.g., strikes). Given the litany of potential pitfalls outlined above, the absence of many well evaluated
interventions claiming to be able to effectively reduce the rates of WMSD’s is not surprising. It has been argued that such research might be better focused taking advantage of natural experiments rather than attempting direct workplace manipulations required by rigid experimental guidelines (Silverstein, 1992).

In spite of the difficulties that can be faced, some work on psychosocial interventions has been done in the area of work stress and cardiovascular disease, as well as general health promotion programmes. However, most of these efforts have been directed towards helping workers to cope with work stress, rather than being aimed at changing the work process itself. While these types of interventions may have been shown to have some beneficial effects, especially in high risk populations (e.g. people exhibiting “type A” behaviour), they can ignore the contribution of the work environment. A few workplace studies have examined the direct biomedical effects of changes in occupational factors believed to be associated with stress. For example, Orth-Gomer et al. (1994) showed significant serum lipid lowering effects (reductions in mean triglycerides and apolipoproteins B/AI ratios) indicative of lowered CVD risk by randomly assigning 129 Swedish health care service workers to a control group (35 subjects) or an intervention group (94 subjects) that was designed to help them recognize and change work-related risk factors specifically associated with the demand-control model. In this study, groups of workers set up action plans consisting of a list of problems to improve, together with the actions to be taken and the people responsible for initiating and evaluating the intervention. The main objective of the
program was to decrease job strain (without decreasing productivity), increase control and increase support in the work environment. In addition to the serum lipid effects reported above, some improvement was seen in the levels of psychosocial risk factors.

Another exception in this area is a recent German study of stress management in bus drivers (who are also known to be at high risk of WMSD’s). This pilot study, which included an intensive therapy intervention as well as recommendations for workplace change, concluded that a theory-based intervention program can indeed show beneficial health effects, perhaps through improvements to individual and structural measures that improve coping thereby lessening the need for control (Aust et al. 1998). Such interventions need to be extended to include components in their design that can assess the potential for impact on musculoskeletal outcomes as well.

Based on a broader understanding of the determinants of workplace health, it seems unlikely that programs aimed only at modifying psychosocial factors will be successful. The same would be true for programs focused exclusively on the physical demands of work. A more comprehensive approach is required that integrates modifications to the physical as well as the psychosocial work environments, since risk factors have now been identified from both domains (Baker et al., 1996). Although this may sound like an unrealistic challenge - to change the overall work environment to satisfy concerns about risk factors for WMSD’s - some programs have been launched elsewhere that have attempted to do this.
In the Danish PRIM study (Project on Research and Intervention in Monotonous work), researchers are trying to examine the health effects of monotonous repetitive work as well as strategies to reduce exposures to this type of work. While some preliminary results have indicated that WMSD symptoms are reversible and may be influenced by job reallocation to less monotonous and repetitive work, the results of the main intervention study have not yet been produced. (Schibye et al. 1995) The authors of this work have adopted a pragmatic approach to determining program effectiveness, whereby they tend not to combine an etiologic component with the intervention (i.e. one that seeks to establish causation), thereby simplifying the prevention effort to one that can focus on exposure as the only outcome measure. (Skov and Kristensen, 1996) The PRIM study is one of the only prevention efforts with a particular focus on psychosocial factors and WMSD’s, although even here the overlap with biomechanical factors is extensive. A similar interrelationship exists in the studies discussed in the companion paper on ergonomics interventions, by Norman and Wells (this volume), where it is proposed that improvements in psychosocial factors could accrue from largely ergonomic-based interventions.

**Conclusion**

The evidence summarized in this paper strongly suggests that psychosocial risk factors are important in the etiology of work-related musculoskeletal disorders. While it is recognized that there are limitations to the quality of the evidence on psychosocial risk factors, there is good reason to believe that interventions that include components addressing psychosocial risk factors could help reduce the incidence of the problem. There is growing evidence of a link between workplace psychosocial factors and cardiovascular disease, and this type of research is now being
extended into other health-related outcomes, including general work absenteeism, as with the
Whitehall study of British civil servants. Recent examinations of the links between WMSD’s and
psychosocial factors are beginning to indicate that there is indeed evidence for a causal
relationship, although more research needs to be done to better clarify both the extent of this
relationship and the biological pathways that may be behind it.

As a final note, despite the growing indications that psychosocial factors may be directly
influencing the onset of WMSD’s, the overall weight of the evidence from published research on
risk factors for WMSD’s clearly indicates that the physical demands of work cannot be ignored in
the search for successful prevention programs. In summarizing the full weight of the available
literature on the topic, it is apparent that the association between workplace physical demands
and musculoskeletal disorders is a more strongly established link than the one between the
psychosocial work environment and musculoskeletal disorders. Better understanding the nature
of the inter-relationships will require more workplace research that gives equal emphasis to
measuring both types of factors. It will also require more basic research into the effective
measurement of these factors and the possible biological pathways leading towards WMSD’s.
Because of the purported link to the workplace environment, much of this work will need to be
performed in workplaces themselves, which has traditionally been a difficult place for researchers
to gain access. Perhaps some discussion of the ways to improve this access, such as premium
incentives or rebates for participating companies, could greatly facilitate the kind of research
required to solve the questions remaining about causation and prevention of WMSD’s.
### APPENDIX: SUMMARY TABLE OF KEY FEATURES OF NEW INTERNATIONAL WMSD STUDIES

<table>
<thead>
<tr>
<th>STUDY GROUP</th>
<th>STUDY POPULATION</th>
<th>DESIGN(S)</th>
<th>MUSCULO-SKELETAL CONDITION(S)</th>
<th>SAMPLE SIZE(S)</th>
<th>EXPOSURES</th>
<th>CASE IDENTIFICATION</th>
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</thead>
<tbody>
<tr>
<td>MUSIC (Sweden)</td>
<td>Population Based (Town of Norrtälje)</td>
<td>Case/Control (Etiology)</td>
<td>Low Back Sprain/Strain</td>
<td>Cases Low 700 M Back 700 F</td>
<td>- Psychosocial Background</td>
<td>Via health care services in community (and questionnaire?)</td>
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<td></td>
<td>20,000 Men &amp; Women Aged 25 - 59</td>
<td>Inception Cohort (Prognosis)</td>
<td>Neck/Shoulder Disorders</td>
<td>Neck 700 F Shoulder 400 M Controls 700 M 700 F (Matched on age, sex and region to low back cases)</td>
<td>- General Conditions</td>
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<td>Back 700 F</td>
<td>- Working Tasks</td>
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<td>Neck 700 F</td>
<td>- Psychosocial - Work</td>
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<td>Shoulder 400 M</td>
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<td>- Life Events</td>
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<td>- Physical</td>
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<td>- Clinical</td>
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<td>- Therapy</td>
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</table>
**APPENDIX: SUMMARY TABLE OF KEY FEATURES OF NEW INTERNATIONAL WMSD STUDIES — (Continued)**

<table>
<thead>
<tr>
<th>STUDY GROUP</th>
<th>STUDY POPULATION</th>
<th>DESIGN(S)</th>
<th>MUSCULO-SKELETAL CONDITION(S)</th>
<th>SAMPLE SIZE(S)</th>
<th>EXPOSURES</th>
<th>CASE IDENTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IWH (Canada)</td>
<td>Worksite - large industrial employers - mostly male approx. 15,000 (largely female worksite in second site)</td>
<td>Case/Control (Etiology)</td>
<td>Low back sprain/strain</td>
<td>Case 150 Unmatched controls 150 Job matched controls 150</td>
<td>- Demographic - Injury Related - Physical Factors - Psychological Factors - Psychosocial Factors - Workplace Organization - Ergonomic Demands - Workers’ Compensation Board Factors - Health Care Experience</td>
<td>Via worksite reporting (Health Services and Personnel)</td>
</tr>
<tr>
<td>LEIDEN (Netherlands)</td>
<td>Worksite based 50 sites with approx. 50 employees each</td>
<td>Cohort with Nested Case/Control (Etiology)</td>
<td>Low back sprain/strain Neck/shoulder disorders</td>
<td>Cohort 2,500 Expected 360 cases Expected 720 controls (2:1 ratio)</td>
<td>- Physical load - at work - outside work - Psychosocial load - at work - outside work - Individual factors</td>
<td>Occupational Health Care Services in Community and Follow-up Questionnaire</td>
</tr>
<tr>
<td>Study</td>
<td>Population</td>
<td>Cohort Type</td>
<td>Primary Outcomes</td>
<td>Case Identification</td>
<td>Follow-up</td>
<td>Data Collection</td>
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<tr>
<td>MALMÖ (Sweden)</td>
<td>Population Based (City of Malmö) 53,000 men and women aged 45 - 64</td>
<td>Mixed Cohort (Etiology/Outcome)</td>
<td>Neck/Shoulder disorders</td>
<td>15,000 out of which cases of various duration will be identified</td>
<td>- Mechanical Factors - Psychosocial Factors - Lifestyle Factors - Anthropometry - Comorbidity</td>
<td>Via Questionnaire</td>
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<tr>
<td>REBUS (Sweden)</td>
<td>Population Based (Random sample from Stockholm Region) - men and women age 40 - 65 in 1993/4</td>
<td>Follow-up of earlier Cohort (23 years)</td>
<td>Musculoskeletal disorders Present MSK function</td>
<td>500</td>
<td>- Job History - Psychosocial Factors - Work - Leisure - Physical Workload - Work - Leisure</td>
<td>Via Questionnaire</td>
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</table>

This table was prepared in collaboration with Dr. Sheilah Hogg-Johnson from the Institute for Work & Health. It is based on discussion held at a meeting of LBP researchers in Stockholm, in the fall of 1993. Each of the studies in the table was represented at this meeting. The purpose of the meeting was to enhance collaboration between LBP researchers and to ensure that the studies were not duplicating one another because of the expense associated with completing them. In other words, the studies were to complement one another rather than replicate. While the importance of the latter is recognized, the state of knowledge in LBP etiology and prognosis at the time of the meeting dictated that new efforts, rather than duplicate efforts be given priority.
BIBLIOGRAPHY


Kerr, M.S. (, 1997). A case-control study of biomechanical and psychosocial risk factors for low-back pain reported in an occupational setting. University of Toronto; 1 p.


