INTERACTION BETWEEN PHYSICAL AND PSYCHOSOCIAL WORK RISK FACTORS FOR LOW BACK SYMPTOMS

A study of:
Prevalence, risk factors, and interaction between physical and psychosocial work risk factors for low back symptoms and its consequences (reduced activities and absenteeism) in a random sample of workers in New Zealand and in Indonesian coal mining workers

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Abstract

The prevalence of low back symptoms (LBS) in developed and industrially developing countries (IDCs) is high, and there have only been a few studies in New Zealand and IDCs. It is well known that the risk factors for LBS include physical and psychosocial exposures, but the interaction between these is not well understood. Even less is known about prevalence of, and risk factors for, twopossible consequences of LBS (reduced activities and absenteeism). Hence, this thesis examines the prevalence, risk factors, and the interaction between physical and psychosocial work risk factors for LBS and its consequences in a developed country and an IDC. This was done in two cross-sectional studies of: A) a large random sample of workers in New Zealand, and; B) Indonesian coal mining workers.

In telephone interviews of 3,003 participants (1,431 males and 1,572 females) aged 20-64 randomly selected from the New Zealand Electoral Roll, the 12-month period prevalence of LBS, reduced activities, and absenteeism due to LBS were 54%, 18%, and 9%, respectively. Risk factors of LBS for the whole population (males and females) increased with work in awkward or tiring positions and stressful jobs. Awkward or tiring positions at work, dissatisfaction with contact and cooperation with management, and stressful jobs were risk factors for women but not for men. The only risk factor for reduced activities was lifting. Risk factors for absenteeism were working in awkward or tiring positions and in a cold or damp environment.

In a self-administered questionnaire among 1,294 Indonesian coal mining workers (1,252 males and 42 females), the 12-month period prevalence of LBS, reduced activities, and absenteeism due to LBS were 75%, 16%, and 13%, respectively. This study afforded an opportunity to examine selection bias due to a healthy worker effect. It showed that blue-collar work (as opposed to white-collar work) was a risk factor for LBS, after adjustment for a healthy worker effect and other potential confounders. The presence of LBS and smoking increased the risk of reduced activities and absenteeism. This study also indicated that those who were exposed to both high physical (awkward posture, whole-body vibration, using vibrating hand tools, and lifting) and high psychosocial (high effort, low reward, job dissatisfaction, and work stress) factors were most likely to report LBS and both consequences. High psychosocial exposure increased the likelihood of reporting LBS, but high physical exposure did so for reduced activities and absenteeism. Current smokers were more likely to report LBS consequences than nonsmokers. Permanent employment and night shift work increased the risk of LBS and its consequences. There was an interaction between physical and psychosocial exposures for LBS. The overall risk for LBS was greater than the sum of the individual risks due to physical and psychosocial factors (as indicated by departure from an additive model of risk). Thirty-nine percent of LBS cases among those who were exposed to high physical and high psychosocial risk factors were due to exposure to both factors. There were also interactions between the risk factors for reduced activities due to LBS, although not significant, whereas for absenteeism due to LBS it was not present.

The implications of these findings for New Zealand workers are that LBS and its consequences could be reduced by using interventions designed to avoid or minimise exposure to physical and psychosocial work factors. In addition, environmental factors should also be improved in order to reduce the consequences of LBS. For Indonesian coal mining workers, addressing both physical and psychosocial factors in the workplace is likely to reduce up to 39% of LBS cases among workers exposed to both factors. This will in turn, reduce the risk of LBS consequences. The intervention strategy should also focus on permanent employment, night shift work, and smokers.

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List of publications from thesis

Journal papers:

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Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., ‘t Mannetje, A., Cheng, S. & Pearce, N. (2012). Gender differences in work-related risk factors associated with low back symptoms. *Ergonomics*, 55(3), 327-342.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., 't Mannetje, A., Cheng, S. & Pearce, N. (2012). Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms. *Applied Ergonomics*, 43(4), 727-737.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., & Jones, G. (2012). Prevalence of low back symptoms and its consequences in relation to occupational group. *American Journal of Industrial Medicine.* doi: 10.1002/ajim.22116.

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Details of this paper has been described in Journal papers and Conference papers, Refereed papers sections above.

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Details of this paper has been described in Conference papers, Refereed papers section above.

Note.

This thesis follows the American Psychological Association (APA) sixth edition (APA, 2010) style.

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SECTION A

List of abbreviations

ACC	Accident Compensation Corporation
AP	attributable proportion
APA	American Psychological Association
AUC	area under the ROC curve
BMI	body mass index
CI	confidence interval
COPSOQ	Copenhagen Psychosocial Questionnaire
ERI	effort reward imbalance
EUR	euro
JCQ	Job Content Questionnaire
IDCs	industrially developing countries
IOM	Institute of Medicine
IRR	incidence rate ratio
kg	kilogram
LBD	low back disorders
LBP	low back pain
LBS	low back symptoms
HR	hazard ratio
MSD	musculoskeletal disorders
MSS	musculoskeletal symptoms
NMQ	Nordic Musculoskeletal Questionnaire
NOHSAC	National Occupational Health and Safety Advisory Committee
NPV	negative predictive value
NRC	National Research Council
OR	odds ratio
PPV	positive predictive value
PR	prevalence ratio
ROC	Receiver Operating Characteristic
SE	standard error

SMEs	small-medium enterprises
UK	United Kingdom
US	United States
USD	United States dollar
VIF	variance inflation factor
WHO	World Health Organization
WMSD	work-related musculoskeletal disorders
WMSS	work-related musculoskeletal symptoms

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INTRODUCTION

Chapter 1 Background, review of literature and aims

1.1 Background

Musculoskeletal symptoms (MSS) are common in developed and industrially developing countries (IDCs). The most frequently reported MSS are in the low back region (Alexopoulos, Stathi, & Charizani, 2004; Chen, Yu, & Wong, 2005; Holmström & Engholm, 2003; Leroux, Dionne, Bourbonnais, & Brisson, 2005; Lipscomb et al., 2004; Morken et al., 2000; Scuffham, Legg, Firth, & Stevenson, 2010; Smith, Mihashi, Adachi, Koga, & Ishitake, 2006; Woods & Buckle, 2006). A review paper reported the 12-month low back symptoms (LBS) period prevalence in developed countries ranged between 22% and 65% (Walker, 2000), and only a few papers (Coggan, Norton, Roberts, & Hope, 1994; Firth, Herbison, McBride, & Feyer, 2001; Harcombe, McBride, Derrett, & Gray, 2009; Laslett, Crothers, Beattie, Cregten, & Moses, 1991; Milosavljevic et al., 2011; Norton, Coggan, Roberts, & Hope, 1995; Palliser, Firth, Feyer, & Paulin, 2005; Pringle, Pirie, & Slappendel, 1993; Scuffham, et al., 2010) have demonstrated the extent of this problem in New Zealand. The 12-month LBS period prevalence among IDCs varied between 21% and 74% (Chen, et al., 2005; Ghaffari, Alipour, Jensen, Farshad, & Vingard, 2006; Jin, Sorock, & Courtney, 2004; Louw, Morris, & Grimmer-Somers, 2007). However, the estimation of the magnitude of LBS in IDCs might not reflect the true burden since only limited studies were conducted in IDCs (Gilgil et al., 2005; Louw, et al., 2007; Volinn, 1997).

LBS is a significant health problem due to its serious economic and social impacts (Hanson, Burton, Kendall, Lancaster, & Pilkington, 2006; National Research Council & Institute of Medicine [NRC & IOM], 2001). For example, 27% of all Washington State fund-accepted health insurance claims in 1997 to 2005 were for work-related musculoskeletal disorders (WMSDs), involving the back (51%), upper extremity

(37%), neck (12%) with an average direct cost of USD 12,377 per claim (Silverstein & Adams, 2007). In South Australia, injury in the lower back was the most common claims (38%) among other body parts during 2008-2009 (WorkCoverSA, 2010). In New Zealand, a report for the National Occupational Health and Safety Advisory Committee (NOHSAC) indicated that 36% of the total compensation cost in 2004-2005 was due to sprains and strains, and 14% due to diseases of the musculoskeletal system and connective tissue (Access Economics, 2006). Edwin, Tappin, and Bentley (2002) assessed Accident Compensation Corporation (ACC) Accident Register data from 1 September 2000 to 31 August 2001 and reported that among workers in the log sawmilling industry in New Zealand, 37% of injuries were to the back. It was also reported that injury to the low back or spine is the most common reason for requiring time off work each year, i.e. over 250,000 paid absence days per year (ACC, 2006). In Europe, LBS is also the cause of significant financial burden. For example, the direct and indirect cost of managing patients with LBS was EUR 624 per visit to general practitioners (Mantyselka, Kumpusalo, Ahonen, & Takala, 2002) in Finland. A 2-year cohort study in Sweden estimated the direct (health-service) and indirect (production losses) cost for sick leave lasting more than one month due to back and neck problems was about 47 million euros (Hansson & Hansson, 2005).

The social consequences of LBS may arise from reduced activities and absenteeism. The World Health Organization (WHO) (2003) reported that musculoskeletal problems, including LBS, are the most important causes of physical disability. While the prevalence of LBS has been reported extensively, less is known about its consequences. The 12-month period prevalence of reduced activities due to LBS ranges from 10% to 42% (Aasa, Barnekow-Bergvist, Angquist, & Brulin, 2005; Chen, et al., 2005; Palliser, et al., 2005; Scuffham, et al., 2010) whereas for absenteeism is between 4% to 36% (Alexopoulos, Konstantinou, Bakoyannis, Tanagra, & Burdorf, 2008; Bovenzi & Betta, 1994; Bovenzi, Pinto, & Stacchini, 2002; Cunningham, Flynn, & Blake, 2006; Ghaffari, et al., 2006; Ijzelenberg, Molenaar, & Burdorf, 2004; Matsudaira et al., 2011; Scuffham, et al., 2010).

Many studies have attempted to examine the risk factors for LBS. Traditionally, LBS has been known to be associated with physical factors, including manual material handling (Beeck & Hermans, 2000; Bernard, 1997; Burdorf & Sorock, 1997; Heneweer, Staes, Aufdemkampe, van Rijn, & Vanhees, 2011; Hoogendoorn, van Poppel, Bongers, Koes, & Bouter, 1999; Lotters, Burdorf, Kuiper, & Miedema, 2003; NRC & IOM, 2001; Wai, Roffey, Bishop, Kwon, & Dagenais, 2010a, 2010b), awkward back posture (Beeck & Hermans, 2000; Bernard, 1997; Burdorf & Sorock, 1997; Heneweer, et al., 2011; Hoogendoorn, et al., 1999; Lotters, et al., 2003; NRC & IOM, 2001), heavy physical work (Beeck & Hermans, 2000; Bernard, 1997; Burdorf & Hulshof, 2006; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; NRC & IOM, 2001), and whole-body vibration (Beeck & Hermans, 2000; Bernard, 1997; Burdorf & Hulshof, 2006; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003; NRC & IOM, 2001).

However, in the last two decades, some studies and systematic reviews showed that psychosocial factors also played a role in developing LBS (Beeck & Hermans, 2000; Bernard, 1997; Bongers, Dewinter, Kompier, & Hildebrandt, 1993; Hartvigsen, Lings, Leboeuf-Yde, & Bakketeig, 2004; Hauke, Flintrop, Brun, & Rugulies, 2011; Hoogendoorn, van Poppel, Bongers, Koes, & Bouter, 2000; Linton, 2001; Lotters, et al., 2003). High job strain (Ijzelenberg, et al., 2004), low job control (Ijzelenberg, et al., 2004), high psychological demands (Aasa, et al., 2005; Elders & Burdorf, 2001; Hooftman, van der Beek, Bongers, & van Mechelen, 2009; Ijzelenberg, et al., 2004), low skill discretion (Hooftman, et al., 2009), low decision latitude (Bernard, Sauter, Fine, Petersen, & Hales, 1994; Bongers, et al., 1993), low social support (Beeck & Hermans, 2000; Bernard, 1997; Bongers, et al., 1993; Hoogendoorn, et al., 2000), job dissatisfaction (Beeck & Hermans, 2000; J. Hartvigsen, et al., 2004; Hoogendoorn, et al., 2000; Linton, 2001; Lotters, et al., 2003), effort-reward imbalance (ERI) (Rugulies & Krause, 2008), and high work stress (Linton, 2000, 2001) have been associated with an increased risk of LBS.

The studies cited above, although having been adjusted for potential confounders, only examined the single relationship between physical or psychosocial factors with

LBS. Some theoretical models have proposed that the role of physical and psychosocial factors in the development of LBS is complex or may involve complex relationships (Bongers, et al., 1993; Carayon, Smith, & Haims, 1999; Davis & Heaney, 2000; Eatough, Way, & Chang, 2012; Karsh, 2006). A recent meta-analysis (Griffith et al., 2012) which included 48 primary studies, surprisingly found that the association between physical factors and LBS was small to moderate, with the pooled odds ratio (*ORs*) between 1.1 and 2.0 (for posture exposure) and between 1.4 and 2.1 (for force exposure). Eatough, Way, and Chang (2012) using a structural equation model found that physical demand was independently associated with MSS (wrist/hand, shoulder, lower back), whereas strain response (depression, frustration, anger, and anxiety) played a role as a mediator in the relationship between psychosocial factors (role conflict, job control, and safety-specific leadership) and MSS. The findings from the last two studies suggest that the association between risk factors and LBS is not bivariate, but multivariate and complex.

Davis and Heaney (2000) specifically suggest that both physical and psychosocial factors may independently influence LBS and also suggest that physical and psychosocial factors may interact. This interaction may give rise to a probability of LBS being greater than the sum of the magnitude of the individual effects. However, only eight studies have examined the combination/interaction between physical and psychosocial factors at work in the occurrence of LBS (Devereux, Rydstedt, Kelly, Weston, & Buckle, 2004; Devereux, Buckle, & Vlachonikolis, 1999; Fernandes, Carvalho, Assuncao, & Neto, 2009; Huang, Feuerstein, Kop, Schor, & Arroyo, 2003; Lapointe, Dionne, Brisson, & Montreuil, 2009; Linton, 1990; Thorbjörnsson et al., 2000; Vandergrift, Gold, Hanlon, & Punnett, 2012). They have shown that individuals exposed to both high physical and high psychosocial factors have the highest risk of LBS. Most of the studies that have examined the interaction between physical and psychosocial risk factors and LBS, as cited above, were conducted in developed countries and only one (Fernandes, et al., 2009) examined this interaction in an IDC (Brazil). However, Fernandes et al. excluded administrative workers, a group that is most commonly exposed to psychosocial factors, such as work demands (Alexopoulos, Tanagra, Konstantinou, & Burdorf, 2006) and job dissatisfaction

(Matsudaira, et al., 2011). In addition, they did not include some psychosocial factors that have been identified as risk factors for LBS and its consequences, e.g. effort (Linton, 2001; Rugulies & Krause, 2008), reward (Rugulies & Krause, 2008), and work stress (Linton, 2000, 2001; NRC & IOM, 2001).

Although quite a lot is known about the risk factors for LBS, less is known about the risk factors for its consequences. Physical factors, including manual material handling (Aasa, et al., 2005; Simon et al., 2008) and awkward posture (Aasa, et al., 2005; Simon, et al., 2008) are reported to be associated with reduced activities due to LBS, whilst manual material handling (Bergström, Bodin, Bertilsson, & Jensen, 2007; Hooftman, et al., 2009; Hoogendoorn et al., 2002), awkward posture (Hooftman, et al., 2009; Hoogendoorn, et al., 2002; Tubach, Leclerc, Landre, & Pietri-Taleb, 2002), and whole-body vibration (Hartman, Oude Vrielink, Metz, & Huirne, 2005) have been found to be associated with absenteeism due to LBS.

Psychosocial factors for reduced activities due to LBS have been reported as high psychological demand (Aasa, et al., 2005; Simon, et al., 2008), low decision latitude (Aasa, et al., 2005; Simon, et al., 2008), low social support (Aasa, et al., 2005), high ERI score (Simon, et al., 2008), and worry about work condition (Aasa, et al., 2005), whilst those for absenteeism due to LBS include low job control (Hemingway, Shipley, Stansfeld, & Marmot, 1997), low social support (Hooftman, et al., 2009; Tubach, et al., 2002; van den Heuvel, Ariens, Boshuizen, Hoogendoom, & Bongers, 2004), and job dissatisfaction (Hooftman, et al., 2009; Hoogendoorn, et al., 2002; van den Heuvel, et al., 2004). Only few studies (Lund, Labriola, Christensen, Bültmann, & Villadsen, 2006; Vahtera, Kivimäki, Pentti, & Theorell, 2000; Vingard et al., 2000; Voss, Floderus, & Diderichsen, 2001) have examined the combination/interaction between risk factors for absenteeism. However, these studies used general absenteeism data (not specific absenteeism due to LBS data) in their analysis.

1.2 Review of literature

1.2.1 Definition of musculoskeletal disorders (MSD) and symptoms (MSS)

Hagberg et al. (1995) and Violante (2000) stressed the importance of distinguishing between the terms *musculoskeletal disorders (MSD)* and *musculoskeletal symptoms (MSS)*. Similar definitions of disorders are explained by two medical dictionaries as follows: “A derangement or abnormality of functions; a morbid physical or mental state” (Miller-Keane, 1991, p. 468) and “A pathologic condition of the mind or body. SEE: disease” (Taber, 1997, p. 559). Recently, Last (2009) in “A dictionary of Public Health” defines MSD as “A miscellaneous group of inflammatory and degenerative disorders of joints and bones that include osteoarthritis, rheumatoid arthritis, gout, osteoporosis, and several other conditions that collectively have been found in most community health surveys”. Furthermore, Buckle & Devereux (2002) suggested that MSD should be reserved for describing common inflammatory and degenerative disease and disorders. In addition, Violante et al. (2000) defined a MSD as a condition that includes both symptoms (subjective evidence perceived by patient) and signs (objective evidence from physical examination) as well as any positive result arising from a diagnostic procedure to identify musculoskeletal pathology.

On the other hand, MSS (including discomfort, fatigue, and pain) represent subjective feelings (Burton, Kendall, Pearce, Birrell, & Bainbridge, 2008) and are self-reported. Finally, it is clear that subjective feelings of discomfort, fatigue, and pain (i.e. MSS) and abnormal physical examination are related to MSD, whereas to definitively identify the presence of clinical disease (i.e. MSD) some kind of diagnostic procedure is required. Therefore, this thesis uses ‘low back symptoms’ (LBS) to refer to any self-reported discomfort, fatigue, or pain in the low back region.

1.2.2 Anatomy of the human spine and mechanism of low back symptoms (LBS)

1.2.2.1 Anatomy of the human spine

The human spine consists of 24 small bones, called vertebrae, which are stacked on top of each other like building blocks. These bones are connected and provide a structure for the upper body and protect the spinal cord. There are 5 sections in the spine: cervical or neck (7 vertebrae), thoracic or mid back (12 vertebrae), lumbar spine or low back (5 vertebrae), sacrum, and coccyx (Martini, Bartholomew, & Welch, 2000) (Figure 1.1). To keep the spine in its position, it is supported by muscles and ligaments that surround the spine.

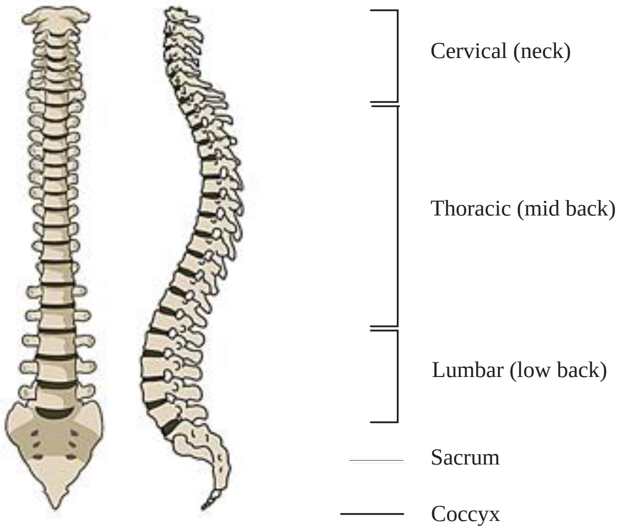

Figure 1.1 The human spine (anterior and left lateral view)

In between each vertebra there is a hydrodynamic elastic structure, called the intervertebral disc (Figure 1.2). It separates vertebrae and also acts as a shock absorber (Humzah & Soames, 1988). Intervertebral discs consist of three components: a central nucleus pulposus, annulus fibrosus (layer sheets of collagen fibres that enclose the nucleus pulposus), and endplate, i.e. a thin layer (semi permeable membrane) that regulates the nutrient flow from vertebrae to intervertebral disc (Humzah & Soames, 1988). The intervertebral discs have no direct blood supply and have few nerve innervations.

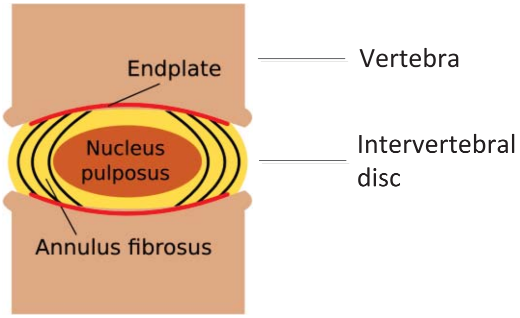

Figure 1.2 Intervertebral disc (sagital view)

1.2.2.2 Mechanism of LBS

There are two pathways to develop symptoms (including pain) in the back low region (Marras, 2008b, 2009). The first pathway is muscular based which involves muscles in the spine. Since the lumbar spine (low back) supports most of the body weight and allows for the greatest movement, this region takes the most stress and is the most common region reported for symptoms. Excessive physical activity, such as bending, twisting, and lifting, may load the muscle beyond the strength of the tissue. This condition stimulates muscle fibre disruption and inflammatory response. However, since muscles are rich with blood supply, they usually heal quickly. If the muscles get sufficient rest, then the muscles will become stronger. In contrast, if the muscles get insufficient rest, the muscle pain in the back region may develop.

The second pathway is structural based, in which stress occurs not only to the muscles but also the intervertebral discs. Loading in the spine exerts force on the intervertebral disc (because of its role as shock absorber), and may cause microfractures on the endplates. This condition may disturb the supply of nutrients from the vertebrae to the intervertebral discs. However, since the intervertebral disc has few innervations, workers do not notice these microfractures. If the spinal trauma is cumulative, it may cause multiple microfractures on the endplates. The trauma on the endplates stimulates the healing process; and scar tissue is formed on the endplate. At some stage the scar tissue becomes thicker and denser than the uncompromised endplate tissue. This condition will reduce the nutrient flow to the intervertebral disc further. Consequently, the intervertebral disc fibres become atrophied or destroyed (fissure or tears), and disc loses its integrity. In addition, the nucleus pulposus can cause a bulge in the intevertebral disc and stimulate the tissue surrounding the disc, which is rich in nerve receptors, so the workers will experience the pain.

Based on the duration of symptoms, back pain is categorised into three: acute back pain (present for less than six weeks), subacute back pain (present six to twelve weeks), and chronic back pain (present more than twelve weeks) (Bratton, 1999; Nachemson & Andersson, 1982). However, considering that LBS typically have a recurrent, intermittent, or episodic course characterised by variation, or fluctuations, this categorisation has been criticised for being inadequate. Hence, this present thesis does not use this classification to determine cases. Ninety percent of people with LBS recovered within three months (Andersson, Svensson, & Oden, 1983). This might be due to the impairment involving only muscles in the low back region (which have rich blood supply), so healing is achieved relatively quickly. However, if the force in the spine is repetitive, the load on the spine will be cumulative, and the impairment may involve muscle and the structures in the spine (which have poor blood supply). Hence, the healing may be relatively slow and the pain may persist and become more severe. Moreover, if the impairment has reached the stage of disruption (e.g. slipped disc or herniated disc), the condition is unlikely to return to normal, and the worker may experience persistent pain (Marras, 2009). Severe LBS, consequently, makes workers reduce their activities at work or home or may even be absent from work.

1.2.3 Causes of LBS: theoretical models

The accumulation of exposure in the workplace is suspected of being related to cumulative load in the tissues of the lower back (Marras, 2008a) and around one third of the risk of back pain has been attributed to occupation (Punnett et al., 2005). Several studies proposed theoretical models to describe the course of Work-related Musculoskeletal Disorders (WMSD). The first model was proposed by Armstrong et al. (1993). This model explains a cascading dose-response process of exposure, dose, capacity, and response variables (Figure 1.3). Internal dose (e.g. tissue loads, metabolic demands, etc) as the response of exposure (work requirements) stimulates physiological response (one or more doses) and in some way decrease (impairment) or increase (adaptation) the capacity for responding.

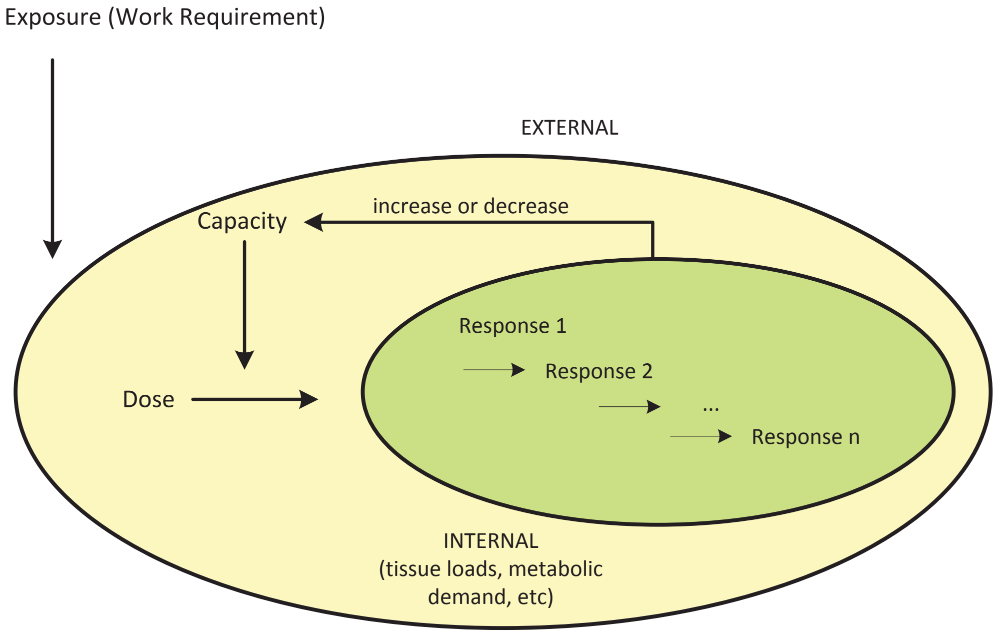

Figure 1.3 The dose-response model
(adapted from Armstrong et al. (1993))

Similar to the first model, the model that was suggested by Hagberg et al. (1995) also explained the influence of exposure from workplace in pathophysiology process (Figure 1.4). This model has three layers, i.e. pathophysiology, generic risk factors, and workplace features. The pathophysiology layer consists of responses related to disease or adaptation. This process is directly triggered by the second layer, that is generic risk factors. This layer encompasses factors that are associated with the presence of WMSD, such as posture, cognitive demands, organisational and psychosocial variables, etc. that interact each other. The base layer, i.e. workplace features, consists of factors in the workplace related to workstation design, work organisation, etc. Since the factors in this layer determine the factors in the second layer (generic risk factors), to prevent development of WMSD, the modification should focus on factors in the base layer.

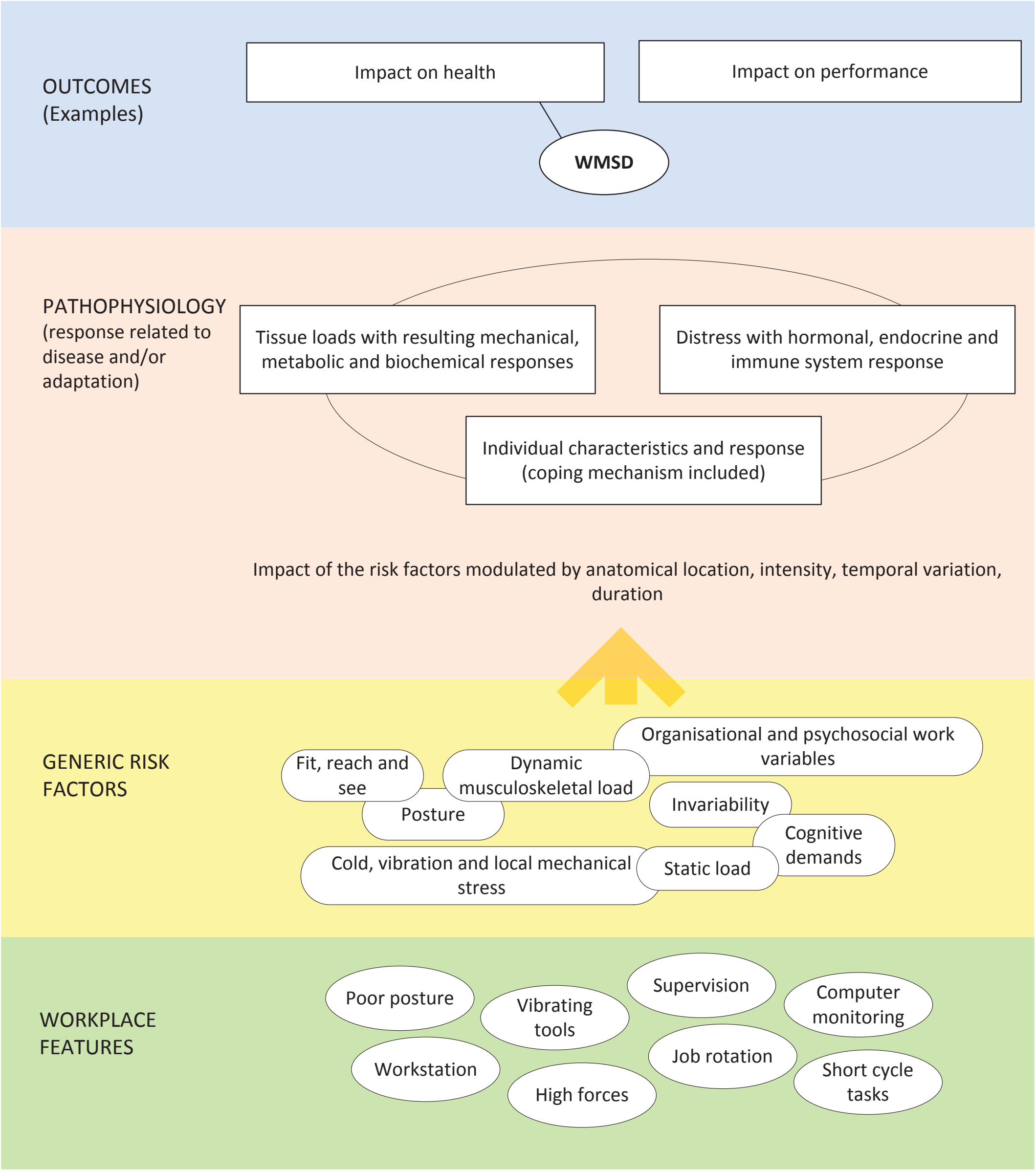

Figure 1.4 Generic model of prevention
(adapted from Hagberg et al. (1995))

Developing Armstrong's model, the National Research Council (NRC) (1999) proposed a model that explains various factors that may contribute to WMSD through a central physiological pathway. The "person" shows physiological processes that occur within the person whereas "workplace" shows the factors that may influence development of WMSD. This model introduced external loads, organisational factors, and social context factors that lead us to regard the WMSD in a broader perspective (Figure 1.5).

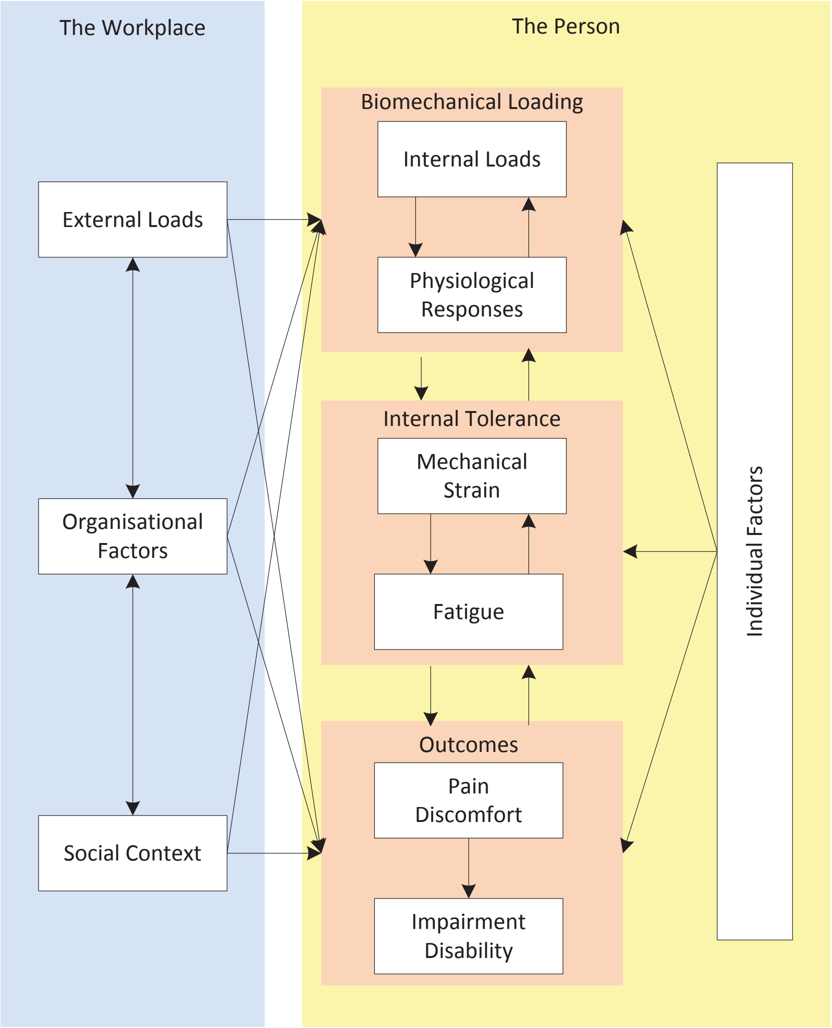

Figure 1.5 Model of risk factors of WMSD through central physiological pathway (adapted from NRC (1999))

Furthermore, the NRC and IOM (2001) proposed the interaction between psychological characteristics, mechanical exposure, and physiological characteristics in broader social, economic, and cultural context and development of musculoskeletal disorders (Figure 1.6).

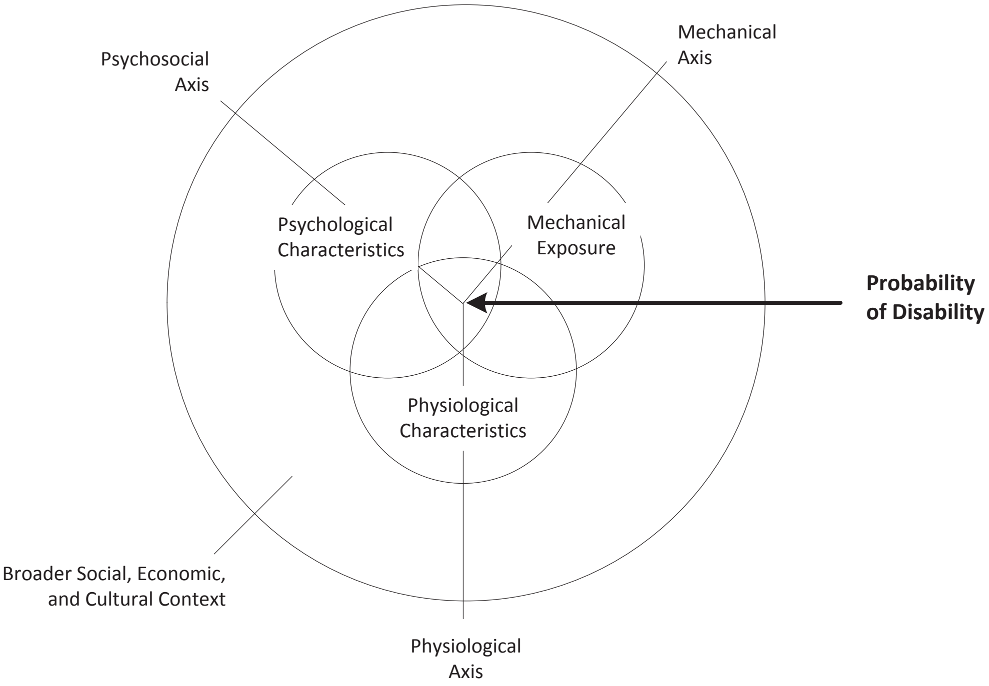

Figure 1.6 Model of risk factors for the injury, impairment, and disability attributable to MSD in the individual
(adapted from NRC and IOM (2001))

The mediating factors that influence developing WMSD were introduced by Carayon et al. (1999) and Macdonald (2004). Carayon et al. (1999) proposed that stress reaction plays a role as mediator in potential relationship between work organisation and WMSD (Figure 1.7). Starting from work organisation, physical and psychosocial risk factors can trigger stress reactions in an individual. Stress reactions can cause strain, including WMSD. Furthermore, when an individual is under stress, there are hormonal changes in the body that lead to increased risk of WMSD. Individual factors may influence work organisation, stress reaction, and strain. These factors may also moderate the association between work organisation and stress reaction and between stress reaction and strain. This model also presents feedback loops showing that strain can influence work organisation and stress reaction.

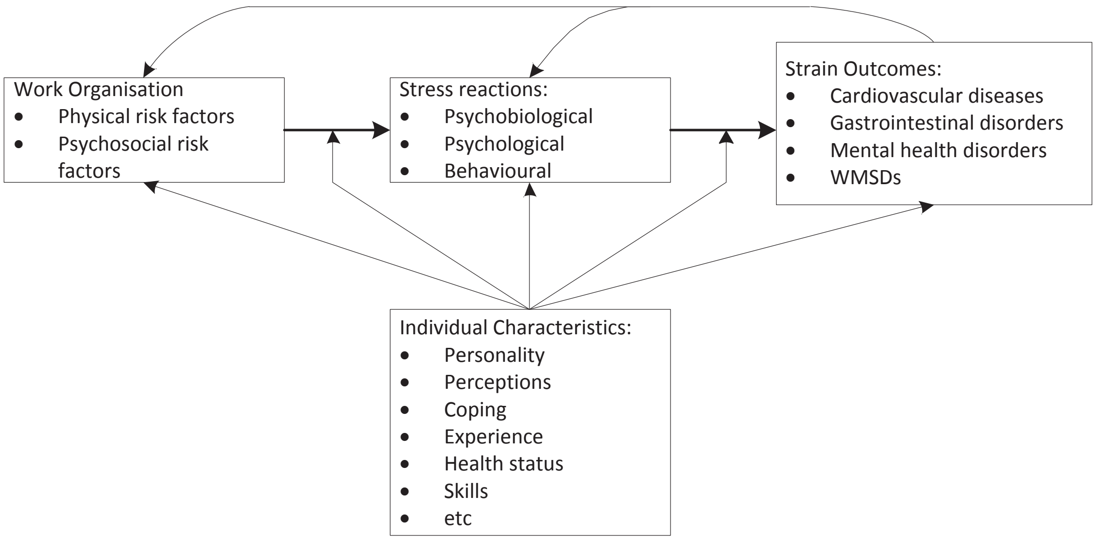

Figure 1.7 Model of the relationship between work organisation and WMSD (adapted from Carayon et al. (1999))

Similarly, Macdonald (2004) proposed mental workload (as well as stress) as a mediating factor that indirectly affects WMSD, whereas physical task demands and work performance duration traditionally directly influence increasing WMSD. Mental workload arises when there is a gap between demands and capacity, and may lead to stress. Physical consequences including developing of WMSD may occur as the response of stress.

As mentioned earlier, it is well understood that physical demands trigger biomechanical strain (physiological response) that lead to musculoskeletal outcomes. However, Sauter and Swanson (1996) suggested a link between work organisation and psychological strain. Psychological strain then may affect the presence of musculoskeletal outcomes through two ways: by stimulating biomechanical strain and moderating the relationship between biomechanical strain and musculoskeletal outcomes (Figure 1.8). Sauter and Swanson's model also introduces a cognitive component as a moderating factor between biomechanical strain and musculoskeletal outcomes. This factor includes detect sensation and labelling/attribution of somatic information.

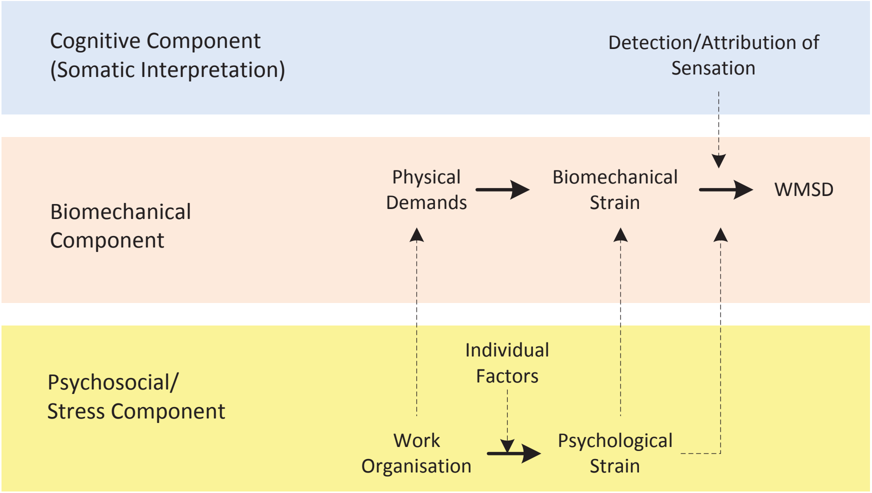

Figure 1.8 Model of ecological of WMSD
(adapted from Sauter and Swanson (1996))

Kumar (2001) proposed a multivariate interaction theory of musculoskeletal injury precipitation (Figure 1.9). This model describes that the cause of musculoskeletal injury is an interactive process between genetic, morphological, psychosocial and biomechanical factors. Considering there are many variables in each factor, many possible interactions may potentially affect the musculoskeletal system. However, this model does not explain how the interaction between factors will influence the outcome. The strain in the musculoskeletal system may trigger biochemical and physiological reactions (chemical reaction and immune reaction) as well as structural reactions (tension, compression, shear, etc.) that in turn may lead to musculoskeletal pain.

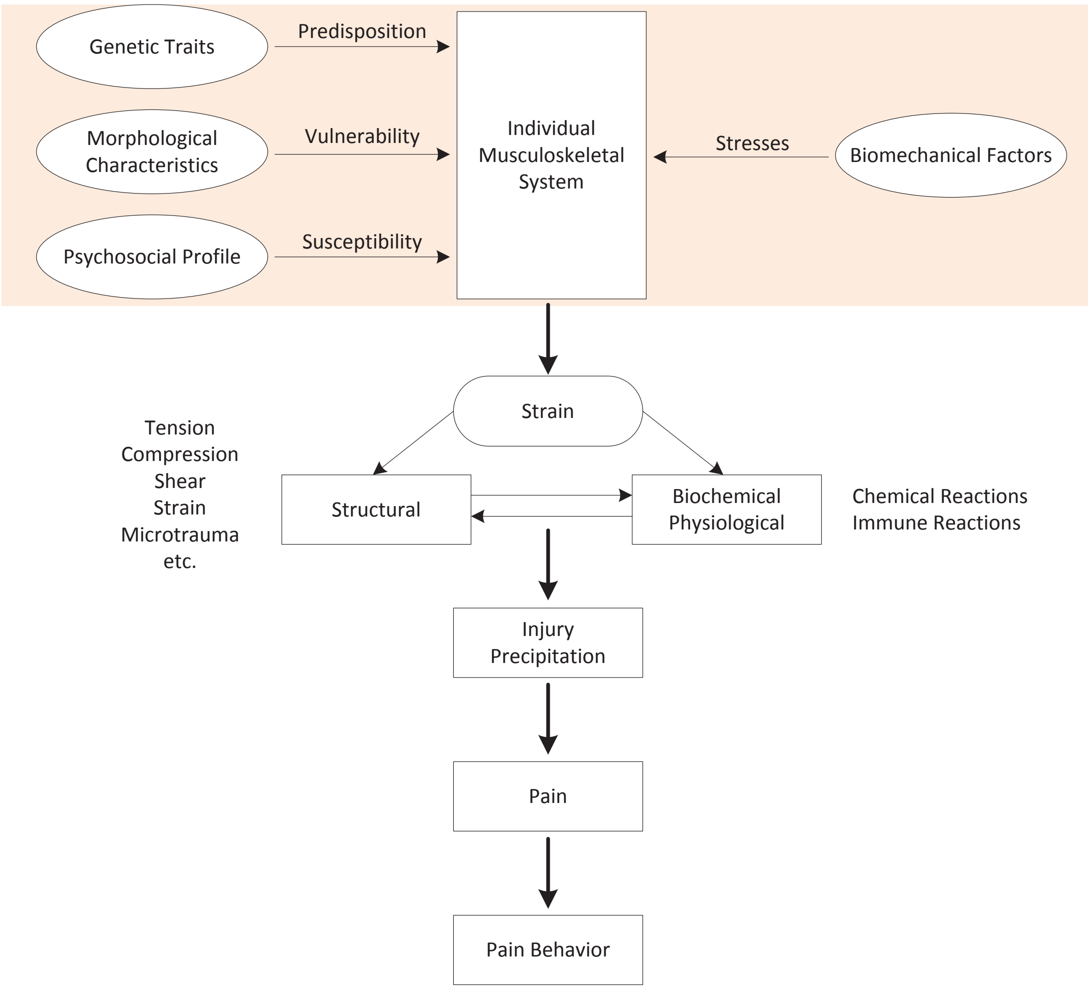

Figure 1.9 Simplified version of multivariate interaction theory of musculoskeletal injury
(adapted from Kumar (2001))

Specifically, Davis and Heaney (2000) explain the relationship between psychosocial and biomechanical risk factors and LBS and its consequences (Figure 1.10). This model proposes that biomechanical factors may influence LBP independently as well as psychosocial factors (shown as number 1 and 2). This model also shows that psychosocial work characteristics may influence the relationship between biomechanical demands and LBP (shown as number 3). Moreover, psychosocial characteristics and biomechanical demands may interact and may raise the possibility of confounding variables (shown as number 4).

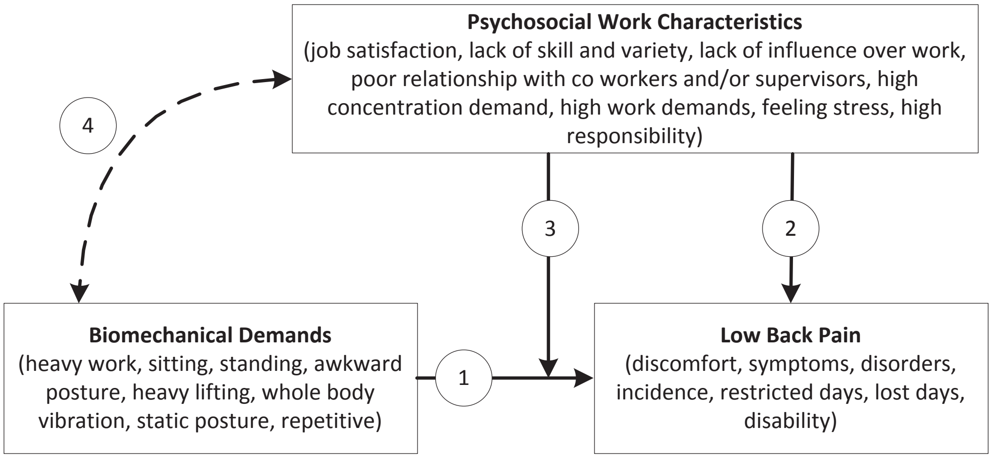

Figure 1.10 Model of the association between physical, psychosocial risk factors and LBS and its consequences
(adapted from Davis and Heaney (2000))

In summary, all of the models address the relationship between physical task demands and musculoskeletal outcomes via physiological response pathways. Carayon et al. (1999) and Macdonald (2004), introduced some factors (e.g. stress, mental workload and cognitive component) to mediate the relationship between physical demands and musculoskeletal outcomes. Sauter and Swanson (1996) suggested that psychological strain, which was determined by work organisation, may play a role as a moderating factor between biomechanical strain and musculoskeletal outcome. The effect of external loads, organisational factors, and social context factors was raised in 1999 by NRC. This model that was broadened in 2001 by NRC and IOM proposed that the association between physical, psychosocial and psychological factors and LBS occurs in the broader social, economic, and cultural context. A model by Kumar (2001) suggested multivariate interaction theory of musculoskeletal injury. However, this model did not explain how the interaction between factors influences the outcome. Specifically, Davis and Heaney (2000) suggested the possibility of a direct pathway between psychosocial factors and LBS and its consequences as well as biomechanical demand. It also suggested that the interaction between poor biomechanical factors and psychosocial factors may raise the risk of LBS and its consequences.

The most recent model is an integrated one, suggested by Karsh (2006) (Figure 1.11). This model combines previous theories and models and explains many possible mechanisms and pathways (indicated numerically in Figure 1.11) for developing WMSS and WMSD. It describes a social/cultural context that determines the condition of both work organisation and psychosocial work demands (shown as pathway 1 and 2) whereas work organisation may also influence psychological work demands (shown as pathway 3). Physical work exposures are determined by work organisation and environmental conditions (shown as pathway 4 and 5). Environmental factors may also determine psychosocial work (shown as pathway 6). That physical work demands may influence psychosocial work demands and *vice versa* is indicated as number 7. It also considers individual factors as a mediator for physical and psychosocial strains (shown as pathway 8, 9, 10, and 11). Finally, it proposes that all the work organisation, psychosocial work demands (shown as pathway 12) and physical work demands via physiological changes (shown as pathway 13 and 14), and individual factors together (directly or indirectly) can influence the detection of symptoms or labelling and attribution of the symptoms, ultimately leading to a diagnosis of a WMSDs (shown as pathway 15). Another pathway (identified as pathway 16) illustrates the presence of WMSD without symptoms. The presence of WMSD or labelling and attribution of the symptoms may cause feedback to impact physical work demands (shown as pathway 17 and 20), psychosocial work demands (shown as pathway 18 and 21), and/or work organisation (shown as pathway 19 and 22).

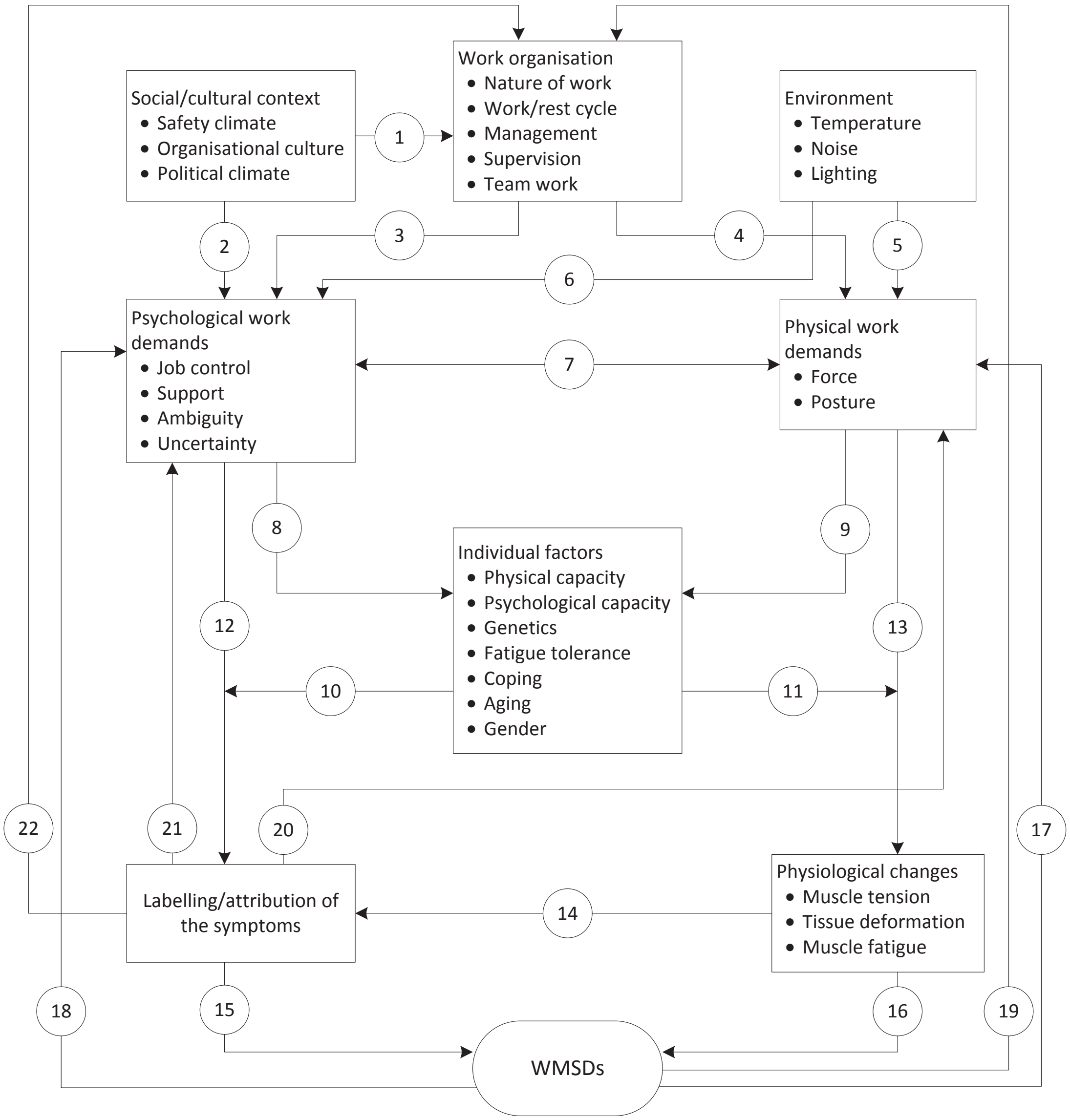

Figure 1.11 Simplified version of Karsh's integrated model
(adapted from Karsh (2006))

There is no doubt that work related factors play an important role in the development of MSD/S (Punnett, et al., 2005). So, all models are almost exclusively concerned with people at work. However, MSD/S can also arise during leisure activities. Van den Heuvel et al. (2005) indicated that practicing sports during leisure time for at least 10 months a year decreased the risk of neck/shoulder symptoms. However, Hildebrandt et al. (2000) reviewed some studies and reported that most studies showed no association between physical activity during leisure time and MSD/S. None of the models above have included leisure activities.

Despite the considerable volume of research underpinning all these models, there is no generally accepted model (Forcier & Kuorinka, 2001; Hagberg, et al., 1995). The various models, and the Karsh integrated model in particular, propose a wide range of risk factors that could contribute to the development of WMSD. In general they all include various combinations of physical, psychosocial and individual risk factors. They assume a dose-response relationship between exposures (risk factors) and the outcomes as independent effects as well as through interactions. Although it is known that physical and psychosocial work demands may influence each other (Davis & Heaney, 2000; Karsh, 2006), the interaction between the physical and psychosocial factors is poorly understood and needs to be investigated further in order to help identify appropriate interventions.

1.2.4 Prevalence of LBS

The prevalence[1] of LBS in developed and developing country is high (Beeck & Hermans, 2000; Volinn, 1997; Walker, 2000; WHO, 2003). The Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka et al., 1987) has been widely used to examine LBS. This self-reported questionnaire has been reported to have good validity (Kuorinka, et al., 1987) and reliability (Dickinson et al., 1992; Kuorinka, et al., 1987). Among those that used NMQ (Kuorinka, et al., 1987) or similar question(s) with similar case definitions, the 12-month period LBS prevalence in working populations in developed countries ranges from 30 to 80 per 100 workers (Table 1.1). Although Gallis (2006) showed the 12-month LBS period prevalence was even higher (85 per 100 workers), the small sample size in this study (*N*= 78)

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[1] Porta, Greenland, and Last (2008, pp. 191-192) in “A Dictionary of Epidemiology” define prevalence as “a measure of disease occurrence: the total number of individuals who have an attribute or disease at a particular time (it may be a particular period) divided by the population at risk of having the attribute or disease at the time or midway through the period.” This includes point, period, and lifetime prevalence. Point prevalence defines as “the proportion of individuals with a disease or an attribute at a specified point of time.” Period prevalence defines as “the proportion of individuals with a disease or an attribute at a specified period of time.” Lifetime prevalence defines as “the proportion of individuals who have had the disease or condition for at least part of their lives at any time during their lifecourse.”

may have produced a wide confidence interval, indicating a less precise and less informative estimation. Altman (1991a) suggested that a sample size of 80 is rather small for estimating a proportion. A lower 12-month LBS period prevalence was found in most studies that used a specific case definition, e.g. LBS were experienced quite often (24 to 30 per 100 workers) (Hildebrandt, 1995a), LBS were experienced often and very often (14 to 27 per 100 workers) (Engholm & Holmström, 2005; Holmström & Engholm, 2003), and back pain lasting for more than 30 days (15 to 23 per 100 workers) (Madan, Reading, Palmer, & Coggon, 2008) (Table 1.1).

As a country typical of developed countries, the 12-month LBS period prevalence in New Zealand is reported to be between 31 and 73 per 100 workers, and there have only been a few studies among the working population in New Zealand (Coggan, et al., 1994; Firth, et al., 2001; Harcombe, et al., 2009; Laslett, et al., 1991; Milosavljevic, et al., 2011; Norton, et al., 1995; Palliser, et al., 2005; Pringle, et al., 1993; Scuffham, et al., 2010) (Table 1.1). Two other studies in New Zealand reported that the lifetime back pain prevalence was between 21 and 41 per 100 people (depending on age) (James, Large, Bushnell, & Wells, 1991) and 1-month back pain period prevalence was between 21 and 30 per 100 females and between 15 and 28 per 100 males (depending on age) (Taylor, 2005). However, the last two studies were conducted amongst the general population.

The 12-month LBS period prevalence in working populations in IDCs ranges from 20 to 74 per 100 workers (Table 1.1). Similarly, a review paper by Louw et al. (2007) reported the 12-month LBS period prevalence was 50 cases per 100 in Africa. Three other studies in IDCs reported that the 12-month period prevalence was 64 per 100, 95% CI [63 per 100, 65 per 100] in China (Barrero et al., 2006) and 36 cases per 100, 95% CI [34 per 100, 38 per 100] in Turkey (Gilgil, et al., 2005), whereas the 1-week LBS period prevalence was 17 cases per 100 in Ethiopia (El-Sayed et al., 2010). It is notable that the previous three studies were conducted amongst the general populations.

Since IDCs may have a high proportion of workers engaged in heavy manual work, it might be expected that the prevalence of LBS and its consequences would be greater than in developed countries (Volinn, 1997). However, the prevalence of LBS in IDCs is similar to that in developed countries (Table 1.1), but it is hard to be confident to make firm conclusion because relatively few studies of LBS have been undertaken in IDCs (Gilgil, et al., 2005; Louw, et al., 2007; Volinn, 1997).

Most of the studies cited above are cross-sectional. An issue when conducting this type of research concerns a study bias called the healthy worker effect. The phenomenon of the healthy worker effect was first observed in 1885 when William Ogle found mortality rate dependent on difficulty of occupation; some occupations may repel, while others attract workers (Checkoway, Pearce, & Krebel, 2004). McMichael (1976), who first gave it the name healthy worker effect, also observed lower mortality rates in occupational populations than the general population. The healthy worker effect arises when only relatively healthy workers remain in employment are more likely to be included in the study, whereas less healthy workers are more likely to have left their jobs and are excluded (Arrighi & Hertzpicciotto, 1994; Checkoway, et al., 2004). This means that in cross-sectional studies, particularly among working populations, where details of exposures and outcomes are gathered from a population during the same period of time, study populations are likely to be biased towards healthy individuals.

Hartvigsen et al. (2001) showed that the healthy worker effect masked the association between physical workload and the outcome in a cross-sectional study among a work population. They found that there are no differences in LBS prevalence among workers in sedentary work and those exposed to physically heavy work in the baseline study. Two possible explanations were offered. First, workers who did heavy physical work were significantly more likely to migrate to sedentary work if they had low back pain for more than 30 days (out of the last year) compared with those without low back pain. However, among workers who did sedentary work initially (with or without low back pain) the change of work was not significant (Hartvigsen, et al., 2001). Other authors have also shown that heavy physical workers with musculoskeletal problems more often transfer to lighter work than those with no musculoskeletal problems (Ostlin, 1988; Palsson, Horstmann, Attewell, Ohlsson, & Skerfving, 1997). Second, people with existing LBS tend to choose light physical work to begin with (Hartvigsen, et al., 2001). It is therefore necessary to take into account a healthy worker effect bias in cross-sectional studies, but only a few studies (Liira, Shannon, Chambers, & Haines, 1996; Punnett, 1996) considered this bias.

Table 1.1 *Prevalence of LBS among the working populations in developed countries and IDCs*

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
Studies in developed countries							
Lloyd, Gauld, and Soutar (1986)	Cross-sectional	Scottish miners (*n* = 359) and office workers (*n* = 181)	Questions about any back pain				3-month period prevalence: • Miners 35 • Office workers 26
Laslett, Crothers, Beattie, Cregten, and Moses (1991)	Cross-sectional	General working population in urban area in New Zealand (*N* = 365)	Self-reported questionnaire (telephone interview)			31	Lifetime prevalence 78 Case definition: Back pain and sciatica
Pringle, Pirie, and Slappendel (1993)	Cross-sectional	Academics and general staff (keyboard users) in a university in New Zealand (*N* = 563)	NMQ		29	53	
Bovenzi and Betta (1994)	Cross-sectional	Tractor drivers (*n* = 1,155) and revenue officers (control) in Italy (*n* = 220)	NMQ (interview)			• Tractor drivers 72 • Revenue officers 37	Lifetime prevalence • Tractor drivers 81 • Revenue officers 42 1-month period prevalence • Tractor drivers 39

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
							• Revenue officers 19
Coggan, Norton, Roberts, and Hope (1994)	Cross-sectional	Nurses in New Zealand (*N* = 3,650)	Self-reported questionnaire (not specified) by mail	12		37	Lifetime prevalence 74
Hildebrandt (1995a)	Cross-sectional	General working population (trades and professions) in the Netherlands (*N* = 8,748)	Questionnaire on psychosomatic health symptoms by Dirken (1967)			• Men 25 • Women 29 • Total 27 • Nonsedentary 30 • Sedentary 24	Case definition: LBS were quite often
Norton, Coggan, Roberts, and Hope (1995)	Cross-sectional	Nurses in New Zealand (*N* = 3,650)	Self-reported questionnaire (not specified) by mail	12			Case definition: Not specified
Skov, Borg, and Orhede (1996)	Cross-sectional	Danish salespeople (*N* = 1,306)	NMQ			• Women 64 • Men 63	
Knibbe and Friele (1996)	Cross-sectional	Community nurses in the Netherlands (*N* = 390)	NMQ			67	3-month period prevalence 52
Alcouffe, Manillier,	Cross-sectional	Workers from small	NMQ			• Males 52	Case definition:

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
Brehier, Fabin, and Faupin (1999)		companies in the Paris area (*N* = 7,010)				• Females 60 • Total 55	LBS for more than 8 days
Devereux, Buckle, and Vlachonikolis (1999)	Cross-sectional	General working population in UK (*N* = 891)	Used similar questionnaire to NMQ		49	61	
Picavet, Schouten, and Smit (1999)	Cross-sectional	Working and nonworking population in the Netherlands (*N* = 13,927)	Used similar questionnaire to NMQ			Working Men 44 [43, 46] Women = 48 [46, 50] Nonworking Men 46 [43, 48 Women = 55 [53, 57]	
Morken et al. (2000)	Cross-sectional	Aluminium workers in Norway (operators office workers, and managers) (*N* = 5,654)	NMQ			76	
Firth, Herbison, McBride, and Feyer (2001)	Cross-sectional	Farmers in Southland, New Zealand (*N* = 586)	Self-reported questionnaire by interview			• Males 57 • Females 50 • Total 55	
Bovenzi, Pinto, and Stacchini (2002)	Cross-sectional	Port machinery operators (straddle	NMQ			• Controls 53 • Straddle carrier	Lifetime prevalence • Controls 68

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
		carrier drivers, fork-lift truck drivers, crane operators) (*n* = 219) and control manual workers as control group (*n* = 85) in Italy				drivers 52 • Fork-lift truck drivers 80 • Crane operators 55	• Straddle carrier drivers 78 • Fork-lift truck drivers 86 • Crane operators 79
Holmström and Engholm (2003)	Cross-sectional	Swedish construction workers (*N* = 85,191)	NMQ			• Construction 27 • Foremen 17 • Office 14	Case definition: LBS were often and very often
Alexopoulos, Stathi, and Charizani (2004)	Cross-sectional	Dentist in Greece (*N* = 430)	NMQ			46	Case definition: LBS for more than few hours
Guo, Chang, Yeh, Chen, and Guo (2004)	Cross-sectional	General working population in Taiwan (*N* = 18,924)	Used similar questionnaire to NMQ			• Males 18 [18, 19] • Females 20 [19, 20]	Case definition: Soreness or pain in the lower back and waist
Hussain (2004)	Cross-sectional	Truck assembly workers in UK (*N* = 323)	NMQ			65	
Ijzelenberg, Molenaar, and Burdorf (2004)	Cross-sectional	Employees of laundry-works and dry-cleaning	NMQ			50	

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence[§]			Notes
				Point	7-day	12-month	
		establishments in the Netherlands (*N* = 373)					
Jansen, Morgenstern, and Burdorf (2004)	Cohort 1 year	Workers in nursing homes and homes for the elderly in the Netherlands (*N* = 523)	NMQ			• Baseline 58 • Follow up 54	Case definition: LBS for more than few hours 1-year cumulative incidence 26 per 100 workers
Lipscomb et al. (2004)	Cohort (mean follow up 6 months)	Commercial fishers in North Carolina, United States (*N* = 201)	NMQ		• Baseline 18 • Follow up 24	• Baseline 52	Incidence rate 33 [23, 26] per 100 workers-years
Aasa, Barnekow-Bergvist, Angquist, and Brulin (2005)	Cross sectional	Swedish ambulance personnel • Males (*n* = 953) • Females (*n* = 234)	NMQ			• Males 46 [40, 52] • Females 60 [57, 63]	
Engholm and Holmström (2005)	Cross-sectional	Male Swedish construction workers (*N* = 85,191)	NMQ			26	Case definition: LBS were often and very often
Palliser, Firth, Feyer, and Paulin (2005)	Cross-sectional	Dentists in New Zealand (*N* = 413)	NMQ		29	63	

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
Alexopoulos, Tanagra, Konstantinou, and Burdorf (2006)	Cross-sectional	Shipyard employees in Greece (*N* = 853)	NMQ			• White-collars 39 • Metal workers 33 • Welders 40 • Other blue collars 38	
Burdorf and Jansen (2006)	Cohort 2 years	Workers from nursing home and home for the elderly in the Netherlands • Baseline (*N* = 769) • 1-year follow up (*N* = 541) • 2-year follow up (*N* = 341)	NMQ			• Baseline 58 [55, 61] • 1-year follow up 54 [51, 58] • 2-year follow up 50 [47, 54]	• 1-year cumulative incidence 26 [23, 29] per 100 workers • 2-year cumulative incidence 70 [65, 76] per 100 workers
Cunningham, Flynn, and Blake (2006)	Cross-sectional	Irish health service workers (*N* = 246)	NMQ	15 (12 to 19)		30 [26, 35]	Lifetime prevalence 46 [41, 51]
Gallis (2006)	Cross-sectional	Greek forest workers (*N* = 78)	NMQ		64	85	
Wijnhoven, de Vet, and Picavet (2006a)	Cross-sectional	General population in the Netherlands (*N* = 2,087)	Used similar questionnaire to NMQ			• Males 22 • Females 22	Case definition: LBS for more than 3 months

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
						• Total 22	
Smith, Mihashi, Adachi, Koga, and Ishitake (2006)	Cross-sectional	Japanese nurses (*N* = 844)	NMQ			71	
Woods and Buckle (2006)	Cross-sectional	Cleaners in UK (*N* = 1,216)	NMQ		24	46	
Alexopoulos, Konstantinou, Bakoyannis, G., Tanagra, and Burdorf (2008)	Cohort 1 year	Shipyard workers (white and blue collar) (*N* = 853) in Greece	NMQ			• Baseline 37	Lifetime prevalence 56
Madan, Reading, Palmer, and Coggon (2008)	Cross-sectional	Manual and office workers; India (*n* = 343), Indian subcontinental (*n* = 140), UK White (*n* = 331)	Structured interview about pain, disability, and absenteeism			Manual workers • India 10 • Indian subcontinental 16 • UK White 23 Office workers • India 3 • Indian subcontinental 4 • UK White 15	Case definition back pain more than 30 days

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence[§]			Notes
				Point	7-day	12-month	
Mehlum, Kristensen, Kjuus, and Wergeland (2008)	Cross-sectional	Workers in Norway (*N* = 7,293)	Used similar questionnaire to NMQ				1-month period prevalence • Total 46 • Males 43 • Females 48
Rugulies and Krause (2008)	Cohort 7.5 years	San Francisco transit operators (*N* = 1,179)	Using medical examination recorded and an ICD-9 code in the medical bill review				Case definition: nonspecific backache 7.5-year cumulative incidence 66 per 100 workers
Harcombe, McBride, Derrett, and Gray (2009)	Cross-sectional	Nurses (*n* = 118), postal workers (*n* = 116), and office workers (*n* = 146) in New Zealand	NMQ			• Nurses 57 • Postal workers 52 • Office workers 45	Case definition: LBS for more than 1 day
Scuffham, Legg, Firth, and Stevenson (2010)	Cross-sectional	Veterinarian in New Zealand (*N* = 867)	NMQ			73 [70, 76]	
Andersen, Mortensen, Hansen, and Burr (2011)	Cohort 2 years	Blue- and white-collar workers in Denmark (*N* = 5,603)	PRIM Questionnaire based on 10-point pain score			• Blue-collar 33 • White-collar 25	Case definition: reporting more than or equal to 4 (on a scale 0 to 9)

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
Matsudaira et al. (2011)	Cross-sectional	Japanese workers: nurses, office workers, sales/marketing, transportation operatives (*N* = 2,290)	Used similar questionnaire to NMQ			47	1-month period prevalence 28
Milosavljevic, Mcbride, Bagheri, Vasiljev, Mani, Carman, and Rehn (2011)	Cross-sectional	New Zealand rural workers (*N* = 130)	Used similar questionnaire to NMQ		35	58	
Vandergrift, Gold, Hanlon, and Punnett (2012)	Cohort 1 year	Automobile manufacturing workers in Michigan Baseline (*N* = 1,181) Follow up (*N* = 505)	Used similar questionnaire to NMQ			• Baseline 20	Case definition: Any experienced more than 3 times or lasting more than 1 week during the last 12 months 1-year cumulative incidence 5 per 100 workers
Studies in IDCs							
Waluyo, Ekberg, and Eklund (1996)	Cross-sectional	Indonesian (*n* = 136) and Swedish (*n* = 326) assembly workers	NMQ				Prevalence (the period was not specified): • Indonesian 38

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence§			Notes
				Point	7-day	12-month	
							• Swedish 59
Jin, Sorock, and Courtney (2004)	Cross-sectional	Teachers (*n* = 121), battery/kiln workers (*n* = 181), and garment workers (*n* = 81) in China	Used similar questionnaire to NMQ		• Teacher 22 • Battery/kiln 13 • Garment 33	• Teacher 40 • Battery/kiln 46 • Garment 74	Lifetime prevalence • Teacher 50 • Battery/kiln 60 • Garment 79
Smith, Wei, Zhao, and Wang (2004)	Cross-sectional	Female Chinese nurses (*N* = 282)	NMQ			56	
Chen, Yu, and Wong (2005)	Cross-sectional	Chinese offshore oil installation workers (*N* = 561)	NMQ		8	32	
Lei, Dempsey, Xu, Ge, and Liang (2005)	Cross-sectional	Chinese foundry workers (*N* = 617)	NMQ and physical examination		• Molders 30* • Turners 15 • Cleaners 26* • Others 14	• Molders 32* • Turners 27 • Cleaners 25* • Others 27	*Indicates significant difference with positive signs found by physical examination
Ghaffari, Alipour, Farshad, Yensen, and Vingard (2006)	Cross-sectional	Iranian car manufacture workers (*N* = 13,776)	NMQ		Total 8	• Total 21 • Males 20 • Females 27	
Choobineh, Tabatabaei, Mokhtarzadeh, and Salehi (2007)	Cross-sectional	Iranian male rubber factory workers (*N* = 454)	NMQ			50	

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence[§]			Notes
				Point	7-day	12-month	
Sarikaya, Ozdolap, Gumustas, and Koc (2007)	Cross-sectional	Underground Turkish coal miners (N = 50)	Questions about any low back pain				5-year period prevalence 78
Fernandes, Carvalho, Assuncao, and Neto (2009)	Cross-sectional	Plastic industry workers in Northeast Brazil (N = 577)		• Males 21 • Females 21			Case definition: Current symptom severity rating more than or equal to 3 (on a scale 0 to 5) or sought medical care, missing work, light or restricted work or changed jobs due to this problem.
Naidoo, Kromhout, London, Naidoo, and Burdorf (2009)	Cross-sectional	Woman involved in small-scale farming in South Africa (N = 911)	NMQ (interview)			• Workers at irrigation 63 • Workers at dry lands 64	Symptoms in back area (not specific to low back area)
Samad, Abdullah, Moin, Tamrin, and Hashim (2010)	Cross-sectional	School teachers in Malaysia (N = 272)	NMQ			40	
Studies that did not specify the place/country of the study population							
Burdorf, Naaktgeboren, and Post (1998)	Cohort 2 years	Welders and metal workers (N = 283)	NMQ			• Welders 39 • Metal workers 41	

Author(s)	Study Design	Study Population	Methods	Low Back Symptoms Prevalence[§]			Notes
				Point	7-day	12-month	
Guvenc, Dogan, and Akdur (2011)	Cross-sectional	Office workers at vehicle production industry (*N* = 333)	NIOSH Questionnaire (only asked about pain)			• Males 35 • Females 68 • Total 41	

Note. CI = confidence interval.

[§] Prevalence (point or period) is expressed as the number of cases per 100 workers [and 95% CI – if available].

1.2.5 Prevalence of LBS consequences

The consequences of LBS are likely to depend on severity. They may reduce a person’s activities and even increase absenteeism. Since this condition may have serious social and economic impacts (Hanson, et al., 2006; NRC & IOM, 2001), a number of studies have investigated the prevalence of reduced activities and absenteeism due to LBS.

The NMQ has also often been used to assess the consequences of LBS. Among those that used NMQ (Kuorinka, et al., 1987) or similar question(s) with similar case definitions, the 12-month period prevalence in working population for reduced activities ranges from 10% to 42%. Gallis (2006) reported a higher 12-month period prevalence of reduced activities among Greek forest workers (50%). However, as explained in the previous section (Section 1.2.4), the small sample size in Gallis’ study (*N* = 78) may make the 95% CI around the point estimation wide, indicating poor precision in their estimation. The 12-month period prevalence for absenteeism ranges from 4% to 36% (Table 1.2). The lowest 12-month period prevalence (4%) was for Japanese workers in various occupations: nurses, office workers, sales/marketing personnel, and transportation operatives (Matsudaira, et al., 2011) whereas the highest 12-month period prevalence (36%) was for forklift truck drivers (Bovenzi, et al., 2002)

Table 1.2 *Prevalence of LBS consequences (reduced activities and absenteeism) among the working populations in developed countries and IDCs*

Author(s)	Study Design	Study Population	Methods	12-month period prevalence[§]		Notes
				Reduced Activities	Absenteeism	
Studies in developed countries						
Afacan (1982)	Cross sectional	Coal miners in the South Yorkshire area, England (*N* = 12,125)			4	Number of new spells of absence due to back pain in a year divided by number of employed
Lloyd, Gauld, and Soutar (1986)	Cross sectional	Scottish miners (*n* = 359) and office workers (*n* = 181)				3-months period prevalence for absenteeism was • Miners: 32 • Office workers: 14
Pringle, Pirie, and Slappendel (1993)	Cross-sectional	Academics and general staff (keyboard users) in a university in New Zealand (*N* = 563)	NMQ	19		
Bovenzi and Betta (1994)	Cross sectional	Tractor drivers (*n* = 1155) and revenue officers (control) (*n* = 220) in Italy	NMQ (interview)		• Tractor drivers 12 • Revenue officers 5	Case definition: absenteeism >14 days

Author(s)	Study Design	Study Population	Methods	12-month period prevalence[§]		Notes
				Reduced Activities	Absenteeism	
Knibbe and Friele (1996)	Cross sectional	Community nurses in the Netherlands (*N* = 390)	NMQ			3-month period prevalence for absenteeism was, with duration >15 days
Picavet et al. (1999)	Cross sectional	Working and nonworking population in the Netherlands (*N* = 13,927)	Used similar questionnaire to NMQ	Working Men 12 [11, 13] Women = 12 [10, 13] Nonworking Men 19 [17, 20] Women = 18 [17, 19]		
Alcouffe et al. (1999)	Cross sectional	Workers from small companies in the Paris area, France (*N* = 7,010)	NMQ	• Males 12 • Females 12	• Males 7 • Females 9	
Bovenzi et al. (2002)	Cross sectional	Port machinery operators (straddle carrier drivers, fork-lift truck drivers, crane operators) (*n* = 219) and control manual workers as control group (*n* = 85) in Italy	NMQ		• Controls 16 • Straddle carrier drivers 13 • Fork-lift truck drivers 36 • Crane operators 15	

Author(s)	Study Design	Study Population	Methods	12-month period prevalence§		Notes
				Reduced Activities	Absenteeism	
Hoogendoorn et al. (2002)	Cohort 3 years	General working population in the Netherland (*N* = 1,080)	Company’s register sickness absence data		20	Had absenteeism ≥ 3 days
Trinkoff, Lipscomb, Geiger-Brown, and Brady (2002)	Cross sectional	American nurses (*N* = 1,163)	Used similar questionnaire to NMQ	• Reduced or modified work activities 5 • Reduced nonwork activities 7 • Reduced recreation 9		
Alexopoulos, Burdorf, and Kalokerinou (2003)	Cross sectional	Nurses in Greece (*N* = 351)	NMQ		17	
Alexopoulos et al. (2004)	Cross sectional	Dentist in Greece (*N* = 430)	NMQ		10	
Ijzelenberg et al. (2004)	Cross sectional	Employees of laundry-works and dry-cleaning establishments in the Netherlands (*N* = 373)	NMQ		14	

Author(s)	Study Design	Study Population	Methods	12-month period prevalence§		Notes
				Reduced Activities	Absenteeism	
Jansen et al. (2004)	Cohort 1 year	Workers in nursing homes and homes for the elderly in the Netherlands (*N* = 523)	Von Korff et al. disability score	• Baseline 8 • Follow up 12		Disability score >50 (on a scale 0 to 100) 1-year cumulative incidence 9 per 100 workers
Lipscomb et al. (2004)	Cohort (mean follow up 6 months)	Commercial fishers in North Carolina, United States (*N* = 201)	NMQ	• Baseline 18		Symptoms resulting in work interference Incidence rate 13 [7, 23] per 100 worker-years
van den Heuvel, Ariens, Boshuizen, Hoogendoom, and Bongers (2004)	Cohort 3 years	General working population in the Netherland (*N* = 1,738)	Company's register sickness absence data		18	Had absenteeism $\geq$ 1 day
Aasa et al. (2005)	Cross sectional	Swedish ambulance personnel • Males (*n* = 953) • Females (*n* = 234)	NMQ	• Males 23 [21, 26] • Females 11 [7, 15]	• Males 11 [9, 13] • Females 14 [10, 19]	
Leroux, Dionne, Bourbonnais, and Brisson	Cross sectional	General working population in the Quebec, Canada (*N*	Questionnaire	• Women 29 • Men 30		Case definition: the pain having disturbed activities, often or

Author(s)	Study Design	Study Population	Methods	12-month period prevalence[§]		Notes
				Reduced Activities	Absenteeism	
(2005)		= 9,496)				always
Palliser et al. (2005)	Cross Sectional	Dentists in New Zealand (*N* = 413)	NMQ	17		
Alexopoulos et al. (2006)	Cross sectional	Shipyard employees (*N* = 853)	NMQ		• White collars 15 • Metal workers 12 • Welders 17 • Other blue collars 19	
Burdorf and Jansen (2006)	Cohort 2 years	Workers from nursing home and home for the elderly in the Netherland • Baseline (*N* = 769) • 1-year follow up (*N* = 541) • 2-year follow up (*N* = 341)	Similar to NMQ		• Baseline 9 [8, 10] • 1-year follow up 13 [12, 14] • 2-year follow up 11 [11, 13]	• 1-year cumulative incidence 11 [29, 12] per 100 workers • 2-year cumulative incidence 7 [6, 44] per 100 workers
Cunningham et al. (2006)	Cross sectional	Irish health service workers (*N* = 246)	NMQ		16	

Author(s)	Study Design	Study Population	Methods	12-month period prevalence[§]		Notes
				Reduced Activities	Absenteeism	
Gallis (2006)	Cross sectional	Greek forest workers (*N* = 78)	NMQ	• Reduced work activities 64 • Reduced leisure activities 50 • Prevented from normal work 50		
Alexopoulos et al. (2008)	Cohort 1 year	Shipyard workers (white and blue collar) in Greece Baseline and follow up (*N* = 853)	NMQ		• Baseline 15	Incidence rate 16 [13, 19] per 100 worker-years
Madan et al. (2008)	Cross sectional	Manual and office workers; India (*n* = 343), Indian subcontinental (*n* = 140), UK White (*n* = 331)	Structured interview about pain, disability, and absenteeism	Manual workers • India 11 • Indian subcontinental 27 • UK White 15 Office workers • India 7 • Indian subcontinental 15 • UK White 22	Manual workers • India 7 • Indian subcontinental 16 • UK White 15 Office workers • India 6 • Indian subcontinental 12 • UK White 13	Case definition reduced activities: back pain had impaired at least 3 of 5 list of activities

Author(s)	Study Design	Study Population	Methods	12-month period prevalence[§]		Notes
				Reduced Activities	Absenteeism	
Simon et al. (2008)	Cross sectional	Nursing staff in hospital (*n* = 16,770), nursing homes (*n* = 2,140), and home care (*n* = 2,606) in Europe	Van Korff disability score (recall period 6 months)	• Hospital 46 • Nursing homes 48 • Home care 38		
Hooftman, van der Beek, Bongers, adn van Mechelen (2009)	Cohort 3 years	General working population in the Netherland (*N* = 1,259)	Company's register sickness absence data		9	
Scuffham et al. (2010)	Cross sectional	Veterinarian in New Zealand (*N* = 867)	NMQ	42 [39, 46]	9 [8, 12]	
Matsudaira et al. (2011)	Cross sectional	Japanese workers: nurses, office workers, sales/marketing, transportation operatives (*N* = 2,290)	Used similar questionnaire to NMQ		4	1-month period prevalence of reduced activities 11
Studies in IDCs						
Chen et al. (2005)	Cross sectional	Chinese offshore oil installation workers	NMQ	10		

Author(s)	Study Design	Study Population	Methods	12-month period prevalence[§]		Notes
				Reduced Activities	Absenteeism	
		(*N* = 561)				
Ghaffari et al. (2006)	Cross sectional	Iranian car manufacture workers (*N* = 13,776)	NMQ		5	

Note. CI = confidence interval.

[§] Period prevalence is expressed as the number of cases per 100 workers [and 95% CI – if available]

1.2.6 Risk factors for LBS

Risk factors for LBS involve individual, physical, psychosocial, and organisational factors. Individual factor include gender, age, and smoking. There are gender differences in LBS prevalence. Some studies show that females have a significantly higher prevalence of symptoms in the low back (Alcouffe, et al., 1999; Ghaffari, et al., 2006; Guo, et al., 2004; Guvenc, et al., 2011; Leijon & Mulder, 2009; Morken, et al., 2000; Picavet, et al., 1999) than males. However, a study among 953 male and 234 female ambulance workers reported that male ambulance workers had a higher prevalence of LBS compared to female ambulance workers (Aasa, et al., 2005), and only a few studies have failed to find the association between genders (Skov, et al., 1996; Wijnhoven, et al., 2006a). The differences in LBS prevalence between gender are likely due to gender segregation in the workforce, so males and females may have been exposed differently (Bernard, et al., 1994; Burdorf & Sorock, 1997; Hooftman, van Poppel, van der Beek, Bongers, & van Mechelen, 2004).

Although the direction and strength of the association between age and smoking and LBS is inconsistently reported in the literature, it is likely that these two individual factors may be important confounders when identifying risk factors for LBS. Some studies have shown that the prevalence of LBS is higher among older workers compared with younger workers (Cunningham, et al., 2006; Ghaffari, et al., 2006; Holmström & Engholm, 2003). A systematic review by Dionne et al. (2006) pointed out that the occurrence of LBS with age follows a curvilinear relationship, with risk increasing up until the fifth decade and then decreasing from age 60 onwards. Other studies have failed to find an association between age and LBS (Alexopoulos, et al., 2003; Bovenzi, et al., 2002; Ijzelenberg, et al., 2004; Leroux, et al., 2005). As with age, the association between smoking and LBS is inconsistent. Current smokers have been reported to have a higher risk of LBS compared with nonsmokers (Alcouffe, et al., 1999; Lei, et al., 2005; Palmer, Syddall, Cooper, & Coggon, 2003), but a systematic review by Leboeuf–Yde (1999) reported that the positive association between smoking and LBS was significant in studies with a large sample size but not in those where the number of study subjects was much smaller. Since the association between current smoking status and LBS was relatively weak (with estimated risk ratios generally less than 2), Leboeuf–Yde (1999) concluded that smoking was a weak risk factor and unlikely to be a cause of LBS. A systematic review by Shiri et al. (2010b) also identified a modest association between current smoking status and LBS (pooled *OR* 1.33, 95% CI [1.26, 1.41]).

A search of the available literature was made for papers that reviewed epidemiology studies about physical and psychosocial risk factors for LBS. In Web of Science, Scopus, and Google Scholar databases, the search of review papers was conducted using the following keywords: (i) "musculoskeletal" or "back pain" or "low back pain" or "low back symptoms" or ”back ache" or "back disorders", (ii) "risk factors" or "physical" or " manual handling" or "lifting" or "awkward posture" or "repetitive" or "vibration", (iii) "psychosocial" or " job strain" or "demand" or "job stress" or ”effort", and (iv) "review". These keywords were used as separate terms and in combinations. All articles were screened based on their titles and abstracts. Only review papers that reported risk factors in general or mixed working population, provided clear specific outcome (in low back region), and reported in English were included. Additional or further search was done using the reference list of each paper and peer discussion. This literature search was carried out in November 2011.

Some papers have extensively reviewed the evidence concerning physical and psychosocial risk factors for LBS. Table 1.3 presents a summary of the physical risk factors for LBS from nine review papers. The classification and category for the evidence of an association between each physical factors and LBS are as follows: 1) Strong evidence (+++): provided by generally consistent findings in multiple high quality studies or reporting pooled *OR* >2 (Hemingway & Marmot, 1999); 2) Moderate evidence (++): provided by generally consistent findings in one high quality study and one or more low quality studies, or in multiple low quality studies or reporting pooled *OR* between 1 and 2 (Hemingway & Marmot, 1999); 3) Insufficient evidence (+/0): only one study available or inconsistent findings in multiple studies (less than 75% of the studies reported the same conclusions); 4)

Evidence of no relationship (–) or the 95% CI of the pooled *OR* including 1. For review papers that did not use the same category as above (Burdorf & Sorock, 1997; Heneweer, et al., 2011; Lotters, et al., 2003; NRC & IOM, 2001), the judgment was made based on the summary of the findings provided by each review paper (Burdorf & Sorock, 1997; Heneweer, et al., 2011; NRC & IOM, 2001) or the value of pooled *ORs* (Lotters, et al., 2003).

Manual material handling, awkward posture, and whole-body vibration appear to be consistently having a moderate or strong evidence of the relationship with LBS. Although only one review paper reported insufficient evidence, six review papers reported moderate or strong evidence of the relationship between heavy physical work and LBS. Insufficient evidence was found for the association between static work posture and LBS (Table 1.3).

Table 1.3 *A summary of the physical risk factors for LBS from the review papers*

Authors	Manual material handling	Awkward posture	Heavy physical work	Whole-body vibration	Static work posture
Bernard (1997)	+++	++	++	+++	+/0
Burdorf and Sorock (1997)	+++	+++	++	+++	+/0
Hoogendoorn et al. (1999)	+++	+++	++	+++	N/A
NRC and IOM (2001)	+++	+++	+++	+++	+/0
Beeck and Hermans (2000)	+++	++	++	+++	+/0
Lotters et al. (2003)	++	++	+/0	++	N/A
Wai, Roffey, Bishop, Kwon, and Dagenais (2010a)[a]	+++	N/A	N/A	N/A	N/A
Wai, Roffey, Bishop, Kwon, and Dagenais (2010b)[b]	+++	N/A	N/A	N/A	N/A
Heneweer et al. (2011)	+++	+++	+++	N/A	N/A

Note. (+++) = strong evidence or pooled *OR* >2; (++) = moderate evidence or pooled *OR* between 1 and 2; (+/0) = insufficient evidence ; (–) = evidence of no association or the 95% CI of the pooled *OR* including 1; N/A = not available.
[a] carrying. [b] lifting >25 kg.

Table 1.4 presents a summary of the psychosocial risk factors and LBS from 11 review papers. The same classification and category was applied to determine the evidence of an association between each psychosocial factors and LBS: 1) Strong evidence (+++): provided by generally consistent findings in multiple high quality studies or reporting pooled *OR* >2 (Hemingway & Marmot, 1999); 2) Moderate evidence (++): provided by generally consistent findings in one high quality study and one or more low quality studies, or in multiple low quality studies or reporting pooled *OR* between 1 and 2 (Hemingway & Marmot, 1999); 3) Insufficient evidence (+/0): only one study available or inconsistent findings in multiple studies (less than 75% of the studies reported the same conclusions); 4) Evidence of no relationship (–) or the 95% CI of the pooled *OR* including 1. For review papers that did not use the same category as above (Bongers, et al., 1993; Burdorf & Sorock, 1997; Hauke, et al., 2011; Linton, 2000; Lotters, et al., 2003; NRC & IOM, 2001) the judgment was made based on the summary of the findings provided by each review paper (Bongers, et al., 1993; Burdorf & Sorock, 1997; Linton, 2000; NRC & IOM, 2001) or the value of pooled *ORs* (Hauke, et al., 2011; Lotters, et al., 2003)

Seven of nine review papers reported moderate or strong evidence of a positive relationship between job dissatisfaction and LBS (Beeck & Hermans, 2000; Bernard, 1997; Hauke, et al., 2011; Hoogendoorn, et al., 2000; Linton, 2001; Lotters, et al., 2003; NRC & IOM, 2001), whereas six of nine review papers reported moderate or strong evidence of a positive relationship between low social support and LBS (Beeck & Hermans, 2000; Bongers, et al., 1993; Hauke, et al., 2011; Hoogendoorn, et al., 2000; Linton, 2001; NRC & IOM, 2001). Four of seven review papers reported moderate or strong evidence of a positive relationship between high psychological demand (Bernard, 1997; Hauke, et al., 2011; Linton, 2001; NRC & IOM, 2001) and work stress (Bongers, et al., 1993; Linton, 2000, 2001; NRC & IOM, 2001) and LBS. Interestingly, although job strain (encompasses low decision latitude and high psychological job demands) has been established as predictors for important health problems, e.g. cardiovascular disease and related problems (Belkic, Landsbergis, Schnall, & Baker, 2004; Collins, Karasek, & Costas, 2005; Hintsanen et al., 2005; Rosenstrom et al., 2011), of nine review papers, only one (Linton, 2001) showed strong evidence and four studies (Bernard, 1997; Bongers, et al., 1993; Burdorf & Sorock, 1997; NRC & IOM, 2001) showed moderate evidence whereas four studies reported insufficient evidence or no evidence of a positive relationship between low decision latitude and LBS. The association between effort, reward, over commitment and LBS were less well examined. Only one paper reviewed the relationship between high effort and LBS and suggested moderate evidence for such relationship (Linton, 2001). In addition, a cohort study over 7.5 years among transit operators in San Francisco showed that high effort-reward imbalance score significantly increased the risk of low back injury (Rugulies & Krause, 2008).

Table 1.4 *A summary of the psychosocial risk factors and LBS from the review papers*

Authors	High effort	Low reward	High over commitment	Low decision latitude	High psychological demand	Low social support	Job dissatisfaction	Work stress
Bongers et al. (1993)	N/A	N/A	N/A	++[b]	+/0	+++	+/0	++
Bernard (1997)	N/A	N/A	N/A	++[b]	+++	+/0	+++	N/A
Burdorf and Sorock (1997)	N/A	N/A	N/A	++	N/A	–	+/0	+/0
Beeck and Hermans (2000)	N/A	N/A	N/A	+/0[a]	+/0	+++	+++	N/A
Hoogendoorn et al. (2000)	N/A	N/A	N/A	+/0[a]	+/0	+++	+++	N/A
Linton (2000)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	+++
Linton (2001)	++	N/A	N/A	+++[b]	+++	+++	+++	+++
NRC and IOM (2001)	N/A	N/A	N/A	++	+++	+++	+++	+++
Lotters et al. (2003)	N/A	N/A	N/A	–[b]	N/A	N/A	++	N/A
Hartvigsen et al. (2004)	N/A	N/A	N/A	N/A	N/A	+/0	N/A	+/0
Hauke et al. (2011)	N/A	N/A	N/A	–	++	++	++	–

Note. (+++) = strong evidence or pooled *OR* >2; (++) = moderate evidence or pooled *OR* between 1 and 2; (+/0) = insufficient evidence; (–) = evidence of no association or the 95% CI of the pooled *OR* including 1; N/A = not available.

[a] low decision authority. [b] low skill discretion.

Only a small number of papers examined the association between organisational factors and LBS, hence the association between organisational factors and LBS are less clear. A cross-sectional study found that full-time and night shift workers were more likely to report LBS than part-time and day shift workers, respectively (Lipscomb, Trinkoff, Geiger-Brown, & Brady, 2002). In contrast, Devereux et al. (2004) showed that hours worked per week or shift work did not increase the risk of LBS. Whilst two previous cross-sectional studies (Lipscomb, et al., 2002; Schneider, Schiltenwolf, Zoller, & Schmitt, 2005) showed that being a nonpermanent employee was a protective factor for LBS. A recent study among veterinarians in New Zealand showed that dissatisfaction with work organisation and organisational culture was associated with musculoskeletal symptoms (Scuffham, et al., 2010).

1.2.7 Risk factors for LBS consequences

Although quite a lot is known about the risk factors for LBS, less is known about the risk factors for the consequences of LBS. As for LBS, the risk factors for LBS consequences include individual, physical, psychosocial, and organisational. For individual factors, the association between gender and LBS consequences is inconsistent. Most studies reported that there was no difference in reduced activities due to LBS (Alcouffe, et al., 1999; Fernandes, et al., 2009; Leroux, et al., 2005; Madan, et al., 2008; Picavet, et al., 1999) and absenteeism (Aasa, et al., 2005; Alexopoulos, et al., 2006; Cunningham, et al., 2006; Ghaffari, et al., 2006; Ijzelenberg, et al., 2004; van den Heuvel, et al., 2004) between gender. In contrast, Aasa et al. (2005) reported that reduced activities due to LBS was more common among males than females, whereas Alcouffe et al. (1999) reported that females had a higher prevalence of absenteeism due to LBS.

The association between age and LBS consequences is also not consistent. Two cross-sectional studies (Ijzelenberg, et al., 2004; Madan, et al., 2008) and three prospective cohort studies (Burdorf & Jansen, 2006; Burdorf, et al., 1998; van den Heuvel, et al., 2004) failed to show the association between age and LBS consequences. In contrast, a cross-sectional study of 13,776 employees of Iranian car-manufacturing company showed that older workers (more than 51 years old) had a higher risk of absenteeism due to LBS than younger workers (less than 30 years old) (Ghaffari, et al., 2006). A similar finding also reported for Irish health service workers (Cunningham, et al., 2006) and Dutch farmers (Hartman, et al., 2005).

Smoking was reported to be associated with reduced activities (Palmer, et al., 2003) and absenteeism due to LBS (Hartman, et al., 2005; Tubach, et al., 2002). Morken et al. (2003) also reported that smoking increased the risk of both short- and long- term sickness absence due to musculoskeletal symptoms.

Manual material handling and awkward posture are reported to be associated with reduced activities and absenteeism due to LBS, but whole-body vibration was only associated with absenteeism due to LBS (Table 1.5 and Table 1.6). This is due to the fact that none of the studies examining reduced activities due to LBS included whole-body vibration in the potential predictors. For psychosocial factors, low social support was associated with both consequences. Eriksen, Bruusgaard, and Knardahl (2003) suggested that encouragement and supportive culture in the work unit were important organisational factors in reporting absenteeism.

Table 1.5 *Physical and psychosocial risk factors for reduced activities due to LBS*

Risk Factors	References
Physical factors	
• Manual material handling	(Aasa, et al., 2005; Simon, et al., 2008)
• Awkward posture	(Aasa, et al., 2005; Simon, et al., 2008)
Psychosocial factors	
• High psychological demand	(Aasa, et al., 2005; Simon, et al., 2008)
• Low decision latitude	(Aasa, et al., 2005; Simon, et al., 2008)
• Low social support	(Aasa, et al., 2005)
• High ERI score	(Simon, et al., 2008)
• Worry about work condition	(Aasa, et al., 2005)

Table 1.6 *Physical and psychosocial risk factors for absenteeism due to LBS*

Risk Factors	References
Physical Factors	
• Manual material handling	(Bergström, et al., 2007; Hooftman, et al., 2009; Hoogendoorn, et al., 2002)
• Awkward posture	(Hooftman, et al., 2009; Hoogendoorn, et al., 2002; Tubach, et al., 2002)
• Whole-body vibration	(Hartman, et al., 2005)
Psychosocial factors	
• Low job control	(Hemingway, et al., 1997)
• Low social support	(Hooftman, et al., 2009; Tubach, et al., 2002; van den Heuvel, et al., 2004)
• Job dissatisfaction	(Hooftman, et al., 2009; Hoogendoorn, et al., 2002; van den Heuvel, et al., 2004)

1.2.8 Interaction between risk factors for LBS

It is well known that the risk factors for LBS include physical and psychosocial exposures, but the interaction between these is not well understood. Davis and Heaney (2000) and Karsh (2006) proposed that apart from independently influencing LBS, physical and psychosocial factors may also interact. These models are supported by a model of causation by Rothman et al. (2008) that suggested that the interaction can exist when two or more risk factors are causally associated with an outcome. However, to the author's knowledge only 16 studies have investigated the interaction between physical and psychosocial risk factors at work and musculoskeletal symptoms (Brulin et al., 1998; Devereux, et al., 2004; Devereux, et al., 1999; Devereux, Vlachonikolis, & Buckle, 2002; Fernandes, et al., 2009; Fredriksson et al., 2000; Hollmann, Heuer, & Schmidt, 2001; Huang, et al., 2003; Johnston, Jull, Souvlis, & Jimmieson, 2010; Lapointe, et al., 2009; Linton, 1990; Ostergren et al., 2005; Thorbjörnsson, et al., 2000; Tornqvist et al., 2001; Vandergrift, et al., 2012; Wahlstedt, Bjorksten, & Edling, 2001). Of this group, eight studies (Devereux, et al., 2004; Devereux, et al., 1999; Fernandes, et al., 2009; Huang, et al., 2003; Lapointe, et al., 2009; Linton, 1990; Thorbjörnsson, et al., 2000; Vandergrift, et al., 2012) investigated the combination/interaction between work-related physical and psychosocial factors and LBS. The interaction between risk factors at work and during leisure time for LBS was examined by Thorbjörnsson et al. (1998). Table 1.7 presents the summary of studies that investigated combination or interaction between work-related risk factors in the occurrence of LBS.

Table 1.7 *The summary findings of the studies that examined the combination/interaction between work-related risk factors in the occurrence of LBS*

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
Linton (1990)	Cross-sectional Mixed working population in Sweden (*N* = 22,180)	Physical factors (used Work Environment and Habits of Living Questionnaire): • Heavy lifting • Monotonous or assembly-line work • Sitting • Uncomfortable work postures Psychosocial factors (used Work Environment and Habits of Living Questionnaire): • Work content • Work load • Social support at work Outcome: LBS during the last 12 months.	*OR* [95% CI] of 12-month LBS • Monotonous work + psychosocial environment 2.58 [1.94, 3.43] • Lifting + psychosocial environment 2.42 [1.78, 3.30] • Posture + psychosocial environment 3.36 [2.56, 4.40]	No specific information about adjusting potential confounders.
Devereux et al. (1999)	Cross-sectional Mixed working population in UK (*N* = 869)	Physical factors (used self-reported questionnaire): • Lifting • Sitting – Exposed to vibration – Working at a keyboard Psychosocial factors (used self-	*OR* [95% CI] of 12-month LBS Physical and psychosocial • Low/low 1.00 • Low/high 1.35 [0.61, 2.97] • High/low 2.38 [1.13, 4.99] • High/high 2.99 [1.43, 6.24] Attributable proportion 0.15	Adjusted for age, gender, and cumulative exposure (years spent in the present job)

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		reported questionnaire): • Mental demands • Job control • Social support Outcome (used self-reported questionnaire): Any LBS more than 3 times or for more than 1 week in the last 12 months, not experienced before starting the present job, which were also present within the past 7 days		
Thorbjörnsson et al. (2000)	Nested case-control General working population in Stockholm region, Sweden (*N* = 484)	Physical factors (used self-reported questionnaire): • Heavy physical workload – Bent or twisted body postures – Hands below knee level – Lifting/carrying loads between 5 and 15 kg – Lifting/carrying loads exceeding 15 kg • Sedentary work • Whole-body vibration • High perceived work load Psychosocial factors (interview) • Social relations – Dependence of colleagues	*OR* [95% CI] of LBS Work-related factors among women: • Heavy physical workload and time pressure 3.3 [0.8, 13.9] Attributable proportion 0.7 [0.2, 1.2] • High perceived load and low influence over work conditions 1.6 [0.8, 3.1] Attributable proportion 0.4 [-0.2, 1.0] • High perceived load and shift work 1.7 [0.8,4.0] Attributable proportion 0.6 [0.0, 1.2] • Whole-body vibration and low influence over work conditions 2.2 [1.0, 13.9] Attributable proportion 0.4 [-0.2, 1.2]	Adjusted for age

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		– Social support from colleagues and the closest superior – Social interaction with colleagues after work • Influence over work conditions – Demands for new knowledge – Possibilities for influencing working conditions – Influence over the work pace • Few possibilities of development • Time pressure • Social disturbances Organisational factors (used self-reported questionnaire): • Overtime work • Shift work Other work factor: • Risk of accidents Factors during leisure time: • Perceived load outside work • Physical exercise during leisure time Individual factors • Age • Smoking more than ten years	• Shift work and overtime work 3.5 [1.0, 11.6] Attributable proportion 0.9 [0.8, 1.2] Work-related factors among men: • Heavy physical workload and few development opportunities 2.4 [0.9, 6.4] Attributable proportion 0.6 [0.4, 1.1] • Sedentary work and poor social relations 3.1 [1.1, 8.7] Attributable proportion 0.7 [0.4, 1.1] • High perceived load and poor social relations 2.2 [1.1, 4.6] Attributable proportion 0.6 [0.1, 1.0] • High perceived load and overtime work 2.2 [0.9,5.5] Attributable proportion 0.5 [0.0, 1.0] • Poor social relations and overtime work 3.1 [1.4, 7.1] Attributable proportion 0.4 [-0.1, 1.0] • Technical disturbance and high physical workload 1.8 [0.8, 4.2] Attributable proportion 0.5 [-0.1, 1.0] Work- and non-work related factors among women: • Sedentary work and smoking 2.1 [0.9, 4.6]	

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		Outcome (used self-reported questionnaire): • LBS that required medical consultation and treatment (by physician, physiotherapist, or chiropractor), or • Sick leave for more than 7 consecutive days because of LBS, or • LBS reported during the last 12 months	Attributable proportion 0.5 [0.1, 1.0] • High perceived load and lack of physical exercise 1.9 [0.9, 4.0] Attributable proportion 0.7 [0.2, 1.1] • Poor psychosocial work characteristics and lack of physical exercise 2.2 [1.0, 4.6] Attributable proportion 0.6 [0.1, 1.0] • Shift work characteristics and lack of physical exercise 2.4 [1.0, 5.4] Attributable proportion 0.8 [0.4, 1.1] Work- and non-work related factors among men: • Poor social relations and high perceived load outside work 4.8 [2.0, 11.15] Attributable proportion 0.7 [0.3, 1.0] • Poor social relations and smoking 1.6 [0.8, 3.2] Attributable proportion 0.4 [0.2, 1.1]	
Huang et al. (2003)	Cross sectional Active US Marines ($N = 289$)	Physical factors (used self-reported questionnaire): • Movements • Postures • Loads • Environmental factors	*OR* [95% CI] of 12-month LBS Biomechanical and cognitive demands • Low/low 1.00 • High/low 1.31 [0.69, 2.49] • Low/high 0.79 [0.40, 1.57] • High/high 1.54 [0.81, 2.96] Attributable proportion 0.28	Adjusted for age, gender, education level, health behaviour, perceived exertion at work, life-interfering worries, and family conflict.

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		Work organisational factors (used self-reported NIOSH questionnaire): • Cognitive demands • Cognitive processing • Interpersonal demands • Participatory management • Skill discretion • Time pressure Outcome (used NIOSH questionnaire): The presence of any LBS and associated limited duty during the last 12 months	Biomechanical and cognitive processing • Low/low 1.00 • High/low 1.53 [0.80, 2.90] • Low/high 0.39 [0.19, 0.84] • High/high 1.59 [0.81, 3.12] Attributable proportion 0.42 Biomechanical and interpersonal demands • Low/low 1.00 • High/low 1.53 [0.83, 2.83] • Low/high 0.65 [0.35, 1.19] • High/high 1.33 [0.69, 2.57] Attributable proportion 0.11 Biomechanical and participatory management • Low/low 1.00 • High/high 0.90 [0.47, 1.75] • Low/low 0.67 [0.34, 1.32] • High/low 2.34 [1.19, 4.63] Attributable proportion 0.75 Biomechanical and skill discretion • Low/low 1.00 • High/low 1.41 [0.73, 2.70] • Low/high 0.91 [0.50, 1.64]	

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
			• High/high 1.54 [0.82, 2.92] Attributable proportion 0.14 Biomechanical and time pressure • Low/low 1.00 • High/low 0.63 [0.29, 1.35] • Low/high 1.00 [0.48, 2.09] • High/high 2.61 [1.39, 4.91] Attributable proportion 0.76	
Devereux et al. (2004)	Cohort 15 months Mixed working population in UK • Baseline (*N* = 3,139) • Follow up (*N* = 1,182)	Physical factors (used self-reported questionnaire): • Lifting • Back posture • Pushing and pulling objects • Standing • Vibration Psychosocial factors (used self-reported questionnaire): • Job demands • Decision latitude • Social support • Extrinsic effort • Intrinsic effort • Reward • Role ambiguity • Role conflict	*OR* [95% CI] of 12-month LBS Physical and psychosocial • Low/low 1.00 • Low/high 1.18 [0.75, 1.88] • High/low 1.54 [0.57, 4.16] • High/high 2.83 [1.30, 6.18] Attributable proportion 0.24, 95% CI [-0.07, 0.54]	Adjusted for age, gender, perceived work stress, and psychosomatic symptoms

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		• Job future ambiguity • Verbal abuse • Threat of harm/injury Organisational factors (used self-reported questionnaire): • Hours worked • Type of hours • Travel time to work • Shift work Outcome (used self-reported questionnaire): Any LBS more than 3 times or for more than 1 week in the last 12 months		
Fernandes et al. (2009)	Cross sectional Plastic industry workers in Brazil (*N* = 577)	Physical factors (used self-reported questionnaire by interview): • Manual handling • Repetitiveness Psychosocial factors (used Job Content Questionnaire by Karasek by interview): • Decision latitude • Psychological demand • Social support	*PR* [95% CI] of 12-month LBS Material handling/psychosocial exposure • Low/low 1.00 • Low/high 1.87 [1.87, 3.46] • High/low 2.16 [1.19, 3.91] • High/high 3.41 [2.02, 5.75] Attributable proportion 0.11	Adjusted for physical demands, psychosocial demands, job dissatisfaction, years of work, work overtime, age, gender, education, marital status, having children younger than 2 years old, domestic work, body fitness, obesity, smoking, and alcohol consumption

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		Outcome (used NMQ): The presence of LBS in the last 12 months and lasted at least one week or occurred at least once a month and was not caused by an acute injury, and meet one of following condition: • Current symptom severity rating of 3 or greater (on 0-5 scale) • Sought medical care • Missing work (official or unofficial) • Light or restricted work (official or unofficial) • Change job due to these problem		
Lapointe et al. (2009)	Cohort 3 years White-collar workers in Quebec • Base line (*N* = 2,431) • Follow up (*N* = 1,294)	Physical factors (used self-administered questionnaire based on Health Canada ergonomic guidelines): • Static-seated posture • Possibility to take regular breaks • Neck alignment • Neck rotation • Angle of forearms • The use of armrest Psychosocial factors (used self-administered Job Content Questionnaire by Karasek's):	*OR* [95% CI] of 6-month incidence LBS Postural and job strain among males: • Low/low 1.00 • Low/high 0.36 [0.07, 1.70] • High/ low 0.97 [0.47, 2.02] • High/high 1.66 [0.61, 4.55] Attributable proportion 0.8 [0.23, 1.37] Postural and job strain among females: • Low/low 1.00 • Low/high 2.53 [1.09, 5.85] • High/low 2.51 [1.23, 5.09] • High/high 5.51 [2.33, 13.03]	Adjusted for age and stressful life events at baseline and follow up, number of children, education level, and MSS to other body regions at baseline.

Authors	Study Design and Population	Exposures and Outcome	Findings	Notes
		• Psychological demand • Decision latitude Outcome (used NMQ): The presence of LBS during the last 6 months	Attributable proportion 0.27 [-0.34, 0.88]	
Vandergrift et al. (2012)	Cohort 1 year Automobile manufacturing workers in Michigan • Base line (*N* = 1,181) • Follow up (*N* = 505)	Physical factors (used The Borg CR-10 scale by interview): • Awkward back postures • Whole-body vibration • Physical effort • Hand forces relating to handling tools or materials • Work pace Psychosocial factors (used Job Content Questionnaire by Karasek by interview): • Psychological demand • Job control Outcome (by interview): The presence of any LBS more than 3 times or lasting more than 1 week during the last 12 months	Relative risks [95% CI] of incidence LBS for increasing psychological demands Physical and job control • Low/medium to high 1.13 [0.92, 1.40] • Low/low 0.98 [0.83, 1.18] • High/medium to high 0.72 [0.52, 1.00] • High/low 1.30 [1.02, 1.66]	Adjusted for physical and psychosocial factors, but no confounding effects were observed.

Note. CI = confidence interval; *OR* = odds ratio; *PR* = prevalence ratio.

Most studies in Table 1.7 show consistent findings, i.e. those who were highly exposed to both physical and high psychosocial factors had the highest risk of LBS. However, the effect of modification between physical and psychosocial factors is inconsistent. Devereux et al. (1999), Devereux et al. (2004), and Fernandes et al. (2009) suggested that a high physical exposure was necessary to increase the risk of LBS whereas among male workers (Lapointe, et al., 2009) and a US Marine population (Huang, et al., 2003) exposure to physical or psychosocial factors alone was insufficient to increase the risk of LBS. Similarly, Vandergrift et al. (2012) suggested job control only played a role among those in high physical exposures, whereas among those with low physical exposure, job control was not associated with the LBS. Hollmann, Heuer, and Schmidt (2001) who examined the effect of demands, control, physical work load and MSS (not specific to LBS) among 431 staff members of a German nursing home also showed that there is an interaction between physical and psychosocial and MSS. They found that job demands had a higher effect on MSS reported if the physical workload was high than when the physical workload was low. Lapointe et al. (2009) also reported that the risk of LBS among females who were exposed to low physical and high psychosocial (*OR* 2.53, 95% CI [1.09, 5.85]) and high physical and low psychosocial (*OR* 2.51, 95% CI [1.23, 5.09]) was similar. The highest risk was found when females were highly exposed to both physical and psychosocial factors (*OR* 5.51, 95% CI [2.33, 13.03]). The different findings between studies may be partly due to differences in population studied, variable(s) studied and tools used. Also, different methods to determine the criteria of low/high physical and psychosocial exposures as well as variable(s) that were included as potential confounders may have influenced the findings. Since workers are often simultaneously exposed to both physical and psychosocial factors in the workplace, this is an issue that may warrant further investigation.

Interaction between physical and psychosocial factors suggested that the joint exposure effect was greater than the sum of the magnitude of the individual effects (as indicated by a departure from an additive model). This interaction was assessed by computing the attributable proportion (AP) (and its 95% CI) with the following formula: $[(OR_{11} – OR_{10} – OR_{01} + 1)/OR_{11}]$ (Andersson, Alfredsson, Kallberg, Zdravkovic, & Ahlbom, 2005; Hallqvist, Ahlbom, Diderichsen, & Reuterwall, 1996), where OR_{11} represents the *OR* for high physical and high psychosocial exposure, OR_{10} represents the *OR* for high physical and low psychosocial exposure, OR_{01} represents the *OR* for low physical and high psychosocial exposure. A significant positive value for AP (and its 95% CI) indicates the presence of interaction between physical and psychosocial factors, whereas null or negative AP value indicates the absence of interaction. Among eight studies in the Table 1.7, only four studies calculated the AP values (Devereux, et al., 2004; Devereux, et al., 1999; Lapointe, et al., 2009; Thorbjörnsson, et al., 2000). However it was possible to compute the AP values using the results for Huang et al.'s (2003) and Fernandes et al.'s (2009) studies. Whereas Linton (1990) and Vandergrift et al. (2012) did not provide details information about risk ratio for each exposure group, so the AP values could not be obtained. Most of the AP values from six studies (Devereux, et al., 2004; Devereux, et al., 1999; Fernandes, et al., 2009; Huang, et al., 2003; Lapointe, et al., 2009; Thorbjörnsson, et al., 2000) showed positive values which indicated the presence of interaction (or potential interaction) between physical and psychosocial work factors. Thorbjörnsson et al. (2000; 1998) showed that the interaction between risk factors at work and during leisure time were also present.

To the author's knowledge, no previous studies have examined the interaction between physical and psychosocial factors at work for reduced activities and absenteeism due to LBS. However, previous studies that examined this interaction for general absenteeism (not specifically absenteeism due to LBS) reported that combined exposure to physical and psychosocial work risk factors increased the risk of absenteeism (Vahtera, et al., 2000; Vingard, et al., 2000; Voss, et al., 2001). A synergistic effect between working instead of taking sick leave and anxiety about reorganisation for absenteeism was found among males (*OR* 3.65, 95% CI [2.40, 5.56]) (Voss, et al., 2001). Joint effects of high physical demands and low social (supervisor and coworker) support on absenteeism (rate ratio 1.80 and 1.90) were observed among full-time workers in Finland (Vahtera, et al., 2000).

1.2.9 Summary of gaps in knowledge

The gaps in knowledge can be summarised as follows:

- The prevalence of LBS in developed and IDCs is high, and there have been only a few studies in New Zealand and IDCs.
- Although it is widely accepted that the risk factors for LBS include physical and psychosocial exposures, there have been few studies in New Zealand and IDCs, and the interaction between these is not well understood.
- Even less is known about prevalence and risk factors for the consequences of LBS (reduced activities and absenteeism).
- Although study bias due to a healthy worker effect is likely to occur in cross-sectional studies, few studies have taken this bias into account in their analyses.

1.3 Research aims

In order to address the gaps above, this thesis aims to examine the prevalence, risk factors, and the interaction between physical and psychosocial work risk factors for LBS and its consequences. More specifically it aims to do this using study population based in an industrially developed country (New Zealand) and an industrially developing country (Indonesia). The Indonesian study includes consideration of bias due to the healthy worker effect.

1.4 New Zealand study and Indonesian coal mining study

To achieve the aims, two cross-sectional studies were conducted in: A) a large random sample of workers in New Zealand, and; B) Indonesian coal mining workers.

The New Zealand study was part of a large national survey among the general working population in New Zealand (Eng et al., 2010). Information about occupational exposures, workplace practices and occupational ill-health (i.e. respiratory symptoms, sleep patterns, and MSS-including LBS) were collected during 2004 to 2006 using telephone interviews, independent of candidate. The LBS data were analysed by the author in the present thesis during 2008 to 2011. It examined the prevalence and risk factors for LBS and its consequences. These are described in Chapters 2, 3, and 4. The relative contribution of the author for this study can be seen in Appendix A6, Appendix A7, and Appendix A8.

The Indonesian coal mining study specifically investigated the prevalence of LBS and its consequences and risk factors, as well as interactions between physical and psychosocial risk factors. It also afforded an opportunity to examine selection bias due to the healthy worker effect. This study was designed and conducted (including acquisition of data) by the author during 2008 to 2010. Data were analysed by the author during 2010 to 2012. These analyses are described in Chapter 5 and 6. The relative contribution of the author for this study can be seen in Appendix B12 and Appendix B13.

The study was conducted in the Indonesian coal mining industry because it is necessary to have a large sample of workers that are simultaneously exposed to high physical and high psychosocial exposure in order to investigate the interactions between risk factors and LBS and its consequences. The coal mining industry fulfils this requirement. It involves many tasks that require high physical and psychosocial demands (Gallagher, 2008). Not surprisingly, LBS is prevalent among coal miners (Lloyd, et al., 1986; Sarikaya, et al., 2007) and is a common cause of absenteeism (Afacan, 1982). Also, miners engaged in heavy manual work are reported to have high levels of sickness absence (32%) (Lloyd, et al., 1986). Additionally, Indonesia is one of the largest coal mining production countries in the world (Energy Information Administration, 2011), and has more than one million workers in the coal mining sector (Statistics Indonesia, 2009).

Indonesia is the author's home country and access to a large coal mining organisation in Indonesia was assured due to her prior work in this industry. Her previous study (Widanarko, Susilowati, Syaaf, & Rohadi, 2008) used the NMQ (Kuorinka, et al., 1987), and indicated that the 12-month period prevalence of LBS was high (71%) amongst mechanics and heavy vehicle operators working in the coal mining industry.

Of that, 33% a positive result for physical examination (i.e. straight leg test, or Lasegue test, or Patrick lower extremity test, or contra Patrick lower extremity test). However, the study did not examine the predictors for LBS. Hence, the present study described in the present thesis is a logical continuation of earlier work.

Some aspects of the New Zealand study and the Indonesian coal mining study are similar and some are quite different (Table 1.8). Both studies examined the prevalence and risk factors of LBS and its consequences in working populations. However, the New Zealand study was part of a large national survey; hence the nature of the questions about LBS was limited. The New Zealand study did not include questions about when the first episode of LBS occurred or LBS duration. In addition, since the New Zealand study involved a large sample size and did not specifically focus on LBS, the validity and reliability of the physical and psychosocial questionnaire were not assessed because it was time consuming and costly. In contrast, the Indonesian coal mining study did address these limitations. It also afforded an opportunity to examine the association between risk factor (occupational group) with LBS, adjusting for selection bias due to the healthy worker effect. More importantly, it specifically examined the interaction between physical and psychosocial risk factors for LBS and its consequences.

Another difference was that workers in the New Zealand study were from various industries whereas workers in the Indonesian coal mining study were all employed by a single coal mining company. Therefore, workers in the Indonesian coal mining study were exposed to relatively similar socioeconomic conditions, work environments, and organisational factors, and experienced a similar selection process, whereas workers in the New Zealand study were not. Thus, considering some different aspects between the New Zealand and Indonesian coal mining study, this thesis does not attempt to make direct comparison between the findings of the New Zealand study and the Indonesian coal mining study.

Table 1.8 *Characteristics of the New Zealand study and the Indonesian coal mining study*

Characteristics	New Zealand Study	Indonesian Coal Mining Study
Study design	Cross-sectional	Cross-sectional
Aims	• To examine the prevalence and risk factors for LBS and its consequences	• To examine the prevalence and risk factors for LBS and its consequences • To examine the association between risk factors (i.e. occupational group) with LBS, adjusting for a healthy worker effect • To examine the interaction between physical and psychosocial risk factors for LBS and its consequences
Study sample	Workers involved in various occupational groups from various industries (*N* = 3,003): • Legislators and administrators • Professionals • Technicians and associate professionals • Clerks • Service and sales workers • Trade workers • Plant and machine operators and assemblers • Elementary workers	Workers involved in various occupational groups in an Indonesian coal mining company (*N* = 1,294): • General office staffs • Group leaders • Managerial • Driver bus/truck/light vehicle • Mechanics • Operators dump truck and heavy vehicle • Others
Methods	Telephone interview using NMQ	Self-administered using NMQ
	The validity and reliability of the physical and psychosocial questionnaire were not assessed in the study population	The validity and reliability of the physical and psychosocial questionnaire were assessed in a small sample of the study population
Risk factors	Individual factors: • Gender • Age	Individual factors: • Gender • Age • Duration of work • Education • Smoking status
	Physical factors: • Awkward or tiring positions • Awkward grip or hand movements • Lifting • Carrying out repetitive task • Working at high speed	Physical factors: • Awkward back positions • Lifting • Sitting • Squatting • Whole-body vibration • Using tools that vibrate

Characteristics	New Zealand Study	Indonesian Coal Mining Study
	• Standing • Sitting • Using tools that vibrate	
	Psychosocial factors: • Contact and cooperation with management • Level and difficulty of work • Work stress • Working to tight deadlines • Boring work	Psychosocial factors: • Effort • Reward • Over commitment • Decision latitude • Psychological demand • Social support • Job satisfaction • Work stress
	Organisational factors: • Work organisation • Organisational culture	Organisational factors: • Current employment status • Shift work
	Environmental factors: • Working in a cold or damp environment • Working in a hot or warm environment • Working outside • Exposure to loud noise	Environmental factors: None
Outcome of interest	• Any LBS during the last 12 months • Reduced activities due to LBS during the last 12 months • Absenteeism due to LBS during the last 12 months	• Any LBS with symptoms more than 7 days during the last 12 months and onset during their current job and also present within the last 7 days • Reduced activities due to LBS during the last 12 months • Absenteeism due to LBS during the last 12 months

In view of the explanations above, it is clear that there is the sequential progressing from the New Zealand study to the Indonesian coal mining study (Figure 1.12). The New Zealand study only examined the prevalence and risk factors for LBS and its consequences whereas the Indonesian coal mining did the same but also studied the association between risk factor (occupational group) with LBS, adjusting for selection bias due to a healthy worker effect. Furthermore, it examined the interaction between physical and psychosocial risk factors for LBS and its consequences.

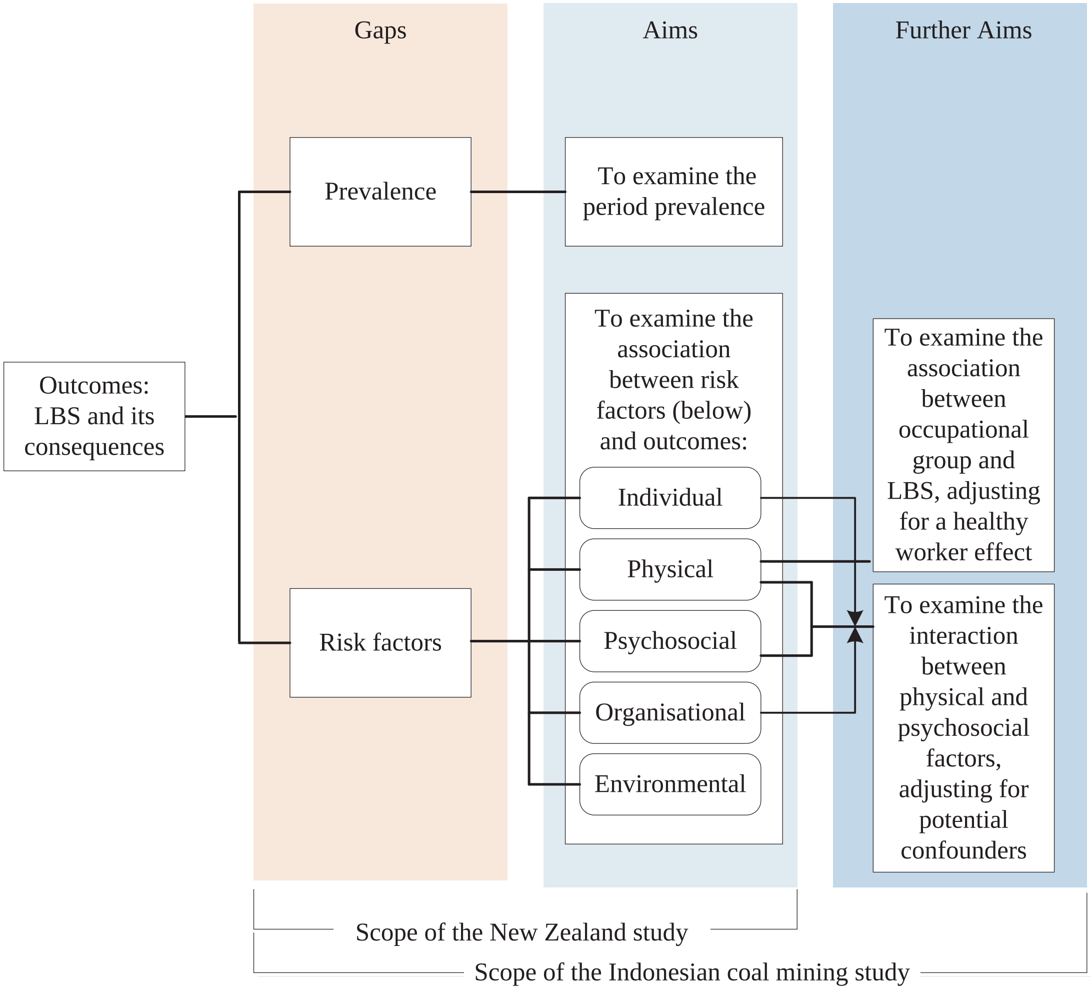

Figure 1.12 Diagram of research aims and scope of the New Zealand study and the Indonesian coal mining study

1.5 Structure of the thesis

The structure of this thesis is based on the gaps and aims that have been identified in sections 1.2.9 and 1.3. A summary of the gaps, general aims, and their relation to the thesis chapter(s) are shown in Table 1.9. The specific aims are described in each chapter (Chapters 2 to 6).

1. Prevalence

   Relatively little is known of the prevalence of LBS amongst the working population in New Zealand and IDCs (Gap 1.1). Thus, the aim is to estimate the prevalence of LBS among the New Zealand working population (Chapter 2) and the Indonesian coal mining workers population (Chapter 5). Less is known about the prevalence for LBS consequences amongst the working population in New Zealand and IDCs (Gap 1.2). Thus, the aim is to estimate the prevalence of LBS consequences (reduced activities and absenteeism) among the New Zealand (Chapter 4) and Indonesian coal mining workers populations (Chapter 5).

2. Risk factors

   There is less information about LBS risk factors amongst the working population in New Zealand and IDCs (Gap 2.1). Thus, the aim is to examine the LBS risk factors amongst the New Zealand working population (Chapter 3) and Indonesian coal mining workers population (Chapter 5 and 6). Although a healthy worker effect is likely to occur in cross-sectional studies, only few studies have taken this bias into account (Gap 2.2). Thus, the aim is to examine the LBS risk factor (occupational group) after adjusting for a healthy worker effect and other potential confounders among the Indonesian coal mining workers population (Chapter 5). Even less is known about LBS consequences risk factors (Gap 2.3). Thus, the aim is to examine LBS consequences risk factors among the New Zealand working population (Chapter 4) and Indonesian coal mining workers population (Chapter 5 and 6). Although it is known that the risk factors for LBS include physical and psychosocial exposures, the interaction between these is not well understood (Gap 2.4). Thus, the aim is to examine risk factors and their potential the interaction for LBS and its consequences among the Indonesian coal mining workers population (Chapter 6).

Table1.9 *Gaps, general aims, and chapter(s)*

Gaps			General aims	Addressed in
1.	Prevalence	1.1. Relatively little is known of the prevalence of LBS amongst the working population in New Zealand and IDCs	To examine the prevalence of LBS among the New Zealand working population and the Indonesian coal mining workers population	• New Zealand study (Chapter 2) • Indonesian coal mining study (Chapter 5)
		1.2. Less is known about the prevalence for LBS consequences (reduced activities and absenteeism) amongst the working population in New Zealand and IDCs	To examine the prevalence of LBS consequences (reduced activities and absenteeism) among the New Zealand and the Indonesian coal mining workers populations	• New Zealand study (Chapter 4) • Indonesian coal mining study (Chapter 5)
2.	Risk factors	2.1. Less is known about LBS risk factors amongst the working population in New Zealand and IDCs	To examine the LBS risk factors amongst the New Zealand working population and the Indonesian coal mining workers population	• New Zealand study (Chapter 3) • Indonesian coal mining study (Chapter 6)
		2.2. Only few studies examine the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential confounding factors	To examine the LBS risk factor (occupational group) after adjusting for a healthy worker effect and other potential confounding factors among the Indonesian coal mining workers population	Indonesian coal mining study (Chapter 5)
		2.2. Even less is known about LBS consequences risk factors	To examine LBS consequences risk factors among the New Zealand working population and the Indonesian coal mining workers population	• New Zealand study (Chapter 4) • Indonesian coal mining study (Chapter 5 and 6)
		2.3. The interaction between physical and psychosocial factors for LBS and its consequences is not well understood	To examine the interaction between physical and psychosocial factors for LBS and its consequences among the Indonesian coal mining workers population	Indonesian coal mining study (Chapter 6)

Thus, the structure of the thesis is as follows:

This thesis begins with an Introduction (Chapter 1) and is followed by Section A and B that consist of five chapters. Section A, comprises Chapter 2 to 4 that address the prevalence and risk factors of LBS and its consequences based on data from the New Zealand study. Section B comprises Chapter 5 and 6 that address the prevalence, risk factors and interaction between physical and psychosocial work risk factors of LBS and its consquences based on data from the Indonesian coal mining study. It was also possible to examine the possibility of bias due to a healthy worker effect. The thesis ends with a General Discussion (Chapter 7) and Conclusions (Chapter 8), followed by References and Appendices.

A more detail of summary of the structure of the thesis is described below:

Introduction : Chapter 1 Background, review of literature, and aims

This chapter describes the background and review of the literature of the thesis. It also summarises the gap in knowledge, describes the aims and structure of the thesis.

Section A : Prevalence and work-related risk factors for LBS and its consequences among New Zealand workers

This section examines the prevalence and work-related risk factors for LBS and its consequences amongst New Zealand working population. It has three chapters (Chapter 2, 3 and 4) that address the gap in knowledge about lack of information about the prevalence of (Gap 1.1 and 1.2) and risk factors for (Gap 2.1 and 2.3) LBS and its consequences in New Zealand.

Chapter 2 : Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group

This chapter examines the prevalence of MSS (including LBS) among New Zealand workers to address Gap 1.1. It also examines the differences in LBS prevalence in relation to gender, age, and occupational/industrial group to address Gap 2.1. It has been published as Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., ‘t Mannetje, A., Cheng, S., Douwes, J., Ellison-Loschmann, L., McLean, D., and Pearce, N. (2011). Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. *International Journal of Industrial Ergonomics, 41*(5), 561-572. The gaps and aims for this chapter are:

Gaps	Aims
Relatively little is known of the prevalence of MSS (including LBS) amongst the working population in New Zealand	To examine the prevalence of MSS (including LBS) among the New Zealand working population
Less is known about LBS risk factors amongst the working population in New Zealand	To examine the differences in LBS prevalence in relation to age group, gender, and occupational group

Chapter 3 : Gender differences in work-related risk factors associated with low back symptoms

This chapter examines the LBS risk factors to address Gap 2.1. It presents the risk factors for LBS for specific populations, i.e. the whole, male, and female population. It has been published as Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., ‘t Mannetje, A., Cheng, S., and Pearce, N. (2012). Gender differences in work-related risk factors associated with low back symptoms. *Ergonomics 55(3),* 327-342. The gap and aims for this chapter are:

Gap	Aim
Less is known about LBS risk factors among the New Zealand working population	To examine the association between physical, psychosocial, organisational, environmental risk factors and LBS for specific population: the whole, male, and female population

Chapter 4 : Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms

This chapter examines the prevalence of LBS consequences (reduced activities and absenteeism) to address Gap 1.2, and the risk factors for LBS consequences to address Gap 2.3. It has been published as Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., 't Mannetje, A., Cheng, S., and Pearce, N. (2012). Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms. *Applied Ergonomics*, *43*(4), 727-737. The gaps and aims for this chapter are:

Gaps	Aims
Less is known about the prevalence for LBS consequences	To examine the prevalence of reduced activities due to LBS To examine the prevalence of absenteeism due to LBS
Less is known about risk factors of LBS consequences	To examine the differences in reduced activities due to LBS prevalence in relation to age group, gender, and occupational group To examine the association between physical, psychosocial, organisational, environmental risk factors and reduced activities due to LBS To examine the differences in absenteeism due to LBS prevalence in relation to age group, gender, and occupational group To examine the association between physical, psychosocial, organisational, environmental risk factors and absenteeism due to LBS

Section B : Prevalence, work-related risk factors, and interaction between physical and psychosocial risk factors for LBS and its consequences among Indonesian coal mining workers

This section consists of two chapters (Chapter 5 and 6) that address the prevalence of (Gap 1.1 and 1.2) and risk factors for (Gap 2.1 and 2.3) LBS and its consequences among the Indonesian coal mining workers. It also afforded an opportunity to examine the risk factor (occupational group) for LBS, adjusting for a healthy worker effect (Gap 2.2). More importantly, it examines the interaction between physical and psychosocial exposure for LBS and its consequences to address Gap 2.4.

Chapter 5 : Prevalence of low back symptoms and its consequences in relation to occupational group

This chapter examines the prevalence of LBS and its consequences among Indonesian coal mining workers to address Gap 1.1 and 1.2. It also examines the association between risk factor (occupational group) and LBS, adjusted for a healthy worker effect and other potential confounders, to address Gap 2.2 and the association between the presence of LBS and LBS consequences to address Gap 2.3. Chapter 5 has been published as Widanarko, B., Legg, S., Stevenson, M., Devereux, J., and

Jones, G. (2012). Prevalence of low back symptoms and its consequences in relation to physical workload and smoking. *American Journal of Industrial Medicine.* doi: 10.1002/ajim.22116. The gaps and aims for this chapter are:

Gaps	Aims
Little is known of the prevalence of LBS in IDCs	To estimate the prevalence of LBS among the Indonesian coal mining workers
Less is known of the prevalence of LBS consequences in IDCs	To estimate the prevalence of reduced activities due to LBS
	To estimate the prevalence of absenteeism due to LBS
Only few cross-sectional studies took into account a healthy worker effect when examine the association between risk factor (occupational group) and LBS	To examine the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential confounders
Less is known about risk factors of LBS consequences	To examine the association between LBS and reduced activities due to LBS
	To examine the association between LBS and absenteeism due to LBS

Chapter 6 : Interaction between physical and psychosocial work risk factors for low back symptoms and its consequences amongst Indonesian coal mining workers

This chapter examine risk factors and their potential the interaction for LBS and its consequences to address Gap 2.1, 2.3 and 2.4. It has been submitted as Widanarko, B., Legg, S., Devereux, J., and Stevenson, M. (2012). Interaction between physical and psychosocial work risk factors for low back symptoms and its consequences amongst Indonesian coal mining workers. *Manuscript submitted for publication*. The gaps and aims for this chapter are:

Gaps	Aims
Less is known about LBS risk factors amongst the working population in IDCs	To examine the association between risk factors and LBS
Less is known about LBS consequences risk factors	To examine the association between risk factors and reduced activities due to LBS
	To examine the association between risk factors and absenteeism due to LBS
The interaction between physical and psychosocial exposure for LBS is not well understood	To examine the interaction between physical and psychosocial factors for LBS, adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment

	status, and shift work)
The interaction between physical and psychosocial exposure for LBS consequences is not well understood	To examine the interaction between physical and psychosocial factors for reduced activities due to LBS, adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status, and shift work)
	To examine the interaction between physical and psychosocial factors for absenteeism due to LBS, adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status, and shift work)

Each paper in chapters 2 to 6 is an independent manuscript containing Introduction, Methods, Results, Discussion and Conclusions. They are reproduced verbatim as each chapter with minor adjustments to follow the style of the thesis, i.e. APA 6th ed. (APA, 2010). Because of this, there is some replication between Chapter 1 and the Introductions in the chapters. Preface is provided in the beginning of each of the chapters (Chapter 2 to 6) in Section A and B so that the linkage between each chapter with the thesis and/or the previous chapter is more clearly described. Each chapter is also followed by a post-script that provides further linkage between chapters. The post-scripts also provide details of additional analyses that the author considers to be necessary to fulfil the requirement of a doctoral thesis. All papers have been published as papers in or submitted to scientific journals.

General Discussion: Chapter 7 General discussion

This chapter describes the general discussion and direction for future work.

Conclusions: Chapter 8 Conclusions

This chapter describes the conclusions of the thesis.

SECTION A

Prevalence and work-related risk factors for LBS and its consequences among New Zealand workers

This section presents the prevalence and work-related risk factors for LBS and its consequences amongst the New Zealand working population. It has three chapters (Chapter 2, 3 and 4) that address the gap in knowledge about lack of information about the prevalence of (Gap 1.1 and 1.2) and risk factors for (Gap 2.1 and 2.3) LBS and its consequences in New Zealand. The titles of the three chapters in this section are as follows:

Chapter 2	Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group
Chapter 3	Gender differences in work-related risk factors associated with low back symptoms
Chapter 4	Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms

Each chapter is the verbatim copy of each paper, as it appeared in print in the respective journal.

Chapter 2 Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., 't Mannetje, A., Cheng, S., Douwes, J., Ellison-Loschmann, L., McLean, D., and Pearce, N. (2011). Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. *International Journal of Industrial Ergonomics, 41*(5), 561-572.

Preface

The estimates of the prevalence of MSS are available for a number of occupational groups in numerous countries, but relatively little is known of the prevalence (Gap 1.1) and risk factors for (Gap 2.1) LBS amongst the working population in New Zealand. Thus, the aims of this chapter are to examine the prevalence of MSS (including LBS) and the differences in LBS prevalence in relation to gender, age, and occupational/industrial group among the New Zealand workers. The gaps, aims, and hypotheses for this chapter are:

Gaps	Aims	Hypotheses
1.1. Relatively little is known of the prevalence of MSS (including LBS) amongst the working population in New Zealand	To examine the prevalence of MSS (including LBS) among the New Zealand working population	Since this aim is not testable (no variable tested), there is no hypothesis for this aim
2.1. Less is known about LBS risk factors amongst the working population in New Zealand	To examine the differences in LBS prevalence in relation to age group, gender, and occupational group	• The LBS prevalence for those in the older group will be higher than in the younger group • The LBS prevalence for males will be higher than females • The LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload

Abstract

Although musculoskeletal symptoms (MSS) are common worldwide, little is known about its prevalence amongst the working population in relation to gender, age, and occupational/industrial group. This paper describes the prevalence of MSS in a sample of 3,003 men and women aged 20-64 randomly selected from the New Zealand Electoral Roll. MSS experienced during the previous 12 months in 10 body regions was assessed in telephone interviews using a modified version of the Nordic Musculoskeletal Questionnaire (NMQ). MSS prevalence was 92% (for any body region). The highest prevalence was for low back (54%), neck (43%), and shoulders (42%). Females reported a statistically significantly higher prevalence of MSS in the neck, shoulders, wrist/hands, upper back and hips/thighs/buttocks regions compared to males while males reported more symptoms of the elbows, low back, and knees. There were no statistically significant differences in prevalence among age groups. In general, participants with heavy physical workloads had significantly higher prevalence of symptoms in most body regions than those with light physical workloads although women with light physical workloads reported more neck symptoms. The study indicates that the New Zealand working population has a high prevalence of MSS and that exposure in the workplace plays a role.

Relevance to Industry: The findings of this study imply that efforts to reduce MSS in the workplace should focus on females and employees with high physical workloads.

Keywords: workforce; musculoskeletal disorders; back pain; Nordic Musculoskeletal Questionnaire; blue-collar worker

2.1 Introduction

In many countries, musculoskeletal problems are common amongst the general and working population and can result in serious social and economic impacts on individuals and communities (Buckle & Devereux, 2002; Hanson, et al., 2006; NRC & IOM, 2001). For example, the United Kingdom (UK) Health and Safety Executive estimated, on the basis of a Labour Force Survey, in 2009-2010 musculoskeletal disorders were the most commonly reported illness types and 37% of working days lost were due to musculoskeletal disorders (Health and Safety Executive & National Statistics, 2010). In the state of Washington between 1997 and 2005, 27% of all state fund-accepted claims were due to work-related musculoskeletal disorders (WMSDs) of the neck, back and upper extremities (Silverstein & Adams, 2007). In South Australia, sprains and strains were the most common claims (35%), and the claims for musculoskeletal and connective diseases were 13.2% during 2008-2009 (WorkCoverSA, 2010). In New Zealand, a report for the National Occupational Health and Safety Advisory Committee (NOHSAC) indicated that 36% of the total compensation cost in 2004-2005 was due to sprains and strains and 14% due to diseases of the musculoskeletal system and connective tissue (Access Economics, 2006).

The apparent magnitude of ‘the musculoskeletal problem’ in society varies depending on the definitions used to identify cases and the population studied. A key point when making a synthesis of the literature on this subject is that one needs to be aware of what actually constitutes the case definition of an individual with a ‘musculoskeletal problem’ (Dykes, Scuffham, Legg, & Widanarko, 2010). Various studies have examined musculoskeletal ‘impairment’ (Cunningham & Kelsey, 1984; Kelsey & Hochberg, 1988), ‘disorders’ (Hartman, et al., 2005; Lawrence et al., 1998; Østensvik et al., 2008), or ‘injuries’ (Gardner, Landsittel, & Nelson, 1999; Tappin, Bentley, Vitalis, & Macky, 2008), whilst others have examined self-reported ‘pain’ (Andersson, Ejlertsson, Leden, & Rsenberg, 1993; Okunribido, Magnusson, & Pope, 2006; Walker, Muller, & Grant, 2004), ‘discomfort’ (Dykes, 2009; Palliser, et al., 2005; Scuffham, et al., 2010), and ‘symptoms’ (Hildebrandt, 1995b; Morken, et al., 2000).

Violante et al. (2000) and Hagberg et al. (1995) discussed the importance of case definition in this context and the necessity to clearly distinguish between the terms musculoskeletal disorders (MSD) and musculoskeletal symptoms (MSS). Buckle and Devereux (2002) suggested that ‘musculoskeletal disorders’ should be a term reserved for describing common inflammatory and degenerative disease and disorders. Violante et al. (2000) defined a ‘disorder’ as a condition that includes both symptoms (subjective evidence perceived by patient) and signs (objective evidence from physical examination) as well as any positive result arising from a diagnostic procedure to identify musculoskeletal pathology. On the other hand, ‘symptoms’ (including discomfort, complaint and pain) represent subjective feelings (Burton, et al., 2008) and are often self-reported. Given the range of case definitions, it is therefore not surprising that prevalence estimates for musculoskeletal ‘problems’ vary so widely.

The Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka, et al., 1987) has often been used to examine MSS. Many studies have reported the 12-month period prevalence of MSS (defined as the number of participants reporting either the presence of existing musculoskeletal symptoms at the start of a 12-month follow-up period in addition to those reporting the onset of symptoms throughout the follow-up period divided by the total number of participants) in specific body regions as follows: low back - 43% (Johansson, 1994), 63% (Palliser, et al., 2005), 71% (Smith, et al., 2006), 73% (Scuffham, et al., 2010), 76% (Morken, et al., 2000), 76% (Engholm & Holmström, 2005), and 85% (Gallis, 2006); neck - 54% (Gallis, 2006), 55% (Smith, et al., 2006), 62% (Engholm & Holmström, 2005), and 68% (Morken, et al., 2000); shoulders - 49% (Palliser, et al., 2005), 64% (Engholm & Holmström, 2005), 67% (Morken, et al., 2000), and 72% (Smith, et al., 2006), and; knee - 48% (Morken, et al., 2000), 61% (Gallis, 2006), and 63% (Engholm & Holmström, 2005).

Some studies have investigated the prevalence of MSS in relation to gender and age. There are gender differences in MSS prevalence for males and females. Females have been shown to have a significantly higher prevalence of symptoms in the neck (Jensen, Ryholt, Burr, Villadsen, & Christensen, 2002; Morken, et al., 2000; Solidaki et al., 2010; Hanneke A. H. Wijnhoven, Henrika C. W. de Vet, & H. Susan J. Picavet, 2006b), shoulders (Jensen, et al., 2002; Morken, et al., 2000; Solidaki, et al., 2010; Wijnhoven, et al., 2006b), wrist/hands (Jensen, et al., 2002; Solidaki, et al., 2010; Wijnhoven, et al., 2006b), upper back (Wijnhoven, et al., 2006b), low back (Alcouffe, et al., 1999; Leijon & Mulder, 2009; Morken, et al., 2000), hip (Wijnhoven, et al., 2006b), and 'any body region' (Kamaleri, Natvig, Ihlebaek, Benth, & Bruusgaard, 2008; Morken, et al., 2000; Wijnhoven, et al., 2006b) than males. In contrast, previous studies reported that males had higher prevalence of symptoms in low back (Aasa, et al., 2005) and knees (Morken, et al., 2000) compared with females.

The association between age and MSS appears to be inconsistent. For instance, the back pain prevalence of people aged 45-54 years (35%) was greater than people aged 25-34 years (23%) (Hildebrandt, 1995a). Similarly, in a cross-sectional study among female workers in South Africa, older women (>40 years) were more likely to report symptoms in the upper extremities (prevalence ratio [*PR*] 1.3, 95% confidence interval [CI] 1.1, 1.4), lower extremities (*PR* 1.7, 95% CI [1.5, 2.0]), and back (*PR* 1.3, 95% CI [1.1, 1.6]) than younger female workers (<40 years) (Naidoo, et al., 2009). Another cross-sectional study showed that the odds of shoulder symptom was 3.58, 95% CI [1.86, 6.89] times greater in Greek nurses aged >40 years compared with nurses <35 years of age (Alexopoulos, et al., 2003). In contrast, the same study also found that older nurses (>40 years of age) were no more likely to have low back (*OR* 1.18, 95% CI [0.57, 2.46]) and neck symptoms (*OR* 0.98, 95% CI [0.55, 1.76]) than nurses aged <35 years (Alexopoulos, et al., 2003). Other studies also failed to show an association between age and symptoms in the neck (Jensen, et al., 2002; Leroux, et al., 2005), low back (Alexopoulos, et al., 2004; Bovenzi, et al., 2002; Ijzelenberg, et al., 2004; van den Heuvel, et al., 2004), shoulders (Alexopoulos, et al., 2004), and hand/wrist (Alexopoulos, et al., 2004; Alexopoulos, et al., 2006).

Other studies have assessed MSS risk in relation to occupational group. The prevalence of MSS for physically light occupations is reported as: dentists 53% (Palliser, et al., 2005) and 62% (Alexopoulos, et al., 2004), and office workers 84% (Harcombe, et al., 2009) whereas for physically heavy occupations it is: commercial fishers 83% (Lipscomb, et al., 2004), postal workers 88% (Harcombe, et al., 2009), and aluminium manufacturing workers 93% (Morken, et al., 2000).

Although estimates of the prevalence of musculoskeletal problems are available for a number of occupational groups in numerous countries (e.g. dentist in Greece (Alexopoulos, et al., 2004), commercial fishers in North Carolina (Lipscomb, et al., 2004), Japanese nurses (Smith, et al., 2006), and aluminium worker in Norway (Morken, et al., 2000)), in New Zealand (Dykes, 2009; Harcombe, et al., 2009; Palliser, et al., 2005; Scuffham, et al., 2010; Tappin, Bentley, Vitalis, et al., 2008) relatively little is known of the magnitude of musculoskeletal problems amongst the general working population in relation to gender, age, and physical workload (occupational group). This study therefore describes data obtained for MSS as part of a national survey of self-reported occupational exposures, workplace practices and occupational ill-health (Eng, et al., 2010). Specifically it reports the prevalence of MSS in relation to gender, age, and occupation/industry amongst New Zealand employees. The findings from this study should help to more clearly identify current and/or emerging hazards that account for a significant burden of occupational ill health.

2.2 Methods

2.2.1 Participants

Potential participants for this study comprised 10,000 individuals aged 20-64 years, randomly selected from the New Zealand Electoral Roll (7,000 from 2003 and 3,000 from 2005). Each potential participant was invited by mail (three letters were sent) to have a telephone interview (Eng, et al., 2010). Of 10,000 mail-outs, 1,209 were returned to sender, 2,719 did not reply to the three invitation letters and could not be contacted by phone, 637 did not meet the study eligibility criteria (i.e. the addressee either no longer lived or never worked in New Zealand, or was deceased) and 2,425 refused to take part. Thus, 3,003 people were interviewed as the study participants (an additional 7 questionnaires were missing and therefore excluded). Ethics approval for the study was obtained from the Massey University Human Ethics Committee (WGTN 13/133).

2.2.2 Definition and measurements

The interview sought information on demographic characteristics (including gender and age), lifetime work history, current self-reported physical, psychosocial, organisational and environmental factors, and various health conditions, including MSS. A complete work history was obtained for all jobs held for a minimum of six months. Details of the full study are described in Eng et al. (2010). The present paper reports only the data for MSS, which was defined as the presence of any existing or acquired trouble (aches, pains, discomfort, and numbness) during the last 12 months. Binary choice (yes/no) questions were used to associate MSS with ten anatomical regions (recorded in body diagrams viewed from the back): neck, shoulders, arms (upper and lower), elbows, wrists/hands, upper back, low back (small of back), hips/thighs/buttocks, knees, and ankles/feet. The questions were based on a modified version of the standardized Nordic Musculoskeletal Questionnaire (Kuorinka, et al., 1987).

2.2.3 Data analysis

The New Zealand Standard Classification of Occupations 1999 was used to group occupations (Statistics New Zealand, 2001) based on the main activity of the participant. The industrial group classification used in this study was the Australian and New Zealand Standard Industrial Classification (Statistics New Zealand, 1997).

The 12-month period prevalence of MSS in any body region (subsequently referred to as ‘any MSS prevalence’) and their 95% CI were calculated for gender, age group, body region, occupational and industrial group. Logistic regression analyses were conducted to investigate exposure-response relationship for age group and reported in term of odds ratios (*OR*s) and their 95% CI (Pearce, 2004). To compare MSS prevalence by physical workload, the occupational groups were classified into those characterised by light physical workloads (i.e. legislator and administrator, professional, technicians and associate professionals, clerks, and service and sales workers) and those characterised by heavy physical workloads (i.e. agriculture and fishery workers, trade workers, plant and machine operators and assemblers, and elementary workers). Differences in prevalence among gender and physical workload were assessed using the chi-square test. The level of significance was set at $p < .05$. All statistical analyses were conducted using Predictive Analytics Software version 18.0 (Predictive Analytics Software (PASW) Statistics 18, 2009).

2.3 Results

2.3.1 Descriptive data for the sample

The overall response rate (the number interviewed as a proportion of the total eligible sample) was 37%. Forty-eight percent of the study population was male (n = 1,431) and 52% female (n = 1,572). The distribution of the sample in relation to age for males, females, and the whole population are presented in Table 2.1. The median age was 45 with interquartile range 36-54 years old.

Table 2.1 *Distribution of the sample in relation to age group for males, females, and the whole population*

Age group (years)	Males		Females		Whole	
	n	%	*n*	%	*n*	%
20-34	302	21	357	23	659	22
35-44	349	25	471	30	820	27
45-54	404	28	464	29	868	29
55+	376	26	280	18	656	22

Table 2.2 shows the distribution of the sample over the occupational groups and also census data from 2006 (Statistics New Zealand, 2008a, 2008b). Comparison indicates that most occupational and industrial groups were well-represented in the sample. However, legislator, professional, technician, service and sales workers, manufacturing, property and business services, education, and health and community

services groups were over-represented and the elementary worker groups were under-represented.

Table 2.2 *Distribution of the sample over the various occupations and industries with corresponding 2006 New Zealand census data*

Group	Males		Females		Whole		Census data
	n	%	*n*	%	*n*	%	%
Occupational group[a]:							
Legislator and administrator	308	22	197	12	505	17	14
Professionals	235	16	390	25	625	21	15
Technicians & associate professionals	177	12	278	18	455	15	12
Clerks	70	5	286	18	356	12	11
Service and sales workers	88	6	260	16	348	11	14
Agriculture and fishery workers	120	8	61	4	181	6	6
Trade workers	225	16	15	1	240	8	8
Plant & machine operators & assemblers	150	11	29	2	179	6	8
Elementary workers (including residuals)	57	4	56	4	113	4	6
Industrial group[b]:							
Agriculture, forestry & fishing	94	7	103	7	197	7	7
Mining	8	1	2	0	10	0.3	0.2
Manufacturing	182	13	218	14	400	13	11
Electricity, gas & water supply	10	1	11	1	21	1	0.4
Construction	105	7	104	7	209	7	7
Wholesale trade	54	4	58	4	112	4	5
Retail trade	135	9	130	8	265	9	10
Accommodation, cafes & restaurants	47	3	49	3	96	3	6
Transport & storage	52	4	59	4	111	4	4
Communication services	28	2	21	1	49	2	2
Finance & insurance	56	4	62	4	118	4	3
Property & business services	159	11	179	11	338	11	3
Government administration & defence	81	6	99	6	180	6	4
Education	150	10	181	12	331	11	7
Health & community services	164	11	186	12	350	12	8
Cultural & recreation services	39	3	50	3	89	3	2
Personal & other services	62	4	51	3	113	4	4

Note. [a]1 missing data from occupational group. [b]14 missing data from industrial group.

2.3.2 Prevalence of MSS for each body region in relation to gender

Table 2.3 presents the prevalence of MSS during the last 12 months in relation to body region affected, stratified by gender. Ninety-two percent (95% CI [91%, 93%]) (*n* = 2,750) of respondents reported MSS in any of the ten body regions. The highest MSS prevalence was for the low back (54%), followed by the neck (43%) and shoulders (42%). The lowest prevalence was for the elbows (14%). In relation to gender, the prevalence of any MSS for males and females were 91% and 92%, respectively. Females reported a statistically significantly higher prevalence of symptoms in the neck, shoulders, wrist/hands, upper back, and hips/thighs/buttocks regions compared with males. However, males had a higher prevalence than females for symptoms in the elbows, low back and knees.

Table 2.3 *Prevalence of musculoskeletal symptoms during the last 12 months, expressed as the number of cases per 100 workers [95% CI], in relation to body region affected for the males, females, and the whole population*

Body region	Males[a]		Females[b]		Whole[c]	
Neck **	39	[37, 42]	46	[44, 49]	43	[41, 45]
Shoulders **	38	[36, 41]	46	[44, 48]	42	[40, 44]
Arm	16	[14, 18]	19	[17, 21]	18	[16, 19]
Elbows **	16	[14, 18]	12	[10, 13]	14	[12, 15]
Wrist hands **	27	[25, 30]	32	[30, 34]	30	[28, 31]
Upper back **	15	[13, 17]	23	[21, 25]	19	[18, 21]
Low back **	56	[54, 59]	51	[49, 54]	54	[52, 56]
Hips thighs buttocks **	16	[14, 18]	23	[21, 25]	19	[18, 21]
Knees **	34	[32, 36]	27	[25, 30]	31	[29, 32]
Ankles-feet	19	[17, 21]	21	[19, 23]	20	[19, 22]
Any MSS	91	[90, 93]	92	[91, 93]	92	[91, 93]

Note. CI = confidence interval.
[a] 8 missing data for MSS for males. [b] 4 missing data for MSS for females. [c] 12 missing data for MSS for the whole population.
$^{*}p < .05$; $^{**}p < .01$ as regards differences between gender.

2.3.3 Prevalence and odds ratio of MSS for each body region in relation to age

Table 2.4 presents the prevalence and odds ratio of MSS in relation to age stratified by body region and gender. There were no statistically significant differences in prevalence between age groups for all body regions for males, females, and the whole population.

Table 2.4 *Prevalence [95% CI] and OR [95% CI] of musculoskeletal symptoms during the last 12 months in relation to age for males, females, and the whole population*

Age group (years)	Males[a]				Females[b]				Whole[c]			
	Prevalence		*OR*		Prevalence		*OR*		Prevalence		*OR*	
Neck:												
20-34	41	[36, 46]	1.00		46	[41, 51]	1.00		42	[39, 46]	1.00	
35-44	38	[33, 43]	0.88	[0.65, 1.20]	47	[42, 51]	1.23	[0.93, 1.63]	44	[40, 47]	1.06	[0.86, 1.30]
45-54	40	[36, 45]	0.96	[0.71, 1.30]	47	[43, 52]	1.15	[0.87, 1.52]	44	[41, 47]	1.06	[0.86, 1.30]
55+	41	[36, 46]	1.00	[0.73, 1.38]	47	[41, 52]	1.21	[0.89, 1.63]	45	[41, 49]	1.10	[0.88, 1.37]
Shoulders:												
20-34	37	[32, 43]	1.00		43	[38, 49]	1.00		42	[38, 46]	1.00	
35-44	40	[35, 45]	1.09	[0.80, 1.49]	48	[44, 53]	1.01	[0.76, 1.34]	43	[40, 47]	0.62	[0.85, 1.29]
45-54	39	[35, 44]	1.08	[0.79, 1.46]	48	[43, 52]	1.04	[0.78, 1.37]	43	[40, 47]	0.61	[0.85, 1.29]
55+	37	[32, 43]	1.00	[0.72, 1.38]	46	[40, 52]	1.01	[0.75, 1.37]	42	[38, 46]	0.99	[0.80, 1.24]
Arms:												
20-34	16	[12, 20]	1.00		17	[14, 22]	1.00		17	[14, 20]	1.00	
35-44	18	[15, 22]	1.16	[0.78, 1.74]	19	[16, 23]	1.12	[0.78, 1.62]	19	[16, 21]	1.14	[0.87, 1.49]
45-54	16	[13, 20]	1.01	[0.68, 1.52]	19	[15, 22]	1.08	[0.75, 1.56]	17	[15, 20]	1.05	[0.80, 1.38]
55+	17	[13, 21]	1.08	[0.70, 1.64]	24	[19, 28]	1.46	[1.00, 2.13]	20	[17, 24]	1.27	[0.96, 1.68]
Elbows:												
20-34	18	[14, 22]	1.00		14	[10, 18]	1.00		15	[13, 18]	1.00	
35-44	17	[14, 21]	0.96	[0.64, 1.43]	11	[8, 14]	0.74	[0.48, 1.14]	14	[11, 16]	0.85	[0.63, 1.14]
45-54	16	[13, 20]	0.92	[0.62, 1.36]	13	[10, 16]	0.98	[0.62, 1.42]	15	[12, 17]	0.93	[0.70, 1.24]
55+	15	[11, 19]	0.79	[0.52, 1.22]	12	[9, 16]	0.86	[0.55, 1.36]	13	[11, 16]	0.83	[0.61, 1.13]
Wrist hands:												

Age group (years)	Males[a]				Females[b]				Whole[c]			
	Prevalence		*OR*		Prevalence		*OR*		Prevalence		*OR*	
20-34	29	[24, 34]	1.00		34	[29, 39]	1.00		31	[28, 35]	1.00	
35-44	29	[24, 33]	1.00	[0.71, 1.39]	33	[29, 38]	0.96	[0.71, 1.29]	31	[28, 34]	0.98	[0.78, 1.22]
45-54	26	[22, 30]	0.85	[0.61, 1.19]	32	[28, 37]	0.92	[0.68, 1.23]	29	[26, 32]	0.89	[0.71, 1.10]
55+	30	[25, 35]	1.06	[0.75, 1.50]	31	[26, 36]	0.86	[0.63, 1.19]	30	[27, 34]	0.95	[0.75, 1.20]
Upper back:												
20-34	14	[11, 19]	1.00		22	[18, 27]	1.00		18	[16, 21]	1.00	
35-44	20	[16, 24]	1.47	[0.97, 2.20]	26	[22, 31]	1.26	[0.91, 1.76]	23	[20, 26]	1.34	[1.04, 1.73]
45-54	13	[11, 17]	0.93	[0.61, 1.42]	23	[20, 28]	1.09	[0.78, 1.52]	19	[16, 21]	1.02	[0.78, 1.32]
55+	16	[12, 20]	1.12	[0.72, 1.73]	22	[18, 27]	1.00	[0.70, 1.44]	19	[16, 22]	1.03	[0.78, 1.37]
Low back:												
20-34	58	[52, 63]	1.00		52	[47, 57]	1.00		55	[51, 58]	1.00	
35-44	57	[52, 62]	0.97	[0.71, 1.31]	53	[48, 57]	1.03	[0.78, 1.37]	55	[51, 58]	1.00	[0.81, 1.23]
45-54	58	[53, 62]	0.99	[0.73, 1.34]	48	[44, 53]	0.87	[0.66, 1.15]	53	[50, 56]	0.93	[0.76, 1.14]
55+	53	[48, 59]	0.83	[0.61, 1.14]	54	[49, 60]	1.10	[0.81, 1.49]	54	[50, 58]	0.97	[0.78, 1.20]
Hips thighs												
20-34	17	[13, 21]	1.00		23	[19, 28]	1.00		20	[17, 23]	1.00	
35-44	14	[11, 18]	0.81	[0.53, 1.23]	22	[19, 26]	0.93	[0.66, 1.30]	18	[16, 21]	0.88	[0.68, 1.14]
45-54	17	[14, 21]	1.05	[0.71, 1.56]	24	[20, 28]	1.03	[0.74, 1.43]	21	[18, 24]	1.03	[0.80, 1.33]
55+	18	[14, 22]	1.09	[0.72, 1.66]	24	[20, 29]	1.06	[0.74, 1.51]	21	[18, 25]	1.06	[0.81, 1.39]
Knees:												
20-34	39	[34, 45]	1.00		28	[23, 33]	1.00		33	[29, 37]	1.00	
35-44	30	[25, 34]	0.65	[0.47, 0.90]	28	[24, 32]	1.01	[0.73, 1.38]	29	[26, 32]	0.81	[0.65, 1.02]
45-54	33	[29, 38]	0.78	[0.57, 1.06]	31	[26, 35]	1.15	[0.84, 1.56]	32	[29, 35]	0.95	[0.76, 1.18]
55+	38	[33, 43]	0.95	[0.69, 1.32]	25	[21, 30]	0.89	[0.63, 1.25]	32	[28, 35]	0.94	[0.74, 1.18]
Ankles-feet:												
20-34	20	[16, 25]	1.00		21	[17, 26]	1.00		21	[18, 24]	1.00	

Age group (years)	Males[a]				Females[b]				Whole[c]			
	Prevalence		*OR*		Prevalence		*OR*		Prevalence		*OR*	
35-44	19	[16, 24]	0.96	[0.66, 1.41]	21	[17, 25]	0.99	[0.70, 1.40]	20	[18, 23]	0.98	[0.76, 1.26]
45-54	18	[14, 22]	0.87	[0.60, 1.27]	22	[18, 26]	1.04	[0.74, 1.46]	20	[17, 23]	0.96	[0.74, 1.23]
55+	22	[18, 26]	1.11	[0.75, 1.64]	24	[20, 29]	1.17	[0.82, 1.68]	23	[20, 26]	1.14	[0.88, 1.49]
Any MSS:												
20-34	92	[89, 95]	1.00		92	[89, 95]	1.00		92	[90, 94]	1.00	
35-44	90	[87, 93]	0.82	[0.48, 1.40]	92	[89, 94]	0.96	[0.57, 1.62]	91	[89, 93]	0.89	[0.61, 1.29]
45-54	91	[89, 94]	0.93	[0.54, 1.58]	91	[88, 93]	0.84	[0.51, 1.39]	91	[89, 93]	0.88	[0.61, 1.27]
55+	92	[89, 95]	1.01	[0.57, 1.79]	93	[91, 96]	1.21	[0.68, 2.17]	93	[91, 95]	1.10	[0.73, 1.66]

Note. CI = confidence interval; *OR* = odds ratio.

[a] 23 missing data for any MSS and age group for males. [b] 4 missing data for any MSS and age group for females. [c] 27 missing data for any MSS and age group for the whole population

2.3.4 Prevalence of any MSS in relation to occupational group and industrial group

Table 2.5 presents the prevalence of any MSS by occupational group and industrial group. The prevalence of MSS was highest amongst agriculture and fishery workers (96%) and elementary workers (96%) for males; legislator and administrators (93%) and professionals (93%) for females; and agriculture and fishery workers (94%) for the whole population. Females reported a statistically significantly higher prevalence of any MSS compared with males for legislator and administrators, whereas elementary male workers had a higher prevalence of any MSS than elementary female workers. Among industrial groups, those working in manufacturing, wholesale trade, health and community services, and cultural and recreation services had the highest prevalence (94%) among males. Cultural and recreational services had the highest prevalence for females (96%) and the whole population (95%).

Table 2.5 *Prevalence of any musculoskeletal symptoms during the last 12 months, expressed as the number of cases per 100 workers [95% CI] in relation to occupational and industrial group for males, females and the whole population*

Group	Males		Females		Whole	
Occupational group^a:						
Legislator and administrator *	87	[84, 91]	93	[90, 97]	90	[87, 92]
Professional	88	[84, 92]	93	[90, 95]	92	[89, 93]
Technicians & associate professional	91	[87, 95]	92	[88, 95]	92	[89, 94]
Clerks	92	[86, 99]	90	[87, 93]	91	[88, 94]
Service and sales workers	95	[91, 99]	91	[88, 95]	93	[90, 95]
Agriculture and fishery workers	96	[93, 99]	90	[82, 97]	94	[90, 97]
Trade workers	91	[88, 95]	86	[67, 100]	92	[87, 95]
Plant & machine operators & assemblers	92	[87, 96]	89	[77, 100]	92	[87, 95]
Elementary workers *	96	[91, 100]	85	[75, 95]	90	[83, 94]
Industrial group ^{b}:						
Agriculture, forestry & fishing	89	[22, 95]	94	[89, 98]	91	[87, 95]
Mining	75	[36, 100]	0	[0, 79]	80	[49, 100]
Manufacturing	94	[91, 97]	91	[87, 96]	92	[90, 95]
Electricity, gas & water supply	80	[49, 100]	90	[70, 100]	85	[69, 100]
Construction	92	[87, 97]	92	[87, 97]	92	[88, 95]

Group	Males		Females		Whole	
Wholesale trade	94	[88, 100]	90	[85, 95]	92	[88, 97]
Retail trade	91	[86, 95]	91	[86, 95]	90	[87, 94]
Accommodation, cafes & restaurants	93	[86, 100]	85	[75, 95]	89	[83, 95]
Transport & storage	92	[84, 99]	91	[84, 98]	91	[86, 97]
Communication services	78	[62, 94]	90	[76, 100]	83	[72, 94]
Finance & insurance	91	[83, 98]	93	[87, 99]	92	[87, 97]
Property & business services	91	[87, 96]	89	[85, 94]	90	[87, 93]
Government administration & defence	90	[83, 96]	92	[87, 98]	91	[87, 95]
Education	89	[84, 94]	92	[89, 96]	91	[88, 94]
Health & community services	94	[90, 98]	91	[87, 95]	92	[90, 95]
Cultural & recreation services	94	[87, 100]	96	[90, 100]	95	[91, 99]
Personal & other services	82	[72, 92]	94	[87, 100]	87	[81, 93]

Note. CI = confidence interval.
[a] 2 missing data for any MSS and occupational group. [b] 15 missing data for any MSS and industrial group.
$^{*}p < .05$; $^{**}p < .01$ as regards differences between gender

2.3.5 Prevalence of MSS for each body region in relation to occupational group and to physical workload

Figures 2.1, 2.2, and 2.3 present the prevalence of MSS during the last 12 months for specific body regions (i.e. neck, shoulders, arms, elbows, wrist hands, upper back, low back, hips thighs buttocks, knees, and ankles feet) stratified by occupational groups for males, females, and the whole population, respectively. The prevalence for some body regions appears to be related to occupational group. Symptoms in the arms were more prevalent among trade workers, plant and machine operators and assemblers, and elementary workers than legislator and administrator, professional, technicians and associate professionals, and clerks for all populations. The prevalence of low back and ankles/feet symptoms were higher for agriculture and fishery workers, trade workers, plant and machine operators and assemblers, and elementary workers than for those who were involved in physically lighter work (i.e. legislator and administrator, professional, technicians and associate professionals, and clerks) for the males and the whole population. In contrast, technicians and associate professionals reported more symptoms in the neck than agriculture and fishery workers among females and the whole population. It is because of these patterns that the occupational groups were classified into those characterised by light physical workloads (i.e. legislator and administrator, professional, technicians and associate professionals, clerks, and service and sales workers) and those characterised by heavy physical workloads (i.e. agriculture and fishery workers, trade workers, plant and machine operators and assemblers, and elementary workers).

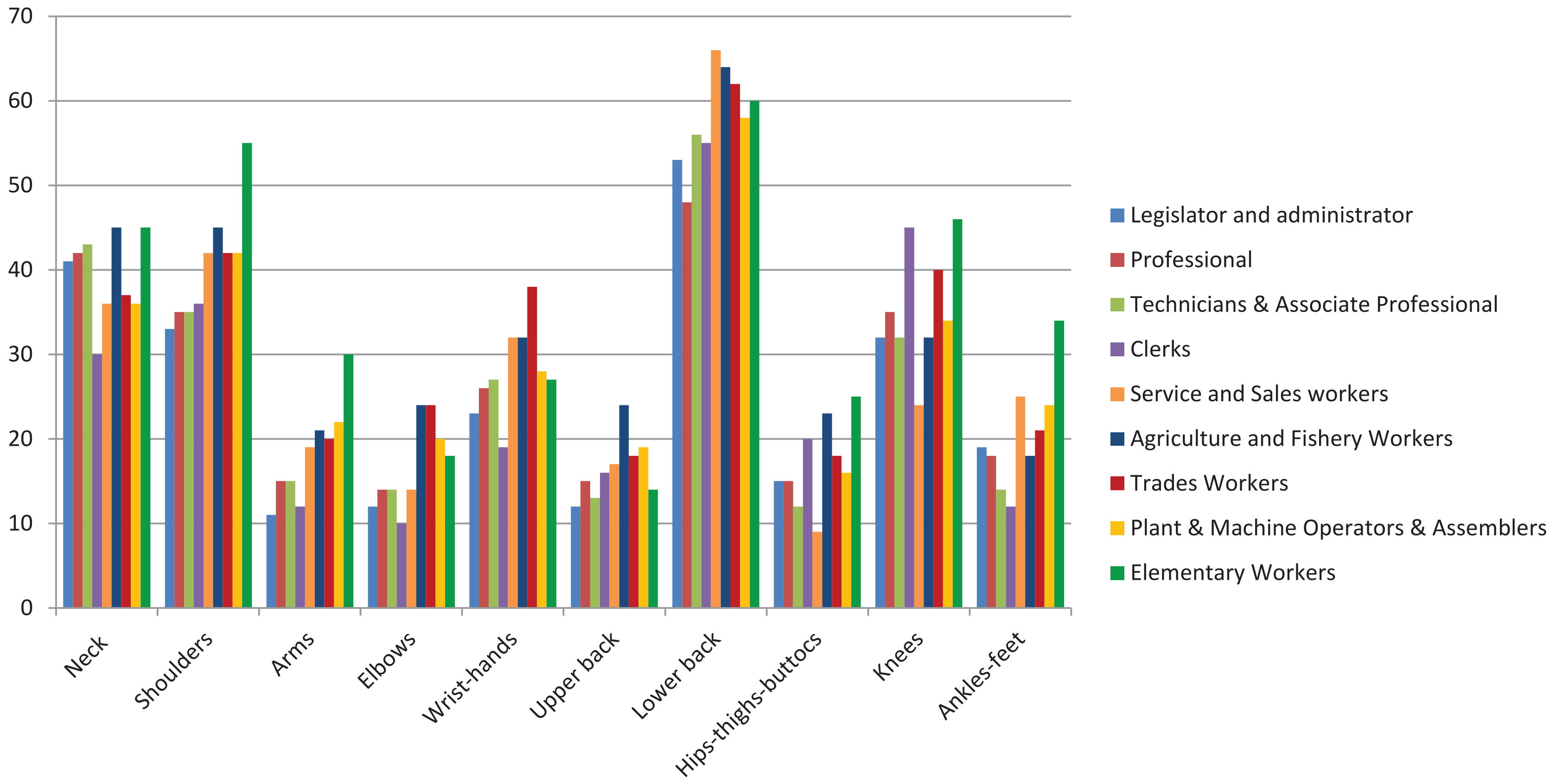

Figure 2.1 Prevalence of musculoskeletal symptoms during the last 12 months (expressed as the number of cases per 100 workers) in relation to body region affected, for the male-only population, stratified by occupational group

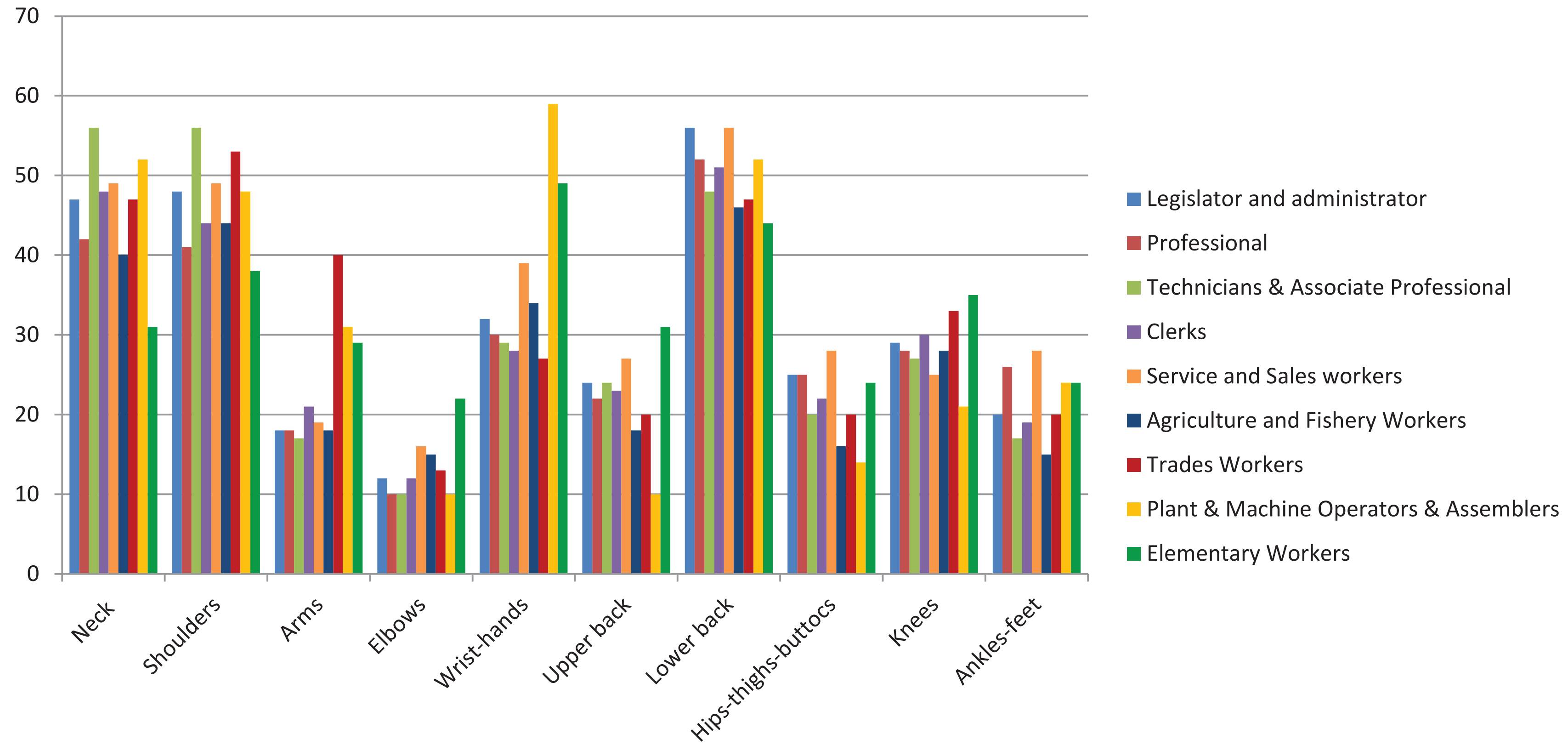

Figure 2.2 Prevalence of musculoskeletal symptoms during the last 12 months (expressed as the number of cases per 100 workers) in relation to body region affected, for the female-only population, stratified by occupational group

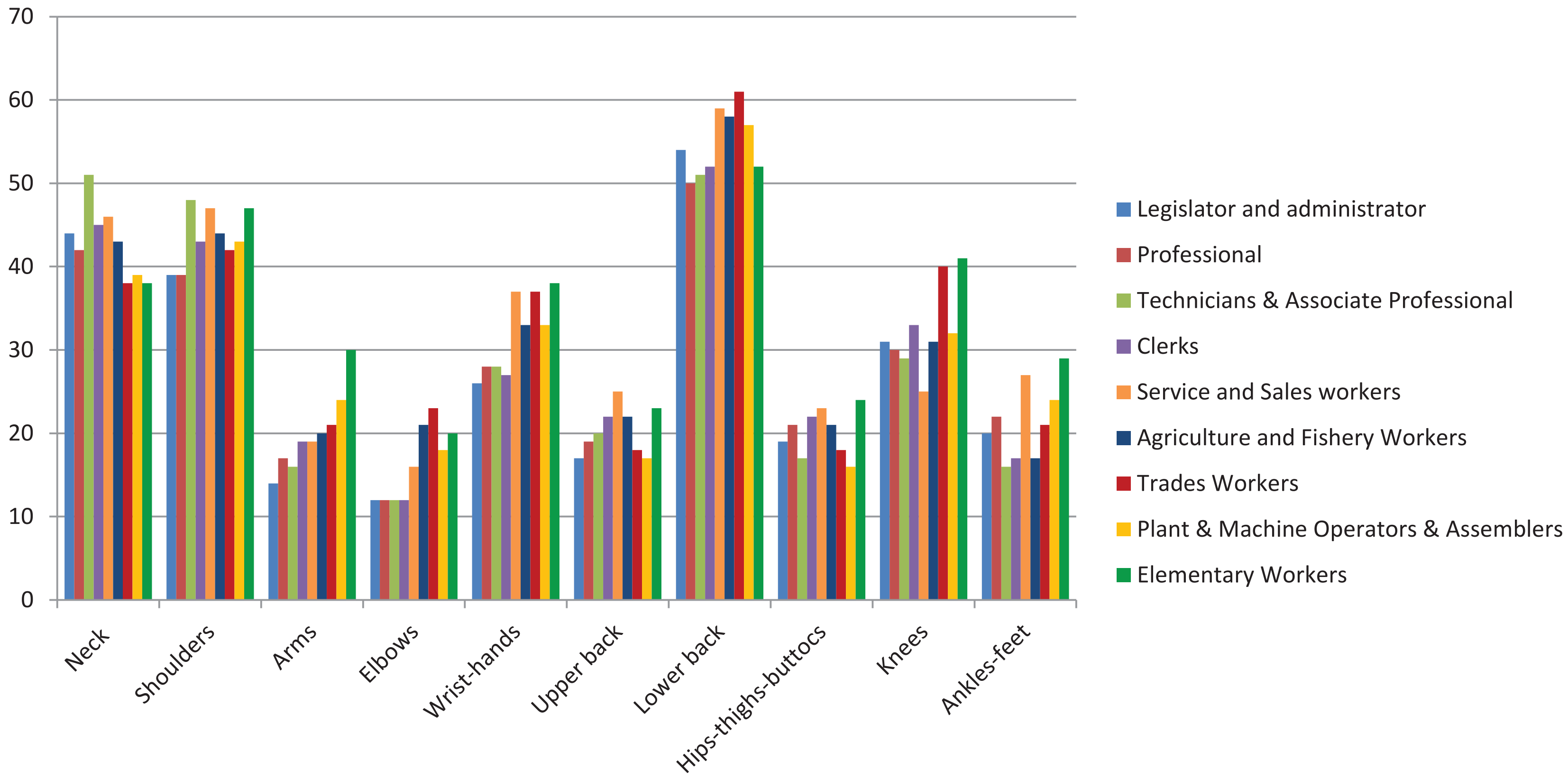

Figure 2.3 Prevalence of musculoskeletal symptoms during the last 12 months (expressed as the number of cases per 100 workers) in relation to body region affected, for the whole population (males and females), stratified by occupational group

Table 2.6 presents the prevalence of symptoms for each body region in relation to physical workload for males, females, and the whole population. Figure 2.4 shows the same data in a form that more readily illustrates patterns of differences. In general, symptoms were more prevalent for those involved in heavy physical workload compared with those involved in light physical workload. Among males, symptoms in almost all body regions (except the neck and knees) were more prevalent for heavy physical workers, whilst symptoms in arms and wrist hands were more prevalent for female heavy physical workers. For the whole population, heavy physical workers had significantly higher prevalence of symptoms in arms, elbows, wrist hands, low back, and knees than light physical workers. In contrast, light physical workers were more likely to report neck symptoms than heavy physical workers for females and the whole population.

Table 2.6 *Prevalence of musculoskeletal symptoms during the last 12 months, expressed as the number of cases per 100 workers [95% CI] in relation to body region affected, for males, females, and the whole population, stratified by light and heavy physical workload*

Body region	Light physical workload		Heavy physical workload	
Males:				
Neck	40	[37, 43]	39	[35, 43]
Shoulders **	35	[32, 38]	43	[39, 48]
Arms **	13	[11, 15]	21	[18, 25]
Elbows **	12	[10, 14]	22	[18, 25]
Wrist hands **	24	[22, 27]	32	[28, 36]
Upper back **	13	[11, 16]	19	[16, 22]
Low back **	53	[50, 57]	61	[57, 65]
Hips thighs buttocks **	14	[11, 16]	19	[16, 22]
Knees	32	[29, 35]	37	[33, 41]
Ankles-feet *	17	[15, 20]	22	[18, 25]
Females:				
Neck *	47	[45, 50]	39	[31, 47]
Shoulders	46	[44, 49]	43	[35, 51]
Arms *	18	[16, 20]	26	[19, 33]
Elbows	11	[10, 13]	16	[10, 22]
Wrist hands *	31	[28, 33]	43	[35, 50]
Upper back	23	[21, 26]	21	[14, 27]
Low back	52	[49, 54]	46	[38, 54]
Hips thighs buttocks	23	[21, 26]	18	[12, 24]

Knees	27	[25, 30]	29	[22, 36]
Ankles-feet	22	[19, 24]	20	[13, 26]
Whole:				
Neck *	44	[43, 47]	39	[35, 43]
Shoulders	42	[40, 44]	43	[40, 47]
Arms **	16	[15, 18]	22	[19, 25]
Elbows **	12	[10, 13]	20	[17, 23]
Wrist hands **	28	[26, 30]	35	[31, 38]
Upper back	19	[18, 21]	19	[16, 22]
Low back *	52	[50, 54]	57	[54, 61]
Hips thighs buttocks	20	[18, 21]	19	[16, 22]
Knees **	29	[27, 31]	35	[31, 38]
Ankles-feet	20	[18, 22]	21	[18, 24]

Note. CI = confidence interval.
$^{*}p < .05$; $^{**}p < .01$ as regards differences between light and heavy physical work

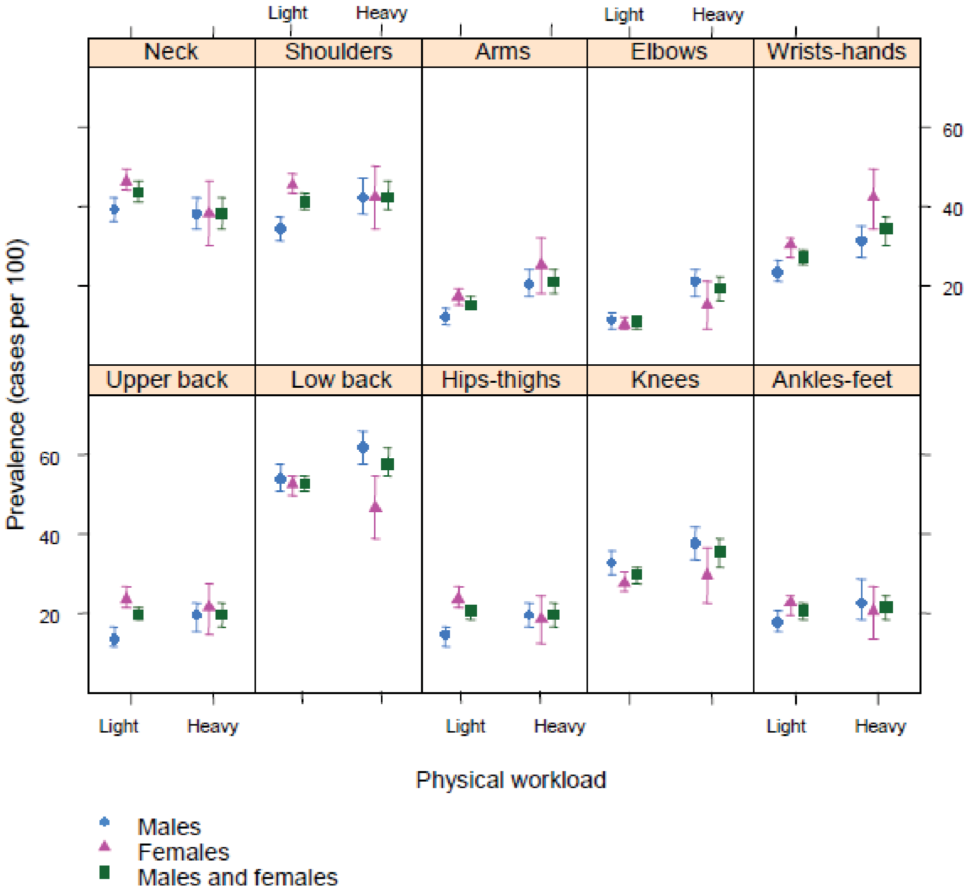

Figure 2.4 Prevalence of musculoskeletal symptoms during the last 12 months, expressed as the number of cases per 100 workers [95% CI] in relation to body region affected, for males, females, and the whole population (males and females), stratified by physical workload

2.4 Discussion

The overall (i.e. for any body region) MSS prevalence of 92% reported in this study for a working population in New Zealand is high. This finding is similar to those of Kamaleri et al. (2008) who conducted a postal survey of MSS among general population in Norway (91%), New Zealand nurses (91%) (Harcombe, et al., 2009), a cross-sectional study among New Zealand teachers (93%) (Dykes, 2009), and aluminium workers in Norway (93%) (Morken, et al., 2000). It is slightly higher than other occupations in New Zealand: postal workers (88%) and office workers (84%) (Harcombe, et al., 2009), and also Japanese nurses (85%) (Smith, et al., 2006), but slightly lower than for New Zealand veterinarians (96%) (Scuffham, et al., 2010). In relation to gender, the prevalence of any MSS for males (91%) was higher than Dutch males (69%) (Wijnhoven, et al., 2006b) and males in Norway (87%) (Kamaleri, et al., 2008) whereas any MSS prevalence for females (92%) was similar to females in Norway (94%) (Kamaleri, et al., 2008) but higher than for Dutch females (73%) (Wijnhoven, et al., 2006b).

Differences in definitions of MSS make comparison between studies difficult (Silverstein, Stetson, Keyserling, & Fine, 1997). Since all of the studies cited above used the NMQ to assess MSS, the differences in prevalence between the studies are most likely to be due to the differences between the populations studied, the use of different study design methods - such as the way in which the data were collected (telephone, online, or mail) (van Ooijen, Ivens, Johansen, & Skov, 1997), or cultural differences (Raspe, Matthis, Croft, O'Neill, & the European Vertebral Osteoporosis Study Group, 2004).

The highest prevalence of MSS in the present study was for the low back (54%). This finding is lower than that reported for New Zealand nurses (57%) (Harcombe, et al., 2009), school teachers in New Zealand (62%) (Dykes, 2009), New Zealand dentists (63%) (Palliser, et al., 2005), Australian adults (67%) (Walker, et al., 2004), Japanese nurses (71%) (Smith, et al., 2006), New Zealand veterinarians (73%) (Scuffham, et al., 2010), aluminium workers in Norway (76%) (Morken, et al., 2000), and Greek forest worker (85%) (Gallis, 2006), but higher than for white- (42%) and blue-collar (43%) workers in the metal industry in Sweden (Johansson, 1994), New Zealand office workers (45%), and New Zealand postal workers (52%) (Harcombe, et al., 2009).

The neck (43%) and shoulders (42%) were the next most commonly reported body region of MSS. These findings are lower than those reported by Harcombe et al. (2009) for New Zealand postal workers (51%), New Zealand office workers (51%), New Zealand nurses (52%) or among Greek forest workers (54%) (Gallis, 2006) or among New Zealand veterinarians (58%) (Scuffham, et al., 2010) or among aluminium workers (68%) (Morken, et al., 2000) for the neck, and by Palliser et al. (2005) (49%), Gallis (2006) (50%), Scuffham et al. (2010) (59%), Morken et al.(2000) (67%), and Smith et al. (2006) (72%) for the shoulder.

The studies described in the above two paragraphs are those for which we feel a direct comparison can be made with the present data because it is only these studies that used a methodological approach similar to that used in our study. Even so, although the questions used by Scuffham et al. (2010) and by Dykes et al. (2009) were identical to those used in our study, the mode of delivery of the questionnaire differed and this may have influenced questionnaire responses. Scuffham et al. (2010) used an on-line response mode whereas Dykes et al. (2009) used a written version of the same questionnaire. The present study used a telephone interview. This merely serves to illustrate the difficulties previously mentioned in determining MSS prevalence and the magnitude of the MSS problem in general.

The present study found gender differences in MSS prevalence for males and females for almost all body regions (i.e. neck, shoulders, elbows, wrists hands, upper back, low back, hips thighs buttocks, and knees). For most body regions females reported significantly more symptoms than males. This is consistent with previous studies for neck (Jensen, et al., 2002; Morken, et al., 2000; Wijnhoven, et al., 2006b), shoulders (Jensen, et al., 2002; Morken, et al., 2000; Wijnhoven, et al., 2006b), wrist hands (Jensen, et al., 2002; Wijnhoven, et al., 2006b), upper back (Wijnhoven, et al., 2006b), hips thighs buttocks (Wijnhoven, et al., 2006b). For other body regions, males had a higher prevalence than females (elbows, low back and knees). This is similar to the findings of a cross-sectional study among ambulance personnel, in which males reported a higher prevalence of low back symptoms than females (Aasa, et al., 2005). In contrast, other studies reported that females were more likely to have low back symptoms (Leijon & Mulder, 2009; Morken, et al., 2000), and Walker et al. (2004) found that among Australian adults there were no differences in prevalence between males (68%, 95% CI [65%, 70%]) and females (70%, 95% CI [67%, 73%]). The differences between studies partially might be due to study population as well as the different definitions of low back disorders/discomfort/pain/symptoms between studies, i.e. any trouble such as aches, pains, discomfort, and numbness in our study *versus* pain for Walker et al. (2004) and Leijon and Mulder (2009).

There are four possible explanations for the gender difference that we have observed in MSS prevalence. Firstly, males and females may have been exposed differently due to gender segregation in the workforce (Bernard, et al., 1994; Burdorf & Sorock, 1997; Hooftman, et al., 2004). In the present study, 77% of heavy physical workers were dominated by males while 62% of light physical workers were dominated by females. This is consistent with previous report that found that males tend to do more manual handling whereas females appear to be more likely to perform jobs requiring more concentrated hand tasks (Silverstein & Adams, 2007). In addition, previous studies have shown that different tasks may be performed differently by males and females even in the same job (Messing, Dumais, Courville, Seifert, & Boucher, 1994; van der Beek, Kluver, Frings-Dresen, & Hoozemans, 2000). Hence, occupational exposures seem to be gender-specific which may lead to different outcomes in body regions affected and reported between males and females. Second, generally females have smaller body size and dimensions and lower physical capacities than males. Hence, for males and females performing the same physical task, females will have a higher workload (Vingard, et al., 2000). This could result in more reported symptoms. The third possible explanation is that there are gender differences in pain perception due to biological mechanisms (i.e. hormonal) (Aloisi, 2003; Aloisi & Bonifazi, 2006; Craft, Mogil, & Aloisi, 2004; Fillingim & Ness, 2000). Fillingim and Ness (2000) have proposed that gonadal hormones affect the nervous systems which in turn influence nociception and analgesic response. Reviews by Marcus (1995) and Aloisi and Bonifazi (2006) found that sex hormones (i.e. estrogens) play a role in reducing pain perception. Thus, females tend to report more pain than males due to low estrogens level during some stages of the menstrual cycle. Finally, the attribution of sex-related stereotypes (i.e. gender role expectation) also plays a role in pain perception (Robinson & Wise, 2003; Wise, Price, Myers, Heft, & Robinson, 2002). Previous studies showed that females were more sensitive to pain and more willing to report pain than males (Robinson et al., 2001; Wise, et al., 2002). All the explanations above fit with our findings that females had a higher prevalence of MSS than males in most of body regions.

There were no statistically significant differences in prevalence between age groups for all body regions for males, females, and the whole population (Table 2.4). Similar findings were reported in previous cross-sectional studies (Alexopoulos, et al., 2003; Alexopoulos, et al., 2004; Bovenzi, et al., 2002; Ijzelenberg, et al., 2004; Leroux, et al., 2005). However, Hildebrandt (1995a) and Naidoo et al. (2009) showed that older workers were more likely to report MSS than younger workers. The differences might be attributable to the different categorisation of age groups (20-34, 35-44, 45-54, and 55+ in our study *versus* <40 or >40 in Naidoo's study), and the age distribution of each study population. In the present study younger age groups were underrepresented. The presence of a healthy worker effect bias (Arrighi & Hertzpicciotto, 1994; de Zwart, Broersen, Frings-Dresen, & van Dijk, 1997; Hartvigsen, et al., 2001; Holmström & Engholm, 2003) cannot be ruled out in the present study. Only healthy workers are likely to have remained employed and hence have been included in the present studies, whereas workers with severe illness and disability are more likely to have left employment prematurely.

Amongst the occupational groups, agriculture and fishery workers had the highest prevalence of any MSS (94%) (Table 2.5). This was greater than that reported for Dutch agriculture workers (75%) (Hildebrandt, 1995b), and commercial fishers in North Carolina (83%) (Lipscomb, et al., 2004), but slightly lower than for New

Zealand veterinarians (96%) (Scuffham, et al., 2010). The prevalence of any MSS in industrial groups (83%-95%) was similar with manufacturing (aluminium industry) in Norway (93%) (Morken, et al., 2000), but greater than in those working in manufacturing in South Africa (50%) (Schierhout, Myers, & Bridger, 1993). Most of these studies (Lipscomb, et al., 2004; Morken, et al., 2000; Schierhout, et al., 1993; Scuffham, et al., 2010) used self-reported NMQ to assess MSS, whereas Hildebrandt's used the LOQUEST questionnaire on musculoskeletal symptoms, which is comparable with NMQ (Hildebrandt, 1995b). These differences could be true or reflect differences in sample size, classification, and the ways in which the data were collected (interview, questionnaire, online, and mailed).

Participants who were involved in heavy physical work had a significantly higher prevalence of MSS in most body regions than those involved in light physical work (Table 2.6). This finding is consistent with previous studies (de Zwart, et al., 1997; Holmström & Engholm, 2003; Johansson, 1994; Lloyd, et al., 1986; Morken, et al., 2000; Schreuder, Roelen, Koopmans, & Groothoff, 2008; Xu, Bach, & Orhede, 1996). A study among Dutch workers found that those working in agriculture had significantly higher physical activity than those who worked in policy and higher executive functions (Proper & Hildebrandt, 2006). In addition, Alexopoulos et al. (2006) showed that blue-collar workers reported significantly more exposure to manual handling, strenuous awkward positions, and had higher perceived exertion than white-collar workers. In the present study, those in heavy physical workload were more likely to be exposed to the physical features which have been found as the risk factors of MSS, i.e. awkward or tiring positions (Beeck & Hermans, 2000; Bernard, 1997; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003; Riihimaki, 1991; Widanarko et al., 2012a), awkward grip or hand movements (Scuffham, et al., 2010), lifting (Bernard, 1997; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003; Riihimaki, 1991), and carrying out repetitive tasks (Andersen, Haahr, & Frost, 2007; Jensen, et al., 2002; Palmer & Smedley, 2007). Consequently, the prevalence of MSS in most body regions was higher in heavy physical workers than light physical workers. However, among females and the whole population, neck symptoms were more prevalent in light physical workers. This finding was supported by the findings of a previous cross-sectional study which showed that although the differences were small, females in secretarial positions had the highest prevalence of neck symptoms compared with other occupations (Palmer et al., 2001). This might be due to the nature of light physical work which requires more sitting work posture (Balogh et al., 2004; Jans, Proper, & Hildebrandt, 2007), using computers, and hand intensive tasks. Previous studies have identified that sedentary work (Ariëns, van Mechelen, Bongers, Bouter, & van der Wal, 2000) and awkward hand and/or neck postures (Ariëns et al., 2001; Bernard, 1997; Cote et al., 2008; Larsson, Søgaard, & Rosendal, 2007) which were more common in light physical workers, were associated with neck symptoms.

The present study also indicated that male heavy physical workers had more symptoms in almost all body regions whereas female light physical workers had more symptoms in the neck. This partially might be due to gender segregation in workforce. In the present study, 39% of males involved in heavy physical workload, which more likely to do manual handling, whereas 89% of females involved in light physical workload, which more likely to do hand task. Therefore, males and females were exposed to different exposure in the workplace which may result in different symptoms reported.

A strength of this study was its large size and representativeness. Although the response rate of 37% was typical for this type of survey (Tourangeau, 2004), there was no evidence of major nonresponse bias (Mannetje et al., 2011). Furthermore, the overall representativeness of the sample was high. Hence, the results of this study are likely to be representative of the magnitude of MSS amongst a working population, and for the New Zealand working population in particular. Despite the possibility of healthy worker effect, the effects of selection bias with respect to MSS is thought to be relatively minor because the study was part of large cross-sectional survey of self-reported occupational exposures, which did not specifically place any special emphasis on MSS in the interview (i.e. questions about MSS were merely one component of a wider range of questions). In order to conduct a survey with such a large sample, it was necessary to use a telephone self-report interview method. This method provides valid (Kallio, Viikari-Juntura, Hakkanen, & Takala, 2000; van Ooijen, et al., 1997) and reliable data (Kallio, et al., 2000). We therefore consider our findings to be reliable and valid.

Longitudinal studies are necessary in order to provide better estimation of MSS risk (Arrighi & Hertzpicciotto, 1994; Hartvigsen, et al., 2001) but they are expensive and difficult to conduct. However, cross-sectional studies may still provide valuable information if care is taken to record some additional information such as retrospective data about the date of first onset of symptoms and years employed, which can be used to adjust for a healthy worker effect (Punnett, 1996). Unfortunately it was not possible to make any such adjustment in the present study since the retrospective information about date of first onset of MSS was not available. An alternative would be to ‘coat-tail’ MSS studies onto prospective cohort studies designed to investigate other exposures and outcomes. Also, future studies need to examine the underlying aetiology of MSS in the form of contributing risk factors i.e. the association between exposure and outcome.

Although studies of the magnitude of the musculoskeletal problem in society have been conducted for more than 25 years, the definitions and methods that have been used are still inconsistent. It is not surprisingly then, that the estimations of the magnitudes of the problem vary greatly between studies. As ‘disorder’ is defined as a condition that includes both symptoms and signs (from physical examination) as well as a positive diagnostic procedure (Violante, et al., 2000), studies reporting musculoskeletal symptoms tend to have a higher prevalence than those that report about musculoskeletal disorders. In order to be able to compare studies, it is important to have a standard definition for musculoskeletal problems (i.e. to clearly differentiate between musculoskeletal disorders and symptoms).

In conclusion, the present study has shown that the prevalence of MSS is high amongst a large random sample of the general working population in New Zealand. The highest prevalence was for the low back, neck, and shoulders. Females reported a statistical significant higher prevalence of symptoms in neck, shoulders, wrist hands, upper back, and hips thighs buttocks region compared to males. However, there were no statistically significant differences in prevalence among age groups. Participants with high physical workloads had significantly higher prevalence of symptoms in most body regions than participants with low physical workloads. The higher prevalence of MSS among females and participants with high physical workloads suggest that a higher risk of MSS is related to exposure in the workplace.

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References

The references for this chapter have been integrated with the list of references at the end of the thesis.

Post-script

Summary of findings

This chapter shows that the prevalence of MSS among New Zealand workers is high (92%) for any body region with the highest prevalence being for the lower back (54%), neck (43%), and shoulders (42%). Despite the differences in proportion between males and females in the 35-44 and 55+ age groups (Table 2.1), there were no significant differences in LBS prevalence among those age groups (Table 2.4). LBS prevalence for those in the older age group was not higher than in the younger age group. Two hypotheses were supported: 1) that LBS prevalence for males was higher than that of females, and 2) the LBS prevalence for those with a current heavy physical workload was higher than those with a light physical workload. In summary, the gap, aims and hypotheses, and findings for this chapter are as follows:

Gap	Aims and Hypotheses	Findings
Relatively little is known of the prevalence of MSS (including LBS) amongst the working population in New Zealand	To examine the prevalence of MSS (including LBS) among the New Zealand working population	The 12-month MSS period prevalence was 92%, 95% CI [91%, 93%] The 12-month LBS period prevalence was 54%, 95% CI [52%, 56%]
Less is known about LBS risk factors amongst the working population in New Zealand	To examine the differences in LBS prevalence in relation to age group, gender, and occupational group The hypotheses are:	
	• The LBS prevalence for those in the older group will be higher than in the younger group	• The LBS prevalence for those in the older group was not higher than in the younger group
	• The LBS prevalence for males will be higher than females	• The LBS prevalence for males was higher than females
	• The LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload	• The LBS prevalence for those with a heavy physical workload was higher than those with a light physical workload

Limitations of the present study

This study shows that the prevalence of LBS among NZ working population was high. However, it did not have any exclusion criteria, such as pregnant woman or individuals with diseases (e.g. cancer or rheumatism), which may have led to overestimation. Although the present study has shown that the LBS prevalence for those with a heavy physical workload was higher than those with a light physical workload, this estimation was not adjusted for possible bias due to the healthy worker effect which is often unavoidable in cross-sectional studies particularly among working populations. Punnett (1996) proposed a method which entails the use of a Cox proportional hazards model to adjust for a healthy worker effect in cross-sectional studies. This method requires information regarding when the first episode of LBS occurred to construct a time-to-event Cox model (details of this analysis are presented in Chapter 5). For this study, it is not possible to explore this possibility of bias in this study population due to the lack of information regarding when the first episode of LBS occurred.

A self-reported questionnaire is useful to obtain data from a large population due to its cost effectiveness and ease of administration (Rothman, et al., 2008; White, Armstrong, & Saracci, 2008). However, self-reported questionnaires have been criticised for not providing accurate information due to recall bias. Recall inconsistencies are more likely among those with less serious LBS (Kuorinka, et al., 1987). The low screening level due to the lack of severity and duration information in a binary (yes/no) answer from NMQ (Kuorinka, et al., 1987) may also lead to misclassification of LBS or non-LBS. It is, therefore, necessary to have additional information about the severity, duration, and frequency of the symptoms and include this information as criteria to determine LBS cases.

Chapter 3 Gender differences in work-related risk factors associated with low back symptoms

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Preface

The previous chapter (Chapter 2) has shown that the prevalence of LBS among the New Zealand working population is high. Males were reported to have a higher LBS prevalence than females. To reduce the prevalence, it is necessary to examine the risk factors of LBS. However, in the case of the working population in New Zealand, little is known about the LBS risk factors (Gap 2.2). Since there were gender differences in LBS prevalence among the New Zealand working population, this chapter presents the risk factors for LBS for specific populations, i.e. the whole, male, and female population. The gap, aims, and hypotheses for this chapter are:

Gap	Aim	Hypotheses
Less is known about LBS risk factors among the New Zealand working population	To examine the association between physical, psychosocial, organisational, environmental risk factors and LBS for specific population: the whole, male, and female population	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the whole population • Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the male population • Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the female population

Abstract

The prevalence of low back symptoms (LBS) in many working populations is high and differences in prevalence between genders are inconsistent. However, gender-specific risk factors for LBS have seldom been examined. Hence, the aim of the present study was to indicate gender-specific LBS risk factors. A sample of 3,003 people was interviewed by telephone to get information about current workplace exposure and LBS. A logistic regression model showed that the risk of LBS for the whole population increased with work in awkward or tiring positions (odds ratio [*OR*] 1.37, 95% confidence interval [CI] 1.12, 1.68) and very/extremely stressful jobs (*OR* 1.46, 95% CI [1.05, 2.03]). None of the explanatory variables were significantly associated with LBS for males but working in awkward or tiring positions (*OR* 1.51, 95% [CI 1.04, 2.20]), dissatisfaction with contact and cooperation with management (*OR* 1.68, 95% CI [1.02, 2.78]), and finding their job to be very/extremely stressful (*OR* 2.27, 95% CI [1.46, 3.52]) were significantly associated with LBS for females. These findings suggest that interventions to reduce LBS in workplaces should focus on reducing working in awkward or tiring positions and stressful jobs, especially amongst females.

Statement of Relevance: Strategies to prevent or reduce LBS should focus on reducing exposure to awkward or tiring positions at work and stressful jobs, especially for females.

Key words: back pain; gender; Nordic questionnaire; organisational culture; psychosocial factor

3.1 Introduction

Low back symptoms (LBS) are a significant health problem in Western countries. The 1-year prevalence has been estimated at 22%-65% for developed countries (Walker, 2000). Among New Zealand workers the prevalence is 54% (Widanarko et al., 2011). Previous studies have identified three categories of risk factors for LBS as: physical, psychosocial, and organisational (Beeck & Hermans, 2000; Bernard, 1997; Lotters, et al., 2003). Systematic reviews of epidemiological studies have identified many risk factors for LBS. For combined-gender populations, they have identified physical risk factors as frequent trunk bending and rotation (Beeck & Hermans, 2000; Bernard, 1997; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003), high levels of manual handling (Bernard, 1997; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003), vibration (Burdorf & Hulshof, 2006; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003), and heavy physical load (Bernard, 1997; Hoogendoorn, et al., 1999). For psychosocial risk factors, only monotonous work (Bernard, 1997; Bongers, et al., 1993; Linton, 2001) and low social support (Beeck & Hermans, 2000; Bernard, 1997; Bongers, et al., 1993; Hoogendoorn, et al., 2000) are reported to have a consistent association with LBS. Inconsistent psychosocial associations have been reported for some other risk factors. Beeck and Hermans (2000), Hoogendoorn et al. (2000), Linton (2001) and Lotters et al. (2003) reported a positive association between job dissatisfaction at work and LBS but Bongers et al. (1993) and Burdorf and Sorock (1997) found inconsistent evidence for this association. Bongers et al. (1993) and Bernard (1997) found a positive association between low job decision latitude and LBS, whereas Burdorf and Sorock (1997) reported inconsistent evidence for this association. Linton (2000) and Linton (2001) proposed a positive association between high work stress and LBS but Hartvigsen et al. (2004) found insufficient evidence to support this association. The inconsistencies between findings in these review papers might be due to the different operational definition of psychosocial factors as well as inclusion criteria used to select the studies used in each of these cited systematic reviews. Bongers et al. (1993), Bernard (1997), Burdorf and Sorock (1997), and Lotters et al. (2003) included cross-sectional studies in their inclusion criteria, whereas Hoogendoorn et al. (2000), Linton (2000), Linton (2001), and Hartvigsen et al. (2004) only reviewed prospective cohort studies. Since investigators are able to monitor exposed and nonexposed groups over time in prospective cohort studies, systematic reviews restricted to these study types are thought to provide estimates of risk with a greater degree of external validity. For organisational factors, a recent study among New Zealand veterinarians showed that dissatisfaction with work organisation and organisational culture was associated with musculoskeletal symptoms (Scuffham, et al., 2010). Only a few studies have investigated the association of environmental factors with LBS. Working in cold (Piedrahita, Punnett, & Shahnavaz, 2004) and hot environments (Harkness, Macfarlane, Nahit, Silman, & McBeth, 2003) increased the risk of LBS.

Differences in prevalence between the genders appear to be an inconsistent finding amongst various studies. Females have been shown to have a higher prevalence of LBS than males (Alcouffe, et al., 1999; Morken, et al., 2000). In contrast, Aasa et al. (2005) reported males had higher LBS prevalence than females, and Hooftman et al. (2004) found that among males and females who did lifting, males had higher risk of LBS than females. Furthermore, a review paper by Burdorf and Sorock (1997) found that gender was not associated with LBS whereas Beeck and Hermans (2000) showed inconsistent findings about the differences in prevalence between the genders in their review. Burdorf and Sorock (1997) and Hooftman et al. (2004) have argued that gender-related differences in prevalence may arise from differences in workplace exposures since activity at work is still a major source of total physical activity among workers (Proper & Hildebrandt, 2006).

Gender differences in risk factors for LBS have seldom been examined but some studies have found that there are differences in risk factors for LBS for males and females. For instance, a prospective cohort study in a general working population found that lifting, flexion/rotation of the upper part of the body, uncomfortable working posture, driving a vehicle, psychosocial demands, skill discretion, coworker support, supervisor support, and job satisfaction were associated with LBS among male workers, whereas among female workers the association was only found for flexion/rotation of the upper part of the body, uncomfortable working posture, and supervisor support (Hooftman, et al., 2009). Similarly, Aasa et al. (2005) reported that physical demands, social support, and worry about different work conditions (i.e. worry about being diseased/injured, worry about making mistakes, worry about being subjected to threats and/or violence) were risk factors for male ambulance personnel, whilst among females the only risk factor for LBS was psychological demands. In a cross-sectional study among 7,010 workers, smoking habits, lifting, uncomfortable working position, and desire to achieve good quality work were associated with LBS for both male and female workers, but driving time and duration of job were associated with LBS among male workers (Alcouffe, et al., 1999).

In view of the relative paucity and inconsistencies of information on work-related gender-specific risk factors for LBS, the aim of the present study was to identify LBS risk factors in a working population and to differentiate between male- and female-specific risk factors.

3.2 Methods

3.2.1 Participants

Data were collected as part of a recent large national survey of self-reported current occupational exposures, workplace practices and occupational ill-health, described in detail elsewhere (Eng, et al., 2010). Potential participants comprised 10,000 individuals aged 20-64 years, randomly selected from the New Zealand Electoral Roll (7,000 from 2003 and 3,000 from 2005). Each potential participant was invited by mail (three letters were sent) to have a telephone interview (Eng, et al., 2010). Of 10,000 mail-outs, 1,209 were returned to sender and 637 did not meet the study eligibility criteria (e.g. the addressee either no longer lived or never worked in New Zealand, or was deceased). Of the 8,154 eligible participants, 2,719 did not reply to the three invitation letters and could not be contacted by phone. Of those we could contact, 3,003 people were interviewed as the study participants (an additional 7 questionnaires were missing and therefore excluded) and 2,425 refused to take part.

3.2.2 Questionnaire

The telephone interview sought information on demographic characteristics (including gender and age), lifetime work history, current self-reported physical, psychosocial and organisational exposures, and various health conditions including musculoskeletal symptoms. The questions about musculoskeletal symptoms for the low back region were based on a modified version of the standardized Nordic Musculoskeletal Questionnaire (Kuorinka, et al., 1987). The original standardized Nordic Musculoskeletal Questionnaire (Kuorinka, et al., 1987) asked about trouble (‘ache, pain, and discomfort with the locomotive organs’) to define musculoskeletal symptoms, whereas in the present study LBS were defined as the presence of any existing or acquired trouble (aches, pains, discomfort, and numbness) in the low back (small of back) during the last 12 months.

3.2.3 Physical, psychosocial, organisational, and environmental exposure assessment

Physical exposures were assessed by asking participants to estimate how much working time (never, quarter, half, three quarters or full time) during their work activities involved any of these situations: awkward or tiring positions, awkward grip or hand movements, lifting, carrying out repetitive tasks, working at very high speed, standing, sitting, or using tools that vibrate.

Psychosocial and organisational exposures in their current working place were assessed using a modified version of the job content questionnaire (Karasek et al., 1998) with a 5-point Likert scale (very satisfied, satisfied, neutral, dissatisfied and very dissatisfied). Cronbach’s alphas were computed for each of the component items for each of the exposure assessments to quantify internal consistency or reliability. For psychosocial exposure, participants were asked about: *contact and cooperation with management* (contact and co-operation between yourself and senior management, the help and support given to you by your colleagues, the help and support given to you by your supervisor, co-operation among you and your fellow workers, with Cronbach’s alpha = .75); and *level and difficulty of work* (the level of enjoyment of your work, the level of difficulty of work, the level of mental demands of work, with Cronbach's alpha = .65). An additional question on perceived job stress asked "In general, how do you find your job?" with a 5-point Likert scale for the response categories as follows: not at all stressful, mildly stressful, moderately stressful, very stressful and extremely stressful (Smith, Johal, Wadsworth, Davey, & Peters, 2000). Participants were also asked to estimate the fraction of total work time (never, quarter, half, three quarters or full time) that the job involved boring work or working to tight deadlines. For organisational exposure, participants were asked about: *work organisation* (the total number of hours worked per week, the way work is organised, the times of the day when you are asked to work, with Cronbach's alpha = .54), and; *organisational culture* (details of the way the work organisation is run, and work as a whole, with Cronbach's alpha = .53).

Environmental exposures were assessed by asking participants to estimate how much of their working time (never, quarter, half, three quarters or full time) was spent in a cold/damp environment, a hot/warm environment, working outside, or exposed to loud noise. The set of questionnaire above had been used in a number of other studies (Dykes, 2009; Scuffham, et al., 2010).

3.2.4 Data Analysis

Analysis of the data based on the five response categories for physical, psychosocial, organisational and environmental exposure showed clear trends in LBS prevalence. Low numbers of cases each of the strata meant that the confidence intervals around the LBS prevalence estimates were unreasonably large. Therefore the 5-point categories were collapsed into three (i.e. the 1s and 2s and the 3s and the 4s and 5s were grouped as separate categories) as follows: physical, psychosocial (working to tight deadlines and boring work), and environmental factors - never, quarter/half or three quarters/full time; psychosocial (contact and cooperation with management and level and difficulty of work) and organisational factors - very satisfied/satisfied, neutral or dissatisfied/very dissatisfied, and; psychosocial (work stress) factors - not at all, mildly/moderately, very/extremely stressful.

Two models from logistic regression analyses determined the association between explanatory variables and LBS. The models were reported in term of odds ratios (*OR*s) and their 95% confidence intervals [95% CI] (Hosmer & Lemeshow, 2000; Pearce, 2004). The first model was not adjusted for gender, age, and any other explanatory variables. The second model was an adjusted model in that it explains the association between explanatory variables and LBS after adjusting for gender, age, and all explanatory variables (fully adjusted). The Hosmer-Lemeshow test was used to assess the fit of the final logistic regression model (Hosmer & Lemeshow, 2000). A Receiver Operating Characteristic (ROC) curve was constructed to quantify the discriminatory ability of the model. The area under the ROC curve (AUC), which should range from 0 to 1, provided a measure of the ability of the model to classify those with and without LBS. These analyses were carried out separately for the whole (male and female) population, for the male-only population, and for the female-only population. All statistical analyses were conducted using PASW version 18.0 (Predictive Analytics Software (PASW) Statistics 18, 2009).

3.3 Results

3.3.1 Descriptive data for the sample

The overall response rate (the number interviewed as a proportion of the total eligible sample) was 37%. Forty-eight percent of the study participants were male (*n* = 1,431) and 52% female (*n* = 1,572). The age distributions of the sample for the whole population were: 20-34 years – 22%; 35-44 years – 27%; 45-54 years – 29%, and; 55+ years – 22%, with a median age of 45 years (interquartile range 36-54 years). For male-only population the age distributions were 20-34 years – 21%; 35-44 years – 25%; 45-54 years – 28%, and; 55+ years – 26% whereas for female-only population the distributions were 20-34 years – 23%; 35-44 years – 30%; 45-54 years – 29%, and; 55+ years – 18%.

3.3.2 Risk factors for LBS

The risk factors for LBS among the whole (male and female) population are shown in Table 3.1. In the unadjusted model there were significant associations with LBS for gender, some physical factors (i.e. awkward or tiring positions, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, and using tools that vibrate), some psychosocial factors (i.e. contact and cooperation with management, level and difficulty of work, work stress, and boring work), all of the organisational factors (i.e. work organisation, organisational culture), and all of the environmental factors (i.e. working in a cold/damp environment, working in a hot/warm environment, working outside and exposure to loud noise). After adjusting for gender, age, and all explanatory variables, there were significant associations between LBS and awkward or tiring positions and work stress.

The odds of LBS in those whose work involved awkward or tiring positions quarter/half time and three quarter/full time were 1.37, 95% CI [1.12, 1.68] and 1.26, 95% CI [0.95, 1.67] times greater than those whose work did not involve such situations, respectively. Participants who reported their work to be mildly/moderately stressful and very/extremely stressful were 1.31, 95% CI [1.02, 1.68] and 1.46, 95% CI [1.05, 2.03] times more likely to have LBS than those who indicated they were not stressed at all, respectively.

Table 3.1 *Risk factors for LBS in unadjusted and adjusted models for the whole (both male and female) population*

	Number of people at risk	Number of people with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*^{a}	[95% CI]
Individual Factors						
Gender						
Females	1572	812	1.00		1.00	
Males	1430	809	1.21	[1.05, 1.40]	1.08	[0.91, 1.29]
Age						
20-34	659	341	1.00		1.00	
35-44	820	457	1.17	[0.95, 1.44]	1.23	[0.99, 1.53]
45-54	868	480	1.15	[0.94, 1.41]	**1.34**	**[1.08, 1.67]**
55+	656	343	1.02	[0.81, 1.26]	1.19	[0.93, 1.51]
Physical Factors						
Awkward or tiring positions						
Never	799	356	1.00		**1.00**	
Quarter/Half	1632	928	1.64	[1.38, 1.94]	**1.37**	**[1.12, 1.68]**
Three quarter/Full	558	328	1.77	[1.42, 2.20]	1.26	[0.95, 1.67]
Awkward grip or hand movements						
Never	1373	683	1.00		1.00	
Quarter/Half	1249	710	1.33	[1.14, 1.55]	1.02	[0.84, 1.22]
Three quarter/Full	370	221	1.49	[1.18, 1.89]	0.97	[0.72, 1.31]
Lifting						
Never	1134	563	1.00		1.00	
Quarter/Half	1512	838	1.26	[1.08, 1.47]	1.38	[1.00, 1.89]
Three quarter/Full	350	218	1.67	[1.31, 2.14]	1.08	[0.90, 1.30]
Carrying out repetitive task						
Never	642	322	1.00		1.00	
Quarter/Half	1188	644	1.17	[0.97, 1.42]	0.98	[0.79, 1.22]
Three quarter/Full	1154	645	1.25	[1.03, 1.52]	0.96	[0.76, 1.22]
Working at high speed						
Never	722	418	1.00		1.00	
Quarter/Half	1112	600	1.10	[0.93, 1.29]	0.98	[0.81, 1.19]
Three quarter/Full	1152	594	1.29	[1.07, 1.55]	1.11	[0.88, 1.39]
Standing						
Never	1669	885	1.00		1.00	
Quarter/Half	991	539	1.05	[0.90, 1.23]	0.93	[0.78, 1.16]
Three quarter/Full	334	192	1.19	[0.94, 1.51]	1.07	[0.81, 1.40]
Sitting						
Never	668	361	1.00		1.00	
Quarter/Half	1332	728	1.02	[0.85, 1.23]	1.04	[0.84, 1.29]

	Number of people at risk	Number of people with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*[a]	[95% CI]
Three quarter/Full	993	525	0.95	[0.78, 1.16]	1.17	[0.92, 1.49]
Using tools that vibrate						
Never	101	66	1.00		1.00	
Quarter/Half	516	313	1.41	[1.16, 1.71]	1.12	[0.88, 1.43]
Three quarter/Full	2372	1237	1.73	[1.13, 2.62]	1.29	[0.80, 2.10]
Psychosocial Factors						
Contact and cooperation with management						
Very satisfied/Satisfied	2077	1064	0.74	[0.62, 0.89]	0.88	[0.71, 1.10]
Neutral	627	336	1.00		1.00	
Very dissatisfied/Dissatisfied	186	120	1.28	[0.91, 1.80]	1.15	[0.79, 1.66]
Level and difficulty of work						
Very satisfied/Satisfied	2177	1141	0.82	[0.68, 0.97]	0.88	[0.72, 1.08]
Neutral	663	380	1.00		1.00	
Very dissatisfied/Dissatisfied	159	98	1.19	[0.83, 1.70]	1.06	[0.71, 1.58]
Work stress						
Not stress at all	361	167	1.00		**1.00**	
Mildly/Moderately stressful	2177	1180	1.37	[1.10, 1.71]	**1.31**	**[1.02, 1.68]**
Very/Extremely stressful	452	268	1.69	[1.28, 2.23]	**1.46**	**[1.05, 2.03]**
Working to tight deadlines						
Never	534	282	1.00		1.00	
Quarter/Half	1169	606	0.96	[0.78, 1.18]	0.81	[0.64, 1.03]
Three quarter/Full	1285	729	1.17	[0.95, 1.43]	0.86	[0.67, 1.10]
Boring work						
Never	333	193	1.00		1.00	
Quarter/Half	1413	795	1.26	[1.08, 1.47]	1.13	[0.95, 1.35]
Three quarter/Full	1237	623	1.35	[1.06, 1.73]	1.01	[0.75, 1.37]
Organisational Factors						
Work organisation						
Very satisfied/Satisfied	2209	365	0.80	[0.67, 0.96]	1.01	[0.82, 1.25]
Neutral	631	1159	1.00		1.00	
Very dissatisfied/Dissatisfied	152	89	1.03	[0.71, 1.47]	0.83	[0.56, 1.22]
Organisational culture						
Very satisfied/Satisfied	1820	929	0.78	[0.66, 0.93]	0.87	[0.72, 1.06]
Neutral	829	472	1.00		1.00	
Very dissatisfied/Dissatisfied	344	215	1.26	[0.97, 1.63]	1.09	[0.81, 1.48]
Environmental Factors						
Working in a cold or damp environment						

	Number of people at risk	Number of people with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*^{a}	[95% CI]
Never	1997	1015	1.00		1.00	
Quarter/Half	859	525	1.52	[1.29, 1.79]	1.21	[0.98, 1.49]
Three quarter/Full	122	68	1.21	[0.84, 1.76]	0.87	[0.58, 1.32]
Working in a hot or warm environment						
Never	1798	902	1.00		1.00	
Quarter/Half	1035	616	1.46	[1.25, 1.70]	1.16	[0.96, 1.41]
Three quarter/Full	147	89	1.52	[1.08, 2.14]	1.23	[0.85, 1.80]
Working outside						
Never	1692	876	1.00		1.00	
Quarter/Half	911	503	1.14	[0.97, 1.35]	0.97	[0.80, 1.18]
Three quarter/Full	380	232	1.46	[1.16, 1.83]	1.05	[0.79, 1.41]
Exposure to loud noise						
Never	1729	883	1.00		1.00	
Quarter/Half	839	483	1.30	[1.10, 1.53]	1.00	[0.81, 1.23]
Three quarter/Full	428	252	1.37	[1.10, 1.70]	0.99	[0.75, 1.31]

Note. CI = confidence interval; *OR* = odds ratio.

[a] Adjusted for age, awkward or tiring positions, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, standing, sitting, using tools that vibrate, contact and cooperation with management, level and difficulty of work, boring work, working to tight deadlines, work stress, work organisation, organisational culture, working in a cold/damp environment, a hot/warm environment, working outside, and exposed to loud noise.

The explanatory variables that were significantly associated with LBS in the adjusted model were indicated in **bold.**

Table 3.2 presents the risk factors for LBS for the male-only population. In the unadjusted model there were significant associations with LBS for some physical factors (i.e. awkward or tiring positions, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, and using tools that vibrate), some of the psychosocial factors (i.e. contact and cooperation with management, level and difficulty of work, and boring work), and all of the environmental factors (i.e. working in cold/damp environment, working in hot/warm environment, working outside and exposure to loud noise). In the adjusted model, none of the physical, psychosocial, organisational, and environmental factors were significantly associated with LBS.

Table 3.2 *Risk factors for LBS in unadjusted and adjusted models for the male-only population*

	Number of men at risk	Number of men with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*^{a}	[95% CI]
Individual Factors						
Age						
20-34	302	163	1.00		1.00	
35-44	349	198	1.12	[0.82, 1.53]	1.10	[0.79, 1.54]
45-54	404	241	1.26	[0.93, 1.70]	**1.47**	**[1.05, 2.05]**
55+	376	207	1.04	[0.77, 1.41]	1.31	[0.93, 1.85]
Physical Factors						
Awkward or tiring position						
Never	371	173	1.00		1.00	
Quarter/Half	787	469	1.68	[1.31, 2.16]	1.22	[0.89, 1.65]
Three quarter/Full	264	162	1.81	[1.31, 2.50]	0.97	[0.62, 1.51]
Awkward grip or hand movements						
Never	584	287	1.00		1.00	
Quarter/Half	648	394	1.60	[1.28, 2.01]	1.27	[0.95, 1.69]
Three quarter/Full	194	125	1.87	[1.34, 2.62]	1.29	[0.81, 2.07]
Lifting						
Never	474	244	1.00		1.00	
Quarter/Half	754	433	1.27	[1.00, 1.60]	1.05	[0.79, 1.41]
Three quarter/Full	199	131	1.81	[1.28, 2.56]	1.47	[0.92, 2.35]
Carrying out repetitive task						
Never	330	172	1.00		1.00	
Quarter/Half	602	339	1.18	[0.90, 1.55]	0.93	[0.67, 1.28]
Three quarter/Full	489	293	1.37	[1.03, 1.82]	0.98	[0.69, 1.39]
Working at high speed						
Never	589	312	1.00		1.00	
Quarter/Half	538	311	1.21	[0.96, 1.50]	1.10	[0.83, 1.47]
Three quarter/Full	295	181	1.41	[1.06, 1.87]	1.19	[0.83, 1.47]
Standing						
Never	751	412	1.00		1.00	
Quarter/Half	520	297	1.09	[0.87, 1.37]	0.93	[0.71, 1.20]
Three quarter/Full	155	98	1.41	[0.99, 2.02]	1.14	[0.76, 1.72]
Sitting						
Never	304	174	1.00		1.00	
Quarter/Half	701	397	0.97	[0.74, 1.28]	1.14	[0.83, 1.58]
Three quarter/Full	419	233	0.93	[0.69, 1.26]	1.36	[0.93, 1.99]
Using tools that vibrate						

	Number of men at risk	Number of men with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*^{a}	[95% CI]
Never	969	516	1.00		1.00	
Quarter/Half	370	236	1.54	[1.20, 1.97]	1.19	[0.86, 1.66]
Three quarter/Full	82	52	1.52	[0.95, 2.42]	1.19	[0.68, 2.09]
Psychosocial Factors						
Contact and cooperation with management						
Very satisfied/Satisfied	974	518	0.67	[0.51, 0.87]	0.81	[0.62, 1.01]
Neutral	315	198	1.00		1.00	
Very dissatisfied/Dissatisfied	78	47	0.89	[0.53, 1.48]	0.73	[0.41, 1.30]
Level and difficulty of work						
Very satisfied/Satisfied	1065	581	0.73	[0.55, 0.95]	0.79	[0.57, 1.08]
Neutral	291	181	1.00		1.00	
Very dissatisfied/Dissatisfied	72	45	1.01	[0.59, 1.72]	0.93	[0.50, 1.73]
Work stress						
Not stress at all	149	86	1.00		1.00	
Mildly/Moderately stressful	1062	596	0.93	[0.66, 1.32]	0.91	[0.60, 1.36]
Very/Extremely stressful	213	124	1.02	[0.66, 1.56]	0.87	[0.52, 1.46]
Working to tight deadlines						
Never	213	119	1.00		1.00	
Quarter/Half	562	308	0.95	[0.69, 1.31]	0.92	[0.64, 1.34]
Three quarter/Full	645	379	1.12	[0.82, 1.53]	1.04	[0.71, 1.53]
Boring work						
Never	555	290	1.00		1.00	
Quarter/Half	700	411	1.30	[1.03, 1.62]	1.15	[0.88, 1.50]
Three quarter/Full	163	100	1.45	[1.01, 2.07]	1.03	[0.65, 1.61]
Organisational Factors						
Work organisation						
Very satisfied/Satisfied	1001	555	0.90	[0.70, 1.17]	1.11	[0.82, 1.51]
Neutral	320	185	1.00		1.00	
Very dissatisfied/Dissatisfied	100	61	1.14	[0.72, 1.80]	1.00	[0.60, 1.67]
Organisational culture						
Very satisfied/Satisfied	855	462	0.84	[0.67, 1.07]	1.00	[0.75, 1.33]
Neutral	415	241	1.00		1.00	
Very dissatisfied/Dissatisfied	153	101	1.40	[0.95, 2.06]	1.33	[0.84, 2.10]
Environmental Factors						
Working in a cold or damp environment						

	Number of men at risk	Number of men with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*[a]	[95% CI]
Never	842	433	1.00		1.00	
Quarter/Half	511	328	1.69	[1.35, 2.12]	1.30	[0.95, 1.77]
Three quarter/Full	60	37	1.52	[0.88, 2.60]	0.96	[0.51, 1.80]
Working in a hot or warm environment						
Never	783	408	1.00		1.00	
Quarter/Half	565	352	1.51	[1.21, 1.89]	1.07	[0.80, 1.43]
Three quarter/Full	67	39	1.28	[0.77, 2.12]	1.05	[0.59, 1.89]
Working outside						
Never	573	302	1.00		1.00	
Quarter/Half	538	301	1.14	[0.90, 1.44]	0.89	[0.68, 1.18]
Three quarter/Full	306	197	1.62	[1.21, 2.15]	1.11	[0.77, 1.60]
Exposure to loud noise						
Never	620	316	1.00		1.00	
Quarter/Half	508	316	1.58	[1.24, 2.01]	1.19	[0.87, 1.61]
Three quarter/Full	300	176	1.36	[1.03, 1.80]	0.93	[0.64, 1.37]

Note. CI = confidence interval; *OR* = odds ratio.

[a] Adjusted for age, awkward or tiring position, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, standing, sitting, using tools that vibrate, contact and cooperation with management, level and difficulty of work, boring work, working to tight deadlines, work stress, work organisation, organisational culture, working in a cold/damp environment, a hot/warm environment, working outside, and exposed to loud noise.

The explanatory variables that were significantly associated with LBS in the adjusted model were indicated in **bold.**

Among the female-only population, in the unadjusted model there were significant associations with LBS for two physical factors (i.e. awkward or tiring position and lifting), two psychosocial factors (i.e. contact and cooperation with management, and work stress), all of the organisational factors (i.e. work organisation and organisational culture), and one environmental factor (i.e. working in hot/warm environment) (Table 3.3). In the adjusted model, there were significant associations between LBS and awkward or tiring position, contact and cooperation with management, and work stress.

Females whose work involved an awkward or tiring position for quarter/half and three quarter/full-time were 1.45, 95% CI [1.11, 1.91] and 1.51, 95% CI [1.04, 2.20] times more likely to report LBS than those whose work did not involve such situations, respectively. Dissatisfaction with contact and cooperation with management also increased the risk of LBS (*OR* 1.68, 95% CI [1.02, 2.78]). The *ORs* for females who reported their work to be mildly/moderately stressful and very/extremely stressful were 1.77, 95% CI [1.27, 2.46] and 2.27, 95% CI [1.46, 3.52], respectively.

Table 3.3 *Risk factors for LBS in unadjusted and adjusted models for the female-only population*

	Number of women at risk	Number of women with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*	[95% CI]
Individual Factors						
Age						
20-34	357	178	1.00		1.00	
35-44	471	259	1.22	[0.93, 1.61]	**1.38**	**[1.03, 1.86]**
45-54	464	239	1.06	[0.81, 1.40]	1.32	[0.97, 1.78]
55+	280	136	0.95	[0.77, 1.41]	1.13	[0.79, 1.61]
Physical Factors						
Awkward or tiring position						
Never	428	183	1.00		**1.00**	
Quarter/Half	845	459	1.59	[1.25, 2.01]	**1.45**	**[1.11, 1.91]**
Three quarter/Full	294	166	1.73	[1.28, 2.34]	**1.51**	**[1.04, 2.20]**
Awkward grip or hand movements						
Never	789	396	1.00		1.00	
Quarter/Half	601	316	1.10	[0.85, 1.65]	0.85	[0.66, 1.10]
Three quarter/Full	176	96	1.19	[0.89, 1.36]	0.79	[0.53, 1.20]
Lifting						
Never	660	319	1.00		1.00	
Quarter/Half	758	405	1.22	[0.99, 1.51]	1.18	[0.87, 1.43]
Three quarter/Full	151	87	1.45	[1.01, 2.07]	1.35	[0.87, 2.11]
Carrying out repetitive task						
Never	312	150	1.00		1.00	
Quarter/Half	586	305	1.17	[0.89, 1.54]	1.05	[0.77, 1.43]
Three quarter/Full	665	352	1.21	[0.92, 1.59]	0.96	[0.70, 1.34]
Working at high speed						
Never	563	282	1.00		1.00	
Quarter/Half	574	289	1.01	[0.80, 1.27]	0.87	[0.66, 1.14]
Three quarter/Full	427	237	1.24	[0.96, 1.60]	1.04	[0.76, 1.42]
Standing						
Never	918	473	1.00		1.00	
Quarter/Half	471	242	0.99	[0.79, 1.24]	0.98	[0.77, 1.26]

	Number of women at risk	Number of women with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*	[95% CI]
Three quarter/Full	179	94	1.04	[0.75, 1.43]	0.99	[0.68, 1.44]
Sitting						
Never	364	187	1.00		1.00	
Quarter/Half	631	331	1.04	[0.80, 1.35]	0.94	[0.70, 1.27]
Three quarter/Full	574	292	0.98	[0.75, 1.27]	1.03	[0.75, 1.43]
Using tools that vibrate						
Never	1403	721	1.00		1.00	
Quarter/Half	146	77	1.05	[0.75, 1.48]	0.93	[0.63, 1.38]
Three quarter/Full	19	14	2.64	[0.94, 7.39]	1.66	[0.54, 5.09]
Psychosocial Factors						
Contact and cooperation with management						
Very satisfied/Satisfied	1103	546	0.82	[0.64, 1.06]	1.09	[0.80, 1.48]
Neutral	312	169	1.00		1.00	
Very dissatisfied/Dissatisfied	108	73	1.76	[1.11, 2.79]	**1.68**	**[1.02, 2.78]**
Level and difficulty of work						
Very satisfied/Satisfied	1112	560	0.88	[0.69, 1.11]	0.97	[0.73, 1.28]
Neutral	372	199	1.00		1.00	
Very dissatisfied/Dissatisfied	87	53	1.35	[0.84, 2.18]	1.18	[0.67, 2.05]
Work stress						
Not stress at all	212	81	1.00		**1.00**	
Mildly/Moderately stressful	1115	584	1.77	[1.31, 2.40]	**1.77**	**[1.27, 2.46]**
Very/Extremely stressful	239	144	2.45	[1.67, 3.58]	**2.27**	**[1.46, 3.52]**
Working to tight deadlines						
Never	321	163	1.00		1.00	
Quarter/Half	607	298	0.93	[0.71, 1.22]	0.79	[0.57, 1.10]
Three quarter/Full	640	350	1.17	[0.89, 1.53]	0.78	[0.55, 1.09]
Boring work						
Never	682	333	1.00		1.00	
Quarter/Half	713	384	1.22	[0.99, 1.51]	1.12	[0.88, 1.43]
Three quarter/Full	170	93	1.26	[0.90, 1.77]	1.09	[0.71, 1.66]
Organisational Factors						
Work organisation						
Very satisfied/Satisfied	1208	604	0.72	[0.56, 0.93]	0.94	[0.70, 1.26]
Neutral	311	180	1.00		1.00	
Very dissatisfied/Dissatisfied	52	28	0.84	[0.47, 1.53]	0.69	[0.36, 1.30]
Organisational culture						

	Number of women at risk	Number of women with LBS	Unadjusted Model		Adjusted Model	
			OR	[95% CI]	*OR*	[95% CI]
Very satisfied/Satisfied	965	467	0.74	[0.58, 0.93]	0.76	[0.58, 1.00]
Neutral	414	231	1.00		1.00	
Very dissatisfied/Dissatisfied	191	114	1.17	[0.82, 1.66]	0.89	[0.59, 1.35]
Environmental Factors						
Working in a cold or damp environment						
Never	1155	582	1.00		1.00	
Quarter/Half	348	197	1.28	[1.00, 1.63]	1.08	[0.80, 1.45]
Three quarter/Full	62	31	0.98	[0.59, 1.64]	0.70	[0.39, 1.25]
Working in a hot or warm environment						
Never	1015	494	1.00		1.00	
Quarter/Half	470	264	1.35	[1.08, 1.68]	1.28	[0.98, 1.67]
Three quarter/Full	80	50	1.75	[1.10, 2.81]	1.47	[0.88, 2.46]
Working outside						
Never	1119	574	1.00		1.00	
Quarter/Half	373	202	1.12	[0.88, 1.41]	1.05	[0.80, 1.38]
Three quarter/Full	74	35	0.85	[0.53, 1.36]	0.71	[0.40, 1.24]
Exposure to loud noise						
Never	1109	567	1.00		1.00	
Quarter/Half	331	167	0.97	[0.76, 1.24]	0.81	[0.61, 1.09]
Three quarter/Full	128	76	1.39	[0.96, 2.02]	1.18	[0.76, 1.82]

Note. CI = confidence interval; *OR* = odds ratio.

[a] Adjusted for age, awkward or tiring position, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, standing, sitting, using tools that vibrate, contact and cooperation with management, level and difficulty of work, boring work, working to tight deadlines, work stress, work organisation, organisational culture, working in a cold/damp environment, a hot/warm environment, working outside, and exposed to loud noise.

The explanatory variables that were significantly associated with LBS in the adjusted model were indicated in **bold.**

The results of the Hosmer-Lemeshow goodness of fit tests were: p = .698 for the model for the whole (male and female) population; p = .894 for the male-only population, and; p = .132 for the female-only population, indicating that lack-of-fit was not large enough to reject the models. The areas under the ROC curve for the model were .603, .627, and .621 for the whole, male-only, and female-only population, respectively, indicating that the models had poor discriminatory ability.

3.4 Discussion

Among all populations, participants who reported LBS were involved in awkward or tiring positions (78%), awkward grip or hand movements (58%), lifting (62%), carrying out repetitive task (79%), working at high speed (63%), standing (45%), sitting (78%), using tools that vibrate (24%), working to tight deadlines (83%), boring work (61%), working in a cold or damp environment (37%), working in a hot or warm environment (44%), working outside (45%), and exposure to loud noise (45%) for more than a quarter of their work time. Only 10% reported that they were ‘‘not at all’ stressed at work. In contrast, participants who did not report LBS were satisfied with their contact and cooperation with management (76%), level and difficulty of work (76%), work organisation (76%), and organisational culture (65%).

Multivariate analyses control for associations among explanatory variables and identify only the factors that are highly associated with the outcome. Hence, although a relatively large number of risk factors for LBS were identified in the unadjusted model, only a small number remained as significant factors in the stronger adjusted model. Awkward or tiring position was significantly associated with LBS among the whole and female-only populations. However, in the whole population, the association did not show a positive dose-response relationship. This might be partially attributed to other variables which confound awkward or tiring position. In the present study, among the whole population, the greatest proportion of participants who reported working in awkward or tiring positions for three quarter/full time did less lifting and were satisfied with their contact and cooperation with management, level and difficulty of work, work organisation, and organisational culture - all factors that might be expected to reduce the risk of LBS. Therefore, participants who reported working in awkward or tiring positions for three quarter/full time were less likely to report LBS than those who reported working in awkward or tiring positions for quarter/half time. The finding of an association between awkward or tiring position and LBS is consistent with review papers by Bernard (1997), Burdorf and Sorock (1997), Hoogendoorn et al. (1999), Beeck and Hermans (2000) and Lotters et al. (2003). The association appears to make sense because there are both physiological and biomechanical causal mechanisms that could explain this finding. Awkward postures reduce tissue oxygenation, which can lead to muscle fatigue in the low back region (McGill, Hughson, & Parks, 2000). Awkward postures can also increase the force on the tissues of the low back and could stimulate pain receptors (Callaghan & Dunk, 2002).

Although previous studies indicated that lifting was associated with LBS for males (Aasa, et al., 2005; Alcouffe, et al., 1999; Hooftman, et al., 2009) and females (Alcouffe, et al., 1999), Aasa et al. (2005) and Hooftman et al. (2009) failed to confirm the association for females. The present study also failed to confirm this association for both males and females, but our data suggest that a positive dose-response relationship may exist. Despite the nonsignificant 95% CI value, the *ORs* increased with increased exposure in adjusted models for both males and females. The odds of LBS in those males whose work involved lifting quarter/half time and three quarter/full time were 1.05, 95% CI [0.79, 1.41] and 1.47, 95% CI [0.92, 2.35] times greater than those who did not do lifting at all, respectively whereas for females the *ORs* were 1.18, 95% CI [0.87, 1.43] and 1.35, 95% CI [0.87, 2.11], respectively. Widanarko et al. (2012b) reported that lifting increased the risk of reduced activities due to LBS.

Although a review by Riihimaki (1991) proposed that maintenance of a sitting posture was a risk factor for LBS and a positive dose response relationship was also indicated in the present study for males, this association was not confirmed in some recent review papers (Hartvigsen, Leboeuf-Yde, Lings, & Corder, 2000; Hoogendoorn, et al., 1999). Hartvigsen et al. (2000) failed to confirm that sitting has a positive association with LBS found in two widely cited sources (i.e. Nachemson and Elfstrom (1970) and Magora (1972)), and proposed that either lack of particular knowledge or systematic citation bias may have created a myth that sitting causes LBS.

A cross-sectional study of 7,730 workers in Canada found that standing without freedom to sit was associated with LBS (Tissot, Messing, & Stock, 2009). This finding supports a previous study by Nelson-Wong et al. (2008) that LBS occurs among standing workers due to the load in the back muscles because of the need to maintain an upright posture. However, the data in the present study do not appear to support a relationship between standing and LBS. This is consistent with the findings of a recent review paper (Roffey, Wai, Bishop, Kwon, & Dagenais, 2010). Since both Tissot's and our study are cross-sectional, the possibility of bias due to different additional physical and psychosocial exposures among standing and nonstanding workers (Tissot, Messing, & Stock, 2005; Tissot, et al., 2009) might explain the different findings. For example, Tissot et al. (2005) found that those who work in a standing posture are more likely to be exposed to manual handling, repetitive work, forceful exertion, and low job decision latitude.

There was a positive dose-response association for work stress with LBS among the whole and female-only population. This result is consistent with findings in several review papers (Linton, 2000, 2001) and two studies (Devereux, et al., 2004; Tissot, et al., 2009). Also, a recent study in a Swedish population reported that females were more likely to suffer from LBS and stress than men (Leijon & Mulder, 2009). Work stress may either play a role as a mediator in the potential relationship between other risk factors (physical, psychosocial, and organisational) and LBS (Bongers, et al., 1993; Carayon, et al., 1999; Macdonald, 2004; Sauter & Swanson, 1996) or influence the detection of symptoms (Bongers, et al., 1993; Karsh, 2006). Our results also indicated an association between dissatisfaction with contact and cooperation with management and LBS (*OR* 1.68, 95% CI [1.02, 2.78]) for female-only population. This finding is in agreement with previous review papers (Beeck & Hermans, 2000; Bernard, 1997; Bongers, et al., 1993; Hoogendoorn, et al., 2000). It is also consistent with the idea that exposure to psychosocial factors can increase trunk muscular strain through neuromuscular mechanisms (i.e. 'Brussels model' (Johansson et al., 2003) and 'Neuromotor Noise Theory' (Van Galen, Muller, Meulenbroek, & Van Gemmert, 2002)) and/or overuse of the low-threshold motor units (Hagg, 1991; Sjogaard, Lundberg, & Kadefors, 2000) due to activation of the symphathetic-adrenal medullary system) which can leads to increased spine loading (Marras, 2008c). Therefore, workers exposed to psychosocial factors (i.e. dissatisfaction and work stress) are more likely to report the presence of LBS.

For the male-only population, none of the physical, psychosocial, organisational, and environmental factors were statistically significant in the adjusted model. This finding was different from previous cross-sectional studies which have reported associations between awkward posture (Aasa, et al., 2005; Alcouffe, et al., 1999), lifting (Aasa, et al., 2005; Alcouffe, et al., 1999), social support (Aasa, et al., 2005), and worry about different work conditions (Aasa, et al., 2005) with LBS among males. The different findings might be due to the use of different questionnaires and statistical methods between studies. The previous studies (Aasa, et al., 2005) asked about work posture for a specific body region (forward bending and twisting of the trunk) using illustration in graphs whereas in the present study the question for awkward or tiring position did not specify the body region. Quantification of load (>10 kg) was used in the questionnaire for lifting by Alcouffe et al. (1999) whilst in the present study the weight of the load was not mentioned. In addition, the previous studies (Aasa, et al., 2005; Alcouffe, et al., 1999) estimated the association between risk factors and LBS without adjusting for all explanatory variables, whereas the present study used logistic regression adjusting for all potential confounders (full adjustment). The lack of statistical significance for each explanatory variable in the logistic model might have been partially due to high correlation (multicollinearity) between explanatory variables (Chatterjee & Hadi, 2006). Chatterjee and Hadi (2006) argued that when the variance inflation factor (VIF) is less than 10, this is unlikely. Since the VIFs for all explanatory variables in the present study were between 1.2 and 2.9, the possibility of high multicollinearity in the present study is unlikely.

Although the present study has identified a number of risk factors for LBS, other studies have also identified additional risk factors such as whole-body vibration (Burdorf & Hulshof, 2006; Burdorf & Sorock, 1997; Hoogendoorn, et al., 1999; Lotters, et al., 2003), heavy physical load (Bernard, 1997; Hoogendoorn, et al., 1999), static work posture (Bernard, 1997), low job decision latitude (Bernard, 1997;

Bongers, et al., 1993), and effort-reward imbalance (Lau, 2008; Rugulies & Krause, 2008). Previous studies have also reported that driving (Alcouffe, et al., 1999; Hooftman, et al., 2009), physical demands (Aasa, et al., 2005), psychosocial demands (Hooftman, et al., 2009), and skill discretion (Hooftman, et al., 2009) were positively associated with LBS (for male-only populations). Also, nonworking activities during leisure time (e.g. farming, hiking, gardening, and sport) might influence the occurrence of LBS. Additionally, greater specificity in the form of the questions about awkward or tiring positions (e.g. trunk bending, trunk rotation) and in the way in which the load for lifting questions are asked – and the responses quantified – would probably be a useful addition in future studies that explore LBS risk factors.

Some studies cited above (Aasa, et al., 2005; Hooftman, et al., 2009; Tissot, et al., 2009) have examined the risk factors for LBS using variable selection process for the multivariate analysis. When our data were analysed using this approach, i.e. only included variables with $p < .20$ (Hosmer & Lemeshow, 2000), the results (the risk factors) for the selected and nonselected processes were the same but there were some small differences in the resultant odds ratios. For the whole population, the odds of LBS in those whose work involved awkward or tiring positions quarter/half time and three quarter/full time were 1.36, 95% CI [1.11, 1.66] and 1.23, 95% CI [0.93, 1.64] times greater than those whose work did not involve such situations, respectively. Participants who reported their work to be mildly/moderately stressful and very/extremely stressful were 1.32, 95% CI [1.03, 1.70] and 1.48, 95% CI [1.07, 2.05] times more likely to have LBS than those who indicated they were not stressed at all, respectively. None of the explanatory variables were significantly associated with LBS among males. Among females, those whose work involved an awkward or tiring position for quarter/half and three quarter/full-time were 1.35, 95% CI [0.95, 1.93] and 1.38, 95% CI [1.06, 1.78] times more likely to report LBS than those whose work did not involve such situations, respectively. Dissatisfaction with contact and cooperation with management also increased the risk of LBS (*OR* 1.69, 95% CI [1.03, 2.77]) among females. The *ORs* for females who reported their work to be mildly/moderately stressful and very/extremely stressful were 1.79, 95% CI

[1.29, 2.48] and 2.28, 95% CI [1.47, 3.52], respectively. The limitation of this approach is that although some variables were not statistically significant ($p > .05$) in the unadjusted model, they can still confound other variables and lead to biased final results (Rothman, et al., 2008). Furthermore, not taking into account potential confounders may lead to invalid estimation of the effect(s) of particular risk factors (Greenland, 1987). Therefore we used a fully adjusted model because it adjusts for all potential confounders (on which information was collected) and therefore provides a more appropriate estimation of risks.

The present study found there are differences between the genders in a few risk factors for LBS. Gender differences in risk factors might be due to gender segregation in the workforce (Burdorf & Sorock, 1997). The exposures might differ between occupation (Aasa, et al., 2005). A technical report which used the same data set as the present study reported that 43% of women participants worked as professionals (i.e. physical, mathematical and engineering science professionals, life science and health professionals, teaching professionals, and other professionals) and clerks, whereas 38% of men participants worked in manual work ('t Mannetje et al., 2009). Messing et al. (1994) showed that even in the same job, women and men performed different tasks. In the present study, it is possible that men and women might have had different exposures, even for the same jobs or tasks. Another possible explanatory factor might be that differences in physiological and psychological characteristics between men and women, such as differences in the methods used to perform the same task (van der Beek, et al., 2000), differences in thermal thresholds and responses to cold environments (Sormunen et al., 2009), and differences in coping strategies in relation to stress (Matud, 2004; Ptacek, Smith, & Dodge, 1994), may have produced gender differences in exposure perceptions that could have been reflected in gender differences in self-reported responses to questions. In addition, since females often have more responsibility at both home and work, and spent more time doing household activities than males (Dahlberg, Karlqvist, Bildt, & Nykvist, 2004), females are more likely to be exposed to some of the physical risk factors (Dahlberg, et al., 2004; Strazdins & Bammer, 2004) such as awkward static posture. Thus, males and females may commonly be exposed to different risk factors. The fact that the association for gender disappears after adjusting for the occupational risk factors (see Table 3.1) suggests that a large part of the gender differences in risk factors of LBS are due to differences in occupational risk factors between men and women. Furthermore, in order to examine the interaction between age and gender and LBS, further analysis was conducted. We created a new variable, that was a combination of age (20-34 and 35-44 age group as a younger group and 45-54 and 55+ age group as an older group) and gender (male and female), and examined its association with LBS using multivariate analyses. After adjusting for all explanatory variables, the *ORs* for younger male, older female, and older male were 1.12, 95% CI [0.91, 1.37], 0.91, 95% CI [0.75, 1.11], and 1.21, 95% CI [0.99, 1.47] compared to the younger female group, respectively. This showed that age and gender was not significantly associated with LBS and therefore suggests that occupational risk factors have a larger impact on the occurrence of LBS than age and gender.

The present study indicates that physical factors as well as psychosocial factors have an important role in developing LBS. This finding is supported by previous studies amongst a general working population in Denmark (Andersen, et al., 2007), scaffolders (Elders & Burdorf, 2001), and Swedish construction workers (Engholm & Holmström, 2005). However, a recent cross-sectional study of a Swiss working population indicates that high physical demands (*OR* 5.0, 95% CI [3.1, 8.0]) have a stronger association with LBS than high psychosocial demands (*OR* 1.4, 95% CI [0.9, 2.1]) (Canjuga, Läubli, & Bauer, 2010). The differences might be due to different tools that were used to collect the data between Canjuga's and the present study. Canjuga's study used the job content questionnaire (Karasek, et al., 1998) to assess both physical (i.e. carrying or moving heavy loads, tiring and painful position, vibration, and repetitive hand or hand movement) and psychosocial factors, whereas more specific physical exposure (i.e. awkward or tiring position, awkward grip or hand movements, lifting, carrying out repetitive tasks, working at very high speed, standing, sitting, or using tools that vibrate) and a modified version of the Job Content Questionnaire (Karasek, et al., 1998) were used in the present study.

Although the present study indicated a number of physical and psychosocial risk factors for LBS, the lack of discriminatory ability of our model clearly indicates that risk factors for LBS are more subtle (and probably more complex) than the very crude exposure estimates that were able to be collected during the telephone interviews used in this study. Therefore it is suggested that to get a better understanding of this problem, more detailed investigations (e.g. prospective cohort studies) need to be carried out.

Previous studies have shown that duration of current work was associated with LBS (Devereux, et al., 1999; Morken, et al., 2000). In the present study we found that after adjusting for duration of current work the risk factors were the same for males, females, and the whole population. Only small differences were found in the ORs. Since the exposure of the previous job may also have impact on the occurrence of the present LBS, a measure of the duration of total lifetime exposure would be a useful addition to this kind of analysis. It would therefore be useful in future research to explore the relationship between cumulative exposure to risk factors, in place of ‘duration of current work’, and LBS.

The large sample size in the present study allowed us to explore dose-response associations and to adjust for all potential confounding factors by conducting multivariate logistic regression analyses. In addition, a previously published paper that used the same data set as the present study indicated that there was no evidence of major nonresponse bias (Mannetje, et al., 2011). Hence, the possibility of response bias in the present study is unlikely. However, two potential limitations may have influenced the interpretation of our results. Firstly, self-reported physical exposure has been criticised for not providing accurate information about real exposures. However, self-reported questionnaires can discriminate between exposed and nonexposed groups (Balogh, et al., 2004). Furthermore, self-reported methods are said to have better capacity, versatility, and generality than observation methods and direct measurement (Winkel & Mathiassen, 1994). In order to conduct a survey with such a large sample, it was necessary to use a telephone self-report interview method.

We selected this approach because it has been reported to provide valid (Kallio, et al., 2000; van Ooijen, et al., 1997) and reliable data (Kallio, et al., 2000).

Second, analyses based on cross-sectional studies cannot be used to make causal inferences. The positive association between risk factors and LBS reported in the present study may have been biased due to the selection processes used to identify the participants (i.e. a healthy worker effect). Although by adjusting for potential confounders multivariate analyses in a cross-sectional study can provide appropriate information about the relationship between LBS and risk factors (Bongers, et al., 1993; Davis & Heaney, 2000), longitudinal studies are needed to reach firm conclusions about the causal relationship between LBS and its risk factors (Hartvigsen, et al., 2001).

In conclusion, this study has shown that self-reported awkward or tiring positions at work, dissatisfaction with contact and cooperation with management, and perceived work stress were significant risk factors for LBS for women, but not for men. The findings imply that any efforts to reduce LBS in the workplace should focus on reducing exposure to awkward or tiring positions, improving contact and cooperation with management, and reducing work stress, especially amongst females. However, longitudinal studies with valid and reliable tools are necessary to provide better estimation of risk factors for LBS with gender differences.

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References

The references for this chapter have been integrated with the list of references at the end of the thesis.

Post-script

Summary of findings

This chapter shows that exposure to the physical and psychosocial factors increased the risk of LBS for the whole and female populations, whereas exposure to organisational and environmental factors did not. It also found that exposure to physical, psychosocial, organisational, and environmental factors did not increase the risk of LBS for the male population. In summary, the gap, aim and hypotheses, and findings for this chapter are as follows:

Gap	Aim and Hypotheses	Findings
Less is known about LBS risk factors among the New Zealand working population	To examine the association between physical, psychosocial, organisational, environmental risk factors and LBS for specific population: the whole, male, and female population The hypotheses are:	
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the whole population	• Exposure to the physical (working in awkward or tiring positions) and the psychosocial (work stress) risk factors increased the risk of LBS for the whole population
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the male population	• None of the risk factors increased the risk of LBS for the male population
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the female population	• Exposure to the physical (working in awkward or tiring positions) and the psychosocial (contact and cooperation with management and work stress) risk factors increased the risk of LBS for the female population

Strengths of the present study

This study employed a fully adjusted model to control for all of the potential confounders that were considered to be appropriate LBS risk factors in the estimation process. An alternative approach that could have been applied would have been to use a variable selection process in a multivariate analysis, such as a stepwise regression analysis. The extent of confounding depends on the association between potential confounder and outcome and also between potential confounder and the exposure. In stepwise analysis, however, the coefficient that is tested for significance only assesses the association between the potential confounder and the outcome. As a result, this approach could include variables that are significantly associated with the outcome but are not confounding. The approach could also omit variables that are not associated with the outcome but yet are still confounders (Rothman, 2012). For these reasons, it was considered that a fully adjusted model is more appropriate that a multiple regression approach in the estimation of LBS risk factors. Apart from other advantages that have been described in the Discussion section of this chapter, there is another advantage. This study examined a wide range of risk factors for LBS in the workplace (physical, psychosocial, organisational, and environmental factors) whereas only a few studies (Harkness, et al., 2003; Piedrahita, et al., 2004; Scuffham, et al., 2010; Virtanen et al., 2008) included environmental factor in their analyses.

Limitations of the present study

There are five limitations in this study. First, as explained in the Post-script of Chapter 2, the low screening level to determine LBS cases may lead to misclassification of LBS or non-LBS. This condition may have influenced the findings, particularly when assessing the association between risk factors and LBS. All workers who answered ‘yes’ to LBS question were grouped as having LBS (cases), meaning that this group may consist of those with LBS with various severity (from mild to severe) and duration (from few hours to several months or years). It may imply that those who experienced LBS for few hours and were not exposed to risk factors were in the same group with those who experienced LBS for several months and were exposed to risk factors. As a result, the strength of the association between risk factors and outcome may be reduced so that most of the association between risk factors and outcome became nonsignificant in this study. In addition, the lack of information about the first occurrence of LBS makes it impossible in this study to adjust for a healthy worker effect. This often occurs in cross-sectional studies. This information is also needed to exclude respondents who already have LBS (i.e. before entering their current job) in the analysis in order to quantify the effect of workplace exposures on LBS risk.

Second, this study did not include some relevant factors that have been found to be associated with LBS by previously being studied, i.e. whole-body vibration, effort, and reward, as explained in the Discussion section of this chapter. It is, therefore, suggested to include these known predictors in future studies.

Third, the validity and reliability of the physical exposure questions used in this study have not been assessed which may lead to misclassification bias. For the psychosocial and organisational questionnaire, Cronbach's alphas were assessed to quantify the reliability for each measure. As described in the Methods section of this chapter, the Cronbach's alphas for psychosocial factors were .75 for contact and cooperation with management, and .65 for level and difficulty of work. The Cronbach's alphas for the organisational factor were .54 for work organisation, and .53 for organisational culture, which were quite low. Nunnally and Bernstein (1994) suggested that Cronbach's alpha should be at least .70. The low Cronbach's alpha means that the items have very little in common as a single measure, which may provide less meaningful results. Therefore, future studies are required to use a valid and reliable questionnaire to avoid biased results.

Fourth, although this study has indicated the risk factors for LBS among the New Zealand workers, it did not examine the interaction between risk factors. In reality, workers are most commonly subject to mixed exposures simultaneously rather than single exposure and each of these exposures may be correlated with each other in the workplace. Thus, it makes sense that examining the interaction between the risk factors may provide appropriate estimation of LBS risk factors.

Finally, due to the nature of cross-sectional studies in which information of exposures and outcomes are gathered from a population during the same period of time, analyses based on cross-sectional studies cannot be used to make causal inferences. A longitudinal study is necessary to obtain firm conclusions about causal inference.

Chapter 4 Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms

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Preface

The previous chapters (Chapter 2 and Chapter 3) have presented the prevalence and risk factors for LBS amongst the New Zealand working population. Although LBS is a significant health problem due to its social and economic impacts, less is known about the prevalence of (Gap 1.2) and risk factors for (Gap 2.3) the consequences of LBS. Hence, this chapter presents the prevalence of and risk factors for LBS consequences, in terms of reduced activities and absenteeism. The gaps, aims, and hypotheses for this chapter are:

Gaps	Aims	Hypotheses
Less is known about the prevalence for LBS consequences among the New Zealand working population	To examine the prevalence of reduced activities due to LBS among the New Zealand working population	Since these aims are not testable (no variable tested), there is no hypothesis for this aim
	To examine the prevalence of absenteeism due to LBS among the New Zealand working population	Since these aims are not testable (no variable tested), there is no hypothesis for this aim
Less is known about risk factors of LBS consequences	To examine the differences in reduced activities due to LBS prevalence in relation to age group, gender, and occupational group	• The reduced activities due to LBS prevalence for those in the older group will be higher than in the younger group • The reduced activities due to LBS prevalence for males will be higher than females • The reduced activities due to LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload
	To examine the association	Exposure to physical, psychosocial,

	between physical, psychosocial, organisational, environmental risk factors and reduced activities due to LBS	organisational, and environmental risk factors will increase the risk of reduced activities due to LBS
	To examine the differences in absenteeism due to LBS prevalence in relation to age group, gender, and occupational group	• The absenteeism due to LBS prevalence for those in the older group will be higher than in the younger group • The absenteeism due to LBS prevalence for males will be higher than females • The absenteeism due to LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload
	To examine the association between physical, psychosocial, organisational, environmental risk factors and absenteeism due to LBS	Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of absenteeism due to LBS

Abstract

Although quite a lot is known about the risk factors for low back symptoms (LBS), less is known about the risk factors for the consequences of LBS. A sample of 3,003 men and women randomly selected from the New Zealand Electoral Roll, were interviewed by telephone about self-reported physical, psychosocial, organisational, environmental factors and the consequences of LBS (i.e. self-reported reduced activities and absenteeism). The 12-month period prevalence of reduced activities and absenteeism were 18% and 9%, respectively. Lifting (*OR* 1.79, 95% CI [1.16, 2.77]) increased the risk of reduced activities. Working in awkward/tiring positions (*OR* 2.11, 95% CI [1.20, 3.70]) and in a cold/damp environment (*OR* 2.18, 95% CI [1.11, 4.28]) increased the risk of absenteeism. Among those with LBS, reduced activities increased with working in a hot/warm environment (*OR* 2.14, 95% CI [1.22, 3.76]) and absenteeism was increased with work in awkward/tiring positions (*OR* 2.06, 95% CI [1.13, 3.77]), tight deadlines (*OR* 1.89, 95% CI [1.02, 3.50]), and a hot/warm environment (*OR* 3.35, 95% CI [1.68-6.68]). Interventions to reduce the consequences of LBS should aim to reduce awkward/tiring positions, lifting and work in a cold/damp environment. For individuals with LBS, additional focus should be to reduce tight deadlines, and work in hot/warm environments.

Keywords: back pain; disability; consequences; Nordic Musculoskeletal Questionnaire; environment

4.1 Introduction

Low back symptoms (LBS) are very prevalent amongst general and working populations and are a significant health problem due to their serious economic and social impacts (Hanson, et al., 2006; NRC & IOM, 2001). Between 1997 and 2005 27% of all Washington State fund-accepted health insurance claims were for work-related musculoskeletal disorders (WMSDs) involving the back (51%), upper extremity (37%), neck (12%) with an average direct cost of USD 12,377 per claim (Silverstein & Adams, 2007). In Finland, the direct and indirect cost of managing patients with LBS was 624 EUR per visit to general practitioners (Mantyselka, et al., 2002). A study in Sweden estimated the annual cost for sick listed more than one month due to back and neck problems was about 1.3% of Gross National Product (Hansson & Hansson, 2005).

The social consequences of LBS, including its severity, may be assessed in terms of the extent to which people are prevented from carrying out their normal activities (i.e. reduced activities) and absenteeism. Although many studies have reported on this, the findings of those that have used identical or very similar methods to that of the present study are summarised below. The social consequences of LBS arise from disability (e.g. diminished capacity for everyday activities and gainful employment, etc) (Waddell, 1991) and absenteeism. Although 10% of Chinese offshore workers (Chen, et al., 2005), 17% of New Zealand dentists (Palliser, et al., 2005), 21% of Swedish ambulance personnel (Aasa, et al., 2005), and 42% of New Zealand veterinarians (Scuffham, et al., 2010) are reported to have had reduced activities due to LBS, there are few other similar studies. The prevalence of absenteeism due to LBS was 9% for Irish health service workers (Cunningham, et al., 2006), 9% of New Zealand veterinarians (Scuffham, et al., 2010), and 10% of dentists in Greece (Alexopoulos, et al., 2004). Ijzelenberg et al. (2004) reported a similar figure of 14% of laundry and dry-cleaning workers in Netherlands whereas 15% of Greek shipyard workers had absenteeism due to LBS (Alexopoulos, et al., 2008). Among general working populations in Netherland, 9% of workers took sick leave due to absenteeism (Hooftman, et al., 2009), 18% of workers had $\geq$1 days of absenteeism due to LBS (van den Heuvel, et al., 2004), and 20% of workers had $\geq$3 days of absenteeism due to LBS (Hoogendoorn, et al., 2002). The last these three studies (Hooftman, et al., 2009; Hoogendoorn, et al., 2002; van den Heuvel, et al., 2004) used the company's register sickness absence data in their analysis.

Previous studies have identified physical and psychosocial risk factors for reduced activities and absenteeism due to LBS. Two cross-sectional studies by Aasa et al. (2005) and Simon et al. (2008) showed that physical factors (i.e. awkward posture and lifting) were associated with reduced activities due to LBS among Swedish ambulance personnel and nurses and auxiliary staff in various countries in Europe. Psychosocial risk factors for reduced activities due to LBS have been reported as: worry about work conditions (i.e. worry about being diseased/injured, worry about making mistakes, worry about being subjected to threats and/or violence) (Aasa, et al., 2005), lack of social support (Aasa, et al., 2005), high quantitative demands (Simon, et al., 2008), low influence at work (Simon, et al., 2008), and high effort reward imbalance ratio (Simon, et al., 2008).

Some prospective cohort studies have shown an association between physical risk factors and absenteeism from work due to LBS. These include manual material handling (Bergström, et al., 2007; Hooftman, et al., 2009; Hoogendoorn, et al., 2002) and awkward posture (Hooftman, et al., 2009; Hoogendoorn, et al., 2002; Tubach, et al., 2002). A case-control study among Dutch farmers also indicated twisting and whole-body vibration to be significantly associated with absenteeism due to LBS (Hartman, et al., 2005). Some psychosocial risk factors have also been shown to be predictors for absenteeism due to LBS in a few prospective cohort studies. These include job dissatisfaction (Hoogendoorn, et al., 2002; van den Heuvel, et al., 2004) and lack of social support (Tubach, et al., 2002; van den Heuvel, et al., 2004). In addition, Bartys et al. (2005) found that low job control, psychological distress and poor organisational climate was associated with absenteeism due to musculoskeletal symptoms among UK workers.

Although some studies have reported the risk factors for the consequences of LBS, most of them have explored only limited risk factors at a time. For example, Hoogendoorn et al. (2002) investigated the association between two physical factors (i.e. awkward posture and lifting), psychosocial factors (using Karasek's job content questionnaire (JCQ)) and absenteeism due to LBS among a general working population. Similarly, Hooftman et al. (2009) and van den Heuvel et al. (2004) assessed awkward posture, lifting, driving, and psychosocial factors in relation to absenteeism due to LBS. A wider range of physical factors were explored by Alexopoulos et al. (2006) and Alexopoulos et al. (2004). They assessed awkward posture, repetitive movements, prolonged sitting or standing, strenuous arm positions, and the use of vibrating tools, psychosocial (using Karasek's JCQ), perceived general health, and need for recovery in relation to LBS consequences. However, to our knowledge only one study has explored environmental factors (noise, draft, heat, cold, poor quality of internal air, and poor of blinding lighting) in relation to absenteeism due to LBS (Virtanen, et al., 2008). This study also included a wide range of psychosocial factors, but only a few physical factors (i.e. work posture, repetitive movements, and physical strain) in its analysis. Since workers are most commonly exposed to physical, psychosocial, organisational, and environment factors simultaneously, and each of these factors may be correlated with each other in the workplace, it is possible that there may be additional risk factors unreported in previous studies. Thus, the present study investigated a wider range of physical factors as well as psychosocial, organisational, and environmental factors in relation to the consequences of LBS, in which exposures were simultaneous. In addition, most studies cited above (Aasa, et al., 2005; Alexopoulos, et al., 2006; Bartys, et al., 2005; Hartman, et al., 2005; Hoogendoorn, et al., 2002; Simon, et al., 2008; Tubach, et al., 2002) examined the risk factors for the consequences of LBS in the whole population, regardless of the presence of LBS. In order to be more focused in preventive strategies, therefore, the present study also examined the risk factors for the consequences of LBS for only those individuals who reported LBS.

4.2 Methods

4.2.1 Participants

This study was part of a recent large national survey of self-reported current occupational exposures, workplace practices and occupational ill-health which has been described in detail elsewhere (Eng, et al., 2010). Ten thousand potential participants aged 20-64 years randomly selected from the New Zealand Electoral Roll (7,000 from 2003 and 3,000 from 2005) were invited by mail (three letters were sent) to have a telephone interview (Eng, et al., 2010). Of 10,000 mail-outs, 1,209 were returned to sender, 2,719 did not reply to the three invitation letters and could not be contacted by phone, 637 did not meet the study eligibility criteria (i.e. the addressee either no longer lived or never worked in New Zealand, or was deceased) and 2,425 refused to take part. Thus, 3,003 people were interviewed as the study participants (an additional seven questionnaires were missing and therefore excluded). Ethics approval for the study was obtained from the Massey University Human Ethics Committee (WGTN 13/133).

4.2.2 Questionnaire

The telephone interview sought information on demographic characteristics (including gender and age), lifetime work history, current self-reported physical, psychosocial, organisational, and environmental exposures, and various health conditions including musculoskeletal symptoms including LBS and the consequences of LBS (Eng, et al., 2010).

4.2.2.1 Consequences of low back symptoms

A modified version of the Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka, et al., 1987) was used to assess musculoskeletal symptoms (aches, pains, discomfort or numbness) in the low back region, and its consequences, with a recall period of 12 months. A yes/no response indicated if the participant had trouble (musculoskeletal aches, pains, discomfort, or numbness) in the low back regions, if the trouble prevented them from carrying out their normal activities (reduced activities) (e.g. housework, hobbies, gardening), and if they had been absent from work due to that trouble within the last 12 months (absenteeism). The prevalence of musculoskeletal symptoms and risk factors for LBS have been reported in earlier papers (Widanarko, et al., 2011; Widanarko, Legg, Stevenson, et al., 2012a).

4.2.2.2 Physical, psychosocial, organisational and environmental exposure assessments

In order to obtain information about physical exposures, participants were asked to estimate how much working time (never, quarter, half, three quarters or full time) during their work activities involved any of these situations: awkward or tiring position, awkward grip or hand movements, lifting, carrying out repetitive tasks, working at very high speed, standing, sitting, or using tools that vibrate.

Psychosocial and organisational exposures in their current working place were assessed using a modified version of the JCQ (Karasek, et al., 1998) with a 5-point Likert scale (very satisfied, satisfied, neutral, dissatisfied and very dissatisfied). Cronbach's alphas were computed for each of the items for the psychosocial and organisational exposure assessment to quantify the internal consistency or reliability. For psychosocial exposure, participants were asked about: *contact and cooperation with management* (contact and cooperation between yourself and senior management, the help and support given to you by your colleagues, the help and support given to you by your supervisor, cooperation among you and your fellow workers, with Cronbach's alpha = .75); and *level and difficulty of work* (the level of enjoyment of your work, the level of difficulty of work, the level of mental demands of work, with Cronbach's alpha = .65). An additional question on perceived job stress asked "In general, how do you find your job?", with a 5-point Likert scale for the response categories as follows: not at all stressful, mildly stressful, moderately stressful, very stressful and extremely stressful (Smith, Brice, Collins, Matthews, & McNamara, 2000; Smith et al., 1998). Participants were also asked to estimate the fraction of total work time (never, quarter, half, three quarters or full time) that the job involved boring work or working to tight deadlines. For organisational exposure, participants were asked about: *work organisation* (the total number of hours worked per week, the way work is organised, the times of the day when you are asked to work, with Cronbach's alpha = .54), and; *organisational culture* (details of the way the work organisation is run, and work as a whole, with Cronbach's alpha = .53).

Environmental exposures were assessed by asking participants to estimate how much of their working time (never, quarter, half, three quarters or full time) was spent in a cold/damp environment, a hot/warm environment, working outside or exposed to loud noise. The set of questions above have been used in a number of other similar studies (Dykes, 2009; Scuffham, et al., 2010).

4.2.3 Data Analysis

The New Zealand Standard Classification of Occupations (1999) (Statistics New Zealand, 2001) was used to group occupations (based on the main activity of the participant) into: legislator and administrator, professional, technicians and associate professionals, clerks, and service and sales workers, agriculture and fishery workers, trade workers, plant and machine operators and assemblers, and elementary workers (the occupation whose main tasks involve the use of hand-held tools and physical effort and the knowledge and experience to perform elementary and routine tasks, e.g. cleaner, pest control worker, courier and deliverer, refuse collector, etc).

Analysis of the data based on the five response categories for physical, psychosocial, organisational, and environmental exposure showed clear trends in LBS prevalence. Low numbers of cases each of the strata meant that the confidence intervals around the LBS prevalence estimates were unreasonably large. Therefore the 5-point categories were collapsed into three (i.e. the 1s and 2s and the 3s and the 4s and 5s were grouped as separate categories) as follows: physical, psychosocial (working to tight deadlines and boring work), and environmental factors - never, quarter/half or three quarters/full time; psychosocial (contact and cooperation with management and level and difficulty of work) and organisational factors - very satisfied/satisfied, neutral or dissatisfied/very dissatisfied, and; psychosocial (work stress) factors - not at all, mildly/moderately, very/extremely stressful.

The 12-month period prevalence of the consequences of LBS and their 95% confidence intervals [95% CI] were calculated for gender, age group, and physical workload. Legislator and administrators, professionals, technicians and associate professionals, clerks, and service and sales workers were classified into light physical workloads. Agriculture and fishery workers, trade workers, plant and machine operators and assemblers, and elementary workers were classified into heavy physical workloads. Differences in prevalence among gender, age group, and physical workload were assessed using the chi-square test. The level of significance was set at $p < .05$.

Two models from logistic regression analyses determined the association between explanatory variables and the consequences of LBS. The models were reported in term of odds ratios (*ORs*) and their 95% CI (Hosmer & Lemeshow, 2000; Pearce, 2004). The first model was not adjusted for gender, age, and any other explanatory variables. The second model was an adjusted model in that it explains the association between explanatory variables and the consequences of LBS after adjusting for gender, age (Davis & Heaney, 2000), and all explanatory variables (fully adjusted). Explanatory variables that were significant at $p < .05$ were identified as variables significantly associated with the risk of LBS consequences. The Hosmer-Lemeshow test was used to assess the fit of the final logistic regression model (Hosmer & Lemeshow, 2000). These analyses were carried out separately for both definitions of outcomes (reduced activities and absenteeism due to LBS). For those who reported LBS, multivariate analysis adjusted for gender, age, and all explanatory variables (fully adjusted) were conducted to find any association between risk factors and both outcomes (reduced activities and absenteeism due to LBS). All statistical analyses were conducted using PASW version 18.0 (Predictive Analytics Software (PASW) Statistics 18, 2009).

4.3 Results

4.3.1 Descriptive data for the sample

The overall response rate (the number interviewed as a proportion of the total eligible sample) was 37%. Forty-eight percent of the study participants were male (*n* = 1,431) and 52% female (*n* = 1,572). The age distributions of the sample were: 20-34 years – 22%; 35-44 years – 27%; 45-54 years – 29%, and; 55+ years – 22%, with a median age of 45 years (interquartile range 36-54 years). Table 4.1 presents the distribution of the sample in relation to age and occupational group for males, females, and the whole population.

Table 4.1 *Distribution of the sample in relation to age and occupational group for males, females, and the whole population*

Group	Male		Female		Whole	
	n	%	*n*	%	*n*	%
Age group:						
20-34	302	21	357	23	659	22
35-44	349	25	471	30	820	27
45-54	404	28	464	29	868	29
55+	376	26	280	18	656	22
Occupational group:						
Legislator and administrator	308	22	197	12	505	17
Professional	235	16	389	25	624	21
Technicians & Associate Professional	177	12	278	18	455	15
Clerks	70	5	286	18	356	12
Service and Sales workers	88	6	260	16	348	11
Agriculture and Fishery Workers	120	8	61	4	181	6
Trades Workers	225	16	15	1	240	8
Plant & Machine Operators & Assemblers	150	11	29	2	179	6
Elementary Workers	57	4	56	4	113	4
Missing	1		1		2	

4.3.2 Prevalence of reduced activities and absenteeism due to LBS

Table 4.2 presents the prevalence of reduced activities and absenteeism due to LBS for males, females, and the whole population. Of those with LBS (*n* = 1,621), 33% (*n* = 554) and 18% (*n* = 276) of participants reported reduced activities and absenteeism, respectively. There were no statistically significant differences in prevalence between gender for reduced activities and absenteeism due to LBS.

Table 4.2 *Prevalence of reduced activities and absenteeism due to LBS, expressed as the number of cases per 100 respondents at risk [95% CI] for males, females, and the whole population.*

	Males (*n* = 1,431)		Females (*n* = 1,572)		Whole (*n* = 3,003)	
	n	Prevalence [95% CI]	*n*	Prevalence [95% CI]	*n*	Prevalence [95% CI]
Low Back Symptoms[**]	809	56 [54, 59]	812	51 [49, 54]	1621	54 [52, 56]
Reduced activities	292	20 [18, 22]	262	17 [15, 19]	554	18 [17, 20]
Absenteeism [a]	143	10 [9, 12]	133	9 [7, 10]	276	9 [8, 10]

Note. CI = confidence interval.
[a] 52 missing data for absenteeism due to LBS.
[**] $p < .01$ as regards differences between gender.

The prevalence of reduced activities and absenteeism due to LBS in relation to age and gender is shown in Table 4.3.

Table 4.3 *Prevalence of reduced activities and absenteeism due to LBS, expressed as the number of cases per 100 respondents at risk [95% CI] in relation to age for males, females, and the whole population*

	20-34 years		35-44 years		45-54 years		55+ years		*p*
Reduced activities due to LBS									
Males	23	[18-27]	22	[18-26]	19	[16-23]	18	[14-22]	*ns*
Females	13	[10-18]	16	[12-19]	20	[16-23]	17	[13-21]	*ns*
Whole population	18	[15-21]	19	[16-21]	20	[17-22]	17	[14-20]	*ns*
Absenteeism due to LBS									
Males	11	[7-14]	10	[7-13]	11	[8-14]	10	[6-13]	*ns*
Females	8	[5-11]	9	[6-12]	9	[6-12]	9	[6-12]	*ns*
Whole population	10	[7-12]	9	[7-11]	10	[8-12]	9	[7-11]	*ns*

Note. CI = confidence interval; *ns* = not statistically significant.

Table 4.4 presents the prevalence of reduced activities and absenteeism due to LBS in relation to light physical workload (i.e. legislator and administrator, professional, technicians and associate professional, clerks, and service and sales workers) and heavy physical workload (i.e. agriculture and fishery workers, trade workers, plant and machine operators and assemblers, and elementary workers) for males, females, and the whole population separately.

Table 4.4 *Prevalence of reduced activities and absenteeism due to LBS, expressed as the number of cases per 100 respondents at risk [95% CI] in relation to light and heavy physical workload for males, females, and the whole population*

	Light physical workers		Heavy physical workers		*p*
Reduced activities due to LBS					
Males	19	[17-22]	22	[18-25]	*ns*
Females	17	[15-19]	14	[9-20]	*ns*
Whole population	18	[16-19]	20	[17-23]	*ns*
Absenteeism due to LBS					
Males	10	[8-12]	11	[8-13]	*ns*
Females	9	[7-10]	8	[4-13]	*ns*
Whole population	9	[8-10]	10	[8-12]	*ns*

Note. CI = confidence interval; *ns* = not statistically significant.

4.3.3 Risk factors for reduced activities due to LBS

The risk factors for reduced activities due to LBS are presented in Table 4.5. In the unadjusted model there were significant associations with reduced activities due to LBS ($p < .05$) for some physical factors (i.e. awkward or tiring position, awkward grip or hand movement, lifting, and using tools that vibrate) and environmental factors (i.e. working in cold/damp environment and exposure to loud noise). None of the psychosocial and organisational factors were statistically significant in the unadjusted model. In the adjusted model (adjusted for age, gender, and all explanatory variables) awkward grip or hand movement and lifting were significantly associated with reduced activities due to LBS.

Participants whose work involved awkward grip or hand movements quarter/half-time and three quarter/full-time were 1.41, 95% CI [1.07, 1.87] and 1.23, 95% CI

[0.79, 1.89] times more likely to have reduced activities due to LBS than those whose work did not involve such activities, respectively. The odds of reduced activities due to LBS in those whose work involved lifting quarter/half-time and three quarter/full-time were 1.26, 95% CI [0.95, 1.67] and 1.79, 95% CI [1.16, 2.77], respectively. The result of the Hosmer-Lemeshow goodness of fit test was *p* = .249, indicating that lack-of-fit was not large enough to reject the model.

Table 4.5 *Risk factors for reduced activities due to LBS in unadjusted and adjusted models for the whole (male and female) population*

	Unadjusted Model			Adjusted Model		
	OR	[95% CI]	*p*-value	*OR*^{a}	[95% CI]	*p*-value
Individual Factors						
Gender			.690			.192
Females	1.00			1.00		
Males	0.95	[0.78, 1.17]		0.84	[0.65, 1.08]	
Age			.781			.541
20-34	1.00			1.00		
35-44	0.94	[0.70, 1.26]		0.97	[0.71, 1.32]	
45-54	0.86	[0.64, 1.16]		0.80	[0.59, 1.10]	
55+	0.97	[0.71, 1.32]		0.91	[0.65, 1.27]	
Physical Factors						
Awkward or tiring position			.000			.260
Never	1.00			1.00		
Quarter/Half	1.03	[0.79, 1.34]		0.93	[0.68, 1.28]	
Three quarter/Full	1.74	[1.27, 2.38]		1.23	[0.81, 1.86]	
Awkward grip or hand movements			.002			**.048**
Never	1.00			1.00		
Quarter/Half	1.34	[1.07, 1.67]		**1.41**	**[1.07, 1.87]**	
Three quarter/Full	1.70	[1.34, 2.33]		1.23	[0.79, 1.89]	
Lifting			.000			**.030**
Never	1.00			1.00		
Quarter/Half	1.23	[0.98, 1.55]		1.26	[0.95, 1.67]	
Three quarter/Full	1.92	[1.39, 2.66]		**1.79**	**[1.16, 2.77]**	
Carrying out repetitive task			.602			.171
Never	1.00			1.00		
Quarter/Half	0.98	[0.74, 1.30]		0.81	[0.58, 1.13]	
Three quarter/Full	1.10	[0.83, 1.46]		0.71	[0.50, 1.01]	
Working at high speed			.499			.776
Never	1.00			1.00		

	Unadjusted Model			Adjusted Model		
	OR	[95% CI]	*p*-value	*OR*^{a}	[95% CI]	*p*-value
Quarter/Half	1.02	[0.80, 1.30]		0.93	[0.70, 1.24]	
Three quarter/Full	1.16	[0.89, 1.51]		0.88	[0.63, 1.23]	
Standing			.078			.151
Never	1.00			1.00		
Quarter/Half	1.07	[0.85, 1.99]		1.03	[0.80, 1.33]	
Three quarter/Full	1.44	[1.05, 1.99]		1.44	[0.99, 2.10]	
Sitting			.644			.510
Never	1.00			1.00		
Quarter/Half	1.06	[0.81, 1.38]		1.18	[0.87, 1.61]	
Three quarter/Full	0.94	[0.71, 1.25]		1.20	[0.84, 1.71]	
Using tools that vibrate			.009			.160
Never	1.00			1.00		
Quarter/Half	1.07	[0.82, 1.39]		0.93	[0.66, 1.31]	
Three quarter/Full	2.19	[1.33, 3.62]		1.74	[0.92, 3.30]	
Psychosocial Factors						
Contact and cooperation with management			.753			.735
Very satisfied/Satisfied	0.95	[0.74, 1.35]		0.91	[0.87, 1.25]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	0.83	[0.51, 1.35]		0.82	[0.47, 1.43]	
Level and difficulty of work			.790			.542
Very satisfied/Satisfied	0.98	[0.77, 1.26]		0.85	[0.63, 1.14]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	1.16	[0.70, 1.90]		1.01	[0.57, 1.79]	
Work stress			.972			.823
Not stress at all	1.00			1.00		
Mildly/Moderately stressful	0.97	[0.70, 1.34]		0.92	[0.64, 1.31]	
Very/Extremely stressful	0.95	[0.63, 1.34]		0.86	[0.54, 1.36]	
Working to tight deadlines			.175			.562
Never	1.00			1.00		
Quarter/Half	1.04	[0.77, 1.42]		1.08	[0.76, 1.52]	
Three quarter/Full	1.25	[0.93, 1.68]		1.19	[0.84, 1.69]	
Boring work			.213			.492
Never	1.00			1.00		
Quarter/Half	0.89	[0.71, 1.11]		0.87	[0.67, 1.12]	
Three quarter/Full	1.18	[0.84, 1.65]		1.02	[0.69, 1.50]	
Organisational Factors						
Work organisation			.861			.467
Very satisfied/Satisfied	0.93	[0.72, 1.20]		0.82	[0.61, 1.11]	

	Unadjusted Model			Adjusted Model		
	OR	[95% CI]	*p*-value	*OR*^{a}	[95% CI]	*p*-value
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	0.93	[0.56, 1.55]		0.89	[0.50, 1.56]	
Organisational culture			.420			.099
Very satisfied/Satisfied	1.17	[0.92, 1.48]		1.37	[0.92, 1.83]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	1.09	[0.75, 1.59]		1.09	[0.69, 1.71]	
Environmental Factors						
Working in a cold or damp environment			.004			.180
Never	1.00			1.00		
Quarter/Half	1.33	[1.07, 1.66]		1.31	[0.98, 1.75]	
Three quarter/Full	1.86	[1.13, 3.06]		1.23	[0.68, 2.24]	
Working in a hot or warm environment			.148			.455
Never	1.00			1.00		
Quarter/Half	1.04	[0.84, 1.29]		0.87	[0.65, 1.14]	
Three quarter/Full	1.55	[0.99, 1.29]		1.14	[0.68, 1.89]	
Working outside			.544			.936
Never	1.00			1.00		
Quarter/Half	1.11	[0.88, 1.40]		1.03	[0.78, 1.36]	
Three quarter/Full	1.14	[0.84, 1.54]		0.96	[0.64, 1.43]	
Exposure to loud noise			.043			.588
Never	1.00			1.00		
Quarter/Half	0.96	[0.76, 1.22]		0.85	[0.62, 1.15]	
Three quarter/Full	1.40	[1.05, 1.87]		0.91	[0.61, 1.37]	

Note. CI = confidence interval; *OR* = odds ratio.
[a] Adjusted for age, awkward or tiring position, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, standing, sitting, using tools that vibrate, contact and cooperation with management, level and difficulty of work, boring work, working to tight deadlines, work stress, work organisation, organisational culture, working in a cold/damp environment, a hot/warm environment, working outside, and exposed to loud noise.
The explanatory variables that were significantly associated with LBS in the adjusted model were indicated in **bold.**

4.3.4 Risk factors for absenteeism due to LBS

Table 4.6 shows the risk factors for absenteeism due to LBS. In the unadjusted model there were significant associations with absenteeism due to LBS ($p < .05$) for some physical factors (i.e. awkward or tiring position, awkward grip or hand movement, lifting, carrying out repetitive tasks, and using tools that vibrate) and environmental factors (i.e. working in cold/damp environment, working outside, and exposure to loud noise). None of the psychosocial and organisational factors were shown to be statistically significant in the unadjusted model. Awkward or tiring positions and working in a cold or damp environment were significantly associated with absenteeism due to LBS after adjusting for age, gender, and all explanatory variables.

The odds ratio for absenteeism due to LBS in those whose work involved awkward or tiring positions quarter/half-time and three quarter/full-time were 1.43, 95% CI [0.91, 2.25] and 2.11, 95% CI [1.20, 3.70] compared to those whose work did not involve such situations, respectively. Working in a cold or damp environment quarter/half-time (*OR* 1.43, 95% CI [0.98, 1.08]) and three quarter/full-time (*OR* 2.18, 95% CI [1.11, 4.28]) also increased the risk of absenteeism due to LBS. The result of the Hosmer-Lemeshow goodness of fit test was *p* = .628, indicating that lack-of-fit was not large enough to reject the model.

Table 4.6 *Risk factors for absenteeism due to LBS in unadjusted and adjusted models for the whole (male and female) population*

	Unadjusted Model			Adjusted Model		
	OR	[95% CI]	*p*-value	*OR*^{a}	[95% CI]	*p*-value
Individual Factors						
Gender			.406			.683
Females	1.00			1.00		
Males	1.11	[0.86, 1.45]		0.93	[0.67, 1.29]	
Age			.054			.060
20-34	1.00			1.00		
35-44	0.81	[0.56, 1.16]		0.82	[0.55, 1.21]	
45-54	0.63	[0.43, 0.92]		0.61	[0.40, 1.02]	
55+	1.00	[0.68, 1.45]		1.02	[0.67, 1.53]	
Physical Factors						
Awkward or tiring position			.000			**.031**
Never	1.00			1.00		
Quarter/Half	1.30	[0.90, 1.86]		1.43	[0.91, 2.25]	
Three quarter/Full	2.42	[1.61, 3.63]		**2.11**	**[1.20, 3.70]**	
Awkward grip or hand movements			.003			.639
Never	1.00			1.00		
Quarter/Half	1.32	[0.98, 1.76]		1.19	[0.82, 1.72]	
Three quarter/Full	1.92	[1.30, 2.82]		1.11	[0.64, 1.93]	

	Unadjusted Model			Adjusted Model		
	OR	[95% CI]	*p*-value	OR^a	[95% CI]	*p*-value
Lifting			.000			.380
Never	1.00			1.00		
Quarter/Half	1.08	[0.80, 1.46]		0.80	[0.55, 1.17]	
Three quarter/Full	2.07	[1.40, 3.05]		1.01	[0.58, 1.74]	
Carrying out repetitive task			.011			.377
Never	1.00			1.00		
Quarter/Half	1.10	[0.74, 1.61]		1.05	[0.66, 1.65]	
Three quarter/Full	1.58	[1.09, 2.30]		1.30	[0.81, 2.09]	
Working at high speed			.964			.209
Never	1.00			1.00		
Quarter/Half	1.02	[0.75, 1.39]		0.85	[0.58, 1.23]	
Three quarter/Full	1.04	[0.74, 1.46]		0.67	[0.43, 1.04]	
Standing			.641			.990
Never	1.00			1.00		
Quarter/Half	1.18	[0.84, 1.48]		1.00	[0.72, 1.39]	
Three quarter/Full	1.16	[0.77, 1.76]		0.99	[0.61, 1.60]	
Sitting			.176			.421
Never	1.00			1.00		
Quarter/Half	1.01	[0.73, 1.42]		1.07	[0.72, 1.57]	
Three quarter/Full	0.76	[0.53, 1.11]		0.82	[0.52, 1.31]	
Using tools that vibrate			.004			.450
Never	1.00			1.00		
Quarter/Half	1.25	[0.90, 1.73]		0.93	[0.61, 1.43]	
Three quarter/Full	2.48	[1.41, 4.34]		1.49	[0.72, 3.07]	
Psychosocial Factors						
Contact and cooperation with management			.807			.766
Very satisfied/Satisfied	0.91	[0.66, 1.25]		0.86	[0.58, 1.29]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	0.84	[0.45, 1.56]		1.00	[0.49, 2.02]	
Level and difficulty of work			.826			.519
Very satisfied/Satisfied	0.91	[0.67, 1.25]		0.83	[0.57, 1.20]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	0.85	[0.44, 1.63]		0.74	[0.35, 1.56]	
Work stress			.832			.682
Not stress at all	1.00			1.00		
Mildly/Moderately stressful	0.95	[0.63, 1.43]		0.93	[0.59, 1.48]	
Very/Extremely stressful	1.06	[0.64, 1.75]		1.12	[0.63, 1.98]	
Working to tight deadlines			.245			.610

	Unadjusted Model			Adjusted Model		
	OR	[95% CI]	*p*-value	*OR*[a]	[95% CI]	*p*-value
Never	1.00			1.00		
Quarter/Half	0.83	[0.56, 1.23]		0.79	[0.51, 1.24]	
Three quarter/Full	1.07	[0.74, 1.54]		0.87	[0.55, 1.36]	
Boring work			.177			.930
Never	1.00			1.00		
Quarter/Half	1.05	[0.78, 1.40]		1.04	[0.75, 1.46]	
Three quarter/Full	1.45	[0.97, 2.17]		0.97	[0.59, 1.58]	
Organisational Factors						
Work organisation			.732			.328
Very satisfied/Satisfied	0.95	[0.69, 1.31]		0.85	[0.58, 1.25]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	0.76	[0.38, 1.49]		0.57	[0.26, 1.22]	
Organisational culture			.998			.932
Very satisfied/Satisfied	0.99	[0.73, 1.33]		1.07	[0.73, 1.55]	
Neutral	1.00			1.00		
Very dissatisfied/Dissatisfied	0.98	[0.61, 1.58]		0.99	[0.55, 1.77]	
Environmental Factors						
Working in a cold or damp environment			.000			**.030**
Never	1.00			1.00		
Quarter/Half	1.65	[1.25, 2.18]		1.43	[0.98, 1.08]	
Three quarter/Full	2.94	[1.68, 5.14]		**2.18**	**[1.11, 4.28]**	
Working in a hot or warm environment			.107			.980
Never	1.00			1.00		
Quarter/Half	1.28	[0.98, 1.69]		0.96	[0.67, 1.38]	
Three quarter/Full	1.50	[0.87, 2.59]		1.01	[0.53, 1.93]	
Working outside			.022			.403
Never	1.00			1.00		
Quarter/Half	1.40	[1.04, 1.87]		1.25	[0.87, 1.79]	
Three quarter/Full	1.53	[1.05, 2.23]		1.02	[0.62, 1.43]	
Exposure to loud noise			.000			.232
Never	1.00			1.00		
Quarter/Half	1.27	[0.93, 1.72]		1.06	[0.71, 1.58]	
Three quarter/Full	2.09	[1.48, 2.95]		1.48	[0.91, 2.42]	

Note. CI = confidence interval; *OR* = odds ratio.

[a] Adjusted for age, awkward or tiring position, awkward grip or hand movements, lifting, carrying out repetitive task, working at very high speed, standing, sitting, using tools that vibrate, contact and cooperation with management, level and difficulty of work, boring work, working to tight deadlines, work stress, work organisation, organisational culture, working in a cold/damp environment, a hot/warm environment, working outside, and exposed to loud noise.

The explanatory variables that were significantly associated with LBS in the adjusted model were indicated in **bold.**

4.3.5 Risk factors for reduced activities and absenteeism due to LBS for only those who reported LBS

Among those who reported LBS (*n* = 1,621), working in a hot/warm environment three quarter/full time increased the risk of reduced activities due to LBS 2.14, 95% CI [1.22, 3.76] times more than those who did not work in such situations, after adjustment for gender, age, and all explanatory variables. The risk factors for absenteeism due to LBS were working in awkward or tiring positions three quarter/full time (*OR* 2.06, 95% [CI 1.13, 3.77]), working to tight deadlines three quarter/full time (*OR* 1.89, 95% CI [1.02, 3.50]), and working in a hot/warm environment three quarter/full time (*OR* 3.35, 95% CI [1.68, 6.68]), after adjustment for gender, age, and all explanatory variables.

4.4 Discussion

4.4.1 Prevalence of reduced activities and absenteeism due to LBS

The prevalence of reduced activities due to LBS in the present study was 18%. This finding is similar to that of Palliser et al. (2005) who reported 17% in a survey of musculoskeletal symptoms among New Zealand dentists. It is higher than for Chinese offshore workers (10%) (Chen, et al., 2005), but it is lower than for New Zealand veterinarians (42%) (Scuffham, et al., 2010). Of those who reported LBS, 33% reported reduced activities during the last 12 months. It is similar with previous studies among Chinese offshore workers (31%) (Chen, et al., 2005) and lower than American nurses (36%) (Trinkoff, et al., 2002) and New Zealand veterinarians (58%) (Scuffham, et al., 2010). The differences are likely to be due to the differences between the populations studied, i.e. the general working population in our study *versus* particular working populations in the other studies. In addition, the differences may also be due to differences in the nature of the specific questions regarding reduced activities due to LBS used in the various studies. For example, in the present study, the question about reduced activities due to LBS was followed by the example of work activities that were affected (i.e. house work, hobbies, and gardening). This may lead participants to recall reduced activities that related to recreational (i.e. nonwork) activities. In contrast, Trinkoff et al. (2002) asked specific questions, i.e. whether the LBS resulted in reducing or modifying work activities, reducing nonwork activities (such as climbing stairs or housework), or reducing recreation (such as exercising, jogging).

There was no difference in the prevalence of reduced activities due to LBS between women and men in our study. This finding is similar to that of Madan et al. (2008), whose study investigated the prevalence of disabling low back pain among Indian and UK workers. In contrast, in a cross-sectional study among 234 female and 953 male ambulance personnel in Sweden, Aasa et al. (2005) found that males had higher prevalence (23%) than females (11%). Although it is difficult to compare directly between studies, the different outcomes for our and Aasa's studies may be related to different study population, different methodologies including terminology, cultural differences (Madan, et al., 2008) and the higher proportion of male participants (80%) reported by Aasa et al. (2005).

In relation to age, in our study there was no difference in the prevalence of reduced activities due to LBS among age groups. This is similar to that found in a cross-sectional study for Indian and UK workers (Madan, et al., 2008). Since our and Madan's study were cross-sectional, the possibility of a healthy worker effect is real. This would be due to only healthy workers remaining in employment and who are likely to be healthier than those who leave their job (Arrighi & Hertzpicciotto, 1994).

The prevalence of absenteeism due to LBS in the present study was 9%. This finding is in line with a study among Dutch general working population (9%) (Hooftman, et al., 2009), but lower than a study by van den Heuvel et al. (2004) (18%) and Hoogendoorn et al. (2002) (20%). Although Hooftman et al. (2009), van den Heuvel et al. (2004), and Hoogendoorn et al. (2002) studies were conducted among general working population that was similar to the present study, these three studies used company's register sickness absence data. In addition, they selected only those who had absence ≥1 days (van den Heuvel, et al., 2004) and ≥3 days (Hoogendoorn, et al., 2002) in their analysis while in the present study we did not consider the duration of absenteeism. However, while comparing with other specific working population that used self-reported questionnaire, the 9% prevalence in the present study is in agreement with a similar study among Irish hospital workers (9%) (Cunningham, et al., 2006), New Zealand veterinarians (9%) (Scuffham, et al., 2010), and dentist in Greece (10%) (Alexopoulos, et al., 2004). It is lower than laundry and dry-cleaning workers in Netherlands (14%) (Ijzelenberg, et al., 2004), Greek shipyard workers (15%) (Alexopoulos, et al., 2006), and nurse in Greek (17%) (Alexopoulos, et al., 2003). Among those who reported LBS, the prevalence of absenteeism due to LBS was 18%. It is higher than American nurses (12%) (Trinkoff, et al., 2002) and New Zealand veterinarians (12%) (Scuffham, et al., 2010) but lower than laundry and dry-cleaning workers in Netherlands (29%) (Ijzelenberg, et al., 2004) and Irish hospital workers (32%) (Cunningham, et al., 2006). This may be partially attributed to the different methodologies such as the way in which questionnaire was delivered (interview, online, or mail) and study population.

There was no difference in absenteeism due to LBS prevalence between women and men in this study. This finding is similar to the finding of a mailed survey among general working population in The Netherlands (van den Heuvel, et al., 2004), and other studies (Aasa, et al., 2005; Alexopoulos, et al., 2006; Cunningham, et al., 2006; Ijzelenberg, et al., 2004). In relation to age, there was no difference in absenteeism due to LBS prevalence among age groups. This finding is supported by an cross-sectional study (Ijzelenberg, et al., 2004) and two prospective cohort studies (Burdorf & Jansen, 2006; Burdorf, et al., 1998). It would be expected that the prevalence of absenteeism should be higher in an older population due to aging processes (i.e. degenerative process of the intervertebral discs (Buckwalter, 1995)). In fact, in our study the differences were not significant among age group. Low prevalence of absenteeism due to LBS in older population might be due to decreasing pain perception or increasing tolerance to pain among older people (Bressler, Keyes, Rochon, & Badley, 1999). Also, recall bias due to memory recall error (failed to memorize the absenteeism), which was common among older people, might influence the prevalence of absenteeism due to LBS (Bressler, et al., 1999). In addition, the possibility of switching to lighter tasks among older workers might have influenced the findings (Gardner, et al., 1999).

The prevalence of absenteeism due to LBS in the present study might have been under or over estimated. For example, there may have been a disincentive to take sick leave since absence from work would reduce income. The use of self-report questionnaires could also be associated with under or over reporting and may lack reliability due to recall bias. The use of more objective data (e.g. medical record or absenteeism data from company) may have provided a better estimate of absenteeism. In addition, duration of absence or the number of episodes of absence experienced will have allowed more sophisticated analysis in order to explore more about the economic or social impacts of LBS. However, it was not possible to collect such data in the present study.

There were no statistically significant differences in prevalence of reduced activities and absenteeism due to LBS among light and heavy physical workers. This finding was similar to that found in a cross-sectional study among shipyard workers (Alexopoulos, et al., 2006). This may partially be due to the proportion of light physical workers (about 75%) and heavy physical workers (about 25%) in the present study was not equal. In addition, job title may not reflect the true occupational exposure. Even within the same job, workers might be exposed to different exposures (Messing, et al., 1994; van der Beek, et al., 2000).

4.4.2 Risk factors for reduced activities and absenteeism due to LBS

The adjusted model showed strong associations between lifting (Table 4.5) and working in awkward or tiring positions and in a cold/damp environment (Table 4.6) with reduced activities and absenteeism due to LBS, respectively. Although working with awkward grip or hand movement was significantly associated with reduced activities due to LBS, there were neither positive nor negative dose-response associations, indicative of a weak association. Our finding of lifting as a risk factor for reduced activities due to LBS is in agreement with previous studies (Aasa, et al., 2005; Simon, et al., 2008) whilst the finding of awkward or tiring positions as a risk factor for absenteeism due to LBS is also supported by previous studies (Hooftman, et al., 2009; Hoogendoorn, et al., 2002; Tubach, et al., 2002). The fact that awkward or tiring position was associated with absenteeism but lifting was not, suggests than static loading may play a more important role than lifting in the occurrence of absenteeism due to LBS. This finding is in agreement with two other cross-sectional studies (Alexopoulos, et al., 2006; Ijzelenberg, et al., 2004) and one prospective study (van den Heuvel, et al., 2004) that failed to find the association between lifting and absenteeism due to LBS.

Working in a cold/damp environment was significantly associated with absenteeism due to LBS in the present study. Virtanen et al. (2008) investigated the environmental exposure in relation to absenteeism due to LBS by asking six questions about any inconvenience caused by noise, draft, heat, cold, poor quality of internal air, and poor or blinding lighting with 5-point Likert scale as the reply alternatives. The score from six questions then were summed into a single final environmental variable. So, although Virtanen et al. (2008) also explored environmental factors, it is difficult to compare their findings with our study since the final environmental variable in Virtanen's study was not specific to cold/warm environment exposure. However, the association between working in a cold/damp environment and LBS was found in two cross-sectional studies of meat processing workers (Piedrahita, et al., 2004) and seafood industry workers (Bang et al., 2005), a critical review about risk factors for low back pain among people's Republic of China (Jin et al., 2000), and also in a review paper of cold exposure and musculoskeletal disorders and disease (Pienimaki, 2002). Sundelin and Hagberg (1992) also reported that exposure to cold environments activated the muscles in the shoulder and back region and speculated that this activation may be due to the hunched posture that is commonly adopted as a protective behavioural response to cold – a posture that can lead to muscle strain and the development of muscle fatigue in the low back region (McGill, et al., 2000), which in turn, may make workers take sick leave.

None of the psychosocial and organisational factors were associated with reduced activities and absenteeism due to LBS. This finding is in line with previous studies that failed to find association between psychosocial factors and LBS consequences (Alexopoulos, et al., 2008; Alexopoulos, et al., 2006; Burdorf & Jansen, 2006; Cunningham, et al., 2006; Ijzelenberg, et al., 2004) and a review of prospective cohort studies (J. Hartvigsen, et al., 2004). In contrast, two prospective cohort studies reported psychosocial and organisational factors as predictors of absenteeism due to LBS (Hoogendoorn, et al., 2002; van den Heuvel, et al., 2004). The differences between these findings and ours may be due to differences in study design and methodology, such as differences between the instruments (questions) used to measure psychosocial factors. The lack of association between psychosocial factors and organisational factors and the consequences of LBS in the present study may be an artefact of the way that the study was designed rather than a true finding. This highlights the weakness of retrospective questioning (perhaps particularly on subjective issues), since the prospective cohort studies referenced above demonstrate this association.

4.4.3 Risk factors for reduced activities and absenteeism due to LBS for only those who reported LBS

Although only physical factors were associated with LBS consequences for the whole population (regardless of the presence of LBS), the analysis for those who only reported LBS showed that psychosocial and environmental factors also played a role. There are three possibilities that might explain this finding. Firstly, working in a hot/warm environment with tight deadlines is usually associated with heavy physical work activities (commonly characterised by awkward or tiring posture or manual handling). This may reduce the likelihood of the workers doing other activities or may even make them want to be absent from work. In the present study, 80% and 78% of those who were exposed to a hot or warm environment were also exposed to an awkward or tiring position and did lifting, respectively. This explanation is consistent with that reported by Harkness et al. (2003) who found that shipbuilders exposed to a hot environment had a higher risk of new onset LBS, and speculated that the reason could have been that they adopted awkward working postures (due to welding and furnace work). A second explanation is based on the findings that skin temperature, which are partially dictated by environmental temperature, plays a role in thermal discomfort and behaviour (Schlader, Prange, Mickleborough, & Stager, 2009; Schlader, Stannard, & Mündel, 2010). Thus, exposure to a hot/warm environment may increase skin temperature and stimulate perceptions of warmth and thermal discomfort, which may ultimately result in avoidance of the hot or warm environment. These perceptions may be even greater among those with LBS and in turn, may lower their inclinations and their attitudes or mood towards working. This speculation is supported by two studies (Keller et al., 2005; McMorris et al., 2006) that found that mood was lower in a hot environment. In addition, a review paper by Woo and Postolache (2008) suggested that exposure to harsh physical environments (such as noise, light) may lead to stress reactions (i.e. dysphoria, depressive syndrome, somatic complaints), leading to clinical illnesses as well as vocational symptoms (i.e. absenteeism, presenteeism, and accidents) with sometimes fatal work-related outcomes. However, they also reported that the association between exposure to hot environments and mood disorders was inconsistent. A third, but likely related, explanation may be related to the increased physiological strain associated with working in a hot or warm environment. In order to meet the concurrent demands of blood flow to the working musculature and to the skin, for the purposes of temperature regulation (Rowell, 1974), the perceptions of work effort (Schlader, et al., 2010) and fatigue (McMorris, et al., 2006) are likely elevated, which are associated with a voluntarily reduced work intensity and an earlier onset of muscular fatigue (Cheuvront, Kenefick, Montain, & Sawka, 2010). In the present study, this explanation would be consistent with the observation that those with LBS may be reducing their activity levels or even choosing to be absent from work. All three explanations fit with our findings that exposure to a hot/warm environment increases the risk of LBS consequences among those with LBS. However, since each individual's assessment of environmental exposure was subjective, it would be desirable to examine this finding more carefully, using objective measures of thermal exposure, e.g. WBGT.

The strength of the present study was its size. This allowed analysis of the prevalence of reduced activities and absenteeism due to LBS in a general population and assessment of associations with physical, psychosocial and organisational risk factors. The effects of selection bias with respect to LBS consequences is considered to be relatively small because the study was part of a large national survey of self-reported occupational exposures, which did not specifically emphasise LBS consequences in the interview. In addition, although the response rate of 37% in the present study was typical for this type of survey (Tourangeau, 2004), 't Mannetje et al. (2011) who examined potential non response bias using the same data set as the present study indicated that there was no evidence of major non response bias. Hence, the possibility of response bias in the present study is unlikely.

Some weaknesses of the study need to be considered in the interpretation of the results. Firstly, although self-reported interviews can provide valid data (Kallio, et al., 2000; van Ooijen, et al., 1997), the prevalence of LBS consequences may be underestimated when this method is used, due to recall bias (Ekberg et al., 1995). Recall inconsistencies are more likely amongst those with LBS requiring no medical care (Kuorinka, et al., 1987). Self-reported physical exposure has been criticised for not providing accurate information about real exposures (Barrero, Katz, & Dennerlein, 2009). Furthermore, the perception of LBS and its consequences can bias self-reported workload (Wiktorin, Karlqvist, Winkel, & Stockholm Music Study Group, 1993). The presence of observer-based measurement can reduce this bias, but it is expensive and difficult to conduct and was impractical since our study involved such a large sample.

Secondly, the present (cross-sectional) study does not allow any indication of the sequence of events. Hence, it was impossible to infer causality. Although our adjustments for any potentially confounding factors through the use of multivariate analyses provided better estimation in this cross-sectional study, we consider that longitudinal cohort studies may be more appropriate to investigate associations between risk factors and the LBS consequences (Arrighi & Hertzpicciotto, 1994; Hartvigsen, et al., 2001; Li & Sung, 1999).

In summary, the present study has shown that the prevalence of reduced activities due to LBS is 18% while the prevalence of absenteeism due to LBS is 9%. This study also found that self-reported lifting had a strong association with reduced activities whereas self-reported exposure to awkward or tiring positions and working in a cold/damp environment had a strong association with absenteeism due to LBS. Psychosocial and organisational factors were not significantly associated with reduced activities and absenteeism due to LBS. However, among those with LBS, working in awkward or tiring positions, working to tight deadlines, and working in a hot/warm environment were associated with LBS consequences. The findings imply that in order to reduce the occurrence of LBS consequences in workplaces, intervention effort should focus on reducing awkward or tiring positions, lifting activities and work in a cold/damp environment. In addition, decreasing working in awkward or tiring positions, working to tight deadlines, and working in a hot/warm environment, especially for those with LBS, may be important to prevent LBS consequences.

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References

The references for this chapter have been integrated with the list of references at the end of the thesis.

Post-script

Summary of findings

This study shows that the prevalence of reduced activities and absenteeism due to LBS was in the New Zealand working population was 18% and 9%, respectively. The consequences of LBS prevalence for those in the older age group, males, and those with a heavy physical workload were not higher than those in the younger age group, females, and those with a light physical workload, respectively. Two hypotheses that related to exposure were supported: 1) Exposure to the physical (lifting) risk factor increased the risk of reduced activities due to LBS, and; 2) Exposure to the physical (working in an awkward or tiring positions), and environmental (working in a cold/damp environment) risk factors increased the risk of absenteeism due to LBS. In summary, the gaps, aims and hypotheses, and findings for this chapter are as follows:

Gaps	Aims and Hypotheses	Findings
Less is known about the prevalence for LBS consequences	To examine the prevalence of reduced activities due to LBS among the New Zealand working population	The 12-month reduced activities due to LBS prevalence was 18%, 95% CI [17%, 20%]
	To examine the prevalence of absenteeism due to LBS among the New Zealand working population	The 12-month absenteeism due to LBS prevalence was 9%, 95% CI [8%, 10%]
Less is known about risk factors of LBS consequences	To examine the differences in reduced activities due to LBS prevalence in relation to age group, gender, and occupational group The hypotheses are:	
	• The reduced activities due to LBS prevalence for those in the older group will be higher than in the younger group	• The reduced activities due to LBS prevalence for those in the older group was not higher than in the younger group
	• The reduced activities due to LBS prevalence for males will be higher than females	• The reduced activities due to LBS prevalence for males was not higher than females
	• The reduced activities due to LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload	• The reduced activities due to LBS prevalence for those with a heavy physical workload was not higher than those with a light physical workload

	To examine the association between physical, psychosocial, organisational, environmental risk factors and reduced activities due to LBS The hypothesis is:	
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of reduced activities due to LBS	• Exposure to the physical (lifting) risk factor increased the risk of reduced activities due to LBS
	To examine the differences in absenteeism due to LBS prevalence in relation to age group, gender, and occupational group The hypotheses are:	
	• The absenteeism due to LBS prevalence for those in the older group will be higher than in the younger group	• The absenteeism due to LBS prevalence for those in the older group was not higher than in the younger group
	• The absenteeism due to LBS prevalence for males will be higher than females	• The absenteeism due to LBS prevalence for males was not higher than females
	• The absenteeism due to LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload	• The absenteeism due to LBS prevalence for those with a heavy physical workload was not higher than those with a light physical workload
	To examine the association between physical, psychosocial, organisational, environmental risk factors and absenteeism due to LBS The hypothesis is:	
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of absenteeism due to LBS	• Exposure to the physical (working in working in awkward or tiring positions), and the environmental (working in a cold/damp environment) risk factors increased the risk of absenteeism due to LBS

Strengths of the present study

Since Chapter 3 and Chapter 4 used the same dataset, the advantages are similar. The use of a fully adjusted model may provide appropriate estimation of LBS risk factors. Rothman et al. (2008) proposed that although some variables were not statistically significant in the unadjusted model, they can still confound other variables and lead to biased final results. Also, in addition to wide range of physical, psychosocial, and organisational factors, the inclusion of environmental exposure in the analysis may provide useful information that can be used to develop a holistic prevention strategy. In addition, since this chapter also examined the risk factors for only those with LBS, the specific intervention strategy can be applied.

Limitations of the present study

There are four limitations in this chapter that are also present and have been explained in details in Chapter 3. First, this study did not include some factors that have been shown to be associated with LBS consequences by previous studies, i.e. whole-body vibration (Hartman, et al., 2005), effort (Simon, et al., 2008), and reward (Simon, et al., 2008). Second, the validity and reliability of the physical exposure questions used in this study have not been assessed. The results may therefore be subject to misclassification bias. Third, it did not examine the interaction between risk factors for LBS consequences. Lastly, the cross-sectional study design limits the ability to provide conclusions regarding causal inference.

Conclusions for Section A

The 12-month period prevalence of LBS (54%, 95% CI [52%, 56%]) in the New Zealand working population is high. Males had a higher prevalence of LBS than females. There were no differences in LBS prevalence between age groups. Those with a heavy physical workload had a higher prevalence of LBS compared to those with a light physical workload (Chapter 2). Exposure to the physical (working in awkward or tiring positions) and the psychosocial (work stress) risk factors increased the risk of LBS for the whole and female population. Dissatisfaction with contact and cooperation with management also increased the risk of LBS for females. However, exposure to any organisational and environmental risk factors did not increase the risk of LBS for the whole and female population. None of the explanatory variables increased the risk of LBS for males (Chapter 3).

For LBS consequences, the 12-month period prevalence of reduced activity and absenteeism due to LBS were 18%, 95% CI [17%, 20%] and 9%, 95% CI [8%, 10%], respectively. There were no differences in prevalence of LBS consequences between age group, gender, and heavy/light physical workload group. Exposure to the physical (lifting) risk factor increased the risk of reduced activities due to LBS, but exposure to the psychosocial, organisational, and environmental risk factors did not. Exposure to the physical (working in awkward or tiring positions) and the environmental (working in a cold/damp environment) risk factor increased the risk of absenteeism due to LBS, but exposure to psychosocial and organisational risk factors did not (Chapter 4).

The studies in this section imply that intervention to reduce LBS and its consequences should address physical and psychosocial factors. It should also improve environmental factors to reduce LBS consequences.

SECTION B

Prevalence, work-related risk factors, and interaction between physical and psychosocial factors for LBS and its consequences among Indonesian coal mining workers

Little is known of the prevalence (Gap 1.1 and 1.2) and risk factors for (Gap 2.1 and 2.3) LBS and its consequences in IDCs. Thus, this section presents the prevalence of and work-related risk factors for LBS and its consequences among the Indonesian coal mining workers. Since a healthy worker effect is likely to occur in the cross-sectional studies and only few cross-sectional studies have taken into account this bias (Gap 2.2), this section also afforded an opportunity to examine the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential confounders. In addition, the lack of information about the interaction between physical and psychosocial risk factors for LBS and its consequences (Gap 2.4) is also addressed.

The five limitations in the New Zealand study, i.e. the possibility of misclassification of LBS or non-LBS due to the lack of severity and duration of symptoms information, not including some relevant factors that have been found to be associated with LBS, lack of information regarding the first occurrence of LBS, the use of the unvalidated self-reported questionnaire about physical and psychosocial exposure, and not examining the interaction between risk factor for LBS and its consequences (Post-scripts for Chapter 2, 3, and 4) are addressed in the Indonesian coal mining study. First, this study obtained information about the severity and duration of LBS as a basis to determine LBS or non-LBS. Second, it included three risk factors that have been found to be predictors for LBS by previous studies, i.e. whole-body vibration, effort, and reward. Third, the information about when the first episode of the symptoms occurred was also obtained, so this study was able to examine potential bias due to a healthy worker effect. Fourth, to avoid misclassification bias in exposures, the questions selected for inclusion in the questionnaire of physical and psychosocial exposure were determined by an analysis of the validity and reliability of a wide variety of self-reported physical and psychosocial assessment questions used in a variety of studies (see Appendix B2 and Appendix B3). Since the original questions for the questionnaire were in English and the study was conducted in Indonesia(n), a cross-cultural adaptation of the questionnaire was undertaken in order to assure equivalence between the English and Indonesian versions (Beaton, Bombardier, Guillemin, & Ferraz, 2000) (see Appendix B4). The validity and reliability of the Indonesian version of the questionnaire then were assessed in this study population by conducting observations and interviews. Almost all questions were reported to have good validity and/or reliability (Appendix B9). Finally, the interaction between physical and psychosocial risk factors was examined in this study.

This section has two chapters (Chapter 5 and 6) as follows:

Chapter 5	Prevalence of low back symptoms and its consequences in relation to occupational group
Chapter 6	Interaction between physical and psychosocial work risk factors for low back symptoms and its consequences amongst Indonesian coal mining workers

Each chapter is the verbatim copy of each paper published or submitted to respective journal.

Chapter 5 Prevalence of low back symptoms and its consequences in relation to occupational group

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., and Jones, G. (2012). Prevalence of low back symptoms and its consequences in relation to physical workload and smoking. *American Journal of Industrial Medicine.* doi: 10.1002/ajim.22116.

Preface

Although many studies have estimated the prevalence of and risk factors for LBS, only few studies have been conducted in IDCs (Gap 1.1 and 2.1). Even less is known about prevalence (Gap 1.2) and risk factors for (Gap 2.3) the consequences of LBS. Hence, this chapter aims to examine the prevalence of LBS and its consequences among the Indonesian coal mining workers and the association between the presence of LBS and its consequences. The New Zealand study (Chapter 2) found that those in the heavy physical workload group had a higher LBS prevalence than those in the light physical workload group. However, this study did not take into account the bias due to a healthy worker effect in the analysis (Gap 2.2). Therefore, this chapter examines the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential confounders. The gaps, aims, and hypotheses for this chapter are:

Gaps	Aims	Hypotheses
Little is known of the prevalence of LBS in IDCs	To estimate the prevalence of LBS among the Indonesian coal mining workers	Since these aims are not testable (no variable tested), there is no hypothesis for this aim
Less is known of the prevalence of LBS consequences in IDCs	To estimate the prevalence of reduced activities due to LBS among the Indonesian coal mining workers	Since these aims are not testable (no variable tested), there is no hypothesis for these aims
	To estimate the prevalence of absenteeism due to LBS among the Indonesian coal mining workers	
Only few cross-sectional studies took into account	To examine the association between risk factor (occupational	Those in blue-collar work will have a higher LBS risk than

a healthy worker effect when examine the association between risk factor (occupational group) and LBS	group) and LBS, adjusting for a healthy worker effect and other potential confounders	those in white-collar work after adjusting for a healthy worker effect and other potential confounders
Less is known about risk factors of LBS consequences	To examine the association between the presence of LBS and reduced activities due to LBS	The presence of LBS will increase the risk of reduced activities due to LBS
	To examine the association between the presence of LBS and absenteeism due to LBS	The presence of LBS will increase the risk of absenteeism due to LBS

Abstract

Background: The purpose of this study was to examine: (a) the prevalence of low back symptoms (LBS) and its consequences (reduced activities and absenteeism), (b) the association between occupational group and LBS, and (c) the association between LBS and its consequences.

Methods: A self-administered questionnaire was used to determine the prevalence of LBS in 1,294 Indonesian coal mining workers. A Cox proportional hazards model was developed to quantify the 12-monthly hazard of LBS. Logistic regression models were developed to identify risk factors for reduced activity and absenteeism from the workplace.

Results: The 12-month period prevalence for LBS, reduced activities, and absenteeism were 75%, 16%, and 13%, respectively. The 12-monthly hazard of LBS for blue-collar workers was 1.85, 95% CI [1.06, 3.25] times that of white-collar workers. LBS and smoking increased the risk of reduced activity and absenteeism.

Conclusions: Indonesian coal mining workers have a high prevalence of LBS. The findings imply that efforts to reduce LBS and in the workplace should focus on blue-collar workers. For smokers who report reduced activities and/or absenteeism, there should be a focus on rehabilitation and/or return-to-work programs.

Keywords: back pain; developing country; blue-collar worker; sick leave; healthy worker effect

5.1 Introduction

The prevalence of low back symptoms (LBS) and its associated risk factors has been widely reported. The 12-month period prevalence of LBS has been reported to range between 21% and 73% among various occupational groups (Ghaffari, et al., 2006; Matsudaira, et al., 2011; Scuffham, et al., 2010; Widanarko, et al., 2011). Since the amount of physical work activity undertaken in different occupations represents a substantial component of a person's overall physical activity (Proper & Hildebrandt, 2006) and around one third of the risk of back pain has been attributed to occupation (Punnett, et al., 2005), various studies have assessed the prevalence of LBS in relation to occupational groupings (Alexopoulos, et al., 2006; Ghaffari, et al., 2006; Holmström & Engholm, 2003; Johansson, 1994; Widanarko, et al., 2011). The accumulation of exposure in the workplace is suspected of being related to cumulative load in the tissues of the lower back (Marras, 2008a). This, in turn, may influence the occurrence of LBS. Since measuring accumulation of exposure in the workplace is difficult, a reasonable proxy comes from measuring the number of years an individual has worked in a given occupation.

One might expect that the prevalence of LBS in occupations that are physically demanding to be greater than those where workloads are lighter. Surprisingly, the findings of studies investigating these issues are inconsistent. For instance, the LBS prevalence in white-collar workers in the metal industry (42%) was similar to that of blue-collar workers (43%) (Johansson, 1994) and a study among health service workers failed to show any association between occupation and LBS (Cunningham, et al., 2006). Alexopoulos et al. (2006) reported that blue-collar workers were no more likely to report LBS than white-collar workers in the shipyard industry in Greece (*OR* [odds ratio] 0.84, 95% confidence interval [95% CI] 0.57 to 1.23). In contrast, LBS prevalence for light physical workload occupational groups was significantly lower than that reported for heavy physical workload occupational group (Widanarko, et al., 2011). In Italy, LBS was found to be more prevalent in a group of tractor drivers with heavier workloads (*OR* 2.39, 95% CI [1.57, 3.66]) compared with a control group (Bovenzi & Betta, 1994). In a study of Swedish construction workers, asphalt workers (*OR* 2.41, 95% CI [2.06, 2.83]), crane operators (*OR* 2.08, 95% CI [1.73, 2.51]), and vehicle drivers (*OR* 1.96, 95% CI [1.62, 2.37]) were more likely to report LBS than a control group comprised of foreman (Holmström & Engholm, 2003). Different exposure metrics and/or categorical descriptor of low/high physical exposure between studies (Punnett & Wegman, 2004) are an explanation for these inconsistent findings.

A consequence of LBS is that a person's activities are reduced and, ultimately, they may have to take time off work (i.e. absenteeism). The consequences of LBS are likely to be greater when LBS are more serious. For example, Turner et al. (2004) reported that moderate or severe back pain (rated as level 5 or higher on a scale ranging from 1 to 10) was particularly related to disability. Since a reduction in the ability to move around and carry out routine daily tasks and absenteeism may have serious economic and social impacts (Hanson, et al., 2006; NRC & IOM, 2001), a number of studies have investigated the prevalence of reduced activities and absenteeism. The 12-month period prevalence for reduced activities due to LBS has been reported to be between 10% and 42% (Chen, et al., 2005; Scuffham, et al., 2010; Widanarko, Legg, Stevenson, et al., 2012b) whereas for absenteeism arising from LBS the 12-month period prevalence ranged from 4% to 36% (Alexopoulos, et al., 2006; Bovenzi, et al., 2002; Cunningham, et al., 2006; Ijzelenberg, et al., 2004; Matsudaira, et al., 2011; Scuffham, et al., 2010; Widanarko, Legg, Stevenson, et al., 2012b).

The coal mining industry consists of various jobs that involve both physical workload and psychosocial demands (Gallagher, 2008). Not surprisingly, LBS is prevalent among coal miners (Lloyd, et al., 1986; Sarikaya, et al., 2007) and is a common cause of absenteeism (Afacan, 1982). In the US, an analysis of injury claims for low-seam coal mines indicated that the highest proportion of total compensation cost in 2008 was for injuries to the knee (17.4%) and lower back (11.2%) (Gallagher, Moore, & Dempsey, 2009). Few studies of LBS and its consequences have been conducted in industrially developing countries (IDCs). To address this knowledge gap, the aim of the present study was to examine in a coal mining industry in an IDC: (a) the prevalence of LBS and its consequences (reduced activities and absenteeism), (b) the association between occupational group and LBS, and (c) the association between LBS and its consequences.

5.2 Methods

5.2.1 Participants and questionnaire administration

The study was conducted in a large coal mining contractor company that serviced 12 sites in The Republic of Indonesia. The main activities at each site were as follows: exploration (geology mapping, drilling exploration, and stockpile evaluation), mining planning, supporting infrastructure (warehouse, workshop, office, road, hauling road, and stockpile), mining operations (drilling, blasting, overburden removing, coal excavating coal crushing, coal hauling, and shipment), reclamation and re-vegetation of ex-mining areas, and transhipment and sales.

With prior agreement and facilitation from the Safety, Health and Environmental manager of the company, invitations to participate in the study were delivered in person to 2,150 white- and blue-collar coal mining workers at three sites (two located in the provinces of East Borneo and one in the province of South Borneo). Workers who had worked one year or more in their current position and had never previously had an accident involving the low back region were eligible for inclusion in the study. The company arranged for the workers to complete the questionnaire in groups of 20-25 under the supervision of the investigators, so the investigators would be available to respond to queries. Before completing the questionnaire, two trained investigators gave the groups a brief explanation about the aims of the study and the content of the questionnaire. Company management were not present when the questionnaires were being completed and the workers were not required to append their name to their responses i.e. the questionnaire was completed anonymously.

The study design was evaluated by peer review and judged to be low risk. This study was recorded on the Low Risk Database of the Massey University Human Ethics Committee. Since we only obtained information from the workers about age, gender, occupation, LBS and its consequences using self-reported questionnaire and the questionnaire was completed anonymously, a signed informed consent was not necessary. The first page of the questionnaire comprised an information sheet to be read by participants prior to answering the questions. In the information sheet it was clearly stated that by completing and returning the questionnaire it was implied that respondents agreed to participate in the study.

5.2.2 Questionnaire

Since the original questions for the questionnaire were in English and the study was conducted in Indonesia(n), a cross-cultural adaptation of the questionnaire was undertaken in order to assure equivalence between the English and Indonesian versions (Beaton, et al., 2000). The process of cross-cultural adaptation included both translation into Indonesian (and back translation into English) and cultural adaptation (Beaton, et al., 2000). It was performed in accordance with guidelines for adaptation of health related subjective data collection tools (Beaton, et al., 2000). The cross-cultural adaptation was conducted for all questions that were used in this study (including demographic characteristics, smoking status, occupation, and outcomes).

The questionnaire enquired about LBS and its consequences. It also sought information about demographic characteristics (age, gender, education), smoking status (never smoked – defined as never smoked 100 cigarettes; former smoker – defined as having smoked ≥ 100 cigarettes but quit smoking during the year prior to the survey or longer ago, and; smoker – defined as having smoked ≥ 100 cigarettes and currently smoke (Albanes, Jones, Micozzi, & Mattson, 1987)), work history (date of first being employed in the company and date of first being employed in the current position), and any accident(s) that involved the lower back region of the body.

LBS and its consequences were assessed using a modified version of the standardized Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka, et al., 1987). The NMQ has been frequently used to quantify the consequences of LBS and an encouraging trend in this area of research is that many researchers are now using the

NMQ, making it easier to compare findings across different study populations and time frames. Participants were asked if they had any trouble (such as aches, pains, discomfort, numbness or fatigue) in the low back region (recorded on a body diagram viewed from behind) during the last 7 days and the last 12 months. Instead of using binary outcome (yes/no) as in the original NMQ, 5-scale response alternatives (no never, yes-once or twice, yes-sometimes, yes-often, and yes-all the time) were used, as in previous studies (Balogh, et al., 2004; Ektor-Andersen, Isacsson, Lindgren, Orbaek, & Malmo Shoulder-Neck Study Group, 1999; Hansson et al., 2001).

An additional question asked about the total length of time that low back trouble occurred during the last 12 months, with response options: 0 days, 1-7 days, 8-30 days, more than 30 days but not every day, and every day. The consequences of LBS were assessed by requesting a yes/no response to the following questions: ‘Has LBS prevented you from carrying out your normal activities within the last 12 months?’ (reduced activities) and; ‘Have you been absent from work due to LBS within the last 12 months?’ (absenteeism). A question about the total duration of absence from work due to LBS invited an open response. A final question, ‘In what year did you first experience low back symptoms?’ was adapted from Punnett (1996).

5.2.3 Data analysis

The prevalence of LBS was calculated as the total number of participants that answered ‘yes’ to the LBS question (regardless of the frequency of the symptoms) divided by the total number of participants. Additional information contained in response alternatives about the frequency of the symptoms were not used in this analysis but will be reported in a separate paper. The following measures of LBS frequency were also reported: (a) the prevalence of LBS during the last 12 months with onset during current job, (b) the prevalence of LBS during the last 12 months where symptoms were present for more than 7 days, (c) the prevalence of LBS during the last 12 months where onset was during the current job and symptoms were present for more than 7 days, and (d) the prevalence of LBS during the last 12 months where onset was during the current job and symptoms were present for more than 7 days and were also present within the last 7 days at the time of survey. For LBS consequences, the prevalence of reduced activities and absenteeism due to LBS during the last 12 months was reported.

Occupational groups were classified as either white-collar (i.e. general office staff, group leaders, and managerial staff) or blue-collar (i.e. bus drivers, truck drivers, light vehicle drivers, mechanics, dump truck operators, heavy vehicle operators, and others).

The incidence rate of LBS, expressed as the number of incident (i.e. new) cases of LBS per 100 person-years, was calculated for blue- and white-collar occupational groups for complete 12-month periods prior to the date on which the survey was administered. Using the individual respondent frequencies for each category of occupational group the incidence rate ratio (*IRR*) was then calculated as the incidence rate of LBS in the blue-collar occupational group divided by the incidence rate in the white-collar occupational group. This provided a numeric estimate of how many times greater (or less) the incidence rate in blue-collar workers was, compared with white-collar workers.

An issue that may arise when conducting a cross-sectional study relates to that of the healthy worker effect (Hartvigsen, et al., 2001). The healthy worker effect arises when only those that are healthy remain in the work force; those who become unhealthy and leave their job are excluded. This means that in cross-sectional studies, where details of exposures and outcomes are gathered from a population over a relatively short period of time, study populations are biased towards healthy individuals. It also means that the strength of association between hypothesised risk factors and outcomes will be underestimated (Hartvigsen, et al., 2001; Siebert, Rothenbacher, Daniel, & Brenner, 2001). Although healthy worker effect bias can be minimised using a prospective cohort study design, this approach is both time consuming and expensive. To adjust risk estimates derived from cross-sectional studies to account for healthy worker effect bias we applied the methodological approach proposed by Punnett (1996) which entails the use of a Cox proportional hazards model.

Two Cox proportional hazards models were constructed. The outcomes of interest of Model I and Model II were time to onset, expressed as the number of years between the start date of the current job and the date of onset of LBS symptoms, where LBS symptoms had persisted for more than 7 days and had occurred in the 7 day period before the date on which the questionnaire was completed. For those who were free of LBS (censored observations) time to onset was the number of years between the start date of the current job and the date on which the questionnaire was completed. The first Cox model included explanatory variables as follows: (a) a dichotomous variable representing occupational group (white-collar, blue-collar); (b) a continuous variable representing age at first employment (the date on which participants started work minus birth date); (c) a categorical variable representing smoking status (never smoked, former smoker, current smoker); (d) a categorical variable representing level of education (primary, secondary, tertiary); (e) a dichotomous variable representing gender (female, male), and; (f) a continuous variable representing duration of work (in years). The second Cox model included all explanatory variables in Model I, and two additional variables to adjust for the possibility of a healthy worker effect, i.e. (a) a continuous variable representing duration of first LBS (questionnaire date minus LBS onset date for those with LBS and 0 for those without LBS), and (b) a term to account for the interaction between occupational group and LBS duration. All explanatory variables were entered into the model and were retained, regardless of their significance (Greenland, 1987; Rothman, et al., 2008). Biologically plausible, two-way interactions (in addition to the occupational group-LBS duration term) were tested with none being statistically significant.

The outputs from the Cox models were expressed in terms of hazard ratios (*HR*), representing for each covariate how many times more (or less) likely LBS onset was to occur per unit time compared to a reference category, adjusted for the other explanatory variables in the model. The proportional hazards assumption was checked using the scaled Scoenfeld residuals, as suggested by Therneau and Grambsch (2000).

To assess the need of adjusting the healthy worker effect and/or the covariates, Models I and II were compared using a likelihood ratio test. In Model II, loss of subjects due to a healthy worker effect was accounted for by inclusion of the LBS duration term and its interaction with occupational group. The LBS duration term allowed for a trend in reported incidence, assumed to be caused by those experiencing LBS in earlier years being less likely to still be present at the time of the survey. The interaction term allowed this effect to be different for each occupational group.

Both the *IRR* and *HR* provided an estimate of the association between occupational group and LBS, the key difference being that the *HR* estimates from the Cox model are adjusted to account for the effect of healthy worker effect bias and other potential confounders whereas the *IRR* estimates are not.

Two logistic regression models were developed to quantify the association between LBS and the possible consequences of LBS: reduced activities and absenteeism. The first model used LBS as an explanatory variable and the presence or absence of reduced activities as the outcome. The second used LBS as an explanatory variable and the presence or absence of absenteeism as the outcome. In both models age at the time when LBS was first reported (in years), smoking status, education, gender, and duration of work were included *a priori* as confounders. The strength of association between each of the explanatory variables and the outcome variables are reported in terms of *OR* and their 95% CI (Hosmer & Lemeshow, 2000). The Hosmer-Lemeshow test was used to assess the fit of the final logistic regression models, with a nonsignificant test indicative that lack-of-fit was not enough to reject the models (Hosmer & Lemeshow, 2000). While the Hosmer-Lemeshow test provides a crude indication of goodness of fit, it provides no indication of the ability of a model to successfully discriminate between those who experienced LBS consequences and those who do not. To assess discriminatory ability a Receiver Operating

Characteristic (ROC) curve was constructed for each model. The area under a ROC curve, which ranges from 0 to 1, provides a measure of the ability of the model to classify those with and without the outcome of interest, with higher values indicative of better discriminatory ability.

To examine the possibility that the group of individuals that elected to take part in the study was a biased subset of all individuals working for the company, we collected data on age, duration of employment in the current job, and the 12-month period prevalence of LBS from a small proportion of the nonrespondents (*n* = 26) by informal interview which included the same questions as were used in the self-reported questionnaire. The differences in age and duration of employment of in the current job between respondents and nonrespondents were analysed using the Mann-Whitney U test. Differences in the 12-month period prevalence of LBS were analysed using the chi-square test.

All statistical analyses were conducted using Stata (Intercooled Stata for Windows, 2003). Survival analyses were carried out using the survival package (Therneau, 2012) implemented in R (R Development Core Team, 2012).

5.3 Results

5.3.1 Description of the sample

Seventy three percent of workers (*n* = 1,565) completed the questionnaire. Two hundred and seventy one were excluded from the analysis: 260 did not meet the study eligibility criteria (211 had less than 1 year work experience in the current position and 49 reported that previously they had experienced an accident resulting in low back symptoms) and 11 answered less than 50% of the questions. A total of 1,294 questionnaires (68% of the total eligible sample and 60% of total questionnaires distributed) were considered to be valid and were used in the present analysis.

Table 5.1 presents the distribution of the sample in relation to gender, education, smoking status, occupation in the current job. The median age was 26 years (Q1 was 23 years; Q3 was 33 years). The median duration of work time in the current job was 3 years (Q1 was 2 years; Q3 was 6 years).

Table 5.1 *Distribution of the sample in relation to gender, education, smoking status, and occupation*

Characteristic		*n*	%
Gender			
	Female	42	3
	Male	1252	97
Education[a]			
	Primary	168	13
	Secondary	1100	85
	Tertiary	22	2
Smoking status[b]			
	Never smoked	478	37
	Former smoker	162	13
	Current smoker	649	50
Occupation[c]			
	General office staff	142	11.1
	Group leader	80	6.2
	Managerial	28	2.2
	Bus/truck/light vehicle driver	42	3.3
	Mechanics	333	26.0
	Dump truck operator	437	34.1
	Heavy vehicle operator	126	9.8
	Others	95	7.4

Note. [a]4 missing data for education. [b]5 missing data for smoking status. [c]11 missing data for occupation

5.3.2 Nonrespondent characteristics

The median age was 24 years (Q1 was 23 years; Q3 was 29 years) whereas the median duration of work in the current job was 2 years (Q1 was 1 year; Q3 was 4 years). The 12-month period prevalence of LBS was 61, 95% CI [41, 81] cases per 100 workers. There were no differences in age, duration of employment in the current job and the 12-month period prevalence between respondents and nonrespondents.

5.3.3 Prevalence of LBS and its consequences

Table 5.2 shows the prevalence of LBS and its consequences. The 12-month period prevalence of LBS for light- and blue-collar workers was 69, 95% CI [64, 75] cases per 100 and 77, 95% CI [75, 80] cases per 100, respectively. Of those with LBS during the last 12 months (*n* = 972), 83% (*n* = 808) reported that they had their first LBS episode during the current job, 31% (*n* = 307) had LBS for more than 7 days, and 27% (*n* = 266) had LBS for more than 7 days with its onset during the current job and also present within the last 7 days at the time of survey, 22% (*n* = 211) reported that their activities were reduced as a result of LBS and 17% (*n* = 169) reported that they had taken time off work because of LBS during the previous 12 months. The total duration of absence due to LBS in a year, accumulated for all participants who reported absenteeism, was 805 days. The median duration of each absence due to LBS was 2 days (Q1 was 1 day; Q3 was 4 days).

Table 5.2 *Period prevalence of LBS and its consequences, expressed as the number of cases per 100 workers [95% CI]*

Outcomes	*n*	Prevalence [95% CI]	
LBS during the last 7 days	814	63	[61, 66]
LBS during the last 12 months	972	75	[73, 78]
LBS during the last 12 month and onset during the current job	808	68	[65, 70]
LBS during the last 12 month with symptoms more than 7 days	307	24	[21, 26]
LBS during the last 12 month with symptoms more than 7 days and onset during the current job	273	23	[21, 26]
LBS during the last 12 month with symptoms more than 7 days and onset during current job and also present within the last 7 days at the time of survey	266	23	[20, 25]
Reduced activities due to LBS during the last 12 months	211	16	[14, 18]
Absenteeism due to LBS during the last 12 months	169	13	[11, 15]

Note. CI = confidence interval.

5.3.4 Occupational group and LBS

The *IRR* for occupational group for the 12-month period immediately prior to the date on which the questionnaire was completed was 1.45, 95% CI [0.73, 3.21]. The *HR* for occupational group was 2.15, 95% CI [1.34, 3.43] after adjustment for age, smoking status, education, gender, and duration of work (Model I, Table 5.3) whereas after adjustment for the presence of bias arising from a healthy worker effect and confounding due to smoking status, education, gender, and duration of work, the HR was 1.85, 95% CI [1.06, 3.25] (Model II, Table 5.3). The results of Schoenfeld residuals test showed that the *p*-values for both models were > .05, indicating that the proportional hazards assumption was justified. The result from the likelihood ratio test comparing Model I and Model II showed that there was a significant trend in incidence (*p* < .0001).

Table 5.3 *Cox proportional hazards models showing the effect of occupational group, age, smoking status, education, gender and duration of work (Model I) and also duration of LBS and the interaction between occupation and LBS duration (Model II) on the 12-monthly hazard of experiencing LBS*

Explanatory variable	Number of workers	Cases	Model I				Model II			
			Coefficient (*SE*)	*p*-value	*HR*	[95% CI]	Coefficient (*SE*)	*p*-value	*HR*	[95% CI]
Occupational group:										
White-collar	192	33	Reference		1.00		Reference		1.00	
Blue-collar	860	223	0.7658 (0.2385)	.01	2.15	[1.34, 3.43]	0.6198 (0.2856)	.03	1.85	[1.06, 3.25][a]
LBS duration[b]	1052	256					3.1622 (0.1843)	< .01	23.62	[16.45, 33.90]
Occupation × LBS duration[c]	1052	256					0.0024 (0.0605)	.96	1.00	[0.89, 1.12]
Age (years)[d]	1052	256	-0.0065 (0.0130)	.61	0.99	[0.96, 1.01]	0.0148 (0.0130)	.25	1.01	[0.98, 1.04]
Smoking status:										
Never smoked	409	91	Reference		1.00		Reference		1.00	
Former smoker	129	39	0.2225 (0.1981)	.26	1.24	[0.84, 1.84]	0.1770 (0.2032)	.38	1.19	[0.80, 1.77]
Current smoker	514	126	0.0342 (0.1410)	.80	1.03	[0.78, 1.36]	0.1072 (0.1465)	.46	1.11	[0.83, 1.48]
Education:										
Primary	133	28	0.0882 (0.5163)	.61	1.32	[0.39, 3.00]	0.6792 (0.5665)	.23	2.36	[0.72, 7.68]
Secondary	904	224	0.2839 (0.5665)	.86	1.09	[0.43, 4.03]	0.8608 (0.6013)	.15	1.97	[0.64, 5.98]
Tertiary	15	4	Reference		1.00		Reference		1.00	
Gender:										
Female	29	7	Reference		1.00		Reference		1.00	
Male	1023	249	-0.5039 (0.4122)	.22	0.60	[0.26, 1.35]	0.1068 (0.4152)	.79	1.11	[0.49, 2.50]
Duration of work[e]	1052	256	-0.3131 (0.0317)	< .01	0.73	[0.68, 0.77]	-3.1292 (0.1752)	< .01	0.04	[0.03, 0.06][f]

Note. *SE* = standard error; *HR* = hazard ratio; CI = confidence interval.

[a] Interpretation: After adjusting for the effect of LBS duration, the interaction between occupational group and time, age, smoking status, education, gender, and duration of work, the 12-monthly hazard of LBS for blue-collar workers was increased by a factor of 1.85, 95% CI [1.06, 3.25] compared with white-collar workers. [b] LBS duration (years) = date on which the questionnaire was completed minus the LBS onset date (as a continuous variable). [c] The interaction between occupational group and LBS duration. [d] Age (in years) at the time of first employment (as a continuous variable). [e] Duration of work (in years) (as a continuous variable). [f] Interpretation: After adjusting for the effect of occupational group, LBS

duration, the interaction between occupational group and LBS duration, age, smoking status, education, and gender the 12-monthly hazard of LBS was decreased by a factor of 0.04, 95% CI [0.03, 0.06] for unit increases in the number or years worked.

5.3.5 Reduced activities and absenteeism due to LBS

Table 5.4 and Table 5.5 show the estimated regression coefficients and their *ORs* from the two logistic regression models. The presence of LBS increased the odds of reporting reduced activities (*OR* 4.42, 95% CI [3.18, 6.15]) and absenteeism (*OR* 4.74, 95% CI [3.32, 6.77] after adjusting for age at the time when the first episode of LBS occurred, smoking status, education, gender, and duration of work. The results of the Hosmer-Lemeshow goodness-of-fit tests were both nonsignificant at the α level of .05 indicating that lack-of-fit was not large enough to reject either of the two models. The areas under the ROC curve for the model were .70 and .72 for reduced activities and absenteeism, respectively, indicating that both models had acceptable discriminatory ability.

Table 5.4 *Logistic regression model showing the effect of LBS, age, education, gender and duration of work on the risk of reporting reduced activities due to LBS during the previous 12 months*

Explanatory variable	Number of workers	Cases	Coefficient (*SE*)	*p*-value	*OR*	[95% CI]
LBS						
Absence	860	102	Reference		1.00	
Presence	259	96	1.4869 (0.1682)	.00	4.42	[3.18, 6.15][a]
Age[b]	1119	198	0.0085 (0.0115)	.45	1.00	[0.98, 1.03]
Smoking status						
Never smoked	427	60	Reference		1.00	
Former smoker	142	22	-0.0444 (0.2876)	.88	0.96	[0.54, 1.68]
Current smoker	550	116	0.5115 (0.1836)	.01	1.67	[1.16, 2.39][c]
Education						
Primary	153	33	0.2518 (0.6330)	.69	1.28	[0.37, 4.44]
Secondary	947	161	-0.0714 (0.5986)	.90	0.93	[0.28, 3.00]
Tertiary	19	4	Reference		1.00	
Gender						
Female	39	10	Reference		1.00	
Male	1080	188	-0.4016 (0.4026)	.32	0.66	[0.30, 1.47]
Duration of work[d]	1119	198	0.0110 (0.0170)	.52	1.01	[0.97, 1.04]

Note. *SE* = standard error; *OR* = odds ratio; CI = confidence interval.
[a] Interpretation: After adjusting for the effect of age, smoking status, education, gender, and duration of work, the odds of reporting reduced activities in those with LBS was increased by a factor of 4.42, 95% CI [3.18, 6.15] compared with those with no LBS. [b] Age (in years) at the time when LBS first occurred (as a continuous variable). [c] Interpretation: After adjusting for the effect of LBS, age, education, gender, and duration of work, the odds of reduced activities for those who were current smokers was increased by a factor of 1.67, 95% CI [1.16, 2.39] compared with those who never smoked. [d] Duration of work (in years) (as a continuous variable).

Table 5.5 *Logistic regression model showing the effect of LBS, age, education, gender and duration of work on the risk of reporting absenteeism due to LBS during the previous 12 months*

Explanatory variable	Number of workers	Cases	Coefficient (*SE*)	*p*-value	*OR*	[95% CI]
LBS						
Absence	862	77	Reference		1.00	
Presence	258	82	1.5571 (0.1813)	.00	4.74	[3.32, 6.77][a]
Age[b]	1120	159	0.0125 (0.0125)	.32	1.01	[0.98, 1.07]
Smoking status						
Never smoked	428	45	Reference			
Former smoker	142	21	0.2121 (0.3041)	.48	1.27	[0.70, 2.29]
Current smoker	550	93	0.5804 (0.2052)	.01	1.69	[1.13, 2.52][c]
Education						
Tertiary	19	4	0.1539 (0.6411)	.81	1.16	[0.33, 4.09]
Secondary	948	125	-0.3874 (0.6044)	.52	0.67	[0.20, 2.21]
Primary	153	30	Reference		1.00	
Gender						
Female	39	7	Reference		1.00	
Male	1081	152	-0.1135 (0.4549)	.80	0.89	[0.36, 2.18]
Duration of work[d]	1120	159	0.0130 (0.0185)	.48	1.01	[0.97, 1.05]

Note. *SE* = standard error; *OR* = odds ratio; CI = confidence interval.
[a]Interpretation: After adjusting for the effect of age, smoking status, education, gender, and duration of work, the odds of reporting reduced activities in those with LBS was increased by a factor of 4.74, 95% CI [3.32, 6.77] compared with those with no LBS. [b]Age (in years) at the time when LBS first occurred (as a continuous variable). [c] Interpretation: After adjusting for the effect of LBS, age, education, gender, and duration of work, the odds of reduced activities for those who were current smokers was increased by a factor of 1.69, 95% CI [1.13, 2.52] compared with those who never smoked. [d]Duration of work (in years) (as a continuous variable).

5.4 Discussion

5.4.1 Prevalence of LBS and its consequences

In the present study the period prevalence of LBS during the last 7 days was 63 cases per 100 workers. This is similar to Greek forest workers (64 cases per 100) (Gallis, 2006) and higher than a general working population in UK (49 cases per 100) (Devereux, et al., 1999), cleaners in UK (24 cases per 100) (Woods & Buckle, 2006), community nurses in The Netherlands (21 cases per 100) (Knibbe & Friele, 1996), Chinese offshore oil installation workers (8 cases per 100) (Chen, et al., 2005) and Iranian car manufacturing workers (8 cases per 100) (Ghaffari, et al., 2006). The high 7-day LBS period prevalence in the present study indicates that LBS was an 'on-going' problem in this workplace. Hence, it is necessary to identify risk factors of LBS in this workplace and use them as the basis for the application of prevention programmes (i.e. improve the workplace) in order to avoid progression towards more severe symptoms.

In this study the 12-month period prevalence of LBS was 75 cases per 100 for all coal mining workers, 69 cases per 100 for white-collar workers, and 77 cases per 100 for blue-collar workers. These findings are compared with other studies that used the NMQ (except for Devereux et al. (1999) which used a very similar questionnaire) in Figure 5.1. In Turkish coal miners the 5-year period prevalence of LBS was 78 cases per 100 (Sarikaya, et al., 2007) and in Scottish coal miners the 3-month period prevalence was 35 cases per 100 (Lloyd, et al., 1986). Because these two studies used different periods over which to estimate prevalence (ours were 7 days and 12 months), direct comparison between this and the Sarikaya and Lloyd studies is difficult.

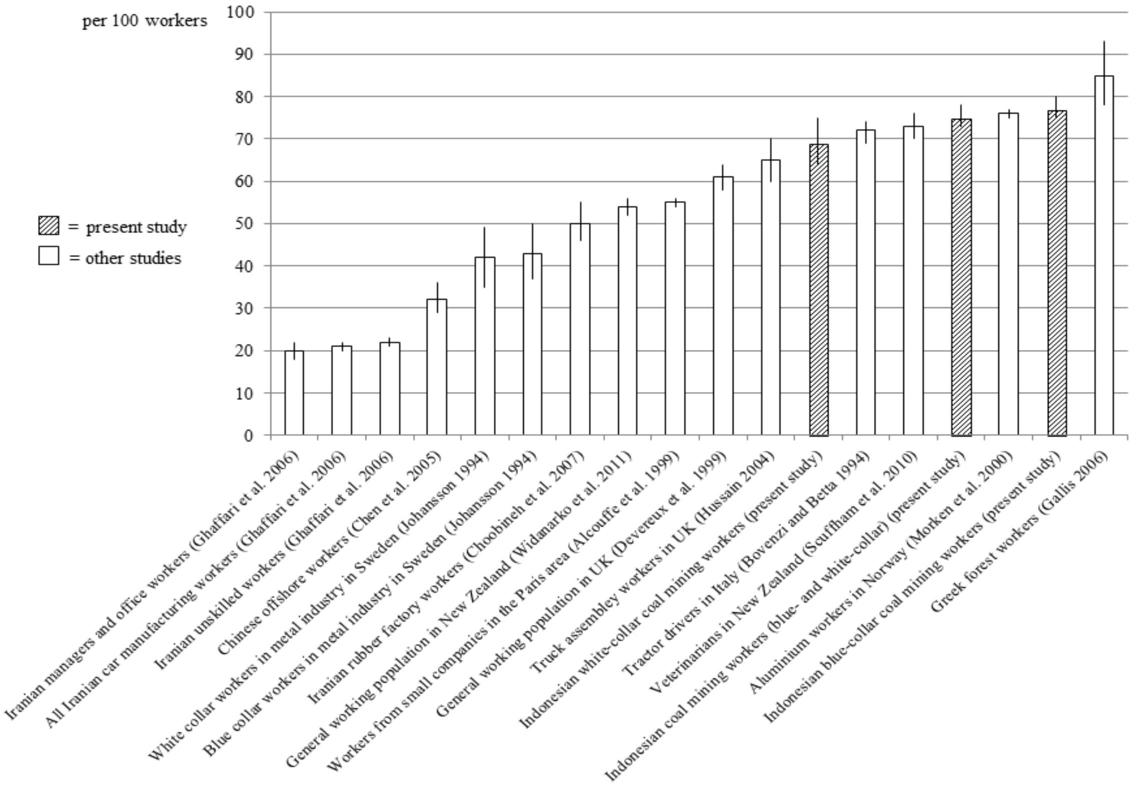

Figure 5.1 Comparison of 12-month period prevalence of LBS (expressed as the number of cases per 100 workers and their 95% CI) between studies

The 12-month period prevalence of LBS with symptoms of more than 7 days duration, at 24 cases per 100 was slightly higher than that reported for automobile manufacturing workers (20 cases per 100) (Vandergrift, et al., 2012) but lower than for workers in the United Kingdom (39 cases per 100) (Devereux, et al., 1999) and Greek forest workers (79 cases per 100) (Gallis, 2006). The period prevalence of LBS during the last 12 months with symptoms more than 7 days and onset during the current job and also present within the last 7 days at the time of survey (22 cases per 100) was similar to the 23 cases per 100 reported by Devereux et al. (1999) in a cross-sectional study among workers in the UK.

Both the 7-day and 12-month period prevalence of LBS in the present study were higher than most of the studies described above. The present study was of Indonesian workers of Southeast Asian ethnicity whereas most of the other studies were conducted amongst Caucasian workers in developed countries. This observation is consistent with two previous studies among the general population in the UK: South Asians were more likely to report back pain with disability (*OR* 2.61, 95% CI [1.25, 5.44]) than non-South-Asians (Webb et al., 2003) and musculoskeletal symptoms were slightly more prevalent in a South Asian population compared with a white population in Greater Manchester (Allison et al., 2002). Another study in the UK found that South Asians had a higher risk of reporting widespread pain (*OR* 3.7, 95% CI [2.9, 4.9]) compared with white Europeans (Palmer et al., 2007). However, the differences in reporting between South Asian and the general population in UK may not reflect ethnic differences, but rather the effect of lower income, a greater proportion of workers performing unskilled manual tasks, and a lower level of general health. The higher prevalence of LBS among Asians could be due to their generally smaller body size and dimensions (Pheasant & Haslegrave, 2006) and lower physical capacities, with a lower tolerance to mechanical pressure (Woodrow, Gary D. Friedman, Siegelaub, & Collen, 1972) and higher sensitivity to pain (Rowell, Mechlin, Ji, Addamo, & Girdler, 2011). So, for identical physical exposure demands it is possible that Asians are likely to experience a relatively higher physical workload which, in turn, may influence their risk of LBS. Alternatively, workers in IDCs, possibly including the Indonesian coal mining workers in the present study, might be exposed to higher physical workplace exposures because they are required to carry out more manual tasks, may also have less occupational health and safety regulations, and have poorer health care and social welfare/insurance programs than those in developed countries. These factors could influence the occurrence of LBS.

A final point that may contribute to the higher prevalence of LBS amongst this study population is that the psychosocial strain may have been present due to globalisation processes which have impacted IDCs in many sectors, socioeconomic, particularly. To be able to compete globally with competitors, IDCs have to face the challenge of managing the changing nature of work, such as the demand of flexible contracts, increased job insecurity, a high work pace, long and irregular working hours, and low incomes (Houtman, Jettinghoff, & Cedillo, 2008). Collectively, these characteristics of the work environment may increase the likelihood of psychosocial problems and stress for those working in IDCs. All of the physical and psychosocially based explanations above fit with our finding that the prevalence of LBS in the present study was higher than in previous studies that were conducted in Western countries.

Sixteen percent of the entire study population reported reduced activities due to LBS. This finding is in agreement with Widanarko et al. (2012b) who reported 18% in a survey of musculoskeletal symptoms among the working population in New Zealand. It is higher than that reported for Chinese offshore workers (10%) (Chen, et al., 2005), but lower than New Zealand veterinarians (42%) (Scuffham, et al., 2010) and Greek forest workers (50%) (Gallis, 2006). Of those with LBS, 22% reported reduced activities which is lower than previous studies among Chinese offshore workers (31%) (Chen, et al., 2005), the general population of workers in New Zealand (33%) (Widanarko, Legg, Stevenson, et al., 2012b), and New Zealand veterinarians (58%) (Scuffham, et al., 2010).

Interestingly, although the prevalence of LBS in this study was higher than that recorded in populations of workers in Western countries, the proportion of LBS individuals with reduced activities due to LBS was generally not higher than that recorded for most of the Western country studies. A possible reason for this may be that the severity of LBS in our study population may have been less serious. This could be partially due to the high proportion of young (less than 30 years old) participants in our study, in which degenerative changes in intervertebral discs may not yet have occurred. Consequently, the relative youthfulness of our study population may have meant that they had a greater ability to cope with physical demands on the spinal region, helping them to avoid progression to more serious LBS. If this is indeed the case, it is not surprising that there is a discrepancy between the higher prevalence of LBS and the higher prevalence of reduced activities due to LBS.

Thirteen percent of the entire study population reported that they were absent from work during the previous 12 months because of LBS. This finding is similar to a study of laundry and dry-cleaning workers in The Netherlands (14%) (Ijzelenberg, et al., 2004) and Greek shipyard workers (15%) (Alexopoulos, et al., 2006). It is higher than that reported for the general population of New Zealand workers (9%) (Widanarko, Legg, Stevenson, et al., 2012b), hospital workers (9%) (Cunningham, et al., 2006), and New Zealand veterinarians (9%) (Scuffham, et al., 2010), but lower than that recorded for nurses (17%) (Alexopoulos, et al., 2003). Among those with LBS, 17% reported that they had taken time off work during the previous 12 months because of LBS. This figure is similar to that of Widanarko et al. (2012b) who found that 18% for workers in New Zealand. It is higher than for New Zealand veterinarians (12%) (Scuffham, et al., 2010), but lower than laundry and dry-cleaning workers (29%) (Ijzelenberg, et al., 2004) and Irish hospital workers (32%) (Cunningham, et al., 2006).

The prevalence of absenteeism due to LBS in the present study might be underestimated. It is possible that two socioeconomic factors could contribute to this. Firstly, there was a disincentive to take sick leave since absence from work would reduce income. Secondly, besides maintaining their income, presence at work was a key performance indicator. So workers who remained at work despite having LBS would be less likely to lose their jobs. Consequently, it is possible that workers with severe LBS may not have taken sick leave so that they would not lose income and so they could increase their chances of keeping their job.

Although the prevalence of absenteeism due to LBS in the present study was not high (13%), the loss of productivity could be significant. Using an average productivity of USD 260 per worker per day (Setyo Rohadi, personal communication, July 20, 2011), the total of 805 days lost due to LBS in a year would mean a reduction of the company's productivity by USD 209,300 annually. If all of the absenteeism due to LBS amongst the 1,254,201 coal mining workers in Indonesia (Statistics Indonesia, 2009) could be prevented, a national annual productivity loss of USD 200 million could be avoided. Additionally, even when workers are present at work, they may experience productivity loss (decreased performance) because of regular or prolonged musculoskeletal symptoms (Van den Heuvel, Ijmker, Blatter, & de Korte, 2007).

5.4.2 Occupational group and LBS

The incidence rate ratio for occupational group for complete 12-month periods prior to the survey shows that blue-collar workers were not significantly more likely to report LBS than white-collar workers (*IRR* 1.45, 95% CI [0.73, 3.21]). However, after accounting for healthy worker effect bias and the effect of other confounders, the results of the Cox proportional hazards regression show that the 12-monthly hazard of LBS was 1.85, 95% CI [1.06, 3.25] times higher in blue-collar workers compared with white-collar workers. A plausible explanation for this finding is that blue-collar workers are likely to be exposed to physical factors (e.g. awkward posture, manual handling and whole-body vibration) that may cause mechanical strain in the spine. This may reduce tissue oxygenation which can lead to muscle fatigue in the low back region (McGill, et al., 2000) as well as stimulate pain receptors due to increasing the force on the tissues of the low back (Callaghan & Dunk, 2002).

A significant trend ($p < .0001$) in incidence after allowing for covariates between Model I and Model II indicates the possibility of the presence of a healthy worker effect. The trend implies that those having experienced LBS in the past are less likely to still be employed (and to have taken part in the study); assuming that the underlying true rate of incidence is constant over time (after adjusting for the covariates). The fact that 12-monthly increases in the duration of employment decreased the hazard of LBS by a factor of 0.04, 95% CI [0.03, 0.06], Table 5.3, strengthen our speculation. It is hypothesised that workers who experienced LBS in the early years of employment had already left the workplace, indicating that healthy worker effect bias was present in this study population. However, there is no evidence that the healthy worker effect affects the two occupational groups differently.

In the analyses where healthy worker effect bias and other potential confounders were ignored the effect of occupational group had a nonsignificant association with LBS (*IRR* 1.45, 95% CI [0.73, 3.21]), whereas after accounting for its presence and other potential confounders the association between occupational group and LBS increased 1.85, 95% CI [1.06, 3.25]. Although the estimation in Model II seems to be confounding the covariate effects and the difference in healthy worker effect, future best practice for cross-sectional studies might be to adjust for both of these in the analysis.

5.4.3 Reduced activities and absenteeism due to LBS

The present study showed that LBS was associated with reduced activities and absenteeism due to LBS. This finding is in agreement with two previous prospective cohort studies (Bergström, et al., 2007; Hemingway, et al., 1997) and implies that by reducing the LBS prevalence, the prevalence of reduced activities and absenteeism may also be reduced.

The present study failed to show an association between smoking and LBS. However, current smokers were more likely to report LBS consequences (reduced activities and absenteeism) compared with those who had never smoked. Palmer et al. (2003) reported a similar finding for reduced activities and Tubach et al. (2002) and Hartman et al. (2005) for absenteeism due to LBS. In the present study smoking only appears to have influenced LBS consequences (more severe LBS). There are two possible pathways to explain the linkage of smoking and LBS. Firstly, smoking may be associated with a higher prevalence of chronic bronchitis which in turn may be associated with persistent coughing. In what appears to have been the first study to link coughing with back pain, Gyntelberg (1974) proposed that persistent coughing (due to chronic bronchitis) may increase the intra-abdominal pressure which in turn may cause mechanical strain in the intervertebral disc, which may lead to a greater risk of disc herniation. However, studies by Heliövaara et al. (1991) and Kanayama et al. (2009) failed to confirm the association between smoking and disc herniation. The second pathway is that smoking may cause aortic atherosclerosis which may in turn, lead to back pain. Ernst (1993) hypothesised that smoking may decrease vertebral blood flow through five possible mechanisms working together (i.e. development of carboxyhaemoglobin, vasoconstriction, development of atheroma, fibrinolytic defect, and haemorheological defect) and cause malnutrition in the intervertebral disc. This condition in turn, may lead to disturbance of the interverbral disc's ability to cope with mechanichal stress as well as its ability to heal, which might cause back pain. Since smoking has systemic rather than localised effects (Ernst, 1993), it makes sense that in the present study smoking was found to be associated only with LBS consequences (more severe LBS) because most of the participants were young and relatively healthy. Workplace smoking cessation campaigns are therefore likely to reduce the risk of LBS consequences in addition to the range of other, positive health outcomes.

Apart from selection bias arising from the health worker effect, it is our belief that selection bias (particularly due to nonresponse) in the present study was relatively minor. Because nonparticipants did not differ from participants for age, duration of employment in the current job, and the 12-month LBS prevalence, the results of this study are likely to provide a good representation of the magnitude of LBS among the target population. An additional strength of the present study is that all of the participants worked in the same company and were therefore exposed to relatively similar socioeconomic conditions, work environments, and organisational factors, and experienced a similar selection process.

In order to conduct a survey with such a large sample it was necessary to use a self-administered questionnaire method for practical reasons (Rothman, et al., 2008; White, et al., 2008). This method is known to provide valid (Kuorinka, et al., 1987; van Ooijen, et al., 1997), reliable (Kuorinka, et al., 1987), and accurate data and more so because the questionnaires were completed anonymously (Rothman, et al., 2008). However, the use of self-report questionnaires has been criticised for not providing accurate information due to recall bias. Recall inconsistencies are more likely among those with less serious LBS (Kuorinka, et al., 1987). Therefore, by selecting those who had LBS during the last 12 months with symptoms of more than 7 days and onset during their current job and also present within the previous 7 days it is our belief that the effect of recall bias was minimised. In addition, a good validity (Kuorinka, et al., 1987) and repeatability (Dickinson, et al., 1992) for the reduced activities question and a good agreement (Ferrie et al., 2005; Voss, Stark, Alfredsson, Vingård, & Josephson, 2008), sensitivity (82%), and specificity (84%) for the absenteeism question (Agius et al., 1994) indicated that recall bias regarding self-reported LBS consequences was unlikely.

Although it is difficult to identify new onset episodes of LBS (Koehoorn, Xu, Village, Trask, & Teschke, 2010), this information can provide valuable additional information about the estimates of LBS prevalence in relation to workplace exposures in cross-sectional studies. However, an inherent flaw in cross-sectional studies is that the temporal sequence between exposures and outcomes can be difficult to distinguish and, as a result, they cannot be used to make causal inferences. Unfortunately, very few cross-sectional studies (Bovenzi, et al., 2002; Devereux, et al., 1999; Punnett, 1996) have ever obtained this information and have taken it into account in their analyses. If respondents who already have LBS (i.e.

before entering their current job) are included in the analysis there may be a biased outcome. This is because there is a possibility that their prior LBS may have been due to previous job exposure(s). This being the case, it is desirable that cross-sectional studies are designed in such a way to identify individuals who had their first LBS episode during their current job in order to quantify the effect of workplace exposures on LBS risk.

In conclusion, the present study has shown that the 7-day and 12-month period prevalence of LBS was high among a large sample of coal mining workers in Indonesia. Blue-collar occupational group was associated with LBS, after adjusting for confounders and healthy worker effect bias. Those who reported LBS and were smokers had a higher risk of reduced activities and absenteeism due to LBS. The findings imply that efforts to reduce LBS and in the workplace should focus on blue-collar workers. For smokers who report reduced activities and/or absenteeism, there should be a focus on rehabilitation and/or return-to-work programs.

Acknowledgements

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References

The references for this chapter have been integrated with the list of references at the end of the thesis.

Post-script

Summary of findings

This chapter showed that the 12-month period prevalence of LBS, reduced activities, and absenteeism due to LBS among the Indonesian coal mining workers were 75%, 16%, and 13%, respectively. All hypotheses were supported: the risk of LBS for blue-collar workers was higher than that of white-collar workers after adjusting for the healthy worker effect and other potential confounders, and the presence of LBS increased the risk of reduced activities and absenteeism. In summary, the gaps, aims and hypotheses, and findings for this chapter are as follows:

Gaps	Aims and Hypotheses	Findings
Little is known of the prevalence of LBS in IDCs	To estimate the prevalence of LBS among the Indonesian coal mining workers	The 12-month LBS period prevalence was 75%, 95% CI [73%, 78%]
Less is known of the prevalence of LBS consequences in IDCs	To estimate the prevalence of reduced activities due to LBS among the Indonesian coal mining workers	The 12-month reduced activities due to LBS period prevalence was 16%, 95% CI [14%, 18%]
	To estimate the prevalence of absenteeism due to LBS among the Indonesian coal mining workers	The 12-month absenteeism due to LBS period prevalence was 13%, 95% CI [11%, 15%]
Only few cross-sectional studies took into account the bias due to a healthy worker effect when examine the association between risk factor (occupational group) and LBS	To examine the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential confounders The hypothesis is: • The risk for LBS for those in blue-collar work will be higher than those in white-collar work after adjusting for a healthy worker effect and other potential confounders	• The risk for LBS for those in blue-collar work was higher than those in white-collar work after adjusting for a healthy worker effect and other potential confounders
Less is known about risk factors of LBS consequences	To examine the association between LBS and reduced activities due to LBS The hypothesis is: • The presence of LBS will increase the risk of reduced activities due to LBS, adjusting for potential confounders (age, smoking, education, gender	• The presence of LBS increased the risk of reduced activities due to LBS • Current smokers had a

	and duration of work)	higher risk of absenteeism due to LBS than nonsmokers
	To examine the association between LBS and absenteeism due to LBS The hypothesis is: • The presence of LBS will increase the risk of absenteeism due to LBS, adjusting for potential confounders (age, smoking, education, gender and duration of work)	• The presence of LBS increased the risk of absenteeism due to LBS • Current smokers had a higher risk of absenteeism due to LBS than nonsmokers

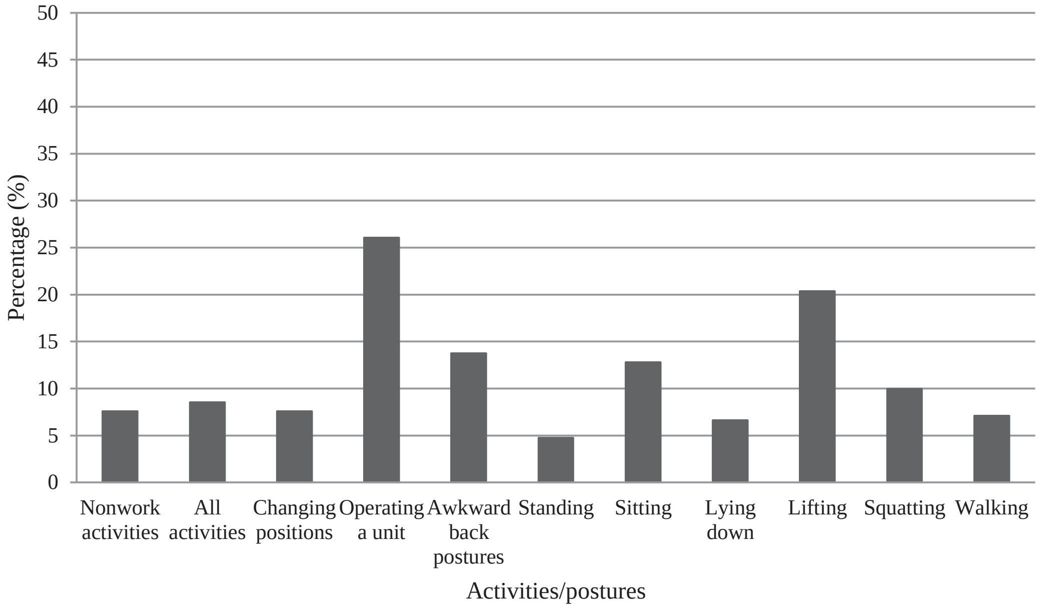
Since this study indicated that a healthy worker bias may be present, a further analysis was conducted to examine how the healthy worker effect affected each occupational group. Two Cox proportional hazards models were constructed. These models were similar to the Cox models in the Methods section of this chapter. The outcomes of interest were the same as the Cox models in this chapter but the explanatory variables were slightly different. There are seven explanatory variables for the first Cox model. Six of the explanatory variables were the same as in the first model in the chapter: 1) a dichotomous variable representing occupational group (white-collar, blue-collar), 2) a continuous variable representing duration of work (in years), 3) a continuous variable representing age at first employment (the date on which participants started work minus birth date), 4) a categorical variable representing smoking status (never smoked, former smoker, current smoker), 5) a categorical variable representing level of education (primary, secondary, tertiary), 6) a dichotomous variable representing gender (female, male). But, in this first model, an explanatory variable was included as the seventh variable, i.e. a continuous variable representing duration of first LBS (questionnaire date minus LBS onset date for those with LBS and 0 for those without LBS). The second Cox model included of all explanatory variables in Model I, and an additional variable to assess the interaction between occupational group and LBS duration. As mentioned earlier, the LBS duration term allowed for a trend in reported incidence, assumed to be caused by those experiencing LBS in earlier years being less likely to still be present at the time of the survey. The interaction term allowed this effect to be different for each occupational group. A likelihood ratio test was carried out to compare these two models. The result of this test showed a nonsignificant trend ($p > .05$) in incidence after allowing for covariates between Model I and Model II. It indicates that there is no evidence that the healthy worker effect affects the two occupational groups differently.

If physical exposure was the only factor that played a role in the occurrence of LBS, it was expected that blue-collar workers would be more likely to be affected by the healthy worker effect than white-collar workers, considering that they are more likely to be exposed to physical factors than white-collar workers. In fact, this study failed to provide evidence of any differences of healthy worker effect influences across the two occupational groups. It was therefore speculated that other factors also influenced the occurrence of LBS in this study population.

Other findings

Additional information was obtained about specific activities that were reduced due to LBS. This information was gathered using an open question to allow respondents who experienced reduced activities due to LBS during the last 12 months to specify what these were (they could specify more than one activity). Thirty-eight percent answered this open question. Sixty-two percent did not. Figure 5.2 shows any activities/postures that were reported as being reduced due to LBS. Operating a unit (heavy vehicle, dump truck) was the activity most affected (26%), followed by lifting activities (21%), and any activities that required awkward back postures (14%). In the Review of literature section (Section 1.2.2.2), it has been explained that LBS occurs when there are impairments in the muscles and/or structures of the spine due to cumulative loading (Marras, 2008b). Hence, operating a unit, in which workers who have been exposed to prolonged sitting combined with whole-body vibration, may load the muscle and/or structure of the spine even more. Similarly, lifting activities and any activities that involved awkward back postures may also load the spine and could trigger more pain. This may, in turn, affect (reduce) a workers' mood, attitude, and inclination to work.

Since most of the activities/postures that were reported as being reduced due to LBS appear to be related to activities at work, any intervention to reduce LBS prevalence may help to increase work productivity. This in turn may help to increase income for the company.



Note. Changing positions = changing positions from lying down or sitting to standing.

Figure 5.2 Activities/postures that had been reduced due to LBS

Data management of the Indonesian coal mining study

The answers from respondents in the questionnaire needed to be transferred to the spread sheet to be analysed. However, since this was done manually, errors (e.g. typo) may have occurred. After randomly selecting 20% of the valid questionnaires, the examinations reviewed a relatively small (0.37%) overall error rate for data entry, indicating high accuracy of the data transferred.

Strengths of the present study

There are three advantages in this study. First, the relatively large sample size implies the 95% CI around the point estimate of prevalence were reasonably narrow. It indicates the precision of the prevalence estimates was good. Second, a cross-cultural adaptation was conducted for all questions to assure equivalence between the English and Indonesian versions (Beaton, et al., 2000) (Appendix B4). Hence, the content validity of the Indonesian version questionnaire was similar to the original questionnaire at the conceptual level. Finally, the availability of information about the occurrence of the first symptoms meant this study was able to examine risk factors of LBS adjusting for the healthy worker effect and potential confounding factors to provide appropriate estimation risks.

Limitations of the present study

Apart from the limitations that have already been described in the Discussion section of this chapter, another limitation of the present study was not taking into account the duration of the absence due to LBS. Tubach et al. (2002) argued that excluding very short absenteeism (less than eight days) from the cases may limit the possibility of report bias since the short absenteeism might be underreported. Unfortunately, this approach could not be applied in the present study since only small numbers (n = 20) had absenteeism more than eight days.

Chapter 6 Interaction between physical and psychosocial work risk factors for low back symptoms and its consequences amongst Indonesian coal mining workers

Widanarko, B., Legg, S., Devereux, J., and Stevenson, M. (2012). Interaction between physical and psychosocial work factors for low back symptoms and its consequences amongst Indonesian coal mining workers. *Manuscript submitted for publication.*

Preface

The previous chapter (Chapter 5) has shown that the prevalence of LBS and its consequences among the Indonesian coal mining workers is high, so it is necessary to examine the risk factors for LBS and its consequences. However, only few studies have examined the risk factors of LBS (Gap 2.1) and its consequences (Gap 2.3) in IDCs. Although in the workplace workers are commonly exposed to physical and psychosocial factors simultaneously, the interaction between these factors for LBS and its consequences is not well understood (Gap 2.4). Thus, this chapter examines risk factors and their potential interactions for LBS and its consequences to address this gap in the knowledge. The gaps, aims, and hypotheses for this chapter are:

Gaps	Aims	Hypotheses
Less is known about LBS risk factors amongst the working population in IDCs	To examine the association between physical and psychosocial risk factors and LBS	Exposure to physical and psychosocial risk factors will increase the risk of LBS
Less is known about LBS consequences risk factors	To examine the association between physical and psychosocial risk factors and reduced activities due to LBS	Exposure to physical and psychosocial risk factors will increase the risk of reduced activities due to LBS
	To examine the association between physical and psychosocial risk factors and absenteeism due to LBS	Exposure to physical and psychosocial risk factors will increase the risk of absenteeism due to LBS
The interaction between physical and psychosocial exposure for LBS is not well	To examine the interaction between physical and psychosocial factors for LBS, adjusting for the potential	• Those with both high physical and high psychosocial factors will be most likely to report

understood	confounders (gender, age, duration of work, education, smoking status, current employment status and shift work)	LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work) • The interaction between physical and psychosocial factors for LBS will be present
The interaction between physical and psychosocial exposure for LBS consequences is not well understood	To examine the interaction between physical and psychosocial factors for reduced activities due to LBS, adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work)	• Those with both high physical and high psychosocial factors will be most likely to report reduced activities due to LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work) • The interaction between physical and psychosocial exposure for reduced activities due to LBS will be present
	To examine the interaction between physical and psychosocial factors for absenteeism due to LBS, adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work)	• Those with both high physical and high psychosocial factors will be most likely to report absenteeism due to LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work) • The interaction between physical and psychosocial exposure for absenteeism due to LBS will be present

A preliminary study was conducted to examine the interaction between physical and psychosocial factors in a subsample (n = 673) of this study population. This preliminary study has won the International Ergonomics Association Triennial KU Smith Student Paper Award for outstanding graduate student research project and been published as (see Appendix B11):

Widanarko, B., Legg, S., Stevenson, M., & Devereux, J. (2012). Interaction between physical, psychosocial, and organisational work factors for low back symptoms and its consequences amongst Indonesian coal mining workers. *Work: A Journal of Prevention, Assessment and Rehabilitation, 41*(Supplement 1), 6112-6119.

Abstract

Introduction: Little is known about the interaction between physical and psychosocial factors for low back symptoms (LBS) and its consequences (reduced activities and absenteeism), particularly in those working in developing countries. **Methods:** 1,294 Indonesian coal mining workers reported occupational exposures, LBS and its consequences using a self-administered questionnaire. Respondents were placed into one of four combination exposure groups: high physical and high psychosocial (HPhyHPsy); low physical and high psychosocial (LPhyHPsy); high physical and low psychosocial (HPhyLPsy), and; low physical and low psychosocial (LPhyLPsy). The attributable proportion due to interaction between physical and psychosocial factors was examined. **Results:** Individuals in the HPhyHPsy group were most likely to report LBS (OR 4.78, 95% CI [3.03, 7.53]), reduced activities (OR 5.89, 95% CI [3.59, 9.65]), and absenteeism (OR 3.24, 95% CI [1.83, 5.75]). An interaction between physical and psychosocial factors was present for LBS. For reduced activities, interaction was also present, although not significant, whereas for absenteeism it was not present. Permanent employment and night shift work increased the risk of LBS and its consequences. Current smokers were more likely to report LBS consequences. **Conclusions:** Interventions should address both factors, with a focus on permanent employment, night shift work, and smokers.

Keywords: coal mining, developing country, manual handling, musculoskeletal disorders, work stress, sick leave.

6.1 Introduction

Low back symptoms (LBS) is an important health problem due to their serious worldwide economic and social impacts (NRC & IOM, 2001). In a review using data collected between 1969 and 1998, the 12-month period prevalence of LBS from eight developed countries ranged between 22% and 65% (Walker, 2000). For the consequences of LBS, i.e. reduced activities and absenteeism, it ranges from 18% to 42% (Scuffham, et al., 2010; Widanarko, Legg, Stevenson, et al., 2012b) and from 9% to 14% (Ijzelenberg, et al., 2004; Scuffham, et al., 2010; Widanarko, Legg, Stevenson, et al., 2012b), respectively. Since industrially developing countries (IDCs) may have a high proportion of workers engaged in heavy manual work, it might be expected that the prevalence of LBS and its consequences would be greater than for developed countries (Volinn, 1997). However, the prevalence of LBS in IDCs (32% to 75%) (Chen, et al., 2005; Louw, et al., 2007; Widanarko, Legg, Stevenson, Devereux, & Jones, 2012) and absenteeism (5% to 13%) (Ghaffari, et al., 2006; Widanarko, Legg, Stevenson, Devereux, & Jones, 2012) are similar to that in developed countries. The prevalence of reduced activities (10% to 16%) (Chen, et al., 2005; Widanarko, Legg, Stevenson, Devereux, & Jones, 2012) in IDCs is lower than for developed countries, but it is hard to be confident that this difference is real because relatively few studies of LBS have been undertaken in IDCs (Volinn, 1997). In worldwide terms, the paucity of information about the magnitude of LBS and its consequences among IDCs is a concern, since more than 80% of the global workforce live and work in the industrially developing world (United Nations, Department of Economic and Social Affairs, & Population Division, 2011). Hence, any study that investigates the burden of LBS in an IDC is important as it will, at the very least, provide baseline data for future comparison.

Risk factors for LBS and its consequences involve physical and psychosocial factors. Physical risk factors for LBS that have been identified in various occupational groups include awkward back posture (Hooftman, et al., 2009; Ijzelenberg, et al., 2004; Lotters, et al., 2003), lifting (Aasa, et al., 2005; Elders & Burdorf, 2001; Hooftman, et al., 2009; Lotters, et al., 2003), and whole-body vibration (Linton, 1990; Lotters, et al., 2003). Risk factors for reduced activity include awkward posture (Aasa, et al., 2005) and lifting (Aasa, et al., 2005; Widanarko, Legg, Stevenson, et al., 2012b). For absenteeism, they include awkward posture (Hoogendoorn, et al., 2002; Widanarko, Legg, Stevenson, et al., 2012b), lifting (Hooftman, et al., 2009; Hoogendoorn, et al., 2002), and whole-body vibration (Hartman, et al., 2005).

Psychosocial risk factors associated with LBS include high job strain (Ijzelenberg, et al., 2004), high psychological demands (Aasa, et al., 2005; Elders & Burdorf, 2001; Hooftman, et al., 2009; Ijzelenberg, et al., 2004), low decision latitude (Aasa, et al., 2005; Ijzelenberg, et al., 2004), low social support (Aasa, et al., 2005; Hooftman, et al., 2009), job dissatisfaction (Hooftman, et al., 2009), high effort-reward imbalance (ERI) score (Rugulies & Krause, 2008), and high work stress (Widanarko, Legg, Stevenson, et al., 2012a). Risk factors for reduced activities have been reported as high psychological demand (Aasa, et al., 2005), low decision latitude (Aasa, et al., 2005), low social support (Aasa, et al., 2005), and high ERI score (Simon, et al., 2008), whilst those for absenteeism include low job control (Hemingway, et al., 1997), low social support (Hooftman, et al., 2009; van den Heuvel, et al., 2004), and job dissatisfaction (Hooftman, et al., 2009; Hoogendoorn, et al., 2002; van den Heuvel, et al., 2004).

The relative role of physical and psychosocial factors in the aetiology of LBS and its consequences is complex. Davis and Heaney (2000) and Karsh (2006) proposed a model of the relationship between physical and psychosocial factors and LBS. These models suggest that both physical and psychosocial factors may independently influence LBS. The physical and psychosocial factors may also interact, giving rise to a probability of LBS being greater than the sum of the magnitude of the individual effects (as indicated by departure from an additive model of risk). Rothman et al. (2008) also suggested that the interaction can exist when two or more risk factors are causally associated with an outcome.

However, to the best of our knowledge only eight studies have investigated the interaction between physical and psychosocial risk factors at work and LBS (Devereux, et al., 2004; Devereux, et al., 1999; Fernandes, et al., 2009; Huang, et al., 2003; Lapointe, et al., 2009; Linton, 1990; Thorbjörnsson, et al., 2000; Vandergrift, et al., 2012). They have shown that individuals exposed to both high physical and high psychosocial factors have the highest risk of LBS. Most of the studies that examined this interaction, as cited above, were conducted in developed countries and only one study (Fernandes, et al., 2009) has examined this interaction in an IDC (Brazil).

With this background, the objective of the present study was to examine the interaction between physical and psychosocial exposures for LBS and its consequences (reduced activities and absenteeism). Since only one study has examined the interaction in an IDC, the present study was conducted in a coal mining company in Indonesia.

6.2 Methods

6.2.1 Participants and questionnaire administration

With prior agreement and facilitation from the Safety, Health and Environmental manager of the company, invitations to participate in the study were delivered in person to 2,150 coal mining workers involved in various occupations at three sites (two located in the province of East Borneo and one in the province of South Borneo). Workers who had worked more than or equal to 1 year of work experience in the current position and had never previously had an accident involving the low back region were eligible for inclusion in the study. The workers were arranged to anonymously complete a self-administered questionnaire in groups of 20 to 25 under the supervision of two trained investigators, who were available to respond to queries and who, in advance, gave the groups a brief explanation about the questionnaire's content and the aims of the study. Company management were not present when the questionnaire was answered.

The first page of the questionnaire comprised an information sheet that had to be read prior to answering the questions. The information sheet clearly stated that completing and returning the questionnaire implied that respondents agreed to participate in the study. Since the questionnaire only sought information about demographic characteristics, occupation (and its related exposure), LBS and its consequences using self-reporting and was completed anonymously, a signed informed consent was not necessary. The study design was evaluated by peer review and judged to be low risk and was recorded on the Low Risk Database of the Massey University Human Ethics Committee.

6.2.2 Questionnaire

The questionnaire was used to obtain information on demographic characteristics (age, gender, education), smoking status (never smoked – defined as never smoked 100 cigarettes; former smoker – defined as having smoked $\geq$ 100 cigarettes but quit smoking during the year prior to the survey or longer ago, and; smoker – defined as having smoked $\geq$ 100 cigarettes and currently smoke (Albanes, et al., 1987)), organisational factors (current employment status: permanent, nonpermanent, and; shift work: no shift work, shift work without night shift, shift work with night shift), physical and psychosocial exposures, LBS and its consequences (reduced activities and absenteeism), and any accident(s) that involved the low back region. Since the original questions were all in English and the study was conducted in Indonesia(n), a cross-cultural adaptation of the questionnaire was undertaken, in accordance with guidelines for adaptation of health related subjective data collection tools (Beaton, et al., 2000).

6.2.2.1 Physical, psychosocial and organisational exposure assessments

Physical exposure questions asked respondents to estimate how much working time (not at all, 1-10%, 11-25%, 26-50%, 51-75%, and 76-100% of the time) during their work activities they were involved in any of these situations: sitting position (Leijon, Wiktorin, Harenstam, Karlqvist, & MOA Research Group, 2002); squatting position (Wiktorin, Hjelm, Winkel, & Koster, 1996; Wiktorin, et al., 1993); bent trunk

(Leijon, et al., 2002); bent and twisted trunk in the same way several times an hour (Leijon, et al., 2002); exposure to whole-body vibration or working on an unstable surface (e.g. vibrating floor, vehicle seat) (Wiktorin, et al., 1996), and; using hand tools which vibrate or give impact (Wiktorin, et al., 1996). They were also asked to estimate the frequency (almost never/not at all, 1-3 days per month, 1 day per week, 2-4 days per week, and every workday) of lifting or carrying objects weighing between 6 and 15 kg (Torgen et al., 1997; Wiktorin, et al., 1993) and between 16 and 25 kg (Torgen, et al., 1997; Wiktorin, et al., 1993). A question about lifting or carrying an object more than 25kg was modified from Viikari Juntura et al. (1996). This modification was justified because lifting more than 25 kg more than once per day has been shown to increase the risk of LBS (Lotters, et al., 2003) and is in accordance with internationally accepted guidelines (Fallentin, Viikari-Juntura, Waersted, & Kilbom, 2001).

Psychosocial exposures in the current working place were assessed using Job Content Questionnaire from Karasek et al. (1998) (nine questions about decision latitude; five questions about psychological demand, and; eight questions about social support) and a standardized short version of the ERI Questionnaire from Siegrist et al. (2008) (three questions about effort; seven questions about reward, and; six questions about over-commitment) with the following response categories: strongly agree; agree; disagree, and; strongly disagree. Information about job satisfaction (four questions) was obtained using the COPSOQ II (Pejtersen, Kristensen, Borg, & Bjorner, 2010). An additional single question on perceived work stress was asked: “In general, how do you find your job?” with response categories: not at all stressful; mildly stressful; moderately stressful; very stressful, and; extremely stressful (Smith, Johal, et al., 2000).

6.2.2.2 Definition of outcomes for LBS and its consequences

Questions about LBS and its consequences were asked using the standardized Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka, et al., 1987). LBS were defined as any symptoms (such as aches, pains, discomfort, numbness, or fatigue) during the last 12 months in the low back region of more than 7 days duration with onset during the current job and with symptoms present within the 7 days immediately prior to the date on which the survey was carried out (Devereux, et al., 1999). LBS consequences were defined as symptoms that prevented the person carrying out normal activities (reduced activities) and absence from work due to those symptoms (absenteeism) within the previous 12 months.

6.2.2.3 Validity and reliability of the questionnaire

The validity of the data collected using the questionnaire was assessed by comparing questionnaire responses with data collected by observations (for physical exposure) and interviews (for psychosocial exposure). Observations were carried out on 15 respondents (office workers, management, mechanics, welder, dump truck operator, and heavy vehicle operator) at the workplace during working hours. A modification of the Back-Exposure Sampling Tool (Back-EST) (Village et al., 2009) observational method was adopted to describe measures of seven physical exposures: sitting position, bent trunk, bent and twisted trunk, whole-body vibration exposure, and lifting or carrying load 6 to 15 kg, 16 to 25 kg, and more than 25 kg. A total of 4 hours of observation for each sample was conducted. The 4-hour observation summary of the percent time exposed for sitting position, bent trunk, bent and twisted trunk, and whole-body vibration risk factor were multiplied by 2 to represent the estimated exposure during a given working day of 8 hours duration. For lifting, the number of times each participant lifted or carried each load weight in 4 hours was observed and multiplied by 2 to obtain an estimate of lifting activity per day. The interviews used for validation of the eight psychosocial exposures (effort, reward, over commitment, decision latitude, psychological demands, social support, job satisfaction, and work stress) were semi-structured and conducted without any interruptions with 14 workers (office workers, management, mechanics, welder, dump truck operator, and heavy vehicle operator) in a quiet room that was provided by company management. The respondents were asked to explain more about the psychosocial conditions in the workplace according to the items relating to psychosocial exposure in the questionnaire.

The validity of the questionnaire was determined by calculating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) (Altman, 1991c). Also, kappa statistic analysis was conducted to provide a quantitative measure of the agreement between the observation/interview data and self-report data adjusted for the level of agreement expected from chance alone (Altman, 1991c). Cronbach’s alphas were computed for each scale of psychosocial exposure to quantify reliability.

6.2.3 Data analysis

Analysis of the data based on the five or six response categories for physical and psychosocial exposure showed clear trends in LBS prevalence. Low numbers of cases in each of the strata meant that the confidence intervals (CI) around the LBS prevalence estimates were unreasonably large. Therefore the 5- or 6-point categories were collapsed into three.

Before examining the combined effects of physical and psychosocial factors, it was necessary to determine the criteria for high and low physical and psychosocial exposures. For the physical exposures, this was done in four steps. First, logistic regression was conducted to quantify the association between each explanatory physical factor and the outcome of interest adjusted for age, gender, and duration of work (Table 6.1). High physical risk factors for LBS were identified as those with an odds ratio (*OR*) significantly greater than 1. They were found to be working with bent trunk >50% of time, exposure to whole-body vibration >50% of time, using hand tools which vibrate or give impact >50% of time, lifting or carrying 16-25 kg ≥2 days/week, and lifting >25kg at all (Table 6.1). Low physical risk factors for LBS were identified as those with *OR* significantly less than 1 or with *OR* >1 (with its 95% CI including 1). They were found to be working with bent trunk <50% of time, exposure to whole-body vibration ≤50% of time, using hand tools which vibrate or give impact ≤50% of time, lifting 16-25 kg <2 days/week, and did not do lifting >25kg at all) (Table 6.1).

Second, the physical exposures that were associated with the outcome in the step 1 were combined to create physical exposure groups. For example, working with bent trunk was combined with whole-body vibration to create the first risk factor group; working with bent trunk was combined with using vibrating tools to create the second risk factor group, etc. (Table 6.2).

Third, a logistic regression analysis was then conducted to quantify the association between each risk factor group and outcomes, adjusted for the effect of age, gender, and duration of work. Physical exposure groups that were associated with the outcome in step 3 were used as the basis to determine the final criteria of high/low physical exposure. Finally, respondents were classified as having high physical exposure if they were exposed to at least one significant physical risk factor group whereas respondents were classified as having low physical exposure if they were not exposed to any physical risk factor group.

The cut-off points to classify high/low psychosocial exposure were: upper mean-based quartiles for effort (Siegrist, et al., 2008), over commitment (Siegrist, et al., 2008), and psychological demand (Karasek, Choi, Ostergren, Ferrario, & De Smet, 2007); lower mean-based quartiles for reward (Siegrist, et al., 2008), and decision latitude (Karasek, et al., 2007); median for social support (Landsbergis, Schnall, Warren, Pickering, & Schwartz, 1994); and mean for job satisfaction (Pejtersen, et al., 2010). Respondents were classified as having high psychosocial exposure if they were exposed to at least two significant psychosocial factors (Devereux, et al., 1999; Fernandes, et al., 2009) and as having low psychosocial exposure if they were exposed to none or one psychosocial factor.

To examine the interaction effects of physical and psychosocial risk factors, all respondents were grouped into one of four combination exposure groups based on the final physical and psychosocial exposure categories: high physical and high psychosocial (HPhyHPsy), low physical and high psychosocial (LPhyHPsy), high physical and low psychosocial (HPhyLPsy), and low physical and low psychosocial group (LPhyLPsy) (as the reference group). Three logistic regression models were developed to quantify the association between physical and psychosocial exposure group and each outcome: LBS, reduced activities, and absenteeism. In all models, gender (Davis & Heaney, 2000), age (Burdorf & Sorock, 1997; Davis & Heaney, 2000), duration of work (Devereux, et al., 1999), education (Burdorf & Sorock, 1997), smoking status (Burdorf & Sorock, 1997), and organisational factors were included *a priori* as confounders. The strength of association between each of the explanatory variables and the outcome variables are reported in terms of *OR* and their 95% CI (Hosmer & Lemeshow, 2000). The Hosmer-Lemeshow test was used to assess the fit of the final logistic regression models, with a nonsignificance indicative that lack-of-fit was not sufficient to reject the models (Hosmer & Lemeshow, 2000). To assess the discriminatory ability of the logistic regression models Receiver Operating Characteristic (ROC) curves were constructed for each model (Hosmer & Lemeshow, 2000). The statistical analyses were conducted using Stata for Windows version 12.1 (Intercooled Stata for Windows, 2012).

In each model the interaction between physical and psychosocial factors on the outcome was assessed by computing the attributable proportion (AP) (and its 95% CI) by dividing the risk differences by the risk in exposed workers. Thus, AP was computed using the following formula: $[(OR_{11} – OR_{10} – OR_{01} + 1)/OR_{11}]$ (Hallqvist, et al., 1996; Rothman, et al., 2008), where OR_{11} represents the OR for high physical and high psychosocial exposure, OR_{10} represents the OR for high physical and low psychosocial exposure, and OR_{01} represents the OR for low physical and high psychosocial exposure. A value for AP (and its 95% CI) greater than one indicates the presence of statistically significant interaction between physical and psychosocial factors, whereas an AP of less than or equal to one is indicative of no interaction. The AP value also represents the proportion of LBS among exposed workers that is caused by the exposure. The calculation of AP value and its 95% CI was conducted using work spreadsheet that was developed by Andersson, et al. (2005). These analyses were carried out separately for each outcome.

6.3 Results

6.3.1 Description of the sample

Of the 1,565 completed the questionnaires (73%), 271 were excluded from the analysis: 260 were completed by individuals who did not meet the study eligibility criteria (211 had less than 1 year work experience in the current position and 49 had had an accident involving the low back region previously) and 11 answered less than 50% of the questions. A total of 1,294 questionnaires were considered to be valid and were used in the present analysis.

Of the total sample (*N* = 1,294), 97% were answered by males. The median age was 26 (interquartile range 10 years) and the median duration of work was 3 years (interquartile range 4 years). The distribution for education was 13% (primary); 85% (secondary), and; 2% (tertiary). Thirty-seven percent of respondents never smoked, 13% were former smokers and 50% were current smokers. The survey group was comprised of managerial staff (2%), general office staff (11%), group leaders (6%), drivers of buses, trucks and light vehicles (3%), mechanics (26%), dump truck operators (34%), heavy vehicle operators (10%), and others (e.g. welder, tyre man, etc.) (8%). Fifty-seven percent of the respondents were permanent employees and 43% were nonpermanent employees. The shift work distribution was 16% nonshift work; 6% shift work without night shift, and; 78% shift work with night shift. The prevalence of LBS was 23 per 100 workers, 95% CI [21 per 100 workers, 26 per 100 workers]. Sixteen percent, 95% CI [14%, 18%] and 13%, 95% CI [11%, 15%] of the entire study population reported that they had reduced activities and absenteeism due to LBS during the previous 12 months, respectively.

6.3.2 Validity and reliability of the questionnaire

The sensitivity of the questionnaire to detect the presence of each of the 15 physical and psychosocial exposures ranged from 71% to 100% (except for working with bent and twisted trunk – 50%). Questionnaire specificity ranged from 83% to 100% (except for decision latitude – 66%). The PPV for all physical and psychosocial exposures ranged from 83% to 100% (except for working with bent and twisted trunk – 50%, and lifting more than 25kg – 60%) whereas NPV ranged from 71% to 100% (except for decision latitude – 66%). Although the relatively small number of respondents observed and interviewed made the CI around the point estimates of kappa wide, the kappa values for physical and psychosocial exposure ranged between .61 and .86, indicating good agreement (except for working with bent trunk, bent and twisted trunk, lifting 6-15 kg, lifting more than 25 kg, reward, and work stress, which showed moderate agreement). Apart from low sensitivity and low PPV for working with a bent and twisted trunk, these results indicate that physical and psychosocial exposures obtained from the self-reported questionnaire used in the present study were valid measures. The Cronbach's alphas for each psychosocial scale were as follows: effort (.70); reward (.79); over commitment (.69); decision latitude (.56); psychological demands (.54); social support (.78), and; job satisfaction (.70). This indicates that the reliability of almost all psychosocial scales was acceptable.

6.3.3 Physical and psychosocial exposures

Table 6.1 shows the association between single physical exposure and all outcomes (LBS, reduced activities, and absenteeism due to LBS). Physical exposure groups that were significantly associated with the outcome after adjustment for age, gender, and duration of work were used to determine the final criteria for high and low physical exposure and are indicated in bold in Table 6.2. Combinations between vibration (either whole-body or using vibrating tools) and lifting or carrying were significantly associated with all outcomes.

Table 6.1 *Single physical risk factors for LBS, reduced activities, and absenteeism due to LBS*

Physical factors	LBS		Reduced activities		Absenteeism	
	OR[a]	[95% CI]	*OR*[a]	[95% CI]	*OR*[a]	[95% CI]
Working in sitting position						
Never	1.00		1.00		1.00	
≤50% of time	1.33	[0.37, 4.70]	0.98	[0.28, 3.44]	2.40	[0.31, 18.31]
>50% of time	1.80	[0.52, 6.47]	1.37	[0.39, 4.78]	3.47	[0.46, 26.29]
Working in squatting position						
Never	1.00		1.00		1.00	
≤50% of time	0.89	[0.66, 1.22]	1.08	[0.76, 1.54]	1.06	[0.73, 1.54]
>50% of time	1.07	[0.53, 2.17]	1.83	[0.91, 3.65]	0.72	[0.27, 1.92]
Working with a bent trunk						
Never	1.00		1.00		1.00	
≤50% of time	1.00	[0.72, 1.38]	0.92	[0.65, 1.32]	0.94	[0.64, 1.38]
>50% of time	**2.05**	**[1.13, 3.73]**	**3.75**	**[2.09, 6.75]**	1.90	[0.96, 3.74]
Working with a bent and twisted trunk						
Never	1.00		1.00		1.00	
≤50% of time	1.15	[0.82, 1.61]	1.25	[0.86, 1.81]	1.26	[0.84, 1.89]
>50% of time	1.62	[0.82, 3.17]	**3.28**	**[1.67, 6.44]**	1.55	[0.65, 3.47]
Whole-body vibration						
Never	1.00		1.00		1.00	
≤50% of time	1.03	[0.66, 1.62]	0.90	[0.56, 1.46]	0.93	[0.55, 1.59]
>50% of time	**2.02**	**[1.30, 3.13]**	**1.79**	**[1.12, 2.84]**	**1.86**	**[1.12, 3.09]**
Working using vibrating hand tools						
Never	1.00		1.00		1.00	
≤50% of time	0.97	[0.69, 1.36]	1.10	[0.75, 1.62]	1.46	[0.95, 2.23]
>50% of time	**1.67**	**[1.11, 2.50]**	**2.81**	**[1.84, 4.29]**	**2.83**	**[1.75, 4.56]**
Lifting 6-15 kg						
Almost never	1.00		1.00		1.00	
<2 days/week	1.01	[0.70, 1.45]	1.37	[0.92, 2.05]	0.95	[0.61, 1.50]
≥2 days/week	1.25	[0.89, 1.74]	**1.68**	**[1.16, 2.43]**	**1.66**	**[1.12, 2.46]**
Lifting 16-25 kg						
Almost never	1.00		1.00		1.00	
<2 days/week	0.85	[0.59, 1.23]	0.99	[0.67, 1.47]	1.18	[0.77, 1.80]
≥2 days/week	**1.46**	**[1.02, 2.08]**	**1.88**	**[1.29, 2.73]**	**2.11**	**[1.40, 3.18]**
Lifting >25 kg						
Almost never	1.00		1.00		1.00	
<2 days/week	**1.42**	**[1.01, 2.00]**	1.17	[0.80, 1.71]	1.29	[0.86, 1.95]
≥2 days/week	**2.65**	**[1.69, 4.14]**	**2.04**	**[1.26, 3.29]**	**1.90**	**[1.12, 3.23]**

Note. *OR* = odds ratio; CI = confidence interval.

[a] Adjusted for age, gender, and duration of work.
Physical factors that significantly associated with outcome(s) were indicated **in bold**.

Table 6.2 *Physical risk factor groups for LBS, reduced activities, and absenteeism due to LBS*

Physical risk factor groups	LBS		Reduced activities		Absenteeism	
	OR[a]	[95% CI]	*OR*[a]	[95% CI]	*OR*[a]	[95% CI]
Risk factor group 1: bent trunk + whole-body vibration						
Low	1.00		1.00		1.00	
High	**2.82**	**[1.36, 5.84]**	**5.01**	**[2.47, 10.15]**	1.86	[0.79, 4.40]
Risk factor group 2 : bent trunk + using vibrating tools						
Low	1.00		1.00		1.00	
High	1.59	[0.70, 3.58]	**6.11**	**[2.91, 12.08]**	1.66	[0.67, 4.15]
Risk factor group 3: bent trunk + lifting 6-15kg						
Low	1.00		1.00		1.00	
High	**2.38**	**[1.15, 4.92]**	**3.59**	**[1.73, 7.43]**	1.53	[0.62, 1.04]
Risk factor group 4: bent trunk + lifting 16-25kg						
Low	1.00		1.00		1.00	
High	**2.83**	**[1.15, 6.94]**	**5.26**	**[2.15, 12.88]**	2.21	[0.79, 6.15]
Risk factor group 5: bent trunk + lifting >25kg						
Low	1.00		1.00		1.00	
High	**2.49**	**[1.17, 5.31]**	**5.53**	**[1.36, 22.46]**	2.15	[0.43, 10.52]
Risk factor group 6: bent and twisted trunk + whole-body vibration						
Low	1.00		1.00		1.00	
High	1.58	[0.70, 3.57]	**3.30**	**[1.51, 7.24]**	1.10	[0.37, 3.26]
Risk factor group 7: bent and twisted trunk + using vibrating tools						
Low	1.00		1.00		1.00	
High	0.99	[0.36, 2.73]	**5.70**	**[2.37, 13.67]**	1.48	[0.49, 4.47]
Risk factor group 8: bent and twisted trunk + lifting 6-15kg						
Low	1.00		1.00		1.00	
High	1.45	[0.59, 3.56]	**3.37**	**[1.43, 7.94]**	1.34	[0.45, 4.01]
Risk factor group 9: bent and twisted trunk + lifting 16-25kg						
Low	1.00		1.00		1.00	
High	1.59	[0.54, 4.64]	2.60	[0.87, 7.74]	1.61	[0.45, 5.76]
Risk factor group 10: bent and twisted trunk + lifting >25kg						
Low	1.00		1.00		1.00	
High	2.13	[0.50, 9.02]	2.13	[0.41, 11.16]	1.03	[0.12, 8.51]
Risk factor group 11: whole-body vibration + lifting 6-15kg						
Low	1.00		1.00		1.00	
High	**2.40**	**[1.54, 3.73]**	**2.18**	**[1.37, 3.46]**	**2.43**	**[1.48, 3.97]**
Risk factor group 12: whole-body vibration + lifting 16-25kg						
Low	1.00		1.00		1.00	
High	**4.56**	**[2.03, 10.21]**	**4.54**	**[2.06, 10.03]**	**4.52**	**[2.00, 10.22]**
Risk factor group 13: whole-body vibration + lifting >25kg						
Low	1.00		1.00		1.00	
High	**3.21**	**[1.87, 5.48]**	**3.49**	**[1.12, 10.86]**	**6.80**	**[2.23, 20.73]**

Physical risk factor groups	LBS		Reduced activities		Absenteeism	
	OR[a]	[95% CI]	*OR*[a]	[95% CI]	*OR*[a]	[95% CI]
Risk factor group 14: using vibrating tools + lifting 6-15kg						
Low	1.00		1.00		1.00	
High	**2.27**	**[1.40, 3.69]**	**3.30**	**[1.98, 5.16]**	**2.05**	**[1.19, 3.55]**
Risk factor group 15: using vibrating tools + lifting 16-25kg						
Low	1.00		1.00		1.00	
High	**2.92**	**[1.58, 5.40]**	**3.88**	**[2.12, 7.09]**	**2.10**	**[1.04, 4.24]**
Risk factor group 16: using vibrating tools + lifting >25kg						
Low	1.00		1.00		1.00	
High	**3.08**	**[1.80, 5.26]**	**5.18**	**[2.37, 11.30]**	**3.01**	**[1.29, 7.04]**

Note. *OR* = odds ratio; CI = confidence interval.
[a] Adjusted for age, gender, and duration of work.
Physical risk factor groups that significantly associated with outcome(s) were indicated **in bold**.

Table 6.3 shows the association between each of the psychosocial factors and LBS, reduced activities, and absenteeism due to LBS, adjusted for age, gender, and duration of work. High effort, low reward, job dissatisfaction, and work stress were significantly associated with all outcomes.

Table 6.3 *Psychosocial risk factors for LBS, reduced activities, and absenteeism due to LBS*

Psychosocial factors	LBS		Reduced activities		Absenteeism	
	OR[a]	[95% CI]	*OR*[a]	[95% CI]	*OR*[a]	[95% CI]
Effort						
Low (<9.25)	1.00		1.00		1.00	
High (≥9.25)	**2.51**	**[1.82, 3.46]**	**2.49**	**[1.77, 3.49]**	**2.25**	**[1.55, 3.26]**
Reward						
High (>17.33)	1.00		1.00		1.00	
Low (≤17.33)	**2.65**	**[1.94, 3.63]**	**2.46**	**[1.76, 3.43]**	**2.27**	**[1.58, 3.26]**
Over commitment						
Low (<16.20)	1.00		1.00		1.00	
High (≥16.20)	**1.40**	**[1.03, 1.90]**	**1.67**	**[1.21, 2.32]**	1.26	[0.87, 1.82]
Decision latitude						
High (>64.57)	1.00		1.00		1.00	
Low (≤64.57)	**2.05**	**[1.51, 2.80]**	1.24	[0.87, 1.76]	1.31	[0.89, 1.91]
Psychological demand						
Low (<34.80)	1.00		1.00		1.00	
High (≥34.80)	**1.57**	**[1.14, 2.17]**	1.35	[0.95, 1.93]	1.16	[0.77, 1.73]
Social support						
High (≥24)	1.00		1.00		1.00	
Low (<24)	**1.88**	**[1.40, 2.51]**	1.24	[0.91, 1.68]	**1.40**	**[1.01, 2.00]**

Job satisfaction						
Satisfied (>57.65)	1.00		1.00		1.00	
Not satisfied (≤57.65)	**1.64**	**[1.23, 2.19]**	**1.61**	**[1.18, 2.20]**	**1.55**	**[1.10, 2.17]**
Work stress						
Not at all stressful	1.00		1.00		1.00	
Mildly/moderately stressful	**2.28**	**[1.51, 3.42]**	**2.45**	**[1.56, 3.83]**	**2.26**	**[1.39, 3.68]**
Very/extremely stressful	**6.55**	**[3.69, 11.64]**	**5.23**	**[2.80, 9.76]**	**3.57**	**[1.78, 7.17]**

Note. *OR* = odds ratio; CI = confidence interval.
[a]Adjusted for age, gender, and duration of work.
Psychosocial factors that significantly associated with outcome(s) were indicated **in bold**.

6.3.4 Interaction between physical and psychosocial exposures

All models showed that the HPhyHPsy group had the highest odds ratios for LBS (OR 4.78, 95% CI [3.03, 7.53]), reduced activities (OR 5.89, 95% CI [3.59, 9.65]), and absenteeism (OR 3.24, 95% CI [1.83, 5.75]) (Table 6.4, Table 6.5, and Table 6.6). Those in the LPhyHPsy group had a higher *OR* than those in the HPhyLPsy group for LBS (Table 6.4), whereas for LBS consequences, the HPhyLPsy group had a higher risk than the LPhyHPsy group (Table 6.5 and Table 6.6). Current smokers had a higher risk of LBS consequences than nonsmokers. Permanent employment and night shift work increased the risk of LBS and its consequences. The AP value for LBS was 0.39, 95% CI [0.07, 0.71], indicating that interaction between physical and psychosocial exposures was present. For reduced activities and absenteeism the AP values were 0.20, 95% CI [-0.26, 0.66] and -0.01, 95% CI [-0.80, 0.79], respectively, indicating that for reduced activities the interactions were also present, although not statistically significant, whereas for absenteeism it was not present.

Table 6.4 *Logistic regression model showing the effect of physical and psychosocial exposure, gender, age, duration of work, smoking status, and organisational factors on the risk of reporting LBS*

Explanatory variables	Number of workers	Cases	Coefficient (*SE*)	*OR*	[95% CI]
Physical and psychosocial exposure					
LPhyLPsy	467	66	Reference	1.00	
LPhyHPsy	404	104	0.7939 (0.1789)	**2.21**	**[1.55, 3.14]**
HPhyLPsy	72	16	0.5151 (0.3189)	1.67	[0.89, 3.12]
HPhyHPsy	122	54	1.5648 (0.2319)	**4.78**	**[3.03, 7.53]**
Gender					
Females	33	7	Reference	1.00	
Males	1032	233	-0.7012 (0.4795)	0.49	[0.19, 1.26]
Age [a]	1065	240	0.0021 (0.0159)	1.00	[0.97, 1.03]
Duration of work [b]	1065	240	0.0196 (0.0245)	1.01	[0.97, 1.07]
Education					
Tertiary	14	3	Reference	1.00	
Secondary	913	211	-0.1289 (0.6755)	0.87	[0.23, 3.30]
Primary	138	26	0.0443 (0.7350)	1.04	[0.24, 4.41]
Smoking status					
Never smoked	416	88	Reference	1.00	
Former smoker	138	38	0.3116 (0.2421)	1.36	[0.84, 2.19]
Current smoker	511	114	0.0936 (0.1717)	1.09	[0.78, 1.53]
Organisational factors:					
Current employment status					
Permanent employee	606	154	Reference	1.00	
Nonpermanent employee	459	86	-0.3533 (0.1734)	**0.70**	**[0.49, 0.98]**
Shift work					
No shift work	171	26	Reference	1.00	
Yes, but without night shift	58	10	0.1411 (0.4241)	1.15	[0.50, 2.64]
Yes, with night shift	836	204	0.7273 (0.2932)	**2.06**	**[1.16, 3.67]**
Constant			-1.7381 (0.9642)		

Note. SE = standard error*; OR* = odds ratio; CI = confidence interval.
LPhyLPsy = Low physical and low psychosocial; LPhyHPsy = Low physical and high psychosocial; HPhyLPsy = High physical and low psychosocial; HPhyHPsy = High physical and high psychosocial.

[a] Age (in years) at the time of the survey (as a continuous variable).

[b] Duration of work in the current job (in years) (as a continuous variable).

Explanatory variables that significantly associated with outcome(s) were indicated **in bold**.

The results of the Hosmer-Lemeshow goodness of fit was p = .619 indicating that lack-of-fit was not sufficient enough to reject the models.

The areas under the ROC curve was .67, indicating that this model had poor discriminatory ability.

Table 6.5 *Logistic regression model showing the effect of physical and psychosocial exposure, gender, age, duration of work, smoking status, and organisational factors on the risk of reporting reduced activities due to LBS during the previous 12 months*

Explanatory variables	Number of workers	Cases	Coefficient (*SE*)	*OR*	[95% CI]
Physical and psychosocial exposure					
LPhyLPsy	499	46	Reference	1.00	
LPhyHPsy	459	81	0.8571 (0.2036)	**2.35**	**[1.58, 3.51]**
HPhyLPsy	68	16	1.2119 (0.3354)	**3.36**	**[1.74, 6.48]**
HPhyHPsy	124	46	1.7739 (0.2520)	**5.89**	**[3.59, 9.65]**
Gender					
Females	34	2		1.00	
Males	1116	187	-0.0441 (0.7751)	0.95	[0.20, 4.37]
Age [a]	1150	189	0.0281 (0.0168)	1.02	[0.99, 1.06]
Duration of work [b]	1150	189	-0.0041 (0.0261)	0.99	[0.94, 1.04]
Education					
Tertiary	15	1	Reference	1.00	
Secondary	984	174	0.8257 (1.0554)	2.28	[0.28, 18.07]
Primary	151	14	0.6964 (1.1117)	2.00	[0.22, 17.73]
Smoking status					
Never smoked	434	57	Reference	1.00	
Former smoker	150	21	-0.1445 (0.2949)	0.86	[0.48, 1.54]
Current smoker	566	111	0.4653 (0.1898)	**1.59**	**[1.09, 2.31]**
Organisational factors:					
Current employment status					
Permanent employee	651	125	Reference	1.00	
Nonpermanent employee	499	64	-0.4845 (0.1903)	**0.61**	**[0.42, 0.89]**
Shift work					
No shift work	183	12	Reference	1.00	
Yes, but without night shift	61	9	0.8896 (0.4875)	2.43	[0.93, 6.32]
Yes, with night shift	906	168	1.2161 (0.3669)	**3.37**	**[1.64, 6.92]**
Constant			-4.9861 (1.4212)		

Note. SE = standard error*; OR* = odds ratio; CI = confidence interval.
LPhyLPsy = Low physical and low psychosocial; LPhyHPsy = Low physical and high psychosocial; HPhyLPsy = High physical and low psychosocial; HPhyHPsy = High physical and high psychosocial.
[a] Age (in years) at the time of the survey (as a continuous variable).
[b] Duration of work in the current job (in years) (as a continuous variable).
Explanatory variables that significantly associated with outcome(s) were indicated **in bold**.
The results of the Hosmer-Lemeshow goodness of fit was *p* = .844, indicating that lack-of-fit was not sufficient to reject the model.
The areas under the ROC curve was .71, indicating that this model had acceptable discriminatory ability

Table 6.6 *Logistic regression model showing the effect of physical and psychosocial exposure, gender, age, duration of work, smoking status, and organisational factors on the risk of reporting absenteeism due to LBS during the previous 12 months*

Explanatory variables	Number of workers	Cases	Coefficient (*SE*)	*OR*	[95% CI]
Physical and psychosocial exposure					
LPhyLPsy	442	39	Reference	1.00	
LPhyHPsy	568	77	0.4984 (0.2131)	**1.64**	**[1.08, 2.49]**
HPhyLPsy	45	8	0.9657 (0.4357)	**2.62**	**[1.11, 6.17]**
HPhyHPsy	106	26	1.1781 (0.2921)	**3.24**	**[1.83, 5.75]**
Gender					
Females	36	4	Reference	1.00	
Males	1125	146	-0.7266 (0.5953)	0.48	[0.15, 1.55]
Age [a]	1161	150	0.0305 (0.0175)	1.03	[0.99, 1.06]
Duration of work [b]	1161	150	-0.0298 (0.0280)	0.97	[0.91, 1.02]
Education					
Tertiary	16	2	Reference	1.00	
Secondary	992	137	0.1245 (0.7905)	1.13	[0.24, 5.33]
Primary	153	11	-0.3634 (0.8730)	0.69	[0.12, 3.84]
Smoking status					
Never smoked	439	43	Reference	1.00	
Former smoker	152	19	0.0788 (0.3108)	1.08	[0.58, 1.98]
Current smoker	570	88	0.4741 (0.2101)	**1.60**	**[1.06, 2.42]**
Organisational factors:					
Current employment status					
Permanent employee	657	107	Reference	1.00	
Nonpermanent employee	504	43	-0.7864 (0.2128)	**0.45**	**[0.30, 0.69]**
Shift work					
No shift work	184	13	Reference	1.00	
Yes, but without night shift	64	9	0.6980 (0.4802)	2.00	[0.78, 5.15]
Yes, with night shift	913	128	0.7332 (0.3639)	**2.08**	**[1.02, 4.24]**
Constant			-3.0494 (1.1572)		

Note. SE = standard error*; OR* = odds ratio; CI = confidence interval.
LPhyLPsy = Low physical and low psychosocial; LPhyHPsy = Low physical and high psychosocial; HPhyLPsy = High physical and low psychosocial; HPhyHPsy = High physical and high psychosocial.
[a] Age (in years) at the time of the survey (as a continuous variable).
[b] Duration of work in the current job (in years) (as a continuous variable).
Explanatory variables that significantly associated with outcome(s) were indicated **in bold**.
The results of the Hosmer-Lemeshow goodness of fit was p = .550, indicating that lack-of-fit was not sufficient to reject the model.
The areas under the ROC curve were .70, indicating that this model had acceptable discriminatory ability

6.4 Discussion

The present study found that combined physical and psychosocial exposures increased the risk of all outcomes. Individuals in HPhyHPsy group were most likely to report LBS and its consequences. Although it is difficult to compare this finding with other studies due to differences in risk factor criteria and the characteristics of the populations studied, it is in agreement with cross-sectional studies of LBS among a working population in Sweden (Linton, 1990), UK workers (Devereux, et al., 2004; Devereux, et al., 1999), US Marines (Huang, et al., 2003), a Brazilian working population (Fernandes, et al., 2009), and three prospective studies among a general working population in the UK (Devereux, et al., 2004), female workers in Canada (Lapointe, et al., 2009), and automobile manufacturing workers in Michigan (Vandergrift, et al., 2012).

Psychosocial exposure appears to be more prominent than physical exposure in the occurrence of LBS (*OR* for the LPhyHPsy group 2.21, 95% [CI 1.55, 3.14]). This finding differs from previous studies among UK workers by Devereux et al. (2004; 1999) and Brazilian workers by Fernandes et al. (2009) which have reported that physical factors played a more important role in increasing the possibility of reporting LBS. There are three possible explanations for this finding.

First, the present study was conducted in an IDC (Indonesia) population whereas Devereux et al.'s studies (2004; 1999) were conducted in a developed country (UK). This represents a major difference. Globalisation has impacted developing countries in many sectors, particularly in the socioeconomic sector. To be able to compete globally with competitors, IDCs may have to face the challenge of managing the changing nature of work, such as the demands of flexible contracts, increased job insecurity, a high work pace, long and irregular working hours, low income, etc. (Houtman, et al., 2008) with limited resources. This, in turn, may increase psychosocial problems, including stress at work, for workers in IDCs. A recent study about psychosocial risks and work-related stress in IDCs found that psychosocial risk factors at work were the second most important issue that needed urgent attention after injury/accident prevention (Kortum, Leka, & Cox, 2010). Additionally, employers in IDCs may lack awareness of psychosocial factors and stress at work (Kortum, Leka, & Cox, 2011) and thus be unaware of the importance of managing these and consequently may not have put in place any prevention strategies to manage them. Nonwork factor stressors may also make the psychosocial problems at work worse for workers in developing countries. It is therefore logical that psychosocial factors appear to play a more important role than physical factors in the present study. Although Fernandes et al.'s study (2009) was also conducted in an IDC (Brazil), it was conducted in plastic factories and may have different exposures from the present study. Fernandes et al. excluded administrative workers, a group that is most commonly exposed to psychosocial factors, such as psychosocial work demands (Alexopoulos, et al., 2006) and job dissatisfaction (Matsudaira, et al., 2011). In addition, they did not include some psychosocial factors that have been identified as risk factors for LBS and its consequences, e.g. effort (Linton, 2001; Rugulies & Krause, 2008), reward (Rugulies & Krause, 2008), and work stress (Linton, 2000, 2001; NRC & IOM, 2001; Widanarko, Legg, Stevenson, et al., 2012a). Hence, the lack of a sample group that is commonly exposed to psychosocial factors and some psychosocial factors may have masked the effect size of psychosocial factors in Fernandes et al.'s study (2009).

The second possible explanation is that there may have been a healthy worker effect, particularly because the present study was cross-sectional in design. A previous study that examined the possibility of healthy worker effect using the same data set as the present study found that the duration of employment decreased the hazard of LBS by a factor of 0.04, 95% CI [0.03, 0.06] (Widanarko, Legg, Stevenson, Devereux, & Jones, 2012). Thus, it was speculated that workers who experienced LBS in the early years of employment had already left the workplace, whereas relatively healthy workers remained in employment and were preferentially included in the present study. Alternatively, a migration of work/attrition among heavy physical workers with LBS may have also influenced the result. This speculation is supported by the findings of a 5-year prospective study among a Danish population by Hartvigsen et al. (2001) which showed that workers who did heavy physical work were significantly more likely to change to sedentary work if they had low back pain for more than 30 days (out of the last year) compared with those without low back pain. In contrast, among workers who did sedentary work initially (with or without low back pain) the change of work was not significant (Hartvigsen, et al., 2001).

Lastly, the possibility of some study bias in physical exposure classification may be present in the present study. The results from the validity assessment show that most of the self-reported physical and psychosocial exposure questions used in the present study were valid. In addition, although the validity assessment for the lifting questions was based on only four hours of observation in one working day, we feel that the validity outcome is justified even though the question in the questionnaire asked about the frequency of lifting in a month/week. However, considering that there are only small numbers in HPhyLPSy group (*n* = 72 for LBS; *n* = 68 for reduced activities, and; *n* = 45 for absenteeism), there may be bias in physical exposure classification. This condition, in turn, may mask the effect size of physical exposure. A higher *OR* for this group would impact on the AP due to interaction. Despite this potential limitation to address interaction effect with greater confidence, combined exposure to both sets of risk factors would be important for intervention research.

Physical exposure appears to be more prominent than psychosocial exposure in the occurrence of LBS consequences. For more severe conditions of LBS, this could ultimately lead to workers' reducing their physical activity at work or taking time off work i.e. being absent. This seems more likely to occur for LBS associated with chronic (and gradual process) conditions in which the muscles and/or structures of the spine are already impaired due to cumulative loading (Marras, 2008b). So, any additional or over-exertion physical activities (such as bending, twisting, and lifting) which may increase the load on the spine even more, could trigger more pain. This may, in turn, affect (reduce) a workers' mood, attitude, and inclination to work. At present these considerations must remain speculative since no studies, other than the present one, have examined interactions between physical and psychosocial exposures and LBS consequences.

Current smokers were more likely to report LBS consequences (reduced activities and absenteeism) compared with those who had never smoked. This finding is similar to that of Palmer et al. (2003) for reduced activities, Tubach et al. (2002) and Hartman et al. (2005) for absenteeism due to LBS, and also to that of Widanarko, Legg, Stevenson, Devereux, and Jones (2012) for the same population as in the present study but using a different analysis with a different set of explanatory variables.

The present study showed that being a nonpermanent employee was a protective factor for LBS. Schneider et al. (2005) hypothesed that full-time workers (permanent employees) were more likely to be exposed to risk factors at work (due to a longer working time and period of employment) and more likely to report LBS than part-time workers (nonpermanent employees). Alternatively, nonpermanent employees might be at higher risk of losing their jobs than permanent employees, if health impairment occurs. Therefore, bias due to under-reporting of LBS and its consequences among nonpermanent employees may occur. Another possibility that may have influenced the findings is the exposure patterns may differ between permanent and nonpermanent employees.

Shift workers had a higher risk of LBS and its consequences than nonshift workers in the present study. This is in line with a previous study by Lipscomb et al. (2002). It is consistent with Theorell et al. (1991), who proposed that disturbed sleep may increase muscle tension which can lead to pain in the low back region. It also fits with observations by Jansen et al. (2003), who found that shift workers had a higher *OR* for an elevated need for recovery from work compared to nonshift workers. An explanation for these findings could be that shift work, particularly night shifts, is associated with short or disturbed sleep (Härmä, 2006) and may reduce the production of testosterone and growth hormone, which stimulate anabolism to assist musculoskeletal tissue regeneration (Theorell, 1996).

Interaction between physical and psychosocial exposures was present for LBS in the present study. This finding is similar to most previous studies (Devereux, et al., 2004; Devereux, et al., 1999; Fernandes, et al., 2009; Huang, et al., 2003; Lapointe, et al., 2009; Thorbjörnsson, et al., 2000). The interaction was also present for reduced activities, although not statistically significant, whereas the interaction was not present for absenteeism. Other factors that were not included in this study (e.g. job security and disincentive) may have influenced the interaction between physical and psychosocial exposure for severe condition of LBS. As explained earlier, nonpermanent employees may tend not to report their limitations in work activities or in taking sick leave due to concerns about job security. In addition, there was a disincentive to take leave since absence from work would reduce income. Also, if workers reported that their work activities were reduced or limited due to LBS, their supervisor might ask them to take sick leave which may reduce their income. Hence, it is possible that workers with severe LBS may not have reported reduced activities nor have taken sick leave. Exploring the association between job security and disincentive and/or decision to report LBS consequences may help in explaining the nonsignificant interaction for reduced activities and the absence of interaction for absenteeism. Unfortunately it was not possible to do this in the present study since data about job security, disincentive, and decision to report LBS consequences was not available.

The advantage of the present study was the outcome definition for LBS. For a study that investigates work-related LBS, the lack of information about the occurrence of first symptoms (whether before or after employment) may also lead to bias. Therefore, defining LBS by their presence during the last 12 months with symptoms more than 7 days and onset during the current job and also present within the past 7 days at the time of survey, as was done in the present study, may provide appropriate estimation. Furthermore, additional questions about reduced activities and absenteeism due to LBS might reflect real symptoms with important impacts on function and quality of life.

Widanarko et al. (2012) who examined potential nonresponse bias using the same data set as the present study found that there were no differences in the characteristics (i.e. median age and median duration of employment in the current job) and the 12-month period prevalence between respondents and nonrespondents. It indicates that the selection bias (particularly due to nonresponse) in this study population was relatively minor.

The limitation of this study was typical of the design of all cross-sectional studies, in which the temporal sequence between exposures and outcomes can be difficult to distinguish. Hence, longitudinal studies are needed to develop more definitive conclusions about the causal relationship between LBS (and its consequences) and its risk factors (Hartvigsen, et al., 2001). However, Linton (2005) and Nixon et al. (2011) suggest that similar patterns of results have been found in both cross-sectional and prospective studies, indicating that despite the possibility of a healthy worker effect, cross-sectional studies (and therefore by implication the present study) may have considerable value. In particular, the study by Devereux et al., (2004) showed that for LBS and hand/wrist problems, the *ORs* for each of the four low/high physical and psychosocial exposure groups for the cross-sectional study and the prospective study were similar in magnitude despite a substantial reduction in subject participation in the follow-up study that included workers without symptoms at the beginning of the follow-up.

In conclusion, the present study has shown that Indonesian coal mining workers with both high physical and high psychosocial exposures were most likely to report LBS and its consequences. It also showed that a high psychosocial exposure appears to be more prominent in reporting LBS, but high physical exposure does so for LBS consequences. Current smokers were more likely to report LBS consequences than nonsmokers. Permanent employment and night shift work increased the risk of LBS and its consequences. Interaction between physical and psychosocial exposure was present for LBS. For reduced activities the interaction was also present, although not significant, whereas for absenteeism it was not present. Interventions in this kind of workplace should address both physical factors and psychosocial factors with a focus on permanent, night shift workers, and smokers. It is logical to suppose that similar conclusions might apply for other industries in other IDCs.

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References

The references for this chapter have been integrated with the list of references at the end of the thesis.

Post-script

Summary of findings

This study supports the hypothesis that exposure to a combination of high physical and high psychosocial risk factors increased the risk of LBS, reduced activities, and absenteeism due to LBS, after adjusting for gender, age, duration of work, education, smoking status, and organisational factors (current employment status and shift work). It also supports the hypothesis that the interaction between physical and psychosocial exposure for LBS was present. The interaction was also present for reduced activities, although not statistically significant, whereas it was not present for absenteeism. In summary, the gaps, aims and hypotheses, and findings for this chapter are as follows:

Gaps	Aims and Hypotheses	Findings
Less is known about LBS risk factors amongst the working population in IDCs	To examine the association between physical and psychosocial risk factors and LBS The hypothesis is: • Exposure to physical and psychosocial risk factors will increase the risk of LBS	• Exposure to the physical (working with a bent trunk, exposed to whole-body vibration, working using vibrating hand tools, and lifting) and the psychosocial (high effort, low reward, over commitment, low decision latitude, high psychological demand, low social support, job dissatisfaction, and work stress) factors increased the risk of LBS
Less is known about LBS consequences risk factors	To examine the association between physical and psychosocial risk factors and reduced activities due to LBS The hypothesis is: • Exposure to physical and psychosocial risk factors will increase the risk of reduced activities due to LBS	• Exposure to the physical (working with a bent trunk, working with a bent and twisted trunk, exposed to whole-body vibration, working using vibrating hand tools, and lifting) and the psychosocial (high effort, low reward, over commitment, job dissatisfaction, and work

		stress) factors increased the risk of reduced activities due to LBS
	To examine the association between physical and psychosocial risk factors and absenteeism due to LBS The hypothesis is: • Exposure to physical and psychosocial risk factors will increase the risk of absenteeism due to LBS	• Exposure to the physical (exposed to whole-body vibration, working using vibrating hand tools, and lifting) and the psychosocial (high effort, low reward, low social support, job dissatisfaction, and work stress) factors increased the risk of absenteeism due to LBS
The interaction between physical and psychosocial exposure for LBS consequences is not well understood	To examine the interaction between physical and psychosocial factors for LBS, adjusting for potential confounders The hypotheses are: • Those with both high physical and high psychosocial factors were most likely to report LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work) • The interaction between physical and psychosocial factors in the occurrence of LBS will be present	• Those with both high physical and high psychosocial factors were most likely to report LBS • Permanent employment and night shift work increased the risk of LBS • The interaction between physical and psychosocial factors in the occurrence of LBS was present
	To examine the interaction between physical and psychosocial factors for reduced activities due to LBS, adjusting for potential confounders The hypotheses are: • Those with both high physical and high psychosocial factors were most likely to report reduced activities due to LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work) • The interaction between	• Those with both high physical and high psychosocial factors were most likely to report reduced activities due to LBS • Current smokers had a higher risk of reduced activities due to LBS than nonsmokers • Permanent employment and night shift work increased the risk of reduced activities due to LBS • The interaction between

	physical and psychosocial factors in the occurrence of reduced activities due to LBS will be present	physical and psychosocial factors in the occurrence of reduced activities due to LBS was present, although not statistically significant
	To examine the interaction between physical and psychosocial factors for absenteeism due to LBS, adjusting for potential confounders The hypotheses are: • Those with both high physical and high psychosocial factors were most likely to report absenteeism due to LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status and shift work)	• Those with both high physical and high psychosocial factors were most likely to report absenteeism due to LBS • Current smokers had a higher risk of absenteeism due to LBS than nonsmokers • Permanent employment and night shift work increased the risk of reduced activities due to LBS
	• The interaction between physical and psychosocial factors in the occurrence of absenteeism due to LBS will be present	• The interaction between physical and psychosocial factors in the occurrence of absenteeism due to LBS was not present

Implications

There are two implications from the findings of this study. First, as presented in the Results section of this chapter, the AP value for LBS was 0.39, 95% CI [0.07, 0.71]. It indicates that 39% of LBS cases among those who were exposed to high physical and high psychosocial factors were due to exposures to both factors. This implies that addressing both physical and psychosocial factors in this workplace could reduce the number LBS cases among workers exposed to both factors up to 39%.

Second, although these models were not designed to be predictive (rather explanatory models), the probability that an individual will experience the outcome of interest can be predicted using the appropriate values for each of the risk factors in the final model and the regression coefficients shown in Table 6.4, Table 6.5, and Table 6.6. A general logistic regression equation to predict the outcome of interest is as follows (Altman, 1991b):

$$\mathrm{Pr} = \frac{\mathrm{e}^{\mathrm{logit\ P(X)}}}{(1 + \mathrm{e}^{\mathrm{logit\ P(X)}})} \tag{6.1}$$

Where:
Pr = the probability of the occurrence of the outcome of interest
e = the base of natural logarithms (approximately 2.72)
The value of logit P(X) can be obtained from Equation 6.2 as follows:

logit P(X) = α + β (‘low physical and high psychosocial’ score)
+ β (‘high physical and low psychosocial’ score)
+ β (‘high physical and high psychosocial’ score)
+ β (‘males’ score)
+ β (‘age’ in years)
+ β (‘duration of work’ in years)
+ β (education, i.e. ‘secondary’ score)
+ β (education, i.e. ‘primary’ score)
+ β (smoking status, i.e. ‘former smoker’ score)
+ β (smoking status, i.e. ‘current smoker’ score)
+ β (employment status, i.e. ‘nonpermanent employee’ score)
+ β (night work, i.e. ‘shift work without night shift’ score)
+ β (night work, i.e. ‘night shift work’ score)
(6.2)

Where:
α = the constant number of the regression model
β = the coefficient number of independent variables

The constant number (α) and coefficient number (β) of each independent variable for each outcome are presented in Table 6.4, Table 6.5, and Table 6.6.

The score for the independent variable could be either 0, representing ‘No’, or 1, representing ‘Yes’ for all independent variables, except for age and duration of work variables, where the scores were on a continuum (in years).

For example, the probability of having LBS for a worker with the following circumstances: male; exposed to high physical and high psychosocial factors, so he is in HPhyHPsy group; 31 years old; had been working for 6 years; his highest education in secondary school; current smoker; permanent employee, and; night shift worker can be predicted by inserting α value, β value (can be obtained from Table 6.4) and the score of each independent variable to the Equation 6.2:

$$\begin{aligned}
\text{logit P(LBS)} \quad = \quad & (-1.7381) + 0.7939\ (0) \\
& + 0.5151\ (0) \\
& + 1.5648\ (1) \\
& + (-0.7012)\ (1) \\
& + 0.0021\ (31) \\
& + 0.0196\ (6) \\
& + (-0.1289)\ (1) \\
& + (0.0443)\ (0) \\
& + 0.3116\ (0) \\
& + 0.0936\ (1) \\
& + (-0.3533)\ (0) \\
& + 0.1411\ (0) \\
& + 0.7273\ (1) \\
\text{logit P(LBS)} \quad = \quad & 0.0002
\end{aligned}$$

Then this number was inserted into Equation 6.1:

$$\text{Pr} = \frac{2.72^{(0.0002)}}{(1 + 2.72^{(0.0002)})}$$

Pr = 0.500

Thus, the probability for a 31 year-old male worker with the following circumstances: exposed to a high physical and a high psychosocial factors; had been working for 6 years; with the highest education in secondary school; current smoker; permanent employee, and; night shift worker was 50%. Using similar steps, the probability of reduced activities and absenteeism due to LBS for this worker could be predicted, and the results were 52%, and 38%, respectively.

Using the same method as above, an increasing trend of the probability of the events can be predicted as a function of age (Figure 6.1). With the assumption that age at the time of first employment was 20, the probability of LBS for the ‘average’ workers (male with the highest education in secondary school; current smoker; permanent employee, and; night shift worker) who had been working for 2 years (so his age would be 22 years) and exposed to high physical and a high psychosocial factors was 47%. With the same conditions as above, the probability of LBS for the worker who had been working for 3 years (so his age would be 23 years) and exposed to a high physical and a high psychosocial factors was 48%. Using the same method the probability for all of the next ages, i.e. from 24 to 55 years can be obtained. The results are presented in Figure 6.1. This figure shows that the probability of LBS increased with increasing age (and duration of employment). Similar trends were also found for reduced activities.

The probability of the LBS, reduced activities, and absenteeism can also be predicted for workers for the same conditions as above but were in low physical and low psychosocial exposure group. Although the probability of LBS and reduced activities is lower, it also increased with increasing age (and duration of employment) (Figure 6.1).

Interesting findings were found concerning the probabilities of absenteeism due to LBS. Figure 6.1 shows that the probability of absenteeism among both exposure groups did not increase (nor decrease) with increasing age and duration of work. It shows that age and duration of work did not have a significant contribution in the estimation of the probability of absenteeism. A possible explanation is the presence of healthy worker effect may have biased these findings. Since only workers who are relatively healthy remained in employment, they were less likely to report absenteeism. This speculation was based on the findings of Chapter 5 that shows that the healthy worker effect may occur in the Indonesian coal mining study and affect LBS reported. The analysis of the possibility of a healthy worker effect used information about the occurrence of the first episode of the outcome. However, since this study did not obtain the information for absenteeism, it was not able to explore this any further in this thesis. Alternatively, as explained in the Discussion section of this chapter, socioeconomic factors might have contributed to absenteeism due to LBS reported. Despite having severe LBS, workers may not take sick leave due to theirs concern about their job security and income. If socioeconomic factors significantly contribute to the absenteeism due to LBS, any changes in this factor will increase (or decrease) the probability of the absenteeism due to LBS. At present this must remain speculative since no studies, other than the present one, have specifically examined interactions between physical and psychosocial exposures and absenteeism due to LBS. It is an issue that warrants further investigation.

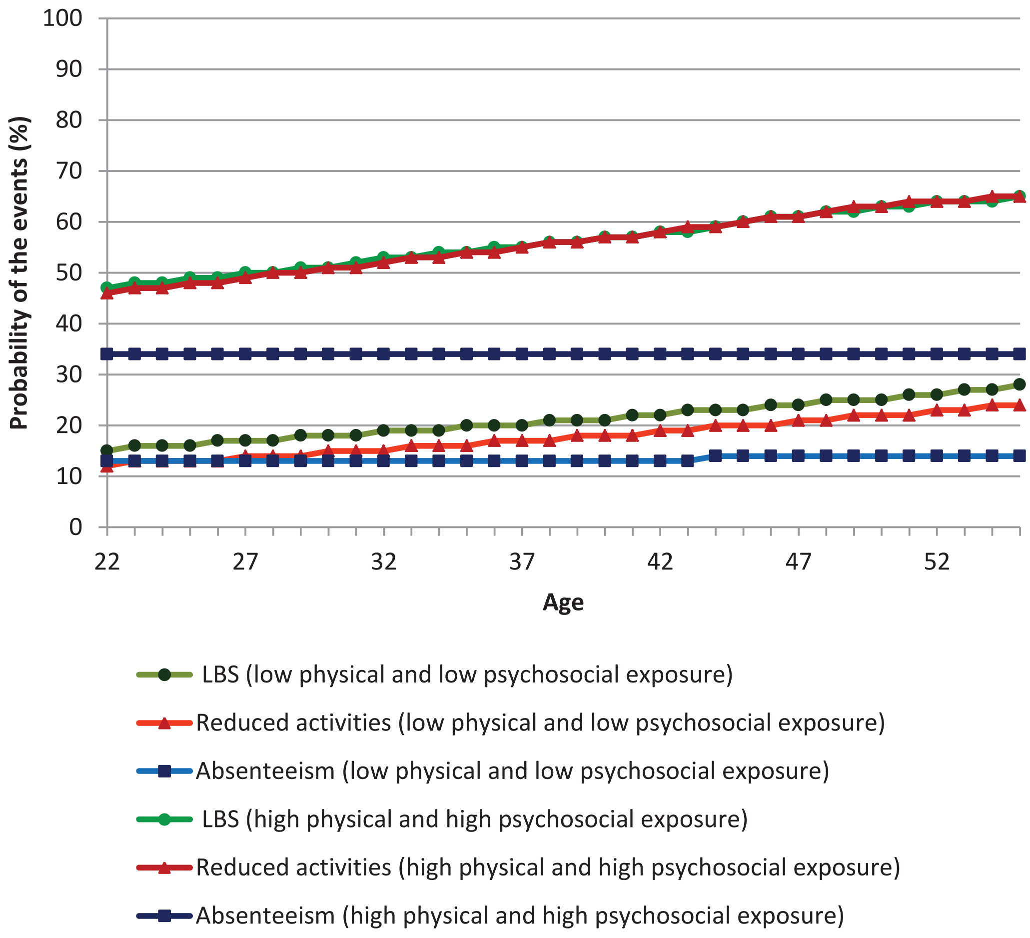


Figure 6.1 The trend of the probability of the events as a function of age

Other findings

Apart from the findings that have been described in the Results and Discussion sections of this chapter, the present study also provides supportive evidence for the hypothesis by Armstrong et al. (1993) that a combination of two known physical risk factors may further increase the risk of LBS. For example, for LBS, the *OR* for working with the bent trunk >50% of time was 2.05, 95% CI [1.13, 3.73] and the *OR* for whole-body vibration >50% of time was 2.02, 95% CI [1.30, 3.13] (Table 6.1). Combining these two risk factors (i.e. working with a bent trunk >50% of time with whole-body vibration >50% of working time) gave an *OR* of 2.82, 95% CI [1.36, 5.84] (Table 6.2). Similarly, for absenteeism, the *OR* for whole-body vibration >50% of time was 1.86, 95% CI [1.12, 3.09] and the *OR* for lifting 16-25 kg ≥2 days/week was 2.11, 95% CI [1.40, 3.18] (Table 6.1). Combining these two risk factors gave an *OR* of 4.52, 95% CI [2.00, 10.22] (Table 6.2). Since exposure to single physical risk factors in the workplace is unlikely, future studies should explore the risk associated with combinations of physical exposures.

Strengths of the present study

Since Chapter 5 and Chapter 6 used the same dataset, the advantages are similar. First, the relatively large sample size allows this study to examine the interaction between physical and psychosocial factors by creating four physical and psychosocial exposure groups: HPhyHPsy, HPhyLPsy, LPhyHPsy, and LPhyLPsy. Second, a special care was taken to assure equivalence between the English and Indonesian versions at conceptual level by conducting the cross-cultural adaptation for this study (Beaton, et al., 2000). Finally, the use of a valid and reliable questionnaire in the present study will have reduced the possibility of information bias. Thus, the likelihood of misclassification bias in the results of the present study will have been minimised.

Limitations of the present study

The validity of the data collected using the questionnaire was assessed by comparing questionnaire responses with data collected by observations (for physical exposure) and interviews (for psychosocial exposure). However, the small number of workers observed (n = 14) and interviewed (n = 15) produced a wide confidence interval for the kappa estimation. A larger observation and interview sample may be required to increase the precision of the kappa estimation and also avoid selection bias in observations and interviews. Similarly, the small numbers for the consequences of LBS make the confidence intervals around the point *ORs* relatively wide so the actual estimations were less informative. A larger sample size may be needed to address this issue.

The other limitation of the present study as explained in the Discussion section of this chapter was there may be bias in physical exposure classification, considering that there were only small numbers in the HPhyLPSy group (*n* = 72 for LBS; *n* = 68 for reduced activities, and; *n* = 45 for absenteeism). The low sensitivity of the question relating to working with a bent and twisted trunk (50%) implies that there is a 50% chance that a worker that carries out this activity will be incorrectly classified as unexposed. Assuming that the misclassification does not differ between the LBS and the non-LBS group (i.e. nondifferential misclassification), this condition, in turn, may lead to an underestimation of the risk estimation (Rothman, et al., 2008) and mask the effect size of physical exposure.

An alternative method of analysis

To obtain relatively equal numbers for each physical and psychosocial exposure group, an alternative method of analysis is proposed. The same nine questions about physical exposure (awkward posture, sitting, exposed to whole-body vibration, using vibrating hand tools, and lifting or carrying object) that were used in this chapter were analysed using factor analysis. A principal component analysis with a varimax rotation using eigenvalues greater than one was conducted to classify the questions into different components. This analysis indicated that three components could be identified from the nine physical exposure questions. The first component, i.e. lifting and carrying, consisted of three questions about the frequency of lifting or carrying objects weighing between 6 and 15 kg (Torgen, et al., 1997; Wiktorin, et al., 1993), between 16 and 25 kg (Torgen, et al., 1997; Wiktorin, et al., 1993), and >25kg (modified from Viikari Juntura et al. (1996)), with the reply alternatives as follows: almost never/not at all, 1-3 days per month, 1 day per week, 2-4 days per week, and every workday (scored 1 to 5). The initial eigenvalues for this component was 3.81, variance 42.39%, and factor loading between .77 and .88. The second component, that is awkward posture, consisted of three questions about the percentage of working time during their work activities they were involved in any of these situations: bent trunk (Leijon, et al., 2002), bent and twisted trunk in the same way several times an hour (Leijon, et al., 2002), and squatting (Wiktorin, et al., 1996; Wiktorin, et al., 1993). The reply alternatives are as follows: not at all, 1-10%, 11-25%, 26-50%, 51-75%, and 76-100% of the time (scored 1 to 6). The initial eigenvalues for this component was 1.68, variance 18.74%, and factor loading between .70 and .88. The third component consisted of three questions, asking about: sitting position (Leijon, et al., 2002); exposure to whole-body vibration or working on an unstable surface (e.g. vibrating floor, vehicle seat) (Wiktorin, et al., 1996), and; using vibrating hand tools (Wiktorin, et al., 1996) with following possible answers: not at all, 1-10%, 11-25%, 26-50%, 51-75%, and 76-100% of the time (scored 1 to 6). The initial eigenvalues for this component was 1.02, variance 11.36%, and factor loading between .56 and .86. However, since each question in the third component appears to have different characteristics, these three questions were analysed separately (not as one component). So, in total, there are five physical exposure components (lifting or carrying, awkward posture, sitting, exposure to whole-body vibration, and using vibrating hand tools). For each component, the scores of the response(s) to the question(s) were summed then divided by the number of questions in each component to obtain the average score. The average score, which was a continuous scale, ranged between 1 and 5 (for lifting or carrying) or 1 and 6 (for awkward posture, sitting, whole-body vibration, and using vibrating hand tools).

The exposure level (low, scored 0; high, scored 1) for each physical component was determined by the average score relative to its median value (from the entire population), i.e. 2 for awkward posture, 1.67 for lifting or carrying, 5 for sitting, 4 for whole-body vibration, and 3 for using vibrating hand tools. For example, if the average value of awkward posture component was higher than its median value (from the entire population), then it was classified as having high exposure for awkward posture, and scored 1. If the average value was below its median value, then it was classified as having low exposure, and scored 0. A composite physical exposure score, which represents the total physical exposure from five components, ranged from 0 to 5. Then the median value of the composite physical exposure score (i.e. 3) was used as a cut-off point to determine the final category of low/high physical exposure (Vandergrift, et al., 2012). Participants were classified as having high physical exposure if the composite physical exposure score was above or equal to the median (i.e. exposed to three or more physical components) whereas participants were classified as having low physical exposure if the composite score was below the median (i.e. exposed to none to two physical components). The aim of using of the median value as a cut-off point was to obtain relatively equal numbers in the high and low physical exposure group.

Similar steps were also undertaken for psychosocial exposure. The cut-off points to classify high exposure (scored 1) for each scale in psychosocial exposure were: upper mean-based quartiles for effort (Siegrist, et al., 2008), over commitment (Siegrist, et al., 2008), and psychological demand (Karasek, et al., 2007); lower mean-based quartiles for reward (Siegrist, et al., 2008) and decision latitude (Karasek, et al., 2007); median for social support (Landsbergis, et al., 1994); mean for job satisfaction (Pejtersen, et al., 2010); and median for work stress question. The low exposure of each psychosocial item was scored 0. A composite psychosocial exposure score, which represents the total psychosocial exposure from eight areas, was calculated by adding the score of eight areas of psychosocial exposure (effort, reward, over commitment, decision latitude, psychological demand, social support, job satisfaction, and work stress) giving a continuous scale between 0 and 8. The median score (i.e. 3) was used as a cut-off point to determine the final low/high psychosocial exposure category. Participants were classified as having high psychosocial exposure if the composite psychosocial exposure score was above or equal to the median (i.e. exposed to three or more psychosocial factors), whereas participants were classified as having low psychosocial exposure if the composite score was below the median (i.e. exposed to none to two psychosocial factors). As in physical exposure classification, the aim of using of the median value as a cut-off point was to obtain relatively equal numbers in the high and low psychosocial exposure group.

The same process as in the original method (as described in the Methods section in this chapter) then was conducted to obtain the interaction between physical and psychosocial factors. All respondents were grouped into one of four combination exposure groups based on the final physical and psychosocial exposure categories: high physical and high psychosocial (HPhyHPsy), low physical and high psychosocial (LPhyHPsy), high physical and low psychosocial (HPhyLPsy), and low physical and low psychosocial group (LPhyLPsy) (as the reference group). Three logistic regression models were developed to quantify the association between physical and psychosocial exposure and each outcome: LBS, reduced activities, and absenteeism. In all models gender (Davis & Heaney, 2000), age (Burdorf & Sorock, 1997; Davis & Heaney, 2000), duration of work (Devereux, et al., 1999; Devereux, et al., 2002), education (Burdorf & Sorock, 1997), smoking status (Burdorf & Sorock, 1997), and organisational factors were included *a priori* as confounders. The Hosmer-Lemeshow goodness of fit, AUC, and AP were also examined for each model. The three models from logistic regressions analysis are presented in Table 6.7 to Table 6.9 below:

Table 6.7 *Logistic regression model showing the effect of physical and psychosocial exposure, gender, age, duration of work, smoking status, and organisational factors on the risk of reporting LBS (using the alternative method)*

Explanatory variables	Number of workers	Cases	Coefficient (*SE*)	*OR*	[95% CI]
Physical and psychosocial exposure					
LPhyLPsy	282	36	Reference	1.00	
LPhyHPsy	233	57	0.8968 (0.2401)	**2.45**	**[1.53, 3.92]**
HPhyLPsy	260	54	0.5799 (0.2415)	**1.78**	**[1.11, 2.86]**
HPhyHPsy	293	99	1.2489 (0.2242)	**3.48**	**[2.24, 5.41]**
Gender					
Females	33	7	Reference	1.00	
Males	1035	239	-0.6817 (0.4798)	0.50	[0.19, 1.29]
Age [a]	1068	246	0.0066 (0.0155)	1.00	[0.97, 1.03]
Duration of work [b]	1068	246	0.0180 (0.0236)	1.01	[0.97, 1.06]
Education					
Tertiary	14	3	Reference	1.00	
Secondary	914	216	0.1210 (0.6821)	1.12	[0.29, 4.29]
Primary	140	27	0.2823 (0.7368)	1.32	[0.31, 5.62]
Smoking status					
Never smoked	418	90	Reference	1.00	
Former smoker	139	38	0.2174 (0.2389)	1.24	[0.77, 1.98]
Current smoker	511	118	0.0840 (0.1685)	1.08	[0.78, 1.51]
Organisational factors: Current employment status					
Permanent employee	606	157	Reference	1.00	
Nonpermanent employee	462	89	-0.3383 (0.1690)	**0.71**	**[0.51, 0.99]**
Shift work					
No shift work	170	26	Reference	1.00	
Yes, but without night shift	61	13	0.4786 (0.3938)	1.61	[0.74, 3.49]
Yes, with night shift	837	207	0.7610 (0.2903)	**2.14**	**[1.21, 3.78]**
Constant			-2.2782 (0.9679)		

Note. SE = standard error; *OR* = odds ratio; CI = confidence interval.
LPhyLPsy = Low physical and low psychosocial; LPhyHPsy = Low physical and high psychosocial; HPhyLPsy = High physical and low psychosocial; HPhyHPsy = High physical and high psychosocial

[a] Age (in years) at the time of the survey (as a continuous variable). [b] Duration of work in the current job (in years) (as a continuous variable).

Explanatory variables that significantly associated with outcome(s) were indicated **in bold**.

The results of the Hosmer-Lemeshow goodness of fit was *p* = .391 indicating that lack-of-fit was not sufficient to reject the model.

The AUC was .65, indicating that this model had poor discriminatory ability.

Table 6.8 *Logistic regression model showing the effect of physical and psychosocial exposure, gender, age, duration of work, smoking status, and organisational factors on the risk of reporting reduced activities due to LBS (using the alternative method)*

Explanatory variables	Number of workers	Cases	Coefficient (*SE*)	*OR*	[95% CI]
Physical and psychosocial exposure					
LPhyLPsy	313	24	Reference	1.00	
LPhyHPsy	249	41	1.0204 (0.2806)	**2.77**	**[1.60, 4.80]**
HPhyLPsy	283	47	0.8655 (0.2726)	**2.37**	**[1.39, 4.05]**
HPhyHPsy	309	77	1.3457 (0.2576)	**3.84**	**[2.31, 6.36]**
Gender					
Females	35	2	Reference	1.00	
Males	1119	187	0.1154 (0.7772)	1.12	[0.24, 5.14]
Age [a]	1054	189	0.0251 (0.0168)	1.02	[0.99, 1.05]
Duration of work [b]	1054	189	0.00013 (0.0256)	1.00	[0.95, 1.05]
Education					
Tertiary	16	1	Reference	1.00	
Secondary	985	174	1.2879 (1.0552)	3.62	[0.45, 28.67]
Primary	153	14	1.1160 (1.1078)	3.05	[0.34, 26.77]
Smoking status					
Never smoked	437	58	Reference	1.00	
Former smoker	152	21	-0.2200 (0.2898)	0.80	[0.45, 1.41]
Current smoker	565	110	0.3819 (0.1861)	**1.46**	**[1.01, 2.11]**
Organisational factors: Current employment status					
Permanent employee	652	125	Reference	1.00	
Nonpermanent employee	502	64	-0.4860 (0.1869)	**0.61**	**[0.42, 0.88]**
Shift work					
No shift work	182	12	Reference	1.00	
Yes, but without night shift	66	9	0.8258 (0.4859)	2.28	[0.88, 5.92]
Yes, with night shift	906	168	1.1710 (0.3676)	**3.22**	**[1.56, 6.63]**
Constant			-5.6107 (1.4361)		

Note. SE = standard error; *OR* = odds ratio; CI = confidence interval.

LPhyLPsy = Low physical and low psychosocial; LPhyHPsy = Low physical and high psychosocial; HPhyLPsy = High physical and low psychosocial; HPhyHPsy = High physical and high psychosocial.

[a] Age (in years) at the time of the survey (as a continuous variable). [b] Duration of work in the current job (in years) (as a continuous variable).

Explanatory variables that significantly associated with outcome(s) were indicated **in bold**.

The results of the Hosmer-Lemeshow goodness of fit was *p* = .262 indicating that lack-of-fit was not sufficient to reject the model.

The AUC was .69, indicating that this model had poor discriminatory ability.

Table 6.9 *Logistic regression model showing the effect of physical and psychosocial exposure, gender, age, duration of work, smoking status, and organisational factors on the risk of reporting absenteeism due to LBS (using the alternative method)*

Explanatory variables	Number of workers	Cases	Coefficient (*SE*)	*OR*	[95% CI]
Physical and psychosocial exposure					
LPhyLPsy	314	20	Reference	1.00	
LPhyHPsy	249	30	0.8030 (0.3092)	**2.23**	**[1.21, 4.09]**
HPhyLPsy	284	40	0.9445 (0.2968)	**2.57**	**[1.43, 4.60]**
HPhyHPsy	309	58	1.2777 (0.2841)	**3.58**	**[2.05, 6.26]**
Gender					
Females	36	4	Reference	1.00	
Males	1120	144	-0.9388 (0.6034)	0.39	[0.11, 1.27]
Age [a]	1156	148	0.0341 (0.0178)	1.03	[0.99, 1.07]
Duration of work [b]	1156	148	-0.0327 (0.0281)	0.96	[0.91, 1.02]
Education					
Tertiary	16	2	Reference	1.00	
Secondary	986	135	0.2679 (0.7971)	1.30	[0.27, 6.23]
Primary	154	11	-0.2533 (0.8799)	0.77	[0.13, 4.35]
Smoking status					
Never smoked	438	43	Reference	1.00	
Former smoker	152	19	0.0348 (0.3113)	1.03	[0.56, 1.90]
Current smoker	566	86	0.4631 (0.2110)	**1.58**	**[1.05, 2.40]**
Organisational factors: Current employment status					
Permanent employee	653	105	Reference	1.00	
Nonpermanent employee	503	43	-0.7908 (0.2123)	**0.45**	**[0.29, 0.68]**
Shift work					
No shift work	183	13	Reference	1.00	
Yes, but without night shift	66	9	0.6529 (0.4804)	1.92	[0.74, 4.92]
Yes, with night shift	907	126	0.6146 (0.3677)	1.84	[0.89, 3.80]
Constant			-3.3508 (1.1654)		

Note. *SE* = standard error; *OR* = odds ratio; CI = confidence interval.
LPhyLPsy = Low physical and low psychosocial; LPhyHPsy = Low physical and high psychosocial; HPhyLPsy = High physical and low psychosocial; HPhyHPsy = High physical and high psychosocial.
[a] Age (in years) at the time of the survey (as a continuous variable).
[b] Duration of work in the current job (in years) (as a continuous variable).
Explanatory variables that significantly associated with outcome(s) were indicated **in bold**.
The results of the Hosmer-Lemeshow goodness of fit was p = .376 indicating that lack-of-fit was not sufficient to reject the model.
The AUC was .69, indicating that this model had poor discriminatory ability.

For LBS, a similar trend was found for models that used the original methods (Table 6.4) and the alternative method (Table 6.7). Both models showed that psychosocial exposure played a more important role than physical exposure for LBS. Similarly, both models in Table 6.6 and Table 6.9 showed that physical exposure appeared to be more prominent than psychosocial exposure in the absenteeism reported. However, there are inconsistent findings between the models for reduced activities due to LBS in Table 6.5 and Table 6.8. Table 6.5 shows that physical exposure played a more important role in the occurrence of reduced activities whereas Table 6.8 shows that psychosocial did. The AP value of the model for LBS that used the alternative method was 0.07, 95% CI [-0.29, 0.44], indicating that the interaction between physical and psychosocial exposure for LBS was present, although not significant. The negative AP values for reduced activities (AP -0.08, 95% CI [-0.53, 0.37]) and absenteeism (AP -0.06, 95% CI [-0.55, 0.43]) indicates that the interactions between physical and psychosocial exposure for the consequences of LBS were not present.

The advantage of the alternative method is that workers were relatively evenly distributed (due to the use of the median value as a cut-off point), so each physical and psychosocial exposure group had a large sample allowing sufficient statistical power. As a result, a reasonable confidence interval for each physical and psychosocial exposure group was obtained. However, classification bias for physical exposure may also occur when applying this approach. In the original analysis, workers with no physical exposure were classified as having low physical exposure, whereas in the alternative method workers exposed to zero to two physical exposures were classified as having low physical exposure. One might argue that classifying those with two risk factors as having low physical exposure may suggest a potential combined exposure effect in the reference group that could mask the effect size of the high physical exposure group. This condition may have influenced the AP value due to the interaction between physical and psychosocial exposures. As a result, there were no statistically significant interactions between physical and psychosocial exposure for all outcomes.

Although the alternative approach provides relatively equal numbers for each physical and psychosocial exposure group and produced a similar trend for LBS, it is suggested that the original method is more appropriate in classifying low/high exposure in order to assess the interaction between risk factors for LBS. The criteria for classifying low/high exposure in the original method were determined based on the association between each physical/psychosocial exposure and the outcome(s) which may show the actual significant risk factors in the workplace. In addition, the original method was supported by approaches taken in previous research (Devereux, et al., 2004) and based on biological plausibility.

Conclusions for Section B

The 12-month period prevalence of LBS (75%, 95% CI [73%, 78%]) among the Indonesian coal mining workers is high. The 12-month period prevalence of reduced activities and absenteeism due to LBS was 16%, 95% CI [14%, 18%] and 13%, 95% CI [11%, 15%], respectively. The finding of this study showed that those in blue-collar work had a higher risk of LBS compared to those in white-collar work, after adjusting for a healthy worker effect and other potential confounders. The presence of LBS increased the risk of reduced activities and absenteeism (Chapter 5).

Individuals with both high exposure to physical and high psychosocial work risk factors were most likely to report LBS and both consequences (reduced activities and absenteeism). High psychosocial exposure increased the likelihood of reporting LBS, whereas high physical exposure did so for reduced activities and absenteeism. Current smokers were more likely to report LBS consequences. Permanent employment and night shift work increased the risk of LBS and its consequences. A statistically significant interaction (AP 0.39, 95% CI [0.07, 0.71]) between physical and psychosocial exposures was present for LBS, as indicated by departure from an additive model of risk. Interactions were also present for reduced activities due to LBS (AP 0.20, 95% CI [-0.26, 0.66], although not significant, whereas for absenteeism due to LBS it was not present (AP -0.01, 95% CI [-0.80, 0.79]) (Chapter 6).

The studies in this section imply that addressing both physical and psychosocial factors in this workplace could reduce the number of LBS cases among workers exposed to both factors by up to 39%. This may, in turn, reduce the risk of LBS consequences. The intervention strategy should also focus on permanent employees, night shift workers and smokers.

Chapter 7 General Discussion

The overall aims of the thesis were to examine the prevalence, risk factors, and the interaction between physical and psychosocial factors for LBS and its consequences. More specifically it aimed to do this in New Zealand and Indonesia, and included consideration of the healthy worker effect as part of the Indonesian coal mining study. The summary findings of the New Zealand study and of the Indonesian coal mining study are presented in Table 7.1 and Table 7.2, respectively. These two tables represent a compilation of summary of findings presented in the Post-scripts of each chapter. The findings of each chapter have already been discussed specifically within each chapter. The purpose of this chapter is to discuss the general findings from the two groups of studies.

Table 7.1 *The summary findings of the New Zealand study*

	Gaps	Aims	Findings
1. Prevalence	1.1. Relatively little is known of the prevalence of LBS amongst the working population in New Zealand	To examine the prevalence of LBS among the New Zealand working population	The 12-month LBS period prevalence was 54%, 95% CI [52%, 56%]
	1.2. Less is known about the prevalence for LBS consequences (reduced activities and absenteeism) amongst the working population in New Zealand	To examine the prevalence of reduced activities due to LBS among the New Zealand working population	The 12-month reduced activities due to LBS period prevalence was 18%, 95% CI [17%, 20%]
		To examine the prevalence of absenteeism due to LBS among the New Zealand working population	The 12-month absenteeism due to LBS period prevalence was 9%, 95% CI [8%, 10%]
2. Risk factors	2.1. Less is known about LBS risk factors amongst the working population in New Zealand	To examine the differences in LBS prevalence in relation to age group, gender, and occupational group The hypotheses are: • The LBS prevalence for those in the older group will be higher than the in the younger group • The LBS prevalence for males will be higher than females • The LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload	• The LBS prevalence for those in the older group was not higher than in the younger group • The LBS prevalence for males was higher than females • The LBS prevalence for those with a heavy physical workload was higher than those with a light physical workload

Gaps	Aims	Findings
	To examine the association between physical, psychosocial, organisational, and environmental risk factors and LBS for specific population: the whole, male, and female population The hypotheses are:	
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the whole population	• Exposure to the physical (working in awkward or tiring positions) and the psychosocial (work stress) risk factors increased the risk of LBS for the whole population
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the male population	• None of the risk factors increased the risk of LBS for the male population
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of LBS for the female population	• Exposure to the physical (working in awkward or tiring positions) and the psychosocial (contact and cooperation with management and work stress) risk factors increased the risk of LBS for the female population
2.2. Only few studies examine the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential confounders	To examine the LBS risk factors (occupational group), adjusting for a healthy worker effect and other potential confounders	Not addressed in this study
2.3. Less is known about LBS consequences risk factors	To examine the differences in reduced activities due to LBS prevalence in relation to age group, gender, and occupational group	

Gaps	Aims	Findings
	The hypotheses are:	
	• The reduced activities due to LBS prevalence for those in the older group will be higher than in the younger group	• The reduced activities due to LBS prevalence for those in the older group was not higher than in the younger group
	• The reduced activities due to LBS prevalence for males will be higher than females	• The reduced activities due to LBS prevalence for males was not higher than females
	• The reduced activities due to LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload	• The reduced activities due to LBS prevalence for those with a heavy physical workload was not higher than those with a light physical workload
	To examine the association between physical, psychosocial, organisational, and environmental risk factors and reduced activities due to LBS The hypothesis is:	
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of reduced activities due to LBS	• Exposure to the physical (lifting) risk factor increased the risk of reduced activities due to LBS
	To examine the differences in absenteeism due to LBS prevalence in relation to age group, gender, and occupational group The hypotheses are:	
	• The absenteeism due to LBS prevalence for those in the older group will be higher than in the younger group	• The absenteeism due to LBS prevalence for those in the older group was not higher than in the younger

Gaps	Aims	Findings
		group
	• The absenteeism due to LBS prevalence for males will be higher than females	• The absenteeism due to LBS prevalence for males was not higher than females
	• The absenteeism due to LBS prevalence for those with a heavy physical workload will be higher than those with a light physical workload	• The absenteeism due to LBS prevalence for those with a heavy physical workload was not higher than those with a light physical workload
	To examine the association between physical, psychosocial, organisational, and environmental risk factors and absenteeism due to LBS The hypothesis is:	
	• Exposure to physical, psychosocial, organisational, and environmental risk factors will increase the risk of absenteeism due to LBS	• Exposure to the physical (working in awkward or tiring positions) and the environmental (working in a cold/damp environment) risk factors increased the risk of absenteeism due to LBS
2.4. The interaction between physical and psychosocial factors for LBS and its consequences is not well understood	To examine the interaction between physical and psychosocial factors for LBS and its consequences	Not addressed in this study

Table 7.2 *The summary findings of the Indonesian coal mining study*

	Gaps	Aims	Findings
1. Prevalence	1.1. Relatively little is known of the prevalence of LBS amongst the working population in IDCs	To estimate the prevalence of LBS among the Indonesian coal mining workers population	The 12-month LBS period prevalence was 75%, 95% CI [73%, 78%]
	1.2. Less is known about the prevalence for LBS consequences (reduced activities and absenteeism) amongst the working population in IDCs	To examine the prevalence of reduced activities due to LBS among the Indonesian coal mining workers population	The 12-month reduced activities due to LBS period prevalence was 16%, 95% CI [14%, 18%]
		To examine the prevalence of absenteeism due to LBS among the Indonesian coal mining workers population	The 12-month absenteeism due to LBS period prevalence was 13%, 95% CI [11%, 15%]
2. Risk Factors	2.1. Less is known about LBS risk factors amongst the working population in IDCs	To examine the association between physical and psychosocial risk factors and LBS The hypothesis is: • Exposure to physical and psychosocial risk factors will increase the risk of LBS	• Exposure to the physical (working with a bent trunk, exposed to whole-body vibration, using vibrating hand tools, and lifting) and the psychosocial (high effort, low reward, over commitment, low decision latitude, high psychological demand, low social support, job dissatisfaction, and work stress) factors increased the risk of LBS
	2.2. Only few studies examine the association between risk factor (occupational groups) and LBS, adjusting for a healthy worker	To examine the association between risk factor (occupational group) and LBS, adjusting for a healthy worker effect and other potential	

Gaps	Aims	Findings
effect and other potential confounders	confounders The hypothesis is: • The risk for LBS for those in blue-collar work will be higher than for those in white-collar work, adjusting for a healthy worker effect and other potential confounders	• The risk for LBS for those in blue-collar work was higher than those in white-collar work after adjusting for a healthy worker effect and other potential confounders
2.3. Less is known about LBS consequences risk factors	To examine the association between risk factors and reduced activities due to LBS after adjusting for potential confounders The hypotheses are: • The presence of LBS will increase the risk of reduced activities due to LBS, adjusting for potential confounders (age, smoking, education, gender, and duration of work) • Exposure to physical and psychosocial risk factors will increase the risk of reduced activities due to LBS	• The presence of LBS increased the risk of reduced activities due to LBS • Current smoker had a higher risk of reduced activities due to LBS than nonsmoker • Exposure to the physical (working with a bent trunk, working with a bent and twisted trunk, exposed to whole-body vibration, using vibrating hand tools, and lifting) and the psychosocial (high effort, low reward, over commitment, job dissatisfaction, and work stress) factors increased the risk of reduced activities due to LBS
	To examine the association between risk factors and absenteeism due to LBS, adjusting for potential confounders The hypotheses are: • The presence of LBS will increase the risk of absenteeism due to LBS, adjusting for	• The presence of LBS increased the risk of absenteeism due to LBS

Gaps	Aims	Findings
	potential confounders (age, smoking, education, gender, and duration of work)	• Current smokers had a higher risk of absenteeism due to LBS than nonsmokers
	• Exposure to physical and psychosocial risk factors will increase the risk of absenteeism due to LBS	• Exposure to the physical (exposed to whole-body vibration, using vibrating hand tools, and lifting) and the psychosocial (high effort, low reward, low social support, job dissatisfaction, and work stress) factors increased the risk of absenteeism due to LBS
2.4. The interaction between physical and psychosocial factors for LBS and its consequences is not well understood	To examine the interaction between physical and psychosocial factors for LBS, adjusting for potential confounders The hypotheses are:	
	• Those with both high physical and high psychosocial factors will be most likely to report LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status, and shift work)	• Those with both high physical and high psychosocial factors were most likely to report LBS • Permanent employment and night shift work increased the risk of LBS
	• The interaction between physical and psychosocial exposure for LBS will be present	• The interaction between physical and psychosocial exposure for LBS was present
	To examine the interaction between physical and psychosocial factors for reduced activities due to LBS adjusting for potential confounders The hypotheses are:	
	• Those with both high physical and high psychosocial factors will be most likely to	• Those with both high physical and high psychosocial factors were most likely to report

Gaps	Aims	Findings
	report reduced activities due to LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status, and shift work) • The interaction between physical and psychosocial factors for reduced activities due to LBS will be present	reduced activities due to LBS • Current smokers had a higher risk of reduced activities due to LBS than nonsmokers • Permanent employment and night shift work increased the risk of reduced activities due to LBS • The interaction between physical and psychosocial factors for reduced activities due to LBS was present, although not statistically significant
	To examine the interaction between physical and psychosocial factors for absenteeism due to LBS, adjusting for potential confounders The hypotheses are: • Those with both high physical and high psychosocial factors will be most likely to report absenteeism due to LBS, after adjusting for the potential confounders (gender, age, duration of work, education, smoking status, current employment status, and shift work) • The interaction between physical and psychosocial factors for absenteeism due to LBS will be present	• Those with both high physical and high psychosocial factors were most likely to report absenteeism due to LBS • Current smokers had a higher risk of absenteeism due to LBS than nonsmokers • Permanent employment and night shift work increased the risk of reduced activities due to LBS • The interaction between physical and psychosocial factors for absenteeism due to LBS was not present

7.1 Prevalence of LBS and its consequences

Both the New Zealand study and the Indonesian coal mining study examined the prevalence of LBS and its consequences (reduced activities and absenteeism). Compared with previous studies among the general working population (Table 1.1), the 12-month LBS period prevalence (54%, 95% CI [52%, 56%]) among the New Zealand workers was high, but similar to the 12-month LBS period prevalence among the British general work population (52%) (Devereux, et al., 2004).

The 12-month period prevalence of LBS may be higher within companies performing specific high risk manual handling work tasks, e.g. the gas cylinder manufacturing/delivery and mining industries. The 12-month period prevalence of LBS was 61% among a mixed working population in the UK within the same company primarily engaged in frequent manual handling or office work within the gas cylinder industry (Devereux, et al., 1999). The 12-month LBS period prevalence among the Indonesian coal mining workers was even higher (75%, 95% CI [73%, 78%]). Table 1.1 in the Review of literature section shows that the range of 12-month LBS period prevalence from previous studies that have been conducted in various occupations in various countries from 1993 to 2011 appears to be large (from 30% to 85%) and there is no consistent pattern over time. As explained in the Discussion sections of Chapter 2 and Chapter 5, the variation of the LBS prevalence may partly be due to different exposures, different pain thresholds (Rowell, et al., 2011; Woodrow, et al., 1972), and socioeconomic conditions (Houtman, et al., 2008) between each of the populations studied. However, Raspe, Matthis, Croft, O'Neill, and the European Vertebral Osteoporosis Study Group (2004) argued that although Germany and UK have similar social security and benefit systems and there was no difference in biologic basis or pathology of back pain and pain thresholds between these two countries, the prevalence of back pain still varied. They suggested that intercultural differences may play a role in the LBS reported. Madan et al. (2008) found that Indian manual workers had the lowest prevalence of low back pain compared to other groups (UK manual workers of Indian subcontinental origin, white UK manual workers, Indian office workers, UK office workers of Indian subcontinental origin, and white UK office workers) and also hypothesised that cultural factors may have impacted the low back pain reported.

To be able to assess whether cultural factors may explain the difference in LBS reported, Adamson and Atkin (2008) suggested that each population has to be homogenous and share similar cultural factors, i.e. cultural values, health beliefs and expectation, and there is some inherent logic as the basis of the comparison process. In our case, both the New Zealand study and the Indonesian coal mining study did not gather any information related to the cultural factors. In addition, the New Zealand study population consisted of various ethnic groups (European/Pakeha, Maori, Pacific Island, African, Asian, etc.) so it is less likely that they shared common cultural factors. Similarly, although all participants in the Indonesian coal mining study were Indonesian, and so are likely to have shared a common Indonesian cultural value, any differences in their background in terms of ethnic group may have had implications for differences in how they appreciated health beliefs and expectations. Thus, due to the lack of information about the cultural values, health beliefs and expectation of each study population, and the various ethnic groups' background, this thesis was not able to explore any further about the possibility of cultural differences in relation to LBS.

Although the LBS prevalence among the New Zealand working population and the Indonesian coal mining workers was high, the prevalence of reduced activities for the New Zealand study (18%, 95% CI [17%, 20%]) and the Indonesian coal mining study (16%, 95% CI [14%, 18%]) was similar to previous studies, which ranged from 10% to 42% (Table 1.2). The prevalence of absenteeism for the New Zealand study (9%, 95% CI [8%, 10%]) was slightly lower than for most previous studies, which ranged from 4% to 36% (Table 1.2). For the Indonesia coal mining study (13%, 95% CI [11%, 15%]) it was similar to previous studies.

Taking a broader view, apart from physical and psychosocial work factors, socioeconomic factors may have also influenced the workers' inclination to report the outcomes directly or indirectly - as proposed in three theoretical models of

WMSD (Karsh, 2006; NRC, 1999; NRC & IOM, 2001). The model of risk factors of WMSD by NRC (1999) indicates that social context may influence the outcomes (pain, discomfort, or disability) directly or indirectly through organisational factors or biomechanical loading (Figure 1.5). The NRC and IOM (2001) model indicates that the interaction between physical, psychosocial, and psychological factors for MSD and its consequences occurs in a broad perspective of social, economic, and cultural factors (Figure 1.6). A similar idea was presented in Karsh's model (2006), which indicates that social or cultural context may determine work organisation and psychological work, which in turn may influence the WMSD reported. However, it did not show the possibility of the direct association between social or cultural context and WMSD reported (Figure 1.11). Tappin, Bentley, and Vitalis (2008) also pointed out that a broader contextual factors (wider economic, political, social and cultural, and organisational factors) may also influence MSD and, although it is not simple, need to be considered in the prevention strategies.

In our case, among the Indonesian coal mining workers, taking sick leave will reduce the workers' income and the chances of keeping their job (Discussion section of Chapter 5). It is then reasonable to speculate that workers with severe LBS may not have taken sick leave so that they will not lose their income and will increase the chances of keeping their job. It is therefore logical to suppose that socioeconomic factors may have also influenced other study populations since they would also have had similar socioeconomic condition factors. This factor may have influenced the outcome for any other study populations with different socioeconomic conditions, but perhaps in a different way.

7.2 Risk factors for LBS and its consequences

Risk factors for LBS and its consequences involve individual, physical, psychosocial, and organisational factors. In relation to individual factors, the New Zealand study found that age was associated with LBS. Although there was no differences in LBS prevalence between age group among the New Zealand population (Table 2.4), after adjusting for all explanatory variables, the *OR* for 45-54 age group (1.34, 95% CI

[1.08, 1.67]) was higher than the younger and the older age groups (Table 3.1). Although previous studies showed inconsistent findings between age and LBS, this finding is in line with a systematic review by Dionne et al. (2006) that summarised that the risk of LBS increased until the fifth decade and then decreased from age 60 onwards. Among the Indonesian coal mining workers, age was not associated with any outcomes in all models.

The New Zealand study found that males had a higher prevalence of LBS than females (Table 2.3) whereas the Indonesian coal mining study failed to show this association. The lack of significant association between gender and LBS and its consequences in the Indonesian coal mining study may be due to the high proportion of males (97%) in the study population which made the study population relatively homogenous (which is likely to represent the true population). This might explain why the present study failed to show the effect of gender in relation to LBS and its consequences when other previous studies have reported gender differences in LBS prevalence.

Current smokers were more likely to report LBS consequences (*OR* between 1.59 and 1.69) than nonsmokers among Indonesian coal mining workers (Table 5.4, Table 5.5, Table 6.5, and Table 6.6). Although this thesis showed a modest association between this individual factor and LBS and its consequences, it is likely that this factor may be one of the important confounders when identifying risk factors for LBS and its consequences.

Other individual factors that may influence the occurrence of LBS are body mass index (BMI) and genetics. The association between BMI and LBS appears to be inconsistent. A meta-analysis (Shiri, Karppinen, Leino-Arjas, Solovieva, & Viikari-Juntura, 2010a), which included 33 studies, concluded that overweight and obesity increased the risk of low back pain. Similarly, a survey that involved 30,102 males and 33,866 females in a general population in Norway indicated that BMI was associated with chronic low back pain (Heuch, Hagen, Nygaard, & Zwart, 2010). In contrast, a review paper by Burdorf and Sorock (1997) showed that BMI was consistently not associated with LBS. Some recent papers (Jensen et al., 2012; Samat, Shafei, Yaacob, & Yusoff, 2011; Vandergrift, et al., 2012) also supported this finding. A study among people aged 24 – 39 years in Finland also failed to find any association between BMI and LBS (Shiri et al., 2012). In addition, a recent paper by Andersen, et al. (2011) found that BMI only had a weak association with absenteeism. Unfortunately, the information about body height and body weight was not obtained in the New Zealand study, hence assessing the association between BMI and the occurrence of LBS was not possible. In the Indonesian coal mining study, since the study population was relatively young and homogenous (about 70% were normal weight), BMI is unlikely to have affected the estimation of risk factors significantly.

A review paper by (Leboeuf-Yde, 2004) and other studies (such as Hartvigsen, Christensen, Frederiksen, and Pedersen (2004), MacGregor, Andrew, Sambrook, and Spector (2004)) indicated that genetics have an important influence on back pain. A review by Zhang, Sun, Liu, and Guo (2008) concluded that both genetics and environmental (non-genetic) factors play a causal role in the occurrence of lumbar disc degeneration, which may lead to LBS. Since this thesis only focused on occupational risk factors, a genetic factor was not included, but may be a focus for future studies.

The New Zealand study and the Indonesian coal mining study examined occupational group as a risk factor for LBS. These two studies used job title to classify heavy/light physical workload group. Although this classification method is useful particularly for large surveys in which physical exposure data are limited, Burdorf and Sorock (1997) argued that job title is a poor surrogate for classifying working exposure. Since job title may not reflect real exposures, classifying the respondents into a heavy- and light- physical workload group only based on job title may have created misclassification and have led to biased results. Hence, classification based on real exposure is more appropriate and it is suggested that it should be the preferred approach for future studies. Alternatively, for studies where time and cost are limited, observations of physical exposure on a small sample of study population could be done to validate the classification.

Information regarding the occurrence of the first LBS was obtained in the Indonesian coal mining study. This information allowed to us to assess the association between occupational group and LBS by constructing a Cox proportional hazard model that included covariates (occupational groups and potential confounders) and two variables to adjust for the possibility of a healthy worker effect: a continuous variable representing duration of first LBS (questionnaire date minus LBS onset date for those with LBS and 0 for those without LBS) and a term to account for the interaction between occupational group and LBS duration (Punnett, 1996). This analysis provided an appropriate estimation of risk factor (occupational group) adjusted for a healthy worker effect in cross-sectional studies. Since the bias due to a healthy worker effect is often unavoidable in this kind of study, adding a simple question that asks when the first LBS occurred in the questionnaire may help to reduce any bias due to a healthy worker effect. However, since this approach would use retrospective data about the occurrence of the first LBS, recall bias may occur - particularly when the occurrence of the first episode of LBS is a quite long time prior to the survey. In addition, Koehoorn et al. (2010) argued that identifying new onset episodes of LBS is difficult. Hence, the best approach to minimise bias due to a healthy worker effect is to conduct a cohort longitudinal study despite it being time consuming and expensive.

In cohort longitudinal studies, the details pertaining to changing of jobs could be recorded. This would have implications for changes for risk factors. The pattern of the migration of work/attrition could also be observed. This information would be important for investigation of the causal association between risk factors and outcomes, by adjusting for potential bias including any healthy worker effect. This approach could not only be applied to musculoskeletal symptoms or disorders, but also for other occupational diseases that may occur due to exposure in the workplace, such as occupational lung disease (e.g. asbestosis, pneumoconiosis, and silicosis), occupational skin disease (e.g. dermatitis), noise-induced hearing loss, etc.

Previous literature reviews and previous studies support the present findings of a significant association between some physical and psychosocial factors and outcomes (LBS and its consequences) in both the New Zealand study and the Indonesian coal mining study (Discussion section Chapter 3, 4, and 6). Among the New Zealand workers, a psychosocial factor (work stress *OR* 1.46, 95% CI [1.05, 2.03]) had a slightly stronger association with LBS than physical factor (awkward or tiring positions *OR* 1.37, 95% CI [1.12, 1.68]). The association between awkward or tiring positions and LBS did not have a positive nor negative dose-response relationship, which may indicate a weak relationship (Table 3.1). In contrast, the association between work stress and LBS showed a positive dose-response relationship, which may indicate a strong relationship (Table 3.1). For LBS consequences, physical factors appeared to play a more important role than psychosocial factors. Two physical factors, i.e. lifting (*OR* 1.79, 95% CI [1.16, 2.77]) and awkward or tiring positions (*OR* 2.11, 95% CI [1.20, 3.70]), were associated with reduced activities (Table 4.5) and absenteeism (Table 4.6), respectively. None of the psychosocial factors were associated with LBS consequences (Table 4.5 and Table 4.6).

Among the Indonesian coal mining workers, the strength of association between physical and psychosocial factors for LBS was similar. For LBS, the *ORs* for physical factors (working with a bent trunk, exposed to whole-body vibration, using vibrating hand tools, and lifting) were between 1.46 and 2.65 (Table 6.1) whereas the *ORs* for psychosocial factors (high effort, low reward, over commitment, low decision latitude, high psychological demand, low social support, and job dissatisfaction) were between 1.40 and 2.65 (Table 6.3). However, different figures were found for reduced activities and absenteeism due to LBS. The physical factors had a slightly stronger association with absenteeism than psychosocial factors. For reduced activities, the *ORs* for physical factors (working with a bent trunk, exposed to whole-body vibration, using vibrating hand tools, and lifting) were between 1.68 and 2.81 (Table 6.1) whereas the *ORs* for psychosocial factors (high effort, low reward, over commitment, and job dissatisfaction) were between 1.61 and 2.49 (Table 6.3). For absenteeism, the *ORs* for physical factors (whole-body vibration, using vibrating hand tools, and lifting) were between 1.66 and 2.83 (Table 6.1) whereas the *ORs* for psychosocial factors (high effort, low reward, low social support, and job dissatisfaction) were between 1.40 and 2.27 (Table 6.3). Although the *ORs* for working with a bent trunk (3.75, 95% CI [2.09, 6.75]) and working with a bent and twisted trunk (3.28, 95% CI [1.67, 6.44]) for reduced activities, and work stress (6.55, 95% CI [3.69, 11.64] for LBS; 5.23, 95% CI [2.80, 9.76] for reduced activities, and; 3.57, 95% CI [1.78, 7.17] for absenteeism) were high, the wide confidence intervals make this estimations less informative. It is notable that the findings above were based on the association between single factor (physical or psychosocial) and outcome, not the interaction between physical and psychosocial factors. The different variables that were included to adjust the association between each explanatory variable and outcome between the New Zealand study and the Indonesian coal mining study also made direct comparison between these two studies difficult. However, the findings above suggest that physical and psychosocial factors may independently influence the outcome, but the strength of the association may vary.

None of the organisational factors were associated with LBS and its consequences in the New Zealand study. However, among Indonesian coal mining workers, organisational factors, i.e. employment status and shift work, were associated with all outcomes and may have influenced the interaction between physical and psychosocial factors for LBS and its consequences (Table 6.5 and Table 6.6.). Karsh (2006) proposed that work organisation, which includes nature of work, work/rest cycle, management, etc., may influence the physical and/or psychosocial exposure at work. However, this association was not explored in this thesis. It is an issue that warrants further investigation.

Environmental factors were included as predictors for LBS and its consequences in the analysis among the New Zealand workers (Chapter 3 and 4). Working in a cold or damp environment increased the risk of absenteeism by a factor of 2.18, 95% CI [1.11, 4.28]. However, considering that almost all Indonesian coal mining workers were exposed to a similar environment at work, this factor was not examined in the

Indonesian coal mining study. The white-collar workers worked in rooms equipped with air conditioning system so the room temperature could be adjusted to provide comfort. Similarly, since the type of coal mining area that was studied was open pit mining (not underground), almost all of the blue-collar workers (except mechanics) worked in the cabin of vehicles that were also equipped with an air conditioning system. With respect to noise, there were no sources of noise that could have significantly affected the white-collar workers, whereas among the heavy vehicle or dump truck operators, the cabin was sound proofed so the noise from outside could be reduced. Sources of noise were observed in the workshop from grinding, hammering, and machine testing activities. Workers involved in these activities were equipped with hearing protection to reduce noise exposure. In addition, the findings from the New Zealand study suggested that expose to loud noise was not associated with LBS and its consequences (Widanarko, Legg, Stevenson, et al., 2012a, 2012b). Thus, taking into account environmental factors in the study among Indonesian coal mining workers was not necessary. However, Karsh (2006) proposed that environmental factors may influence physical and psychosocial factors. For example, poor lighting may influence work posture, particularly for work that requires visual precision. These possible associations were not examined in this thesis and useful inclusion for further investigation in future studies.

7.3 Interaction between physical and psychosocial factors for LBS and its consequences

Most of the studies that examined the interaction between physical and psychosocial factors at work for LBS (Devereux, et al., 2004; Devereux, et al., 1999; Fernandes, et al., 2009; Huang, et al., 2003; Lapointe, et al., 2009; Thorbjörnsson, et al., 2000), including the present Indonesian coal mining study, showed that some interactions were present. In the present thesis, individuals exposed to both high physical and high psychosocial factors were most likely to report LBS. However, the combination of high physical and low psychosocial exposure did not increase the risk of LBS (Table 6.4). There was a similar finding in the preliminary study of this population (Widanarko, Legg, Stevenson, & Devereux, 2012). It is speculated that good psychosocial working conditions may buffer the negative effect of poor physical working conditions on the risk of LBS. Working in poor physical working conditions may increase the risk of reporting LBS, but this risk may be reduced if the workers also work in a good psychosocial working environment. This speculation is supported by the findings of a study among 1,552 Dutch workers which showed that among those with high physical workload, there was a higher MSS risk for those who experienced a poor psychosocial environment (i.e. a low quality of communication) compared to those who experienced a good psychosocial environment (i.e. a high quality of communication) (Joling, Blatter, Ybema, & Bongers, 2008). Similar trends were also found among those with a low physical workload (Joling, et al., 2008). Two studies by Torp, Riise, and Moen (1999, 2001) showed that there were positive and significant relationships between psychosocial factors and how mechanics coped with their MSS. The mechanics were more likely to use many coping strategies to reduce their MSS (e.g. changes in working technique, taking more or longer breaks, or discussing the problem with a colleague and/or health and safety deputy) if the social support and manager's involvement in health and safety was high. Therefore, this might explain why high physical and low psychosocial exposure did not increase the risk of LBS compared to low physical and low psychosocial exposure.

Different figures were observed when individuals were exposed to the combination of high psychosocial and low physical exposure. Exposure to psychosocial factors was necessary to increase the likelihood of reporting LBS (Table 6.4). Despite the possibility of classification bias in physical exposure, the global socioeconomic conditions may increase psychosocial problems, including stress at work, for workers in IDCs as explained in the Discussion section of Chapter 6. There are two plausible ways in which psychosocial factors could influence LBS. First, job stress may increase muscle tension as well as reducing blood flow to the muscles. This may limit the ability of the body to repair and heal microtrauma in the musculoskeletal system (Carayon, et al., 1999). Psychosocial factors may increase trunk muscular strain through neuromuscular mechanisms, i.e. 'Brussels model' (Johansson, et al., 2003) and 'Neuromotor Noise Theory' (Van Galen, et al., 2002), and/or overuse of the low-threshold motor units (Hagg, 1991; Sjogaard, et al., 2000) due to activation of the symphathetic-adrenal medullary system which can leads to increased spine loading (Marras, 2008c). Second, with respect to behaviour, since stress may influence detection of symptoms, individuals who experience stress in their job might be more likely to report MSS, and/or have lack of motivation to seek help (Carayon, et al., 1999). These conditions may partially explain the domination of psychosocial factors' role in the occurrence of LBS.

Although combined exposure to physical and psychosocial work risk factors also increased the risk of LBS consequences, this thesis failed to show any statistically significant interaction between these two factors for LBS consequences. This indicates that the interaction between physical and psychosocial factors is complex. Previous studies have shown that psychosocial factors only interacted with phsycial factors in particular circumstances. For example, job control only played a role among those in high physical exposures, whereas among those with low physical exposure, job control was not associated with LBS (Vandergrift, et al., 2012). Similarly, Hollmann et al. (2001) found that job demands had a higher effect on MSS reported if the physical workload was high, in contrast to when the physical workload was low.

This thesis also shows that interaction between physical and psychosocial factors may also involve other factors. In this thesis, individual (smoking status) and organisational (employment status and shift work) factors have influenced the interaction. Referring to the previous theoretical model of WMSD by NRC and IOM (2001), the association between physical, psychosocial and psychological factors and LBS occurs in the broader social, economic, and cultural context (Figure 1.6). It appears that the physical and psychosocial factors and the interaction between these two factors are likely to be influenced by social, economic, and cultural contexts. Similarly, although Karsh's model (2006) did not point out the direct influence of social, cultural, nor organisation factors on the interaction between physical and psychosocial factors, this model showed that social, cultural, and organisation may determine the physical and psychosocial factors (Figure 1.11).

Carayon et al. (1999) proposed that the existence of LBS and its consequences may feedback to influence the physical and psychosocial factors, due to the modification of work, which then may determine the work stress (Figure 1.7). In more detail, Karsh (2006) explained that the experience of LBS may affect the physical and psychological capacity of the workers. It may also alter worker's psychosocial perception that contributes to work stress. The alterations of physical and psychosocial factors due to the presence of LBS may influence the interaction between these two factors. However, due to the nature of the cross-sectional study, this thesis was not able to explore the possibility of the influence of existence of LBS and its consequences on the interaction.

In summary, this thesis shows that the associations between physical and psychosocial factors and the interaction between these two factors and LBS and its consequences are complex and may involve other various risk factors. Two studies (Eatough, et al., 2012; Truchon, Cote, Fillion, Arsenault, & Dionne, 2008) have examined the complexity of risk factors for LBS. They examined the association between a set of exposures and outcome using structural equation modelling. This method provides a pathway framework that shows the direct or indirect relationships among a set of variables and outcome. Eatough et al. (2012) found that physical factors (physical exertion and awkward posture) were independently associated with MSS (wrist/hand, shoulder, lower back), whereas strain response (depression, frustration, anger, and anxiety) played a role as a mediator in the relationship between psychosocial factors (role conflict, job control, and safety-specific leadership) and MSS. However, Eatough's study did not examine the possible link between physical factors and strain response. Truchon et al. (2008) showed that emotional distress was a mediator factor between life events and cognitive appraisal of LBS in the development of disability due to LBS. Emotional distress appeared to have an indirect effect on disability due to LBS through avoidance coping. Although this approach may be appropriate for exploring the complexity of LBS risk factors, only a few studies have used this method. Thus, an alternative method to examine the complexity of risk factors and interaction between risk factors for LBS and its consequences future studies may be to include a wide range of risk factors in the analysis, using structural equation modelling.

7.4 A proposed model of LBS risk factors, based on the findings of this thesis

In a view of the complexity of LBS risk factors, a model (adapted from Karsh (2006)) that maps the risk factors for LBS and its consequences is proposed based on the findings and discussion of this thesis (Figure 7.1). It shows 16 direct and indirect pathways for the development of LBS and its consequences. Six risk factors and pathways have been examined in this thesis (indicated as blue boxes and solid lines, shown as pathways 1 to 6). Ten risk factors and pathways were not examined in this thesis (indicated as yellow boxes and dash lines, shown as pathways 7 to 16) and may be a focus for future studies.

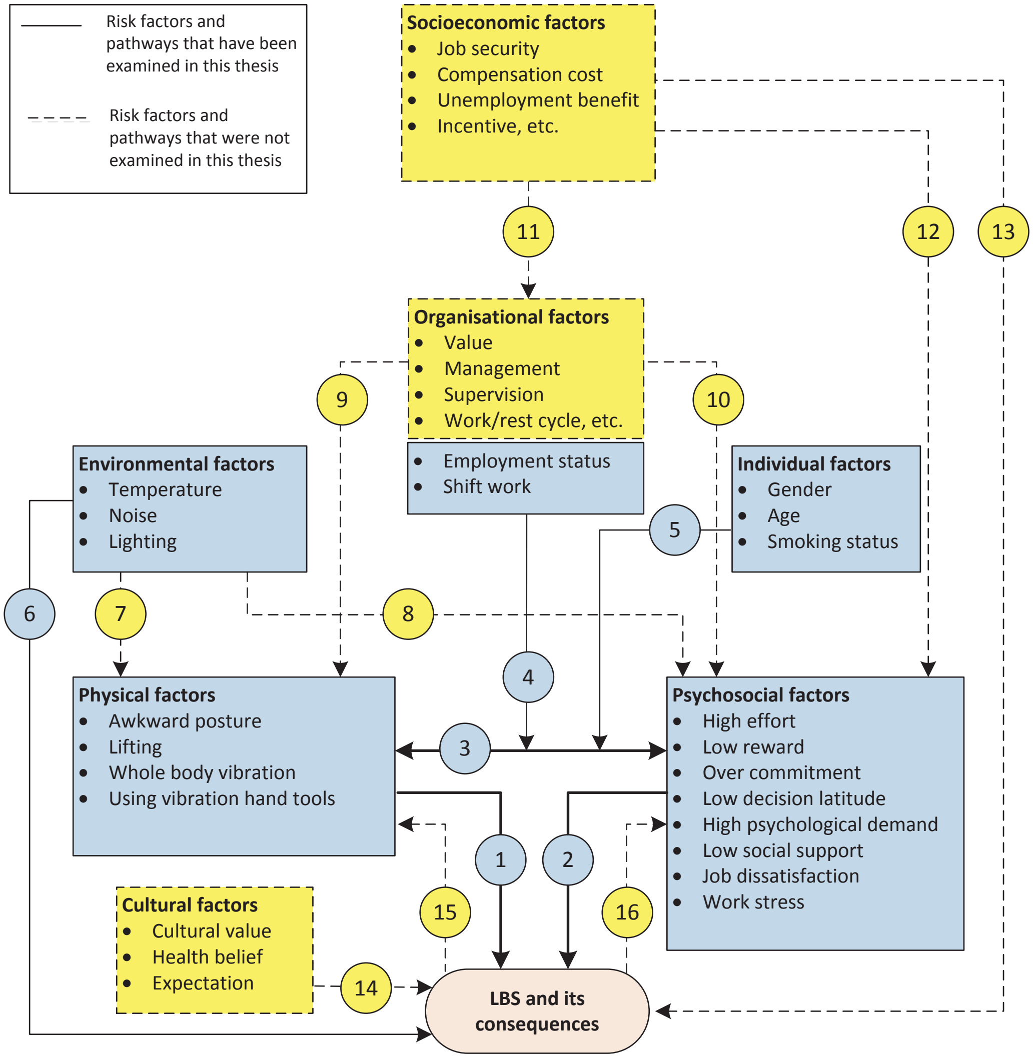


Figure 7.1 A proposed model of LBS risk factors, based on the findings of this thesis (adapted from Karsh (2006))

Pathways 1 and 2 show the association between physical and psychosocial factors and LBS, respectively. This thesis found that some physical factors (awkward posture, lifting, whole-body vibration, and using vibration hand tools) and psychosocial factors (high effort, low reward, over commitment, low decision latitude, high psychological demand, low social support, job dissatisfaction, and work stress) were associated with LBS or were associated with LBS consequences among the New Zealand working population or the Indonesian coal mining workers population (Chapter 3, 4, and 6). Furthermore, this thesis (Chapter 6) found that there was an interaction between physical and psychosocial factors for LBS and a potential interaction for reduced activities, shown as pathway 3. Chapter 6 also shows that the interaction between physical and psychosocial factors may have been influenced by organisational factors (employment status and shift work), shown as pathway 4, and individual factors (gender, age, and smoking status), shown as pathway 5. An environmental factor, i.e. working in a cold or damp environment, was associated with absenteeism due to LBS (Chapter 4). This association is shown as pathway 6.

The following pathways are possible associations that should be examined in future studies. As explained in Section 7.2, Karsh (2006) proposed that environmental factors may influence the physical and psychosocial factors (shown as pathway 7 and 8, respectively). There are some previous studies that support this hypothesis. Sundelin and Hagberg (1992) reported that exposure to cold environments activated the muscles in the shoulder and back region and speculated that this activation may be due to the hunched posture that is commonly adopted as a protective behavioural response to cold – a posture that can lead to muscle strain and the development of muscle fatigue in the low back region (McGill, et al., 2000). Noise has been reported to be associated with psychosomatic complains (Houtman, Bongers, Smulders, & Kompier, 1994). A review by Tennant (2001) suggested that noise can be a predictor for work stress, although the association between these two variables was inconsistent.

Pathways 9 and 10 show that organisational factors (management, supervision, work/rest cycle, etc.) may determine physical and the psychosocial factors (Karsh, 2006). The model also shows that the influence of socioeconomic factors on physical and psychosocial factors is mediated by organisational factors (Karsh, 2006) (shown as pathway 11). As explained in the Discussion section of Chapter 5, globalisation has started to make IDCs face the challenge of managing the changing nature of work, such as demands of flexible contracts, increased job insecurity, a high work pace, long and irregular working hours, low income, etc. (Houtman, et al., 2008) with limited resources. To be able to compete globally with competitors, management ought to set a high target for production. This may make the workers adopt substandard actions, such as lifting manually rather than using lifting devices (such as a hoist) because it is quicker, and may also lead to over commitment and work stress among workers. In addition, Hanse and Winkel (2008) found that organisational factors were positively related to job satisfaction. Due to the important role of organisational factors in the occurrence of MSD, Buckle and Devereux (2002) emphasised that any intervention to reduce MSD should focus on an organisational as well as an individual level. A recent systematic review by Westgaard and Winkel (2011) showed that downsizing and restructuring rationalisation, as an intervention at an organisational level, had a negative effect on health, including MSS. This study indicated that rationalisation may increase physical workload, create a more stressful work situation, and increase the stress due to the uncertainty about the consequences of the rationalisation itself. This condition may then increase the risk of health outcomes, including MSS. In addition, value in the organisation (Hofstede, 2001) may influence psychosocial conditions at work. Hofstede (2001) identified five dimensions to describe the value in the workplace: power distance, individualism vs. collectivism, masculinity vs. femininity, uncertainty/avoidance, and long-term vs. short-term orientation. In this case, for example, a high power distance score that expresses a large degree of hierarchical order may have influenced the low score of decision authority because workers could not really have a say, and increased the stress perception.

Pathway 12 shows that socioeconomic factors (such as job insecurity and low incentive) may affect the psychosocial condition of the workers (such as job dissatisfaction and work stress). The dual pathways hazard – harm model by Cox, Griffiths, and Rial-González (2000) showed that social context, which influenced the psychosocial hazards including job insecurity, may affect the health outcome mediated by stress. Socioeconomic factors may also directly influence the LBS and its consequences reported (shown as pathway 13). For example, among the Indonesian coal mining workers, it was speculated that the disincentive to take sick leave, and hence absence from work, would reduce income. Also, low job security may have influenced the workers' inclination to report the outcomes (Discussion section Chapter 5 and 6).

Pathway 14 shows that cultural factors may also influence LBS and its consequences, as discussed in Section 7.1. Previous studies have provided evidence that beliefs and expectations about MSS influence its occurrence (Jensen, Albertsen, Borg, & Nabe-Nielsen, 2009; Madan, et al., 2008; Ryall, Coggon, Peveler, Poole, & Palmer, 2007). Similarly, Symonds, Burton, Tillotson, and Main (1996) and Mannion et al. (2009) showed that negative beliefs were associated with absenteeism due to LBS. Furthermore, an intervention study among a general population found that a positive media campaign about LBS improved the populations' and general practitioners' beliefs about LBS and was associated with a reduction of disability and compensation costs related to LBS (Buchbinder, Jolley, & Wyatt, 2001).

The last two pathways (shown as 15 and 16) show the existence of LBS and its consequences may provide the feedbacks for physical and psychosocial factors. The experience of LBS and its consequences may make the workers modify how they work and alter their perception of psychosocial factors. These pathways were also proposed by previous models (Carayon, et al., 1999; Karsh, 2006).

The 'risk factors' model proposed above shows that the occurrence of LBS and its consequences involves a wide range of risk factors, and the association between risk factors and LBS and its consequences is complex. It is therefore suggested that in order to reduce the prevalence of LBS and its consequences, any intervention strategy should not only focus on modification of physical, psychosocial, environmental, and organisational factors, but also on improving socioeconomic and cultural factors.

7.5 Practical implications

When using an ergonomics approach to solving problems at the workplace, the characteristics of the users (i.e. most commonly the workers) should be considered, particularly when determining the design of tasks, equipment, workspaces, environments, work organisation and jobs (Wilson, 2002). In practical terms, the findings of this thesis imply that any intervention strategies to reduce the prevalence of LBS and its consequences in the workplace should consider addressing both psychosocial and physical factors, as well as organisational and individual factors. This thesis suggests that the priority of strategy interventions, particularly for Indonesian coal mining workplace, should be as follows:

1. ***Improving psychosocial work conditions***

   The intervention should focus on reducing effort, increasing reward, improving job satisfaction, and managing work stress. This can be achieved by evaluating the job design to reduce the workload (e.g. set up appropriate target to reduce time pressure), improving the remuneration system and job security, and providing clear information about career pathways and job promotion. A stress management strategy should be developed. Identifying work and nonwork stressors is an important part of that process. Furthermore, since exposure to psychosocial factors may affect white- and blue-collar workers differently (Devereux, Rydstedt, & Cropley, 2011; Rydstedt, Devereux, & Sverke, 2007), specific intervention approaches for each occupational group may be needed. Interventions should be evaluated for their effectiveness.
2. ***Improving physical work conditions***

   This intervention should focus on reducing work with a bent trunk, exposure to whole-body vibration, use of vibrating hand tools, and lifting activities. This can be achieved by redesigning of work devices, providing appropriate shock absorptions, and providing lifting assist devices or applying ‘team-lifting’ manual handling procedures. Alternatively, improving work/rest cycles may help to minimise risk from prolonged (awkward) static postures and prolonged vibration exposure. Identifying psychosocial work risk factors that result in an increase in exposure to physical work risk factors is of the upmost importance.
3. ***Reducing night shift work***

   Since the coal mining industry operates 24 hours per day, eliminating night shifts work is not possible. However, the way in which night shifts are organised for workers can be redesigned so that the number of days (both consecutive and total) of working night shift can be reduced and additional rest periods may be given if needed. Further studies are needed to examine the best roster for this study population.

4. ***Conducting a workplace smoking cessation program***

   Since smoking habit affects workers systematically rather than locally, a smoking cessation program is likely to reduce the risk of LBS and its consequences. It would have the added advantage of also minimising other health problems.

7.6 Limitations of the thesis

There were five limitations of the New Zealand study, as outlined at the beginning of Section B. These were the possibility of misclassification of participants with or without LBS due to the lack of severity and duration information, not including some relevant factors that have been found to be associated with LBS, lack of information regarding the first occurrence of LBS, the use of the unvalidated self-reported questionnaire about physical and psychosocial exposure, and not examining the interaction between risk factor for LBS and its consequences. These were addressed in the Indonesian coal mining study. However, in the Indonesian coal mining study, there may have been some bias in physical exposure classification. Therefore, the self-reported physical exposure questionnaire that was used in this study needs further evaluation.

Although this thesis recognises the importance of socioeconomic, organisation, and cultural factors in the occurrence of LBS, this thesis did not specifically examine these factors. This is beyond the scope of this thesis, but would clearly be an important area for future work. In addition, although the Indonesian coal mining study involved participants from various occupations (white- and blue-collar workers), the unique characteristics of the coal mining population means that the findings of this study should be interpreted and generalised with care. Future studies need to be conducted in more general populations.

Overall, the major limitation of this thesis was the study design. Due to the nature of cross-sectional studies, in which information about exposures and outcomes are gathered from a population during the same period of time, causal inferences cannot be made. It cannot be proved that the association between exposures and outcomes is causal because of difficulties establishing the correct temporal sequence of exposure and outcomes. A cohort longitudinal study is necessary to obtain firm conclusions about causal inference.

7.7 Recommendations for future research

Recommendations for future studies are based on the contributions and limitations as previously outlined, and are as follows:

1. Only a few studies of LBS and its consequences have been conducted in IDCs. Future studies should be undertaken in IDCs and also in various industries in order to capture a closer representation of the global problem.
2. In New Zealand, 32% of employees are employed in small businesses (Legg et al., 2009) whereas more than 60% of workers in Indonesia are involved in small-medium enterprises (SMEs) (Statistics Indonesia, 2012). Considering that a high proportion of workforces in countries worldwide are in SMEs, MSS amongst workers in SMEs should be a priority for future research.
3. In the New Zealand study one of the limitations was lack of information regarding the first occurrence of LBS. Thus, in a future study, an additional question to obtain this information is necessary in order to be able to adjust for the possibility of a healthy worker effect in cross-sectional studies. A similar question could also be asked to obtain information regarding the first episode of reduced activities and absenteeism due to LBS occurred. The data about the first episode of the outcome of interest from the self-reported questionnaire could be used if data from a medical record cannot be obtained.
4. To collect information about risk factors in a large sample, self-reported questionnaire may provide the best method. However, this method has been criticised for not providing accurate information about real exposures. Hence, the use of valid and reliable questionnaires is important. The self-reported questionnaire that has been assessed for its validity and reliability in other study populations still needs to be assessed in the target study population, considering different characteristics between study populations.

5. To be able to develop holistic prevention in the workplace, future studies should look at LBS from a broader perspective. A wider range of risk factors (including physical, psychosocial, organisational, individual, environmental, socioeconomic, and cultural factors) need to be taken into consideration.
6. Since only eight studies have examined the combination/interaction between risk factors for LBS since 1990, more studies are needed in this area to provide more scientific evidence in order to develop intervention strategies to reduce LBS cases at work.
7. Structural equation modelling analysis can help in examining the details of the relationships among a set of risk factors and outcome. This approach provides a pathway framework about which factors may be directly or indirectly associated with other risk factors and/or LBS. This approach could help to design and identify priorities for intervention.
8. Intervention studies are necessary to help to reduce the magnitude of LBS. A holistic intervention strategy could be developed based on the previous research that identifies LBS risk factors in a broader perspective.
9. Most importantly, to be able to draw a firm conclusion about causal relationship between risk factors and LBS, a longitudinal study is necessary. This kind of study would also allow us to reduce the bias due to a healthy worker effect.
10. In view of the findings about the association between shift work and LBS and its consequences, future studies should explore this relationship further by examining, for example the association between the need for recovery from work and musculoskeletal symptoms (Devereux, et al., 2011).
11. This thesis has focused on LBS. However, the questionnaires used in the thesis included questions about symptoms in other body regions and the data for these ‘other body regions’ has not yet been analysed. This is a rich source of data for further analysis. Following final completion of this thesis, it is intended that the following papers will be prepared for publication:
    a. The prevalence of neck, shoulder, and upper limb symptoms and their consequences among New Zealand workers

b. The association between work stress and other work-risk factors and neck, shoulder, and upper limb symptoms and their consequences among New Zealand workers
c. The prevalence of neck, shoulder, and upper limb symptoms and their consequences among Indonesian coal mining workers.
d. Interaction between physical and psychosocial work-related risk factors for neck, shoulder, and upper limb symptoms and their consequences among Indonesian coal mining workers.

Chapter 8 Conclusions

In summary, the contributions of this thesis are as follows:

- It provides an estimation of prevalence of LBS and its consequences for the New Zealand working population and for Indonesian coal mining workers
- It provides an estimation of work risk factors for LBS and its consequences for the New Zealand working population and for Indonesian coal mining workers
- It provides an estimation of the association between risk factor (occupational group) and LBS after adjusting for a healthy worker effect and other potential confounders
- It provides an estimation of interaction between physical and psychosocial factors for LBS and its consequences

This thesis shows that the 12-month period prevalence of LBS among the New Zealand workers and the Indonesian coal mining workers is high. The 12-month period prevalence of the reduced activities for both the New Zealand working population and the Indonesian coal mining workers population was similar to previous studies. For absenteeism, the prevalence among the New Zealand workers was slightly lower than previous studies, whereas among the Indonesian coal mining workers it was similar to previous studies.

Gender and age appear to be individual factors for LBS and its consequences. Blue-collar workers were more likely to report LBS than white-collar workers among both the New Zealand workers and the Indonesian coal mining workers. This estimation has been adjusted for a healthy worker effect in the latter study population. Among the New Zealand population, psychosocial factor (work stress) was more prominent, relative to the physical factor (awkward or tiring positions) for the occurrence of LBS, whereas for LBS consequences, physical factors (lifting and awkward or tiring positions) played a more important role than psychosocial factors. An environmental factor (working in a cold or damp environment) was found to be associated with absenteeism in the New Zealand study. Among the Indonesian coal mining workers, the strength of the association between physical factors (awkward position, lifting, whole-body vibration, and using vibrating hand tools) and psychosocial factors (high effort, low reward, over commitment, low decision latitude, high psychological demand, low social support, job dissatisfaction, and work stress) with LBS was similar. However, for reduced activities and absenteeism, the physical factors had a slightly stronger association than the psychosocial factors.

An interaction between physical and psychosocial exposures was present for LBS, as indicated by departure from an additive model of risk. An interaction was also present for reduced activities, although not statistically significant, whereas it was not present for absenteeism. Smoking status, as an individual factor, and employment status and shift work, as organisational factors, have influenced these interactions. Combined exposure to physical and psychosocial work risk factors increased the risk of LBS and its consequences. Psychosocial factors played a more important role than physical factors for LBS, but physical factors did so for reduced activities and absenteeism.

This thesis shows that physical and psychosocial factors are independently associated with LBS and its consequences, but that they also interact in a complex way that involves other factors (individual, organisational, and socioeconomic). The interaction that has been shown in the present thesis increases the risk of LBS and its consequences. Hence, any intervention strategy aimed at reducing the prevalence of LBS and its consequences should address both physical and psychosocial factors and their interactions in the workplace.

References

't Mannetje, A., Slater, T., McLean, D., Eng, A., Briar, C., & Douwes, J. (2009). Women's Occupational Health and Safety in New Zealand. NOHSAC Tehcnical Report 13 *NOHSAC Technical Report 13*. Wellington.

Aasa, U., Barnekow-Bergvist, M., Angquist, K.-A., & Brulin, C. (2005). Relationship between work-related factors and disorders in the neck-shoulder and low-back region among female and male ambulance personnel. *J Occup Health, 47*, 481-489.

ACC. (2006). Return to work guide: A reference tool by practising physicians and ACC (May 2006 ed.). Wellington: Accident Compensation Corporation (ACC).

Access Economics. (2006). *The economic and social costs of occupational disease and injury in New Zealand*. Wellington N.Z.: NOHSAC.

Adamson, J., & Atkin, K. (2008). Commentary: Culture and pain in the work place: the domain of occupational epidemiology? *International Journal of Epidemiology, 37*, 1189–1191.

Afacan, A. S. (1982). Sickness absence due to back lesion in coal-miners. *Journal of the Society of Occupational Medicine, 32*(1), 26-31.

Agius, R. M., Lloyd, M. H., Campbell, S., Hutchison, P., Seaton, A., & Soutar, C. A. (1994). Questionnaire for the identification of back pain for epidemiologic purposes. *Occupational and Environmental Medicine, 51*(11), 756-760.

Albanes, D., Jones, D. Y., Micozzi, M. S., & Mattson, M. E. (1987). Associations between smoking and body-weight in the United-States population - Analysis of NHANES-II. *American Journal of Public Health, 77*(4), 439-444.

Alcouffe, J., Manillier, P., Brehier, M., Fabin, C., & Faupin, F. (1999). Analysis by sex of low back pain among workers from small companies in the Paris area: severity and occupational consequences. *Occupational and Environmental Medicine, 56*(10), 696-701.

Alexopoulos, E. C., Burdorf, A., & Kalokerinou, A. (2003). Risk factors for musculoskeletal disorders among nursing personnel in Greek hospitals. *International Archives of Occupational and Environmental Health, 76*(4), 289-294.

Alexopoulos, E. C., Konstantinou, E. C., Bakoyannis, G., Tanagra, D., & Burdorf, A. (2008). Risk factors for sickness absence due to low back pain and prognostic factors for return to work in a cohort of shipyard workers. *European Spine Journal, 17*(9), 1185-1192.

Alexopoulos, E. C., Stathi, I. C., & Charizani, F. (2004). Prevalence of musculoskeletal disorders in dentists. *BMC Musculoskeletal Disorders, 5*(16). doi: 10.1186/1471-2474-5-16

Alexopoulos, E. C., Tanagra, D., Konstantinou, E., & Burdorf, A. (2006). Musculoskeletal disorders in shipyard industry: prevalence, health care use, and absenteeism. *BMC Musculoskeletal Disorders, 7*(88). doi: 10.1186/1471-2474-7-88

Allison, T. R., Symmons, D. P. M., Brammah, T., Haynes, P., Rogers, A., Roxby, M., & Urwin, M. (2002). Musculoskeletal pain is more generalised among people from ethnic minorities than among white people in Greater Manchester. *Ann Rheum Dis, 61*, 151-156.

Aloisi, A. M. (2003). Gonadal hormones and sex differences in pain reactivity. *Clinical Journal of Pain, 19*(3), 168-174.

Aloisi, A. M., & Bonifazi, M. (2006). Sex hormones, central nervous system and pain. *Hormones and Behavior, 50*(1), 1-7.

Altman, D. G. (1991a). Principles of statistical analysis *Practical statistics for medical research* (pp. 152-178). London: Chapman & Hall.

Altman, D. G. (1991b). Relation between several variables *Practical Statistics for Medical Research* (pp. 325-364). London: Chapman & Hall.

Altman, D. G. (1991c). Some common problems in medical research *Practical Statistics for Medical Research* (pp. 396-439). London: Chapman & Hall.

American Psychological Association (APA). (2010). *Publication manual of the American Psychological Association* (6th ed.). Washington, DC: American Psychological Association.

Andersen, J. H., Haahr, J. P., & Frost, P. (2007). Risk factors for more severe regional musculoskeletal symptoms - A two-year prospective study of a general working population. *Arthritis and Rheumatism, 56*(4), 1355-1364.

Andersen, L. L., Mortensen, O. S., Hansen, J. V., & Burr, H. (2011). A prospective cohort study on severe pain as a risk factor for long-term sickness absence in blue- and white-collar workers. *Occupational and Environmental Medicine, 68*(8), 590-592.

Andersson, G. B., Svensson, H. O., & Oden, A. (1983). The intensity of work recovery in low back pain. *Spine, 8*, 880-884.

Andersson, H. I., Ejlertsson, G., Leden, I., & Rsenberg, C. (1993). Chronic Pain in a Geographically Defined General Population: Studies of Differences in Age, Gender, Social Class, and Pain Localization. *The Clinical Journal of Pain, 9*(3), 174-184.

Andersson, T., Alfredsson, L., Kallberg, H., Zdravkovic, S., & Ahlbom, A. (2005). Calculating measures of biological interaction. *European Journal of Epidemiology, 20*, 575-579.

Ariëns, G., van Mechelen, W., Bongers, P., Bouter, L., & van der Wal, G. (2000). Physical risk factors for neck pain. *Scandinavian Journal of Work Environment and Health, 26*(1), 7-19.

Ariëns, G. A. M., Bongers, P. M., Douwes, M., Miedema, M. C., Hoogendoorn, W. E., van der Wal, G., . . . van Mechelen, W. (2001). Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study. *Occupational and Environmental Medicine, 58*, 200-207.

Armstrong, T. J., Buckle, P., Fine, L. J., Hagberg, M., Jonsson, B., Kilbom, A., . . . Viikarijuntura, E. R. A. (1993). A conceptual model for work-related neck and upper-limb musculoskeletal disorders. *Scandinavian Journal of Work Environment and Health, 19*(2), 73-84.

Arrighi, H. M., & Hertzpicciotto, I. (1994). The evolving concept of the healthy worker survivor effect. *Epidemiology, 5*(2), 189-196.

Balogh, I., Ørbaek, P., Ohlsson, K., Nordander, C., Unge, J., Winkel, J., . . . Malmo Shoulder Neck Study Group. (2004). Self-assessed and directly measured occupational physical activities - influence of musculoskeletal complaints, age and gender. *Applied Ergonomics, 35*(1), 49-56.

Bang, B. E., Aasmoe, L., Aardal, L., Andorsen, G. S., Bjørnbakk, A. K., Egeness, C., . . . Kramvik, E. (2005). Feeling cold at work increases the risk of symptoms from muscles, skin, and airways in seafood industry workers. *American Journal of Industrial Medicine, 47*(1), 65-71.

Barrero, L. H., Hsu, Y. H., Terwedow, H., Perry, M. J., Dennerlein, J. T., Brain, J. D., & Xu, X. P. (2006). Prevalence and physical determinants of low back pain in a rural Chinese population. *Spine, 31*(23), 2728-2734.

Barrero, L. H., Katz, J. N., & Dennerlein, J. T. (2009). Validity of self-reported mechanical demands for occupational epidermiologic research of musculoskeletal disorders. *Scandinavian Journal of Work Environment and Health, 35*(4), 245-260.

Bartys, S., Burton, K., & Main, C. (2005). A prospective study of psychosocial risk factors and absence due to musculoskeletal disorders - implications for occupational screening. *Occupational Medicine, 55*, 375-380.

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25*(24), 3186-3191.

Beeck, R. O. D., & Hermans, V. (2000). Research on work-related low back disorders. Bilbao, Spain: European Agency for Safety and Health at Work.

Belkic, K. L., Landsbergis, P. A., Schnall, P. L., & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? [Review]. *Scandinavian Journal of Work Environment & Health, 30*(2), 85-128.

Bergström, G., Bodin, L., Bertilsson, H., & Jensen, I. B. (2007). Risk factors for new episodes of sick leave due to neck or back pain in a working population. A prospective study with an 18-month and a three-year follow-up. *Occupational and Environmental Medicine, 64*, 279-287.

Bernard, B., Sauter, S., Fine, L., 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.

Bernard, B. P. (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*. Cincinnati (OH): US DHHS (NIOSH) Publication No. 97-141, National Institute for Occupational Safety and Health.

Bongers, P. M., Dewinter, C. R., Kompier, M. A. J., & Hildebrandt, V. (1993). Psychosocial factors at work and musculoskeletal disease. *Scandinavian Journal of Work Environment and Health, 19*(5), 297-312.

Bovenzi, M., & Betta, A. (1994). Low-back disorders in agricultural tractor drivers exposed to whole-body vibration and postural stress. *Applied Ergonomics, 25*(4), 231-241.

Bovenzi, M., Pinto, I., & Stacchini, N. (2002). Low back pain in port machinery operators. *Journal of Sound and Vibration, 253*(1), 3-20.

Bratton, R. L. (1999). Assessment and management of acute low back pain. *American Family Physician, 60*(8), 2299.

Bressler, H. B., Keyes, W. J., Rochon, P. A., & Badley, E. (1999). The prevalence of low back pain in the elderly - A systematic review of the literature. *Spine, 24*(17), 1813-1819.

Brulin, C., Gerdle, B., Granlund, B., Hoog, J., Knutson, A., & Sundelin, G. (1998). Physical and psychosocial work-related risk factors associated with musculoskeletal symptoms among home care personnel. *Scandinavian Journal of Caring Sciences, 12*(2), 104-110.

Buchbinder, R., Jolley, D., & Wyatt, M. (2001). Population based intervention to change back pain beliefs and disability: three part evaluation. *BMJ 322,* 1516-1520.

Buckle, P. W., & Devereux, J. J. (2002). The nature of work-related neck and upper limb musculoskeletal disorders. *Applied Ergonomics, 33*(3), 207-217.

Buckwalter, J. A. (1995). Spine Update - Aging and Degeneration of the Human Intervertebral Disc. *Spine, 20*(11), 1307-1314.

Bullinger, M., Alonso, J., Apolone, G., Leplege, A., Sullivan, M., Wood-Dauphinee, S., . . . Grp, I. P. (1998). Translating health status questionnaires and evaluating their quality: The IQOLA project approach. *Journal of Clinical Epidemiology, 51*(11), 913-923.

Burdorf, A., & Hulshof, C. T. J. (2006). Modelling the effects of exposure to whole-body vibration on low-back pain and its long-term consequences for sickness absence and associated work disability. *Journal of Sound and Vibration, 298,* 480-491.

Burdorf, A., & Jansen, J. P. (2006). Predicting the long term course of low back pain and its consequences for sickness absence and associated work disability. *Occupational and Environmental Medicine, 63*(8), 522-529.

Burdorf, A., Naaktgeboren, B., & Post, W. (1998). Prognostic factors for musculoskeletal sickness absence and return to work among welders and metal workers. *Occupational and Environmental Medicine, 55*(7), 490-495.

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

Burton, A. K., Kendall, N. A. S., Pearce, B. G., Birrell, L. N., & Bainbridge, L. C. (2008). Management of upper limb disorders and the biopsychosocial model (RR 596). Health & Safety Executive.

Callaghan, J. P., & Dunk, N. M. (2002). Examination of the flexion relaxation phenomenon in erector spinae muscles during short duration slumped sitting. *Clinical Biomechanics, 17*(5), 353-360.

Canjuga, M., Läubli, T., & Bauer, G. F. (2010). Can the job demand control model explain back and neck pain? Cross-sectional study in a representative sample of Swiss working population. *International Journal of Industrial Ergonomics, 40*(6), 663-668.

Carayon, P., Smith, M. J., & Haims, M. C. (1999). Work organization, job stress, and work-related musculoskeletal disorders. *Human Factors, 41*(4), 644-663.

Chatterjee, S., & Hadi, A. S. (2006). *Regression Analysis by Example* (Fourth ed.). New Jersey: John Wiley & Sons, Inc.

Checkoway, H., Pearce, N., & Krebel, D. (2004). Precision and Validity in Study Design *Research Methods in Occupational Epidemiology* (pp. 83-121). New York: Oxford University Press, Inc.

Chen, W. Q., Yu, I. T.-S., & Wong, T. W. (2005). Impact of occupational stress and other psychosocial factors on musculoskeletal pain among Chinese offshore oil installation workers. *Occupational and Environmental Medicine, 62*(4), 251-256.

Cheuvront, S. N., Kenefick, R. W., Montain, S. J., & Sawka, M. N. (2010). Mechanisms of aerobic performance impairment with heat stress and dehydration. *J Appl Physiol, 109*, 1989-1995.

Choobineh, A., Tabatabaei, S. H., Mokhtarzadeh, A., & Salehi, M. (2007). Musculoskeletal problems among workers of an Iranian rubber factory. *Journal of Occupational Health, 49*(5), 418-423.

Coggan, C., Norton, R., Roberts, I., & Hope, V. (1994). Prevalence of back pain among nurses. *New Zealand Medical Journal, 107*, 306-308.

Collins, S. M., Karasek, R. A., & Costas, K. (2005). Job strain and autonomic indices of cardiovascular disease risk. *American Journal of Industrial Medicine, 48*(3), 182-193.

Cote, P., van der Velde, G., Cassidy, J. D., Carroll, L. J., Hogg-Johnson, S., Holm, L. W., . . . Peloso, P. M. (2008). The Burden and Determinants of Neck Pain in Workers - Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Eur Spine J, 17*(Suppl 1), S60-S74.

Cox, T., Griffiths, A., & Rial-González, E. (2000). Research on Work-Related Stress. Bilbao, Spain: European Agency for Safety and Health at Work.

Craft, R. M., Mogil, J. S., & Aloisi, A. M. (2004). Sex differences in pain and analgesia: the role of gonadal hormones. *European Journal of Pain*, *8*(5), 397-411.

Cunningham, C., Flynn, T., & Blake, C. (2006). Low back pain and occupation among Irish health service workers. *Occupational Medicine-Oxford, 56*(7), 447-454.

Cunningham, L. S., & Kelsey, J. L. (1984). Epidemiology of Musculoskeletal Impairments and Associated Disability. *American Journal of Public Health, 74*(6), 574-579.

Dahlberg, R., Karlqvist, L., Bildt, C., & Nykvist, K. (2004). Do work technique and musculoskeletal symptoms differ between men and women performing the same type of work tasks? *Applied Ergonomics, 35*(6), 521-529.

Davis, K. G., & Heaney, C. A. (2000). The relationship between psychosocial work characteristics and low back pain: underlying methodological issues. *Clinical Biomechanics, 15*(6), 389-406.

de Zwart, B. C. H., Broersen, J. P. J., Frings-Dresen, M. H. W., & van Dijk, F. J. H. (1997). Musculoskeletal complaints in the Netherlands in relation to age, gender and physically demanding work. *Int Arch Occup Environ Health, 70*(5), 352-360.

Devereux, J., Rydstedt, L., Kelly, V., Weston, P., & Buckle, P. (2004). The role of work stress and psychological factors in the development of musculoskeletal disorders: The stress and MSD study (RR 273): Health and Safety Executive (http://www.hse.gov.uk/research/rrhtm/rr273.htm).

Devereux, J. J., Buckle, P. W., & Vlachonikolis, I. G. (1999). Interactions between physical and psychosocial risk factors at work increase the risk of back disorders: an epidemiological approach. *Occupational and Environmental Medicine*, *56*(5), 343-353.

Devereux, J. J., Rydstedt, L. W., & Cropley, M. (2011). Psychosocial work characteristics, need for recovery and musculoskeletal problems predict psychological distress in a sample of British workers. *Ergonomics, 40*(9), 840-848.

Devereux, J. J., Vlachonikolis, I. G., & Buckle, P. W. (2002). Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. *Occupational and Environmental Medicine, 59*(4), 269-277.

Dickinson, C. E., Campion, K., Foster, A. F., Newman, S. J., O'Rourke, A. M. T., & Thomas, P. G. (1992). Questionnaire development: an examination of the Nordic Musculoskeletal questionnaire. *Applied Ergonomics, 23*(3), 197-201.

Dionne, C. E., Dunn, K. M., & Croft, P. R. (2006). Does back pain prevalence really decrease with increasing age? A systematic review. *Age and Ageing, 35*, 229-234.

Dykes, R. (2009). *Prevalence of musculoskeletal discomfort in seventy three primary and secondary school teachers in New Zealand.* Master Thesis, Massey University, Palmerston North.

Dykes, R., Scuffham, A., Legg, S., & Widanarko, B. (2010). *Variation in the uses of terminology in the Nordic Musculoskeletal Questionnaire amongst 35 recent publications*. Paper presented at the New Zealand Ergonomics Society's 16th Conference: Preventing Work-related musculoskeletal disorders - Present and Future Challenges, Nelson, New Zealand.

Eatough, E. M., Way, J. D., & Chang, C.-H. (2012). Understanding the link between psychosocial work stressors and work-related musculoskeletal complaints. *Applied Ergonomics, 43*(3), 554-563.

Edwin, M., Tappin, D., & Bentley, T. (2002, 14-15 November). *Musculoskeletal disorders in New Zealand log sawmiling industry.* Paper presented at the the 11th Conference of the New Zealand Ergonomics Society, Wellington.

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

Ektor-Andersen, J., Isacsson, S. O., Lindgren, A., Orbaek, P., & Malmo Shoulder-Neck Study Group. (1999). The experience of pain from the shoulder-neck area related to the total body pain, self-experienced health and mental distress. *Pain, 82*(3), 289-295.

El-Sayed, A. M., Hadley, C., Tessema, F., Tegegn, A., Cowan, J. A., & Galea, S. (2010). Back and Neck Pain and Psychopathology in Rural Sub-Saharan Africa Evidence From the Gilgel Gibe Growth and Development Study, Ethiopia. *Spine, 35*(6), 684-689.

Elders, L. A. M., & Burdorf, A. (2001). Interrelations of risk factors and low back pain in scaffolders. *Occupational and Environmental Medicine*, *58*(9), 597-603.

Energy Information Administration. (2011). International Energy Statistics, 21 July 2011, from http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=1

Eng, A., 't Mannetje, A., Cheng, S., Douwes, J., Ellison-Loschmann, L., McLean, D., . . . Pearce, N. (2010). The New Zealand Workforce Survey I: Self-Reported Occupational Exposures. *Annals of Occupational Hygiene, 54*(2), 144-153.

Engholm, G., & Holmström, E. (2005). Dose–response associations between musculoskeletal disorders and physical and psychosocial factors among construction workers. *Scandinavian Journal of Work Environment and Health, 31*(Suppl 2), 57-67.

Eriksen, W., Bruusgaard, D., & Knardahl, S. (2003). Work factors as predictors of sickness absence: a three month prospective study of nurses' aides. *Occupational and Environmental Medicine, 60*(4), 271-278.

Ernst, E. (1993). Smoking, a cause of back trouble? *British Journal of Rheumatology, 32*(3), 239-242.

Fallentin, N., Viikari-Juntura, E., Waersted, M., & Kilbom, A. (2001). Evaluation of physical workload standards and guidelines from a Nordic perspective. *Scandinavian Journal of Work Environment and Health, 27*, 1-52.

Fernandes, R. D. P., Carvalho, F. M., Assuncao, A. A., & Neto, A. M. S. (2009). Interactions between physical and psychosocial demands of work associated to low back pain. *Revista De Saude Publica, 43*(2), 326-334.

Ferrie, J. E., Kivimäki, M., Head, J., Shipley, M., Vahtera, J., & Marmot, M. (2005). A comparison of self-reported sickness absence with absences recorded in employers’ registers: evidence from the Whitehall II study. *Occupational and Environmental Medicine, 62*(2), 74-79.

Fillingim, R. B., & Ness, T. J. (2000). Sex-related hormonal influences on pain and analgesic responses. *Neuroscience and Biobehavioral Reviews, 24*(4), 485-501.

Firth, H., Herbison, P., McBride, D., & Feyer, A.-M. (2001). Health of farmers in Southland: an overview. *Journal of the New Zealand Medical Association, 114*(1140), 426-428.

Forcier, L., & Kuorinka, I. (2001). Work-related Musculoskeletal Disorders: Overview. In W. Karwowski (Ed.), *International Encyclopedia of Ergonomics and Human Factors* (Vol. III, pp. 1625-1632). New York: Taylor & Francis.

Fredriksson, K., Alfredsson, L., Thorbjornsson, C. B., Punnett, L., Toomingas, A., Torgen, M., & Kilbom, A. (2000). Risk factors for neck and shoulder disorders: A nested case-control study covering a 24-year period. *American Journal of Industrial Medicine, 38*(5), 516-528.

Gallagher, S. (2008). Reducing Low Back Pain and Disability in Mining (Vol. Information Circular 9507). Pittsburgh, PA: Department of Health and Human Services,.

Gallagher, S., Moore, S., & Dempsey, P. G. (2009). An analysis of injury claims from low-seam coal mines. *Journal of Safety Research, 40*(3), 233-237.

Gallis, C. (2006). Work-related prevalence of musculoskeletal symptoms among Greek forest workers. *International Journal of Industrial Ergonomics, 36*(8), 731-736.

Gardner, L. I., Landsittel, D. P., & Nelson, N. A. (1999). Risk factors for back injury in 31,076 retail merchandise store workers. *American Journal of Epidemiology, 150*(8), 825-833.

Ghaffari, M., Alipour, A., Jensen, I., Farshad, A. A., & Vingard, E. (2006). Low back pain among Iranian industrial workers. *Occupational Medicine-Oxford, 56*(7), 455-460.

Gilgil, E., Kacar, C., Butun, B., Tuncer, T., Urhan, S., Yildirim, C., . . . Dundar, U. (2005). Prevalence of low back pain in a developing urban setting. *Spine, 30*(9), 1093-1098.

Greenland, S. (1987). Quantitative methods in the review of epidemiologic literature. *Epidemiologic Reviews, 9*, 1-30.

Griffith, L. E., Shannon, H. S., Wells, R. P., Walter, S. D., Cole, D. C., Côté, P., . . . Langlois, L. E. (2012). Individual participant data meta-analysis of mechanical workplace risk factors and low back pain. *American Journal of Public Health, 102*(2), 309-318.

Guo, H. R., Chang, Y. C., Yeh, W. Y., Chen, C. W., & Guo, Y. L. (2004). Prevalence of musculoskeletal disorder among workers in Taiwan: a nationwide study. *Journal of occupational health, 46*(1), 26-36.

Guvenc, B., Dogan, A., & Akdur, R. (2011). The musculoskeletal system complaints of office workers at a vehicle production factory. *Human Factors and Ergonomics in Manufacturing, 21*(5).

Gyntelberg, F. (1974). One year incidence of low back pain among male residents of Copenhagen aged 40-59. *Danish Medical Bulletin, 21*(1), 30-36.

Hagberg, M., Silverstein, B., Wells, R., Smith, M. J., Hendrick, H. W., Carayon, P., & Perusse, M. (1995). WMSDs: conceptual framework. In I. Kuorinka & L. Forcier (Eds.), *Work related musculoskeletal disorders (WMSDs) : A reference book for prevention*. London ; Bristol, PA: Taylor & Francis.

Hagg, G. M. (1991). Static work loads and occupational myalgia - A new explanation model. In P. A. Anderson, D. J. Hobart & J. V. Danoff (Eds.), *Electromyographical Kinesiology* (Vol. 949, pp. 141-144).

Hallqvist, T., Ahlbom, A., Diderichsen, F., & Reuterwall, C. (1996). How to evaluate interaction between causes: A review of practices in cardiovascular epidemiology. *Journal of Internal Medicine, 239*(5), 377-382.

Hanse, J. J., & Winkel, J. (2008). Work organisation constructs and ergonomic outcomes among European forest machine operators. *Ergonomics, 51*(7), 968-981.

Hanson, M. A., Burton, K., Kendall, N. A. S., Lancaster, R. J., & Pilkington, A. (2006). The costs and benefits of active case management and rehabilitation for musculoskeletal disorders (RR 493): Health & Safety Executive Research Report.

Hansson, E. K., & Hansson, T. H. (2005). The costs for persons sick-listed more than one month because of low back or neck problems. A two-year prospective study of Swedish patients. *European Spine Journal, 14*(4), 337-345.

Hansson, G.-Å., Balogh, I., Byström, J. U., Ohlsson, K., Nordander, C., Asterland, P., . . . Malmö Shoulder-Neck Study Group. (2001). Questionnaire versus direct technical measurements in assessing postures and movements of the head, upper back, arms and hands. *Scandinavian Journal of Work Environment and Health, 27*(1), 30-40.

Harcombe, H., McBride, D., Derrett, S., & Gray, A. (2009). Prevalence and impact of musculoskeletal disorders in New Zealand nurses, postal workers and office workers. *Aust N Z J Public Health, 33*(5), 437-441.

Harkness, E. F., Macfarlane, G. J., Nahit, E. S., Silman, A. J., & McBeth, J. (2003). Risk factors for new-onset low back pain amongst cohorts of newly employed workers. *Rheumatology, 42*(8), 959-968.

Härmä, M. (2006). Workhours in relation to work stress, recovery and health. *Scandinavian Journal of Work Environment and Health, 32*(6, special issue), 502-514.

Hartman, E., Oude Vrielink, H. H. E., Metz, J. H. M., & Huirne, R. B. M. (2005). Exposure to physical risk factors in Dutch agriculture: Effect on sick leave due to musculoskeletal disorders. *International Journal of Industrial Ergonomics, 35*(11), 1031-1045.

Hartvigsen, J., Bakketeig, L. S., Leboeuf-Yde, C., Engberg, M., & Lauritzen, T. (2001). The association between physical workload and low back pain clouded by the “Healthy Worker” effect. *Spine, 26*(16), 1788-1793.

Hartvigsen, J., Christensen, K., Frederiksen, H., & Pedersen, H. C. (2004). Genetic and Environmental Contributions to Back Pain in Old Age: A Study of 2,108 Danish Twins Aged 70 and Older. *Spine, 29*(8), 897-901.

Hartvigsen, J., Leboeuf-Yde, C., Lings, S., & Corder, E. H. (2000). Is sitting-while-at-work associated with low back pain? A systematic, critical literature review. *Scandinavian Journal of Public Health, 28*(3), 230-239.

Hartvigsen, J., Lings, S., Leboeuf-Yde, C., & Bakketeig, L. (2004). Psychosocial factors at work in relation to low back pain and consequences of low back pain; a systematic, critical review of prospective cohort studies. *Occupational and Environmental Medicine, 61*, e2.

Hauke, A., Flintrop, J., Brun, E., & Rugulies, R. (2011). The impact of work-related psychosocial stressors on the onset of musculoskeletal disorders in specific body regions: A review and meta-analysis of 54 longitudinal studies. *Work & Stress, 25*(3), 243-256.

Health and Safety Executive, & National Statistics. (2010). The Health and Safety Executive Statistics 2009/10. from Health and Safety Executive http://www.hse.gov.uk/statistics/overall/hssh0910.pdf

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

Hemingway, H., & Marmot, M. (1999). Evidence based cardiology - Psychosocial factors in the aetiology and prognosis of coronary heart disease: systematic review of prospective cohort studies. *British Medical Journal, 318*(7196), 1460-1467.

Hemingway, H., Shipley, M. J., 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.

Heneweer, H., Staes, F., Aufdemkampe, G., van Rijn, M., & Vanhees, L. (2011). Physical activity and low back pain: a systematic review of recent literature. *European Spine Journal*, 1-20.

Heuch, I., Hagen, K., Nygaard, Ø., & Zwart, J. A. (2010). The impact of body mass index on the prevalence of low back pain: the HUNT study. *Spine, 35*(7), 764.

Hildebrandt, V., Bongers, P. M., Dul, J., van Dijk, F. J. H., & Kemper, H. C. G. (2000). The relationship between leisure time, physical activities and musculoskeletal symptoms and disability in worker populations. *International Archives of Occupational and Environmental Health, 73*(8), 507-518.

Hildebrandt, V. H. (1995a). Back pain in the working population: prevalence rates in Dutch traders and profession. *Ergonomics, 38*(6), 1283-1298.

Hildebrandt, V. H. (1995b). Musculoskeletal symptoms and workload in 12 branches of Dutch agriculture. *Ergonomics, 38*(12), 2576-2587.

Hintsanen, M., Kivimaki, M., Elovainio, M., Pulkki-Raback, L., Keskivaara, P., Juonala, M., . . . Keltikangas-Jarvinen, L. (2005). Job strain and early atherosclerosis: The cardiovascular risk in young Finns study. *Psychosomatic Medicine, 67*(5), 740-747.

Hofstede, G. (2001). *Culture's consequences: Comparing valuse, behaviors, institutions, and organizations across nations* (2nd ed.). Thousand Oaks: Sage Publications, Inc.

Hollmann, S., Heuer, H., & Schmidt, K. H. (2001). Control at work: a generalized resource factor for the prevention of musculoskeletal symptoms? *Work and Stress, 15*(1), 29-39.

Holmström, E., & Engholm, G. (2003). Musculoskeletal disorders in relation to age and occupation in Swedish construction workers. *American Journal of Industrial Medicine, 44,* 377-384.

Hooftman, W. E., van der Beek, A. J., Bongers, P. M., & van Mechelen, W. (2009). Is there a gender difference in the effect of work-related physical and psychosocial risk factors on musculoskeletal symptoms and related sickness absence? *Scandinavian Journal of Work Environment and Health, 35*(2), 85-95.

Hooftman, W. E., van Poppel, M. N. M., van der Beek, A. J., Bongers, P. M., & van Mechelen, W. (2004). Gender differences in the relations between work-related physical and psychosocial risk factors and musculoskeletal complaints. *Scandinavian Journal of Work Environment and Health, 30*(4), 261-278.

Hoogendoorn, W. E., Bongers, P. M., de Vet, H. C. W., Ariëns, G. A. M., van Mechelen, W., & Bouter, L. M. (2002). High physical work load and low job satisfaction increase the risk of sickness absence due to low back pain: results of a prospective cohort study. *Occupational and Environmental Medicine, 59*, 323-328.

Hoogendoorn, W. E., van Poppel, M. N., Bongers, P. M., Koes, B. W., & Bouter, L. M. (1999). Physical load during work and leisure time as risk factors for back pain. *Scandinavian Journal of Work Environment and Health, 25*(5), 387-403.

Hoogendoorn, W. E., van Poppel, M. N. M., Bongers, P. M., Koes, B. W., & Bouter, L. M. (2000). Systematic Review of Psychosocial Factors at Work and Private Life as Risk Factors for Back Pain. *Spine, 25*(16), 2114-2125.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied Logistic Regression* (2nd ed.). New York: John Wiley & Sons.

Houtman, I. L., Jettinghoff, K., & Cedillo, L. (2008). *Raising awareness of stress at work in developing countries - a modern hazard in a traditional working environment (Protecting Workers' Health Series No 6)*. Geneva: World Health Organization.

Houtman, I. L. D., Bongers, P. M., Smulders, P. G. W., & Kompier, M. A. J. (1994). Psychosocial stressors at work and musculoskeletal problems. *Scandinavian Journal of Work Environment and Health, 20*(2), 139-145.

Huang, G. D., Feuerstein, M., Kop, W. J., Schor, K., & Arroyo, F. (2003). Individual and combined impacts of biomechanical and work organization factors in work-related musculoskeletal symptoms. *American Journal of Industrial Medicine, 43*(5), 495-506.

Humzah, M., & Soames, R. (1988). Human intervertebral disc: structure and function. *The Anatomical Record, 220*(4), 337-356.

Hussain, T. (2004). Musculoskeletal symptoms among truck assembly workers. *Occupational Medicine-Oxford, 54*(8), 506-512.

Ijzelenberg, W., Molenaar, D., & Burdorf, A. (2004). Different risk factors for musculoskeletal complaints and musculoskeletal sickness absence. *Scandinavian Journal of Work Environment and Health, 30*(1), 56-63.

Intercooled Stata for Windows. (2003). Release, 8.0. College Station, Texas: StataCorp LP.

Intercooled Stata for Windows. (2012). Release, 12.1. College Station, Texas: StataCorp LP.

James, F. R., Large, R. G., Bushnell, J. A., & Wells, J. E. (1991). Epidemiology of pain in New Zealand. *Pain, 44*(3), 279-283.

Jans, M. P., Proper, K. I., & Hildebrandt, V. (2007). Sedentary Behavior in Dutch Workers: Differences Between Occupations and Business Sectors. *American Journal of Preventive Medicine, 33*(6), 450-454.

Jansen, J. P., Morgenstern, H., & Burdorf, A. (2004). Dose-response relations between occupational exposures to physical and psychosocial factors and the risk of low back pain. *Occupational and Environmental Medicine, 61*(12), 972-979.

Jansen, N. W. H., Kant, I., van Amelsvoort, L., Nijhuis, F. J. N., & van den Brandt, P. (2003). Need for recovery from work: evaluating short-term effects of working hours, patterns and schedules. *Ergonomics, 46*(7), 664-680.

Jensen, C., Ryholt, C. U., Burr, H., Villadsen, E., & Christensen, H. (2002). Work-related psychosocial, physical and individual factors associated with musculoskeletal symptoms in computer users. *Work and Stress, 16*(2), 107-120.

Jensen, J. N., Albertsen, K., Borg, V., & Nabe-Nielsen, K. (2009). The predictive effect of fear-avoidance beliefs on low back pain among newly qualified health care workers with and without previous low back pain: a prospective cohort study. *BMC Musculoskeletal Disorders, 10*(117). doi: 10.1186/1471-2474-10-117

Jensen, J. N., Holtermann, A., Clausen, T., Mortensen, O. S., Carneiro, I. G., & Andersen, L. L. (2012). The greatest risk for low-back pain among newly educated female health care workers; Body weight or physical work load? *BMC Musculoskeletal Disorders, 13*(87). doi: 10.1186/1471-2474-13-87

Jin, K., Sorock, G., Courtney, T., Liang, Y., Yao, Z., Matz, S., & Ge, L. (2000). Risk factors for work-related low back pain in the People's Republic of China. *International Journal of Occupational and Environmental Health, 6*(1), 26.

Jin, K., Sorock, G. S., & Courtney, T. K. (2004). Prevalence of low back pain in three occupational groups in Shanghai, People's Republic of China. *Journal of Safety Research, 35*(1), 23-28.

Johansson, H., Arendt-Nilsson, L., Bergenheim, M., Blair, S., Dieen, J. v., Djupsjöbacka, M., . . . Zukowska, Z. (2003). Epilogue: An Integrated Model for Chronic Work-Related Myalgia ”Brussels Model”. In H. Johansson, U. Windhorst, M. Djupsjöbacka & M. Passatore (Eds.), *Chronic Work-Related Myalgia. Neuromuscular Mechanisms behind Work-Related Chronic Muscle Pain Syndromes* (pp. 291-300). Umeå: Gävle University Press.

Johansson, J. Å. (1994). Work-related and non-work-related musculoskeletal symptoms. *Applied Ergonomics, 25*(4), 248-251.

Johnston, V., Jull, G., Souvlis, T., & Jimmieson, N. L. (2010). Interactive effects from self-reported physical and psychosocial factors in the workplace on neck pain and disability in female office workers. *Ergonomics, 53*(4), 502-513.

Joling, C., Blatter, B., Ybema, J., & Bongers, P. (2008). Can favorable psychosocial work conditions and high work dedication protect against the occurrence of work-related musculoskeletal disorders? *Scandinavian Journal of Work Environment and Health, 34*(5), 345-355.

Kallio, M., Viikari-Juntura, E., Hakkanen, M., & Takala, E. P. (2000). Assessment of duration and frequency of work tasks by telephone interview: reproducibility and validity. *Ergonomics, 43*(5), 610-621.

Kamaleri, Y., Natvig, B., Ihlebaek, C. M., Benth, J. S., & Bruusgaard, D. (2008). Number of pain sites is associated with demographic, lifestyle, and health-related factors in the general population. *European Journal of Pain, 12*(6), 742-748.

Kanayama, M., Togawa, D., Takahashi, C., Terai, T., & Hashimoto, T. (2009). Cross-sectional magnetic resonance imaging study of lumbar disc degeneration in 200 healthy individuals. *Journal of Neurosurgery: Spine, 11*(4), 501-507.

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, R., Choi, B., Ostergren, P. O., Ferrario, M., & De Smet, P. (2007). Testing two methods to create comparable scale scores between the Job Content Questionnaire (JCQ) and JCQ-Like questionnaires in the European JACE study. *International Journal of Behavioral Medicine, 14*(4), 189-201.

Karsh, B.-T. (2006). Theories of work-related musculoskeletal disorders: Implications for ergonomic interventions. *Theoretical Issues in Ergonomics Science, 7*(1), 71-88.

Keller, M. C., Fredrickson, B. L., Ybarra, O., Cote, S., Johnson, K., Mikels, J., . . . Wager, T. (2005). A warm heart and a clear head: The contingent effects of weather on mood and cognition. *Psychological Science, 16*(9), 724-731.

Kelsey, J. L., & Hochberg, M. C. (1988). Epidemiology of Chronic Musculoskeletal Disorders. *Ann. Rev. Public Health, 9*, 379-401.

Knibbe, J. J., & Friele, R. D. (1996). Prevalence of back pain and characteristics of the physical workload of community nurses. *Ergonomics, 39*(2), 186-198.

Koehoorn, M., Xu, F., Village, J., Trask, C., & Teschke, K. (2010). Back Injury Trajectories in Heavy Industries: Defining Outcomes for Epidemiological Research. *Journal of Occupational and Environmental Medicine, 52*(9), 908.

Kortum, E., Leka, S., & Cox, T. (2010). Psychosocial risks and work-related stress in developing countries: Health impact, priorities, barriers and solutions. *International Journal of Occupational Medicine and Environmental Health, 23*(3), 225-238.

Kortum, E., Leka, S., & Cox, T. (2011). Perceptions of psyhcosocial hazards, work-related stress and workplace priority risks in developing counties. *Journal of Occupational Health, 53*(2), 144-155.

Kumar, S. (2001). Theories of musculoskeletal injury causation. *Ergonomics, 44*(1), 17-47.

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G., & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, *18*(3), 233-237.

Landsbergis, P. A., Schnall, P. L., Warren, K., Pickering, T. G., & Schwartz, J. E. (1994). Association between ambulatory blood-pressure and alternative formulations of job strain. *Scandinavian Journal of Work Environment and Health*, *20*(5), 349-363.

Lapointe, J., Dionne, C. E., Brisson, C., & Montreuil, S. (2009). Interaction between postural risk factors and job strain on self-reported musculoskeletal symptoms among users of video display units: a three-year prospective study. *Scandinavian Journal of Work Environment and Health*, *35*(2), 134-144.

Larsson, B., Søgaard, K., & Rosendal, L. (2007). Work related neck–shoulder pain: A review on magnitude, risk factors, biochemical characteristics, clinical picture and preventive interventions. *Best Practice & Research Clinical Rheumatology*, *21*(3), 447-463.

Laslett, M., Crothers, C., Beattie, P., Cregten, L., & Moses, A. (1991). The frequency and incidence of low back pain/sciatica in an urban population. *New Zealand Medical Journal*, *104*, 424-426.

Last, J. M. (2009). A Dictionary of Public Health - Oxford Reference Online Premium Retrieved 19 July, 2009, from http://www.oxfordreference.com.ezproxy.massey.ac.nz/views/SEARCH_RESULTS.html?y=2&q=musculoskeletal+disorders&x=25&ssi

Lau, B. (2008). Effort-reward imbalance and overcommitment in employees in a Norwegian municipality: a cross sectional study. *Journal of Occupational Medicine and Toxicology, 3*(9).

Lawrence, R. C., Helmick, C. G., Arnett, F. C., Deyo, R. A., Felson, D. T., Giannini, E. H., . . . Wolfe, F. (1998). Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. *Arthritis and Rheumatism 41*(5), 788-799.

Leboeuf-Yde, C. (2004). Back pain - individual and genetic factors. *Journal of Electromyography and Kinesiology*, *14*(1), 129-133.

Leboeuf–Yde, C. (1999). Smoking and Low Back Pain: A Systematic Literature Review of 41 Journal Articles Reporting 47 Epidemiologic Studies. *Spine, 24*(14), 1463-1470.

Legg, S., Battisti, M., Harris, L.-A., Laird, I., Lamm, F., Massey, C., & Olsen, K. (2009). Occupational Health and Safety in Small Businesses. NOHSAC Technical Report 12. Wellington.

Lei, L., Dempsey, P. G., Xu, J.-g., Ge, L.-n., & Liang, Y.-x. (2005). Risk factors for the prevalence of musculoskeletal disorders among chinese foundry workers. *International Journal of Industrial Ergonomics, 35*(3), 197-204.

Leijon, O., & Mulder, M. (2009). Prevalence of low back pain and concurrent psychological distress over a 16-year period. *Occupational and Environmental Medicine, 66*(2), 137-139.

Leijon, O., Wiktorin, C., Harenstam, A., Karlqvist, L., & MOA Research Group. (2002). Validity of a Self-Administered Questionnaire for Assessing Physical Work Loads in a General Population. *Journal of Occupational and Environmental Medicine, 44*(8), 724-735.

Leroux, I., Dionne, C. E., Bourbonnais, R., & Brisson, C. (2005). Prevalence of musculoskeletal pain and associated factors in the Quebec working population. *International Archieve of Occupational Environmental Health, 78*, 379-386.

Li, C.-Y., & Sung, F.-C. (1999). A review of the healthy worker effect in occupational epidemiology. *Occupational Medicine, 49*(4), 225-229.

Liira, J. P., Shannon, H. S., Chambers, L. W., & Haines, T. A. (1996). Long-term back problems and physical work exposures in the 1990 Ontario Health Survey. *American Journal of Public Health, 86*(3), 382-387.

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

Linton, S. J. (2000). A review of psychological risk factors in back and neck pain. *Spine, 25*(9), 1148-1156.

Linton, S. J. (2001). Occupational psychological factors increase the risk for back pain: A systematic review. *Journal of Occupational Rehabilitation, 11*(1), 53-66.

Linton, S. J. (2005). Do psychological factors increase the risk for back pain in the general population in both a cross-sectional and prospective analysis? *European Journal of Pain, 9*(4), 355-361.

Lipscomb, H. J., Loomis, D., McDonald, M. A., Kucera, K., Marshall, S., & Li, L. (2004). Musculoskeletal symptoms among commercial fishers in North Carolina. *Applied Ergonomics, 35*(5), 417-426.

Lipscomb, J. A., Trinkoff, A. M., Geiger-Brown, J., & Brady, B. (2002). Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scandinavian Journal of Work Environment and Health, 28*(6), 394-401.

Lloyd, M. H., Gauld, S., & Soutar, C. A. (1986). Epidemiologic study of back pain in miners and office workers. *Spine, 11*(2), 136-140.

Lotters, F., Burdorf, A., Kuiper, J., & Miedema, H. (2003). Model for the work-relatedness of low-back pain. *Scandinavian Journal of Work Environment and Health, 29*(6), 431-440.

Louw, Q. A., Morris, L. D., & Grimmer-Somers, K. (2007). The prevalence of low back pain in Africa: a systematic review. *BMC Musculoskeletal Disorders, 8*(105). doi: 10.1186/1471-2474-8-105

Lund, T., Labriola, M., Christensen, K. B., Bültmann, U., & Villadsen, E. (2006). Physical work environment risk factors for long term sickness absence: prospective findings among a cohort of 5357 employees in Denmark. *British Medical Journal., 332*(7539), 449-452.

Macdonald, W. (2004). Workload, stress and psychosocial factors as hazards for musculoskeletal disorders. *Journal of Occupational Health and Safety - Australia and New Zealand, 20*(1), 37-47.

MacGregor, A. J., Andrew, T., Sambrook, P. N., & Spector, T. D. (2004). Structural, psychological, and genetic influences on low back and neck pain: A study of adult female twins. *Arthritis Care and Research, 51*(2), 160-167.

Madan, I., Reading, I., Palmer, K. T., & Coggon, D. (2008). Cultural differences in musculoskeletal symptoms and disability. *International Journal of Epidemiology, 37*(5), 1181-1189.

Magora, A. (1972). Investigation of the relation between low back pain and occupation, 3 physical requirements: sitting, standing and weight lifting. *Industrial Medicine and Surgery, 41*(12), 5-9.

Mannetje, A., Eng, A., Douwes, J., Ellison-Loschmann, L., McLean, D., & Pearce, N. (2011). Determinants of non-response in an occupational exposure and health survey in New Zealand. *The Australian & New Zealand Journal of Public Health, 35*(3), 256-263.

Mannion, A. F., Horisberger, B., Eisenring, C., Tamcan, O., Elfering, A., & Muller, U. (2009). The association between beliefs about low back pain and work presenteeism. *Journal of Occupational and Environmental Medicine, 51*(11), 1256-1266.

Mantyselka, P. T., Kumpusalo, E. A., Ahonen, R. S., & Takala, J. K. (2002). Direct and indirect costs of managing patients with musculoskeletal pain - challenge for health care. *European Journal of Pain-London, 6*(2), 141-148.

Marcus, D. A. (1995). Interrelationships of neurochemicals, estrogen, and recurring headache. *Pain, 62*(2), 129-139.

Marras, W. S. (2008a). The influence of physical factors on muscle activities and spine loads. In W. S. Marras (Ed.), *The working back: A systems view* (pp. 117-173). New Jersey: John Wiley & Sons.

Marras, W. S. (2008b). Potential pathways to back pain *The working back: A system view* (pp. 60-86). New Jersey: John Wiley & Sons.

Marras, W. S. (2008c). Psychosocial and organizational factor influence on spine loading *The working back: A systems view* (pp. 174-186). New Jersey: John Wiley & Sons.

Marras, W. S. (2009). Managing low back pain risk in industrially developing countries. In P. A. Scott (Ed.), *Ergonomics in developing regions: Needs and applications* (pp. 425-436). Boca Raton: CRC Press.

Martini, F. H., Bartholomew, E. F., & Welch, K. (2000). The Skeletal System. In H. Dinsey (Ed.), *The Human Body in Health and Disease* (pp. 142-185). Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Matsudaira, K., Palmer, K. T., Reading, I., Hirai, M., Yoshimura, N., & Coggon, D. (2011). Prevalence and correlates of regional pain and associated disability in Japanese workers. *Occupational and Environmental Medicine, 68*(3), 191-196.

Matud, M. P. (2004). Gender differences in stress and coping styles. *Personality and Individual Differences, 37*(7), 1401-1415.

McGill, S. M., Hughson, R. L., & Parks, K. (2000). Lumbar erector spinae oxygenation during prolonged contractions: implications for prolonged work. *Ergonomics, 43*(4), 486-493.

McMichael, A. J. (1976). Standardized mortality ratios and the" healthy worker effect": Scratching beneath the surface. *Journal of occupational medicine, 18*(3), 165-168.

McMorris, Swain, J., Smith, M., Corbett, J., Delves, S., Sale, C., . . . Potter, J. (2006). Heat stress, plasma concentrations of adrenaline, noradrenaline, 5-hydroxytryptamine and cortisol, mood state and cognitive performance. *International Journal of Psychophysiology, 61*(2), 204-215.

Mehlum, I. S., Kristensen, P., Kjuus, H., & Wergeland, E. (2008). Are occupational factors important determinants of socioeconomic inequalities in musculoskeletal pain? *Scandinavian Journal of Work Environment and Health, 34*(4), 250-259.

Messing, K., Dumais, L., Courville, J., Seifert, A. M., & Boucher, M. (1994). Evaluation of exposure data from men and women with the same job title. *Journal of Occupational and Environmental Medicine, 36*(8), 913-917.

Miller-Keane. (Ed.) (1991) Miller-Keane Encyclopedia & Dictionary of Medicine, Nursing, and Allied Health (Sixth ed.). Saunders Company.

Milosavljevic, S., Mcbride, D. I., Bagheri, N., Vasiljev, R. M., Mani, R., Carman, A. B., & Rehn, B. (2011). Exposure to whole-body vibration and mechanical shock: a field study of quad bike use in agriculture. *Annals of Occupational Hygiene, 55*(3), 286-295.

Morken, T., Moen, B., Riise, T., Bergum, O., Bua, L., Vigeland Hauge, S. H., . . . Thoppil, V. (2000). Prevalence of musculoskeletal symptoms among aluminium workers. *Occupational Medicine-Oxford, 50*(6), 414-421.

Morken, T., Riise, T., Moen, B., Hauge, S., Holien, S., Langedrag, A., . . . Thoppil, V. (2003). Low back pain and widespread pain predict sickness absence among industrial workers. *BMC Musculoskeletal Disorders, 4*(21). doi: 10.1186/1471-2474-4-21

Nachemson, A., & Elfstrom, G. (1970). *Intravital dynamic pressure measurements in lumbar discs: A study of common movements, maneuvers and exercises*. Stockholm: Almqvist & Wiksell

Nachemson, A. L., & Andersson, G. B. J. (1982). Classification of low-back pain. *Scandinavian Journal of Work Environment and Health, 8*(2), 134-136.

Naidoo, S., Kromhout, H., London, L., Naidoo, R. N., & Burdorf, A. (2009). Musculoskeletal pain in women working in small-scale agriculture in South Africa. *American Journal of Industrial Medicine, 52*(3), 202-209.

National Research Council. (1999). *Work-Related Musculoskeletal Disorders: Report, Workshop Summary, and Workshop Papers*. Washington, DC: National Academy Press.

National Research Council, & Institute of Medicine [NRC & IOM]. (2001). *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities*. Washington DC.: National Academy Press.

Nelson-Wong, E., Gregory, D. E., Winter, D. A., & Callaghan, J. P. (2008). Gluteus medius muscle activation patterns as a predictor of low back pain during standing. *Clinical Biomechanics, 23*(5), 545-553.

Nixon, A. E., Mazzola, J. J., Bauer, J., Krueger, J. R., & Spector, P. E. (2011). Can work make you sick? A meta-analysis of the relationships between job stressors and physical symptoms. *Work & Stress, 25*(1), 1-22.

Norton, R., Coggan, C., Roberts, I., & Hope, V. (1995). Obesity and the risk of nursing-related back pain. *Journal of Occupational Health and Safety – Australia and New Zealand 11*, 157-157.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric Theory* (Third ed.). New York: McGraw-Hill.

Okunribido, O. O., Magnusson, M., & Pope, M. (2006). Delivery drivers and low-back pain: A study of the exposures to posture demands, manual materials handling and whole-body vibration. *International Journal of Industrial Ergonomics, 36*(3), 265-273.

Østensvik, T., Veiersted, K. B., Cuchet, E., Nilsen, P., Hanse, J. J., Carlzon, C., & Winkel, J. (2008). A search for risk factors of upper extremity disorders among forest machine operators: A comparison between France and Norway. *International Journal of Industrial Ergonomics, 38*(11-12), 1017-1027.

Ostergren, P. O., Hanson, B. S., Balogh, I., Ektor-Andersen, J., Isacsson, A., Orbaek, P., . . . Malmo Shoulder Neck Study, G. (2005). Incidence of shoulder and neck pain in a working population: effect modification between mechanical and psychosocial exposures at work? Results from a one year follow up of the Malmo shoulder and neck study cohort. *Journal of Epidemiology and Community Health, 59*(9), 721-728.

Ostlin, P. (1988). Negative health selection into physically light occupations. *Journal of Epidemiology and Community Health, 42*(2), 152-156.

Palliser, C. R., Firth, H. M., Feyer, A. M., & Paulin, S. M. (2005). Musculoskeletal discomfort and work-related stress in New Zealand dentists. *Work & Stress, 19*(4), 351-359.

Palmer, B., Macfarlane, G., Afzal, C., Esmail, A., Silman, A., & Lunt, M. (2007). Acculturation and the prevalence of pain amongst South Asian minority ethnic groups in the UK. *Rheumatology, 46*, 1009-1014.

Palmer, K., Walker-Bone, K., Griffin, M., Syddall, H., Pannett, B., Coggon, D., & Cooper, C. (2001). Prevalence and occupational associations of neck pain in the British population. *Scandinavian Journal of Work Environment and Health, 27*(1), 49-56.

Palmer, K. T., & Smedley, J. (2007). Work relatedness of chronic neck pain with physical findings - a systematic review. *Scandinavian Journal of Work Environment and Health, 33*(3), 165-191.

Palmer, K. T., Syddall, H., Cooper, C., & Coggon, D. (2003). Smoking and musculoskeletal disorders: findings from a British national survey. *Ann Rheum Dis, 62*, 33-36.

Palsson, B., Horstmann, V., Attewell, R. G., Ohlsson, K., & Skerfving, S. (1997). Sick-leave and disability pensions among female assembly workers. *European Journal of Public Health, 7*(2), 162-168.

Pearce, N. (2004). Effect measures in prevalence studies. *Environmental Health Perspectives, 112*(10), 1047-1050.

Pejtersen, J. H., Kristensen, T. S., Borg, V., & Bjorner, J. B. (2010). The second version of the Copenhagen Psychosocial Questionnaire. *Scandinavian Journal of Public Health, 38*(Suppl 3), 8-24.

Pheasant, S., & Haslegrave, C. M. (2006). *Bodyspace: Anthropometry, Ergonomics, and the Design fo Work* (Third ed.). Boca Raton: Taylor & Francis Group.

Picavet, H. S. J., Schouten, J., & Smit, H. A. (1999). Prevalence and consequences of low back problems in The Netherlands, working vs non-working population, the MORGEN-study. *Public Health, 113*(2), 73-77.

Piedrahita, H., Punnett, L., & Shahnavaz, H. (2004). Musculoskeletal symptoms in cold exposed and non-cold exposed workers. *International Journal of Industrial Ergonomics, 34*(4), 271-278.

Pienimaki, T. (2002). Cold exposure and musculoskeletal disorders and diseases. A review. *International Journal of Circumpolar Health, 61*(2), 173-182.

Porta, M., Greenland, S., & Last, J. M. (Eds.). (2008) A Dictionary of Epidemiology. Oxford: Oxford University Press.

Predictive Analytics Software (PASW) Statistics 18. (2009). Release 18.0.0. Chicago: SPSS Inc., an IBM Company.

Pringle, D. R. S., Pirie, R., & Slappendel, C. (1993). *Musculoskeletal trouble in keyboard users at a university*. Paper presented at the the fifth conference of the New Zealand Ergonomics Society, Auckland.

Proper, K. I., & Hildebrandt, V. (2006). Physical activity among Dutch workers--differences between occupations. *Preventive Medicine, 43*(1), 42-45.

Ptacek, J. T., Smith, R. E., & Dodge, K. L. (1994). Gender differences in coping with stress: when stressor and appraisals do not differ. *Pers Soc Psychol Bull, 20*(421-430).

Punnett, L. (1996). Adjusting for the Healthy Worker Selection Effect in Cross-Sectional Studies. *International Journal of Epidemiology, 25*(5), 1068-1076.

Punnett, L., Pruss-Ustun, A., Nelson, D. I., Fingerhut, M. A., Leigh, J., Tak, S., & Phillips, S. (2005). Estimating the global burden of low back pain attributable to combined occupational exposures. *American Journal of Industrial Medicine, 48*(6), 459-469.

Punnett, L., & Wegman, D. H. (2004). Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology, 14*(1), 13-23.

R Development Core Team. (2012). R: A Language and Environment for Statistical Computing. Vienna.

Raspe, H., Matthis, C., Croft, P., O'Neill, T., & the European Vertebral Osteoporosis Study Group. (2004). Variation in back pain between countries - The example of Britain and Germany. *Spine, 29*(9), 1017-1021.

Riihimaki, H. (1991). Low back pain, its origin and risk indicators. *Scandinavian Journal of Work Environment and Health, 17*(2), 81-90.

Robinson, M. E., Riley, J. L., Myers, C. D., Papas, R. K., Wise, E. A., Waxenberg, L. B., & Fillingim, R. B. (2001). Gender role expectations of pain: Relationship to sex differences in pain. *Journal of Pain, 2*(5), 251-257.

Robinson, M. E., & Wise, E. A. (2003). Gender bias in the observation of experimental pain. *Pain, 104*(1-2), 259-264.

Roffey, D. M., Wai, E. K., Bishop, P., Kwon, B. K., & Dagenais, S. (2010). Causal assessment of occupational standing or walking and low back pain: results of a systematic review. *The Spine Journal, 10*(3), 262-272.

Rosenstrom, T., Hintsanen, M., Jokela, M., Keltikangas-Jarvinen, L., Kivimaki, M., Juonala, M., . . . Viikari, J. S. (2011). Change in Job Strain and Progression of Atherosclerosis: The Cardiovascular Risk in Young Finns Study. *Journal of Occupational Health Psychology, 16*(1), 139-150.

Rothman, K. J. (2012). Using regression models in epidemiologic analysis *Epidemiology: An Introduction* (Second ed., pp. 211-234). New York: Oxford University Press, Inc.

Rothman, K. J., Greenland, S., & Lash, T. L. (2008). *Modern Epidemiology* (Third ed.). Philadelphia. ISBN 9780781755641: Wolters Kluwer Health, Lippincott Williams & Wilkins.

Rowell, L. B. (1974). Human cardiovascular adjustment to exercise and thermal stress. *Physiological Reviews, 54*(1), 75-159.

Rowell, L. N., Mechlin, B., Ji, E., Addamo, M., & Girdler, S. S. (2011). Asians differ from non-Hispanic Whites in experimental pain sensitivity. *European Journal of Pain, 15*(7), 764-771.

Rugulies, R., & Krause, N. (2008). Effort–reward imbalance and incidence of low back and neck injuries in San Francisco transit operators. *Occupational and Environmental Medicine, 65*(8), 525-533.

Ryall, C., Coggon, D., Peveler, R., Poole, J., & Palmer, K. T. (2007). A prospective cohort study of arm pain in primary care and physiotherapy - prognostic determinants. *Rheumatology, 46*(3), 508-515.

Rydstedt, L. W., Devereux, J., & Sverke, M. (2007). Comparing and combining the demand-control-support model and the effort reward imbalance model to predict long-term mental strain. *European Journal of Work and Organizational Psychology, 16*(3), 261-278.

Samad, N. I. A., Abdullah, H., Moin, S., Tamrin, S. B. M., & Hashim, Z. (2010). Prevalence of Low Back Pain and its Risk Factors among School Teachers. *American Journal of Applied Sciences, 7*(5), 634-639.

Samat, R. A., Shafei, M. N., Yaacob, N. A., & Yusoff, A. (2011). Prevalence and Associated Factors of Back Pain among Dental Personnel in North-Eastern State of Malaysia. *Journal of Collaborative Research on Internal Medicine & Public Health, 3*(7), 576-586.

Sarikaya, S., Ozdolap, S., Gumustas, S., & Koc, U. (2007). Low back pain and lumbar angles in Turkish coal miners. *American Journal of Industrial Medicine, 50*(2), 92-96.

Sauter, S. L., & Swanson, N. G. (1996). An ecological model of musculoskeletal disorders in office work. In S. D. Moon & S. L. Sauter (Eds.), *Beyond Biomechanics: Psychosocial Aspects of Musculoskeletal Disorders in Office Work*: Taylor & Fracis.

Schierhout, G. H., Myers, J. E., & Bridger, R. S. (1993). Musculoskeletal pain and workplace ergonomic stressors in manufacturing industry in South Africa. *International Journal of Industrial Ergonomics, 12*(1-2), 3-11.

Schlader, Z. J., Prange, H. D., Mickleborough, T. D., & Stager, J. M. (2009). Characteristics of the control of human thermoregulatory behavior. *Physiology & Behavior, 98*(5), 557-562.

Schlader, Z. J., Stannard, S. R., & Mündel, T. (2010). Human thermoregulatory behavior during rest and exercise - A prospective review. *Physiology & Behavior, 99*, 269-275.

Schneider, S., Schiltenwolf, M., Zoller, S. M., & Schmitt, H. (2005). The association between social factors, employment status and self-reported back pain – A representative prevalence study on the German general population. *Journal of Public Health, 13*, 30-39.

Schreuder, K. J., Roelen, C. A. M., Koopmans, P. C., & Groothoff, J. W. (2008). Job demands and health complaints in white and blue collar workers. *Work: a Journal of Prevention Assessment & Rehabilitation, 31*(4), 425-432.

Scuffham, A. M., Legg, S. J., Firth, E. C., & Stevenson, M. A. (2010). Prevalence and risk factors associated with musculoskeletal discomfort in New Zealand veterinarians. *Applied Ergonomics, 41*, 444-453.

Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. (2010a). The association between obesity and low back pain: A meta-analysis. *American Journal of Epidemiology, 171*(2), 135-154.

Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. (2010b). The association between smoking and low back pain: a meta-analysis. *The American Journal of Medicine, 123*(1), 87.e87-87.e35.

Shiri, R., Solovieva, S., Husgafvel-Pursiainen, K., Telama, R., Yang, X., Viikari, J., . . . Viikari-Juntura, E. (2012). The role of obesity and physical activity in non-specific and radiating low back pain: The Young Finns study. *Seminars in Arthritis and Rheumatism*. doi: 10.1016/j.semarthrit.2012.09.002

Siebert, U., Rothenbacher, D., Daniel, U., & Brenner, H. (2001). Demonstration of the healthy worker survivor effect in a cohort of workers in the construction industry. *Occupational and Environmental Medicine, 58*(12), 774-779.

Siegrist, J., Wege, N., Pühlhofer, F., & Wahrendorf, M. (2008). A short generic measure of work stress in the era globalization: effor-reward imbalance. *Int Arch Occup Environ Health, 82*(8), 1005-1013.

Silverstein, B., & Adams, D. (2007). Work-related Musculoskeletal Disorders of the Neck, Back, and Upper Extremity in Washington State, 1997-2005: Technical Report Number 40-11-2007. Retrieved 6 Feb 2009, from Safety and Health Assessment and Research for Prevention (SHARP) and Washington State Dept. of Labor and Industries. http://www.lni.wa.gov/Safety/Research/Files/2007WmsdRpt.pdf

Silverstein, B. A., Stetson, D. S., Keyserling, W. M., & Fine, L. J. (1997). Work-related musculoskeletal disorders: Comparison of data sources for surveillance. *American Journal of Industrial Medicine, 31*(5), 600-608.

Simon, M., Tackenberg, P., Nienhaus, A., Estryn-Behar, M., Conway, P. M., & Hasselhorn, H. M. (2008). Back or neck-pain-related disability of nursing staff in hospitals, nursing homes and home care in seven countries-results from the European NEXT-Study. *International Journal of Nursing Studies, 45*(1), 24-34.

Sjogaard, G., Lundberg, U., & Kadefors, R. (2000). The role of muscle activity and mental load in the development of pain and degenerative processes at the muscle cell level during computer work. *European Journal of Applied Physiology, 83*(2-3), 99-105.

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*(5), 351-356.

Smith, A., Brice, C., Collins, A., Matthews, V., & McNamara, R. (2000). The scale of occupational stress: A further analysis of the impact of demographic factors and type of job (CRR 311/2000): Health and Safety Executive.

Smith, A., Johal, S., Wadsworth, E., Davey, G., & Peters, T. (2000). The scale of occupational stress: The Bristol Stress and Health at Work Study (CRR 265/2000): Health and Safety Executive.

Smith, A., Johal, S., Wadsworth, E., Davey Smith, G., Harvey, I., & Peters, T. (1998). The scale of occupational stress. *Occup Health Review, 73*, 19-22.

Smith, D. R., Mihashi, M., Adachi, Y., Koga, H., & Ishitake, T. (2006). A detailed analysis of musculoskeletal disorder risk factors among Japanese nurses. *Journal of Safety Research, 37*(2), 195-200.

Smith, D. R., Wei, N., Zhao, L., & Wang, R.-S. (2004). Musculoskeletal complaints and psychosocial risk factors among Chinese hospital nurses. *Occupational Medicine, 54*(8), 579-583.

Solidaki, E., Chatzi, L., Bitsios, P., Markatzi, I., Plana, E., Castro, F., . . . Kogevinas, M. (2010). Work-related and psychological determinants of multisite musculoskeletal pain. *Scandinavian Journal of Work Environment and Health, 36*(1), 54-61.

Sormunen, E., Rissanen, S., Oksa, J., Pienimaki, T., Remes, J., & Rintamaki, H. (2009). Muscular activity and thermal responses in men and women during repetitive work in cold environments. *Ergonomics, 52*(8), 964-976.

Statistics Indonesia. (2009). Population 15 Years of Age and Over Who Worked by Main Industry 2004 - 2009. Retrieved 25 August 2009, from Statistics Indonesia http://www.bps.go.id/eng/tab_sub/view.php?tabel=1&daftar=1&id_subyek=06&notab=2

Statistics Indonesia. (2012). Keadaan Ketenagakerjaan Feburari 2012. Retrieved 28 July 2012 http://www.bps.go.id/brs_file/naker_07mei12.pdf

Statistics New Zealand. (1997). Australian and New Zealand Standard Industrial Classification (New Zealand Use Version) 1996 Version 4.1.

Statistics New Zealand. (2001). New Zealand Standard Classification of Occupations 1999.

Statistics New Zealand. (2008a). Occupation (ANZSCO Major Group) and Industry (ANZSIC06 Division) by Sex, 2006 Census. Retrieved 12 February 2009, from Statistisc New Zealand http://www.stats.govt.nz/products-and-services/table-builder/2006-census-tables/work-occupation.htm

Statistics New Zealand. (2008b). Occupation (NZSCO99 Sub Major Group) by Age and Sex, 2001 and 2006 Census. Retrieved 12 February 2009, from Statistics New Zealand http://www.stats.govt.nz/products-and-services/table-builder/2006-census-tables/work-occupation.htm

Strazdins, L., & Bammer, G. (2004). Women, work and musculoskeletal health. *Social Science & Medicine, 58*(6), 997-1005.

Sundelin, G., & Hagberg, M. (1992). Effects of exposure to excessive drafts on myoelectric activity in shoulder muscles. *Journal of Electromyography and Kinesiology, 2*(1), 36-41.

Symonds, T. L., Burton, A. K., Tillotson, K. M., & Main, C. J. (1996). Do attitudes and beliefs influence work loss due to low back trouble? *Occupational Medicine-Oxford, 46*(1), 25-32.

Taber, C. W. (Ed.) (1997) Taber's Cyclopedic Medical Dictionary (18 ed.). Philadelphia: F. A. Davis Company.

Tappin, D. C., Bentley, T. A., & Vitalis, A. (2008). The role of contextual factors for musculoskeletal disorders in the New Zealand meat processing industry. *Ergonomics, 51*(10), 1576-1593.

Tappin, D. C., Bentley, T. A., Vitalis, A., & Macky, K. (2008). An analysis of sprain and strain injury data for the New Zealand meat processing industry from national and industry injury surveillance databases. *Ergonomics, 51*(11), 1721-1734.

Taylor, W. (2005). Musculoskeletal pain in the adult New Zealand population: prevalence and impact. *The New Zealand Medical Journal, 118*(1221).

Tennant, C. (2001). Work-related stress and depressive disorders. *Journal of Psychosomatic Research, 51*(5), 697-704.

Theorell, T. (1996). Possible mechanisms behind the relationship between the demand-control-support model and disorders of the locomotor system. In S. D. Moon & S. L. Sauter (Eds.), *Beyond biomechanics : psychosocial aspects of musculoskeletal disorders in office work* (pp. 65-73). London ; Bristol, PA: Taylor & Francis.

Theorell, T., Harms-Ringdahl, K., Ahlberg-Hulten, G., & Westin, B. (1991). Psychosocial job factors and symptoms from the locomotor system - a multicausal analysis. *Scand J Rehabil Med, 23*, 165-173.

Therneau, T. (2012). A Package for Survival Analysis in S (R package version 2.36-14). Retrieved from http://CRAN.R-project.org/package=survival

Therneau, T. M., & Grambsch, P. M. (2000). *Modeling survival data: Extending the Cox model* New York: Springer.

Thorbjörnsson, C. B., Alfredsson, L., Fredriksson, K., Michelsen, H., Punnett, L., Vingard, E., . . . Kilbom, A. (2000). Physical and psychosocial factors related to low back pain during a 24-year period - A nested case-control analysis. *Spine, 25*(3), 369-374.

Thorbjörnsson, C. O. B., Alfredsson, L., Fredriksson, K., Köster, M., Michélsen, H., Vingård, E., . . . Kilbom, Å. (1998). Psychosocial and physical risk factors associated with low back pain: a 24 year follow up among women and men in a broad range of occupations. *Occupational and Environmental Medicine, 55*, 84-90.

Tissot, F., Messing, K., & Stock, S. (2005). Standing, sitting and associated working conditions in the Quebec population in 1998. *Ergonomics, 48*(3), 249-269.

Tissot, F., Messing, K., & Stock, S. (2009). Studying the relationship between low back pain and working postures among those who stand and those who sit most of the working day. *Ergonomics, 52*(11), 1402-1418.

Torgen, M., Alfredsson, L., Koster, M., Wiktorin, C., Smith, K. F., & Kilbom, A. (1997). Reproducibility of a questionnaire for assessment of present and past physical activities. *International Archives of Occupational and Environmental Health, 70*(2), 107-118.

Tornqvist, E. W., Kilbom, A., Vingard, E., Alfredsson, L., Hagberg, M., Theorell, T., . . . Group, M. U.-N. S. (2001). The Influence on Seeking Care Because of Neck and Shoulder Disorders from Work-Related Exposures. *Epidemiology, 12*(5), 537-545.

Torp, S., Riise, T., & Moen, B. E. (1999). How the psychosocial work environment of motor vehicle mechanics may influence coping with musculoskeletal symptoms. *Work and Stress, 13*(3), 193-203.

Torp, S., Riise, T., & Moen, B. E. (2001). The impact of social and organizational factors on workers' coping with musculoskeletal symptoms. *Physical Therapy, 81*(7), 1328-1338.

Tourangeau, R. (2004). Survey research and societal change. *Annual Review of Psychology, 55*, 775-801.

Trinkoff, A. M., Lipscomb, J. A., Geiger-Brown, J., & Brady, B. (2002). Musculoskeletal problems of the neck, shoulder, and back and functional consequences in nurses. *American Journal of Industrial Medicine, 41*(3), 170-178.

Truchon, M., Cote, D., Fillion, L., Arsenault, B., & Dionne, C. (2008). Low-back-pain related disability: An integration of psychological risk factors into the stress process model. *Pain, 137*(3), 564-573.

Tubach, F., Leclerc, A., Landre, M. F., & Pietri-Taleb, F. (2002). Risk factors for sick leave due to low back pain: A prospective study. *Journal of Occupational and Environmental Medicine, 44*(5), 451-458.

Turner, J. A., Franklin, G., Heagerty, P. J., Wu, R., Egan, K., Fulton-Kehoe, D., . . . Wickizer, T. M. (2004). The association between pain and disability. *Pain, 112*(3), 307-314.

United Nations, Department of Economic and Social Affairs, & Population Division. (2011). World Population Prospects: The 2010 Revision. Retrieved November 2011, from United Nations, Department of Economic and Social Affairs, Population Division. http://esa.un.org/unpd/wpp/Excel-Data/population.htm http://esa.un.org/unpd/wpp/Excel-Data/population.htm

Vahtera, J., Kivimäki, M., Pentti, J., & Theorell, T. (2000). Effect of change in the psychosocial work environment on sickness absence: a seven year follow up of initially healthy employees. *J Epidemiol Community Health, 54*, 484-493.

van den Heuvel, S. G., Ariens, G. A. M., Boshuizen, H. C., Hoogendoom, W. E., & Bongers, P. M. (2004). Prognostic factors related to recurrent low-back pain and sickness absence. *Scandinavian Journal of Work Environment and Health, 30*(6), 459-467.

van den Heuvel, S. G., Heinrich, J., van der Beek, A. J., & Bongers, P. M. (2005). The effect of physical activity in leisure time on neck and upper limb symptoms. *Preventive Medicine, 41*(1), 260-267.

Van den Heuvel, S. G., Ijmker, S., Blatter, B. M., & de Korte, E. M. (2007). Loss of productivity due to neck/shoulder symptoms and hand/arm symptoms: Results from the PROMO-Study. *Journal of Occupational Rehabilitation, 17*(3), 370-382.

van der Beek, A. J., Kluver, B. D. R., Frings-Dresen, M. H. W., & Hoozemans, M. J. M. (2000). Gender differences in exerted forces and physiological load during pushing and pulling of wheeled cages by postal workers. *Ergonomics, 43*(2), 269-281.

Van Galen, G. P., Muller, M., Meulenbroek, R. G. J., & Van Gemmert, A. W. A. (2002). Forearm EMG response activity during motor performance in individuals prone to increased stress reactivity. *American Journal of Industrial Medicine, 41*(5), 406-419.

van Ooijen, M., Ivens, U. I., Johansen, C., & Skov, T. (1997). Comparison of a self-administered questionnaire and a telephone interview of 146 Danish waste collectors. *American Journal of Industrial Medicine, 31*(5), 653-658.

Vandergrift, J. L., Gold, J. E., Hanlon, A., & Punnett, L. (2012). Physical and psychosocial ergonomic risk factors for low back pain in automobile manufacturing workers. *Occupational and Environmental Medicine, 69*, 29-34.

Viikari Juntura, E., Rauas, S., Martikainen, R., Kuosma, E., Riihimaki, H., Takala, E. P., & Saarenmaa, K. (1996). Validity of self-reported physical work load in epidemiologic studies on musculoskeletal disorders. *Scandinavian Journal of Work Environment and Health, 22*(4), 251-259.

Village, J., Trask, C., Luong, N., Chow, Y., Johnson, P., Koehoorn, M., & Teschke, K. (2009). Development and evaluation of an observational Back-Exposure Sampling Tool (Back-EST) for work-related back injury risk factors. *Applied Ergonomics, 40*(3), 538-544.

Vingard, E., Alfredsson, L., Hagberg, M., Kilbom, A., Theorell, T., Waldenstrom, M., . . . Grp, M. N. S. (2000). To what extent do current and past physical and psychosocial occupational factors explain care-seeking for low back pain in a working population? Results from the musculoskeletal intervention center-Norrtalje study. *Spine, 25*(4), 493-500.

Violante, F., Isolani, L., & Raffi, G. B. (2000). Case definition for upper limb disorders. In F. Violante, T. Armstrong & A. Kilbom (Eds.), *Occupational ergonomics: Work related musculoskeletal disorders of the upper limb and back* (pp. 120-129). Cornwall: Taylor & Francis.

Virtanen, P., Siukola, A., Luukkaala, T., Savinainen, M., Arola, H., Nygard, C.-H., . . . Vahtera, J. (2008). Sick leaves in four factories-do characteristics of employees and work conditions explain differences in sickness absence between workplaces? *Scandinavian Journal of Work Environment and Health, 34*(4), 260-266.

Volinn, E. (1997). The epidemiology of low back pain in the rest of the world - A review of surveys in low- and middle-income countries. *Spine, 22*(15), 1747-1754.

Voss, M., Floderus, B., & Diderichsen, F. (2001). Physical, psychosocial, and organisational factors relative to sickness absence: a study based on Sweden Post. *Occupational and Environmental Medicine, 58*, 178-184.

Voss, M., Stark, S., Alfredsson, L., Vingård, E., & Josephson, M. (2008). Comparisons of self-reported and register data on sickness absence among public employees in Sweden. *Occupational and Environmental Medicine, 65*(1), 61-67.

Waddell, G. (1991). Occupational Low Back Pain, Illness Behaviour, and Disability. *Spine, 16*(6), 683-685.

Wahlstedt, K. G. I., Bjorksten, M. G., & Edling, C. (2001). Factors at work and musculoskeletal symptoms among postal workers. *International Journal of Behavioral Medicine, 8*(3), 181-193.

Wai, E. K., Roffey, D. M., Bishop, P., Kwon, B. K., & Dagenais, S. (2010a). Causal assessment of occupational carrying and low back pain: results of a systematic review. *Spine Journal, 10*(7), 628-638.

Wai, E. K., Roffey, D. M., Bishop, P., Kwon, B. K., & Dagenais, S. (2010b). Causal assessment of occupational lifting and low back pain: results of a systematic review. *Spine Journal, 10*(6), 554-566.

Walker, B. F. (2000). The prevalence of low back pain: A systematic review of the literature from 1966 to 1998. *Journal of Spinal Disorders, 13*(3), 205-217.

Walker, B. F., Muller, R., & Grant, W. D. (2004). Low back pain in Australian adults. Prevalence and associated disability. *Journal of Manipulative and Physiological Therapeutics, 27*(4), 238-244.

Waluyo, L., Ekberg, K., & Eklund, J. (1996). Assembly work in Indonesia and in Sweden - Ergonomics, health and satisfaction. *Ergonomics, 39*(2), 199-212.

Webb, R., Brammah, T., Lunt, M., Urwin, M., Allison, T., & Symmons, D. (2003). Prevalence and Predictors of Intense, Chronic, and Disabling Neck and Back pain in the UK General Population. *Spine, 28*(11), 1195-1202.

Westgaard, R. H., & Winkel, J. (2011). Occupational musculoskeletal and mental health: Significance of rationalization and opportunities to create sustainable production systems - A systematic review. *Applied Ergonomics, 42*(2), 261-296.

White, E., Armstrong, B. K., & Saracci, R. (2008). *Principles of Exposure Measurement in Epidemiology: Collecting, Evaluating, and Improving Measures of Disease Risk Factors* (2nd ed.). New York: Oxford University Press.

WHO. (2003). The burden of musculoskeletal conditions at the start of the new millennium : report of a WHO scientific group. Geneva: World Health Organization.

Widanarko, B., Legg, S., Stevenson, M., & Devereux, J. (2012). Interaction between physical, psychosocial, and organisational work factors for low back symptoms and its consequences amongst Indonesian coal mining workers. *Work: A Journal of Prevention, Assessment and Rehabilitation, 41*(Supplement 1), 6112-6119.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., ‘t Mannetje, A., . . . Pearce, N. (2011). Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. *International Journal of Industrial Ergonomics, 41*(5), 561-572.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., ‘t Mannetje, A., . . . Pearce, N. (2012a). Gender differences in work-related risk factors associated with low back symptoms. *Ergonomics 55*(3), 327-342.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., ‘t Mannetje, A., . . . Pearce, N. (2012b). Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms. *Applied Ergonomics, 43*(4), 727-737.

Widanarko, B., Legg, S., Stevenson, M., Devereux, J., & Jones, G. (2012). Prevalence of low back symptoms and its consequences in relation to occupational group. *American Journal of Industrial Medicine, doi: 10.1002/ajim.22116*. doi: 10.1002/ajim.22116

Widanarko, B., Susilowati, I., Syaaf, R. Z., & Rohadi, S. (2008). *Low Back Pain Assessment*. Unpublished manuscript, Department of Occupational Health and Safety, Faculty of Public Health, University of Indonesia. Depok, Indonesia.

Wijnhoven, H. A. H., de Vet, H. C. W., & Picavet, H. S. J. (2006a). Explaining sex differences in chronic musculoskeletal pain in a general population. *Pain, 124*, 158-166.

Wijnhoven, H. A. H., de Vet, H. C. W., & Picavet, H. S. J. (2006b). Prevalence of Musculoskeletal Disorders Is Systematically Higher in Women Than in Men. *Clinical Journal of Pain, 22*(8), 717-724.

Wiktorin, C., Hjelm, E. W., Winkel, J., & Koster, M. (1996). Reproducibility of a questionnaire for assessment of physical load during work and leisure time. *Journal of Occupational and Environmental Medicine, 38*(2), 190-201.

Wiktorin, C., Karlqvist, L., Winkel, J., & Stockholm Music Study Group. (1993). Validity of self-reported exposure to work postures and manual materials handling. *Scandinavian Journal of Work Environment and Health, 19*, 208-214.

Wiktorin, C., Vingard, E., Mortimer, M., Pernold, G., Wigaeus-Hjelm, E., Kilbom, A., . . . Grp, M. N. S. (1999). Interview versus questionnaire for assessing physical loads in the population-based MUSIC-Norrtalje study. *American Journal of Industrial Medicine, 35*(5), 441-455.

Wilson, J. R. (2002). A framework and context for ergonomics methodology. In J. R. Wilson & E. N. Corlett (Eds.), *Evaluation of human work: A practical ergonomics methodology* (Second ed., pp. 1-39). London: Taylor & Francis.

Winkel, J., & Mathiassen, S. E. (1994). Assessment of physical work load in epidemiologic studies - concepts, issues and operational considerations. *Ergonomics, 37*(6), 979-988.

Wise, E. A., Price, D. D., Myers, C. D., Heft, M. W., & Robinson, M. E. (2002). Gender role expectations of pain: relationship to experimental pain perception. *Pain, 96*(3), 335-342.

Woo, J. M., & Postolache, T. T. (2008). The impact of work environment on mood disorders and suicide: Evidence and implications. *International Journal on Disability and Human Development, 7*(2), 185.

Woodrow, K. M., Gary D. Friedman, Siegelaub, A. B., & Collen, M. F. (1972). Pain Tolerance: Differences According to Age, Sex and Race. *Psychosomatic Medicine, 34*(6), 548-556.

Woods, V., & Buckle, P. (2006). Musculoskeletal ill health amongst cleaners and recommendations for work organisational change. *International Journal of Industrial Ergonomics, 36*(1), 61-72.

WorkCoverSA. (2010). Statistical Review Part 1, 2008-09. Retrieved 11 November 2010, from WorkCoverSA http://www.workcover.com/site/workcover/resources/publications.aspx

Xu, Y., Bach, E., & Orhede, E. (1996). Occupation and risk for the occurrence of low-back pain (LBP) in Danish employees. *Occupational Medicine, 46*(2), 131-136.

Zhang, Y., Sun, Z., Liu, J., & Guo, X. (2008). Advances in susceptibility genetics of intervertebral degenerative disc disease. *International journal of biological sciences, 4*(5), 283.

Appendices

Appendix A New Zealand Study

Appendix A1 Ethical approval documentation for New Zealand study

Human Ethics Committee: Wellington

16 October 2003

Professor Neil Pearce
Director
Centre for Public Health Research
Massey University
WELLINGTON

Dear Neil

Re: MUHEC: WGTN Protocol - 03/133
The current and future burden of occupational ill-health in New Zealand

Thank you for the above protocol that was received and considered at the Massey University Wellington Human Ethics Committee meeting on 8 October 2003.

The protocol was approved, subject to approval by Mr Jeremy Hubbard, Acting Chair, of the reply to the following questions and comments.

INFORMATION SHEET

- Please include the paragraph: "This project has been reviewed and approved by the Massey University Human Ethics Committee, WGTN Protocol 03/133. If you have any concerns about the conduct of this research, please contact Mr Jeremy Hubbard, Acting Chair, Massey University Wellington Human Ethics Committee, telephone 04 801 2794, ext 6358, email J.J.Hubbard@massey.ac.nz."

QUESTIONNAIRE

- Page 7 Question 23 whezing should be wheezing
- Page 10, question 60a; it is assumed that this should read "please go to Question 69" and "please answer 60b" respectively.

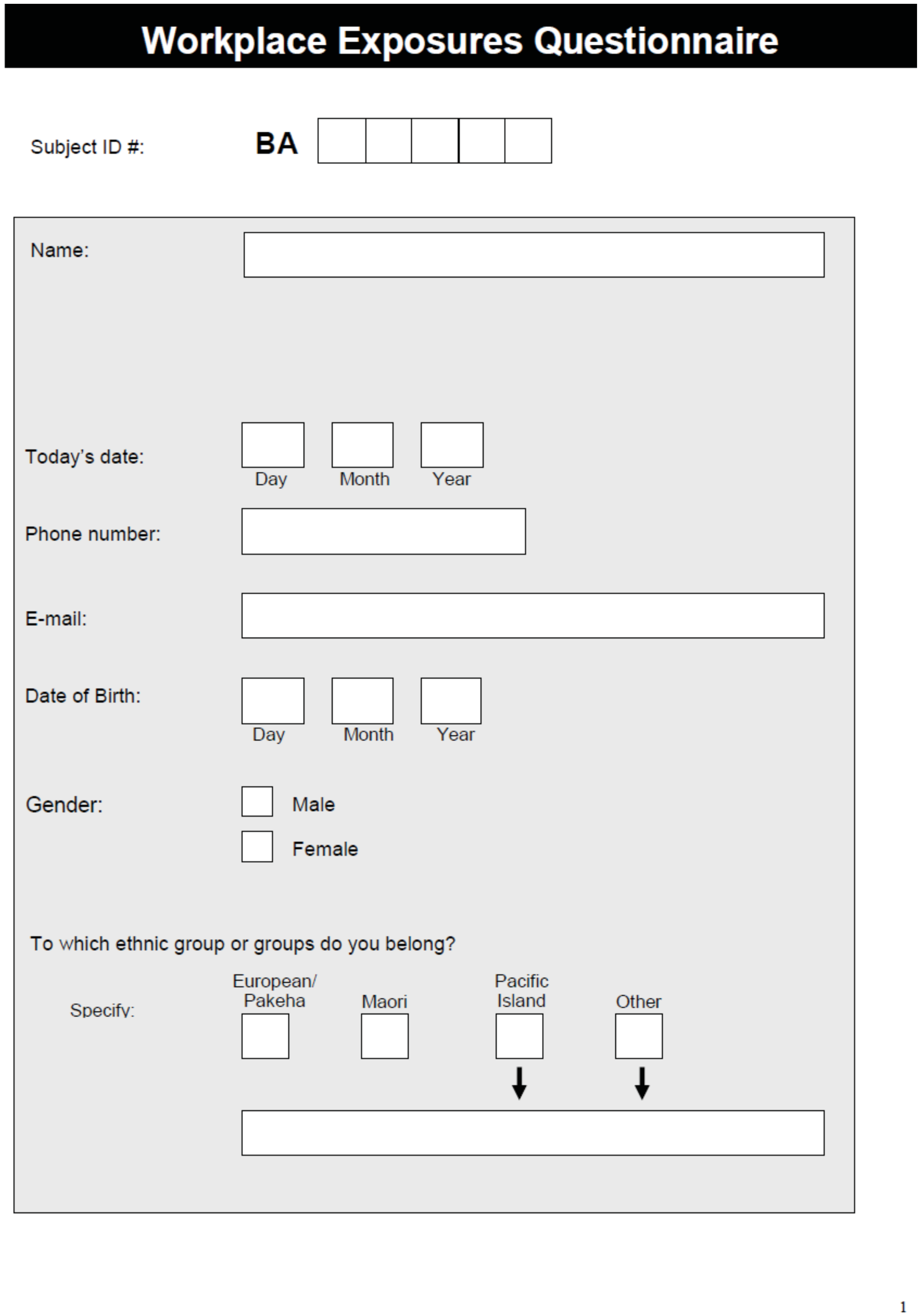
Please supply to Norma Wiley (Secretary) one copy of your response, including an amended Information Sheet.

Any departure from the approved protocol will require the researcher to return this project to the Massey University Human Ethics Committee for further consideration and approval.

Yours sincerely

Jeremy Hubbard (Acting Chair)
Massey University Wellington Human Ethics Committee

Appendix A2 Questionnaire for New Zealand study



Workplace Exposures Questionnaire

Subject ID #: **BA** ☐☐☐☐☐

Name: ☐

Today's date: ☐ Day ☐ Month ☐ Year

Phone number: ☐

E-mail: ☐

Date of Birth: ☐ Day ☐ Month ☐ Year

Gender:
☐ Male
☐ Female

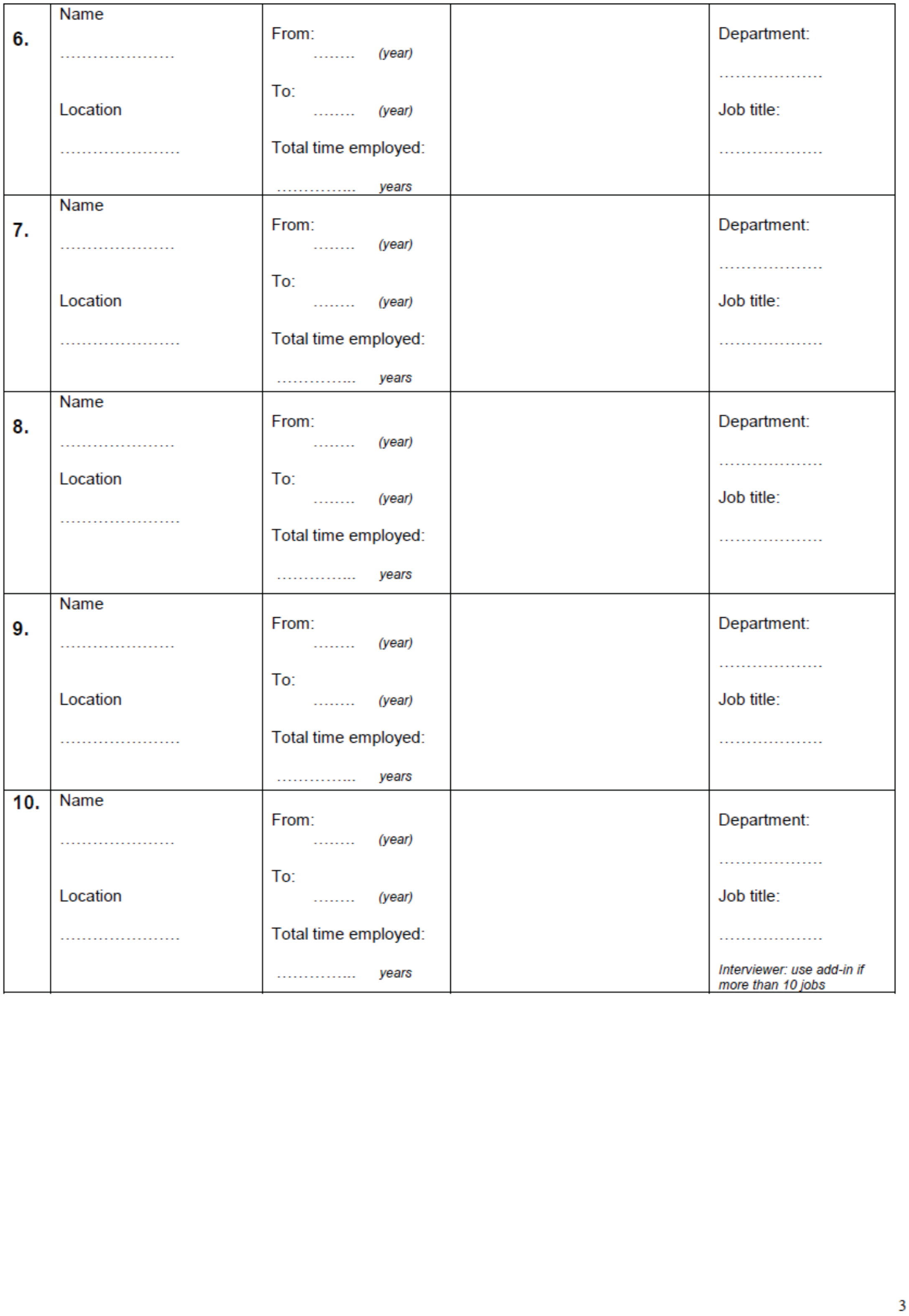
To which ethnic group or groups do you belong?

Specify:
☐ European/ Pakeha
☐ Maori
☐ Pacific Island
☐ Other

1

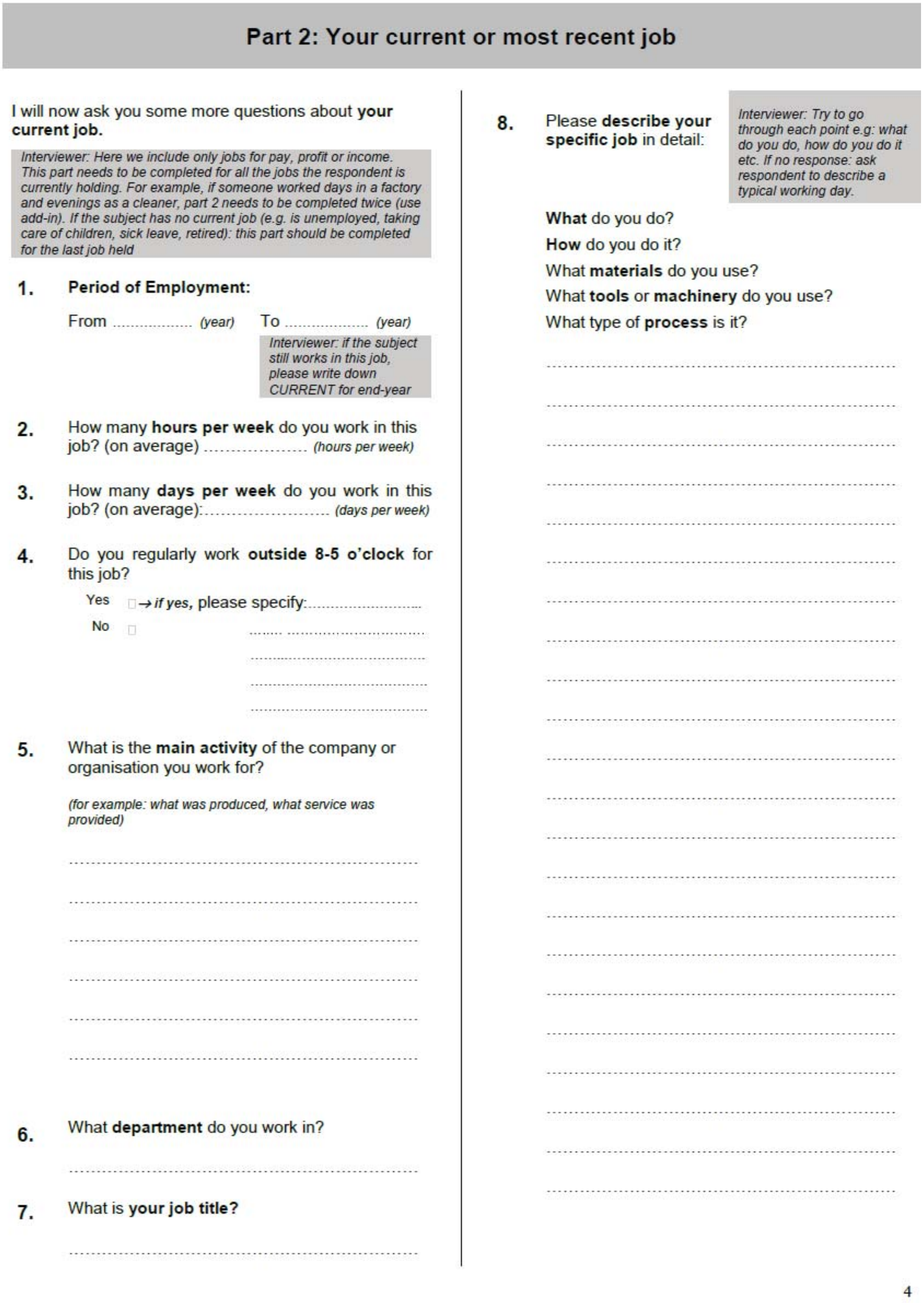
Job Number	Who was your **employer**? (Name and Location)	Over what **period** did you work for this employer?	What was the **main activity** of the **company** or **organisation** you worked for? *(For example: sheep farming, selling shoes, making clothes)*	What **department** did you work in, and what was your **job title**?
1.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: .... *years*		Department: .... Job title: ....
2.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: .... *years*		Department: .... Job title: ....
3.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: .... *years*		Department: .... Job title: ....
4.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: .... *years*		Department: .... Job title: ....

	Who was your **employer**? (Name and Location)	Over what **period** did you work for this employer?	What was the **main activity** of the company or organisation you worked for?	What **department** did you work in, and what was your **job title**?
5.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: .... *years*		Department: .... Job title: ....



6.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: …………... *years*		Department: .... Job title: ....
7.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: …………... *years*		Department: .... Job title: ....
8.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: …………... *years*		Department: .... Job title: ....
9.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: …………... *years*		Department: .... Job title: ....
10.	Name .... Location	From: .... *(year)* To: .... *(year)* Total time employed: …………... *years*		Department: .... Job title: .... *Interviewer: use add-in if more than 10 jobs*

3



Part 2: Your current or most recent job

I will now ask you some more questions about **your current job.**

Interviewer: Here we include only jobs for pay, profit or income. This part needs to be completed for all the jobs the respondent is currently holding. For example, if someone worked days in a factory and evenings as a cleaner, part 2 needs to be completed twice (use add-in). If the subject has no current job (e.g. is unemployed, taking care of children, sick leave, retired): this part should be completed for the last job held

1. **Period of Employment:**

From .... *(year)* To .... *(year)*

Interviewer: if the subject still works in this job, please write down CURRENT for end-year

2. How many **hours per week** do you work in this job? (on average) .... *(hours per week)*

3. How many **days per week** do you work in this job? (on average):........................ *(days per week)*

4. Do you regularly work **outside 8-5 o'clock** for this job?

Yes ☐→ *if yes,* please specify:........................

No ☐ ....

....

....

....

5. What is the **main activity** of the company or organisation you work for?

(for example: what was produced, what service was provided)

....

....

....

....

....

....

6. What **department** do you work in?

....

7. What is **your job title?**

....

8. Please **describe your specific job** in detail:

Interviewer: Try to go through each point e.g: what do you do, how do you do it etc. If no response: ask respondent to describe a typical working day.

What do you do?

How do you do it?

What **materials** do you use?

What **tools** or **machinery** do you use?

What type of **process** is it?

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4

9. In the environment where you work/worked were any of the following present?

** Interviewer: Please list all. If you tick any of these boxes please complete question 10 otherwise go to question 11.*

Dust: e.g. coal, metal, wood, grain, textile fibres, or insulation material ☐

Smoke or **fume:** e.g. combustion products, engine emission, metal fume ☐

Gas: e.g. combustion gases, refrigerant ☐

Oils and **solvents:** e.g. lubricants, cutting oils, degreasers, thinners ☐

Acids or **alkalis** ☐

Fungicides, Insecticides, Herbicides or **Timber Preservatives** ☐

Other chemical products e.g. dyes, inks, adhesives etc. ☐

10. Please state the names of the substances you are/were exposed to, how many weeks per year and hours per day you are/were exposed, and the source of the substance.

Name/s of Substance	**Weeks per year exposed**	**Hours per day exposed**	**Source of Substance**

Name/s of Substance	**Weeks per year exposed**	**Hours per day exposed**	**Source of Substance**

11. What type of **ventilation** does/did your work area have? *(interviewer: please list all)*

No Ventilation ☐

Open doors and windows ☐

Ventilation fan ducted to outside ☐

Air conditioning ☐

Fume hood with fan and air filters ☐

.... Other ☐

12. How **effective** is/was the ventilation of your work area? *(interviewer: please list all)*

Not at all effective ☐
Moderately effective ☐
Very effective ☐
Don't know ☐

13. Do/did you wear any **protective equipment** while at work?

Yes ☐
No ☐ → *to 15*
Don't know ☐

14. If yes, which of the following do you use? For which tasks? *(interviewer: please list all)*

Goggles ☐
For which tasks:..
....
....

Footwear ☐
For which tasks:..
....
....

Apron ☐
For which tasks:..
....
....

Simple Dust Mask ☐
For which tasks:..
....
....

Filter Cartridge Respirator ☐
For which tasks:..
....
....

Air-Supplied Respirator or SCBA ☐
For which tasks:..
....
....

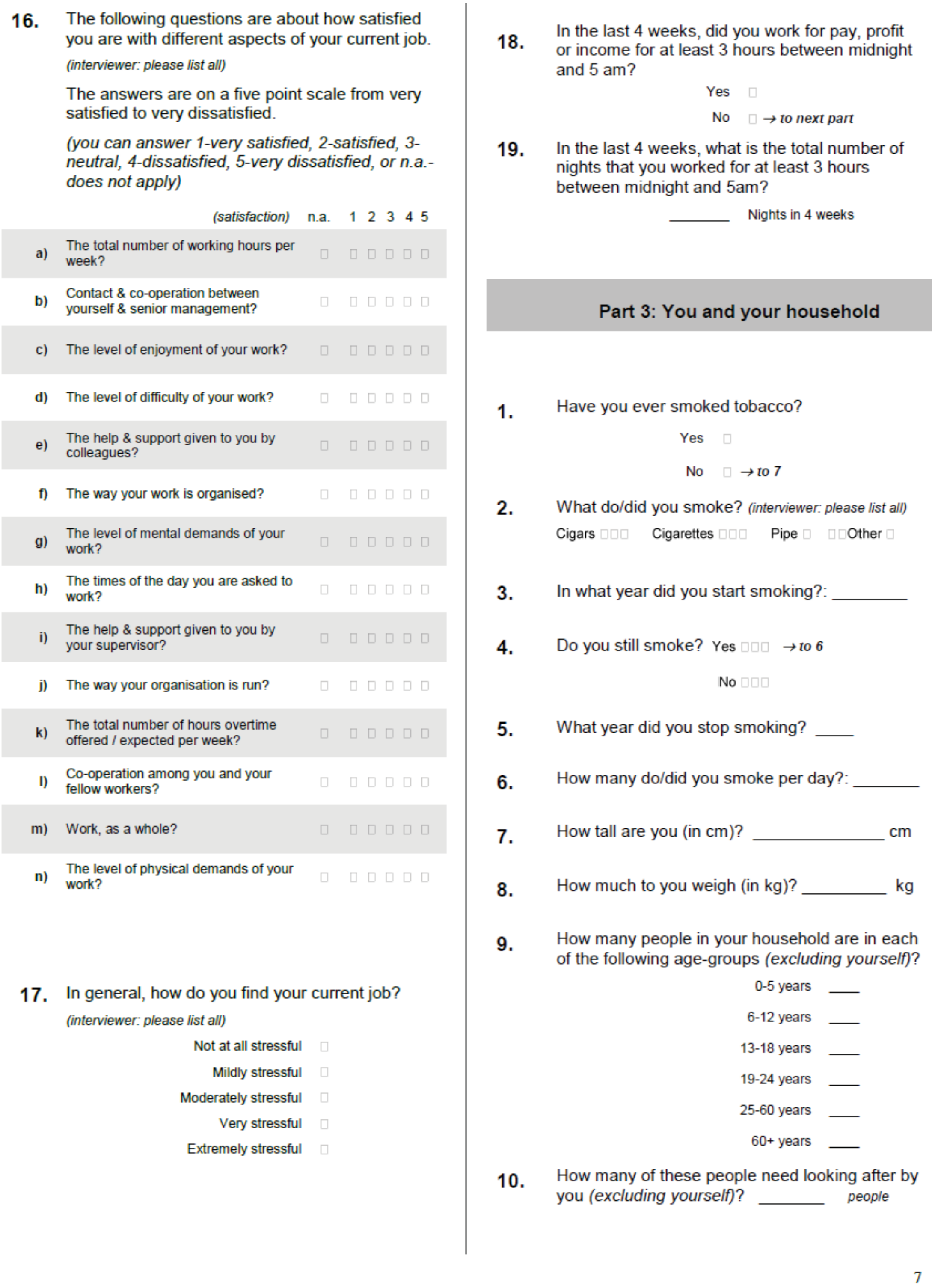
Rubber or Plastic Gloves ☐
For which tasks:..
....
....

Hearing protection (specify) ☐ ....
For which tasks:..
....
....

Other ☐
For which tasks:..
....
....

15. How often does this job involve any of these situations? *(interviewer: please list each situation. Please ask for an estimation of the part of working time this occurs)*

	(estimation of part of working time)	All the time	¾	½	¼	never
a)	awkward or tiring positions	☐	☐	☐	☐	☐
b)	awkward grip or hand movements	☐	☐	☐	☐	☐
c)	lifting	☐	☐	☐	☐	☐
d)	carrying out repetitive tasks	☐	☐	☐	☐	☐
e)	working at very high speed	☐	☐	☐	☐	☐
f)	working to tight deadlines	☐	☐	☐	☐	☐
g)	boring work	☐	☐	☐	☐	☐
h)	working in cold / damp environment	☐	☐	☐	☐	☐
i)	working in a hot / warm environment	☐	☐	☐	☐	☐
j)	standing	☐	☐	☐	☐	☐
k)	sitting	☐	☐	☐	☐	☐
l)	tools that vibrate	☐	☐	☐	☐	☐
m)	working outside	☐	☐	☐	☐	☐
n)	loud noise	☐	☐	☐	☐	☐



16. The following questions are about how satisfied you are with different aspects of your current job.

(interviewer: please list all)

The answers are on a five point scale from very satisfied to very dissatisfied.

(you can answer 1-very satisfied, 2-satisfied, 3-neutral, 4-dissatisfied, 5-very dissatisfied, or n.a.-does not apply)

	(satisfaction)	n.a.	1	2	3	4	5
a)	The total number of working hours per week?	☐	☐	☐	☐	☐	☐
b)	Contact & co-operation between yourself & senior management?	☐	☐	☐	☐	☐	☐
c)	The level of enjoyment of your work?	☐	☐	☐	☐	☐	☐
d)	The level of difficulty of your work?	☐	☐	☐	☐	☐	☐
e)	The help & support given to you by colleagues?	☐	☐	☐	☐	☐	☐
f)	The way your work is organised?	☐	☐	☐	☐	☐	☐
g)	The level of mental demands of your work?	☐	☐	☐	☐	☐	☐
h)	The times of the day you are asked to work?	☐	☐	☐	☐	☐	☐
i)	The help & support given to you by your supervisor?	☐	☐	☐	☐	☐	☐
j)	The way your organisation is run?	☐	☐	☐	☐	☐	☐
k)	The total number of hours overtime offered / expected per week?	☐	☐	☐	☐	☐	☐
l)	Co-operation among you and your fellow workers?	☐	☐	☐	☐	☐	☐
m)	Work, as a whole?	☐	☐	☐	☐	☐	☐
n)	The level of physical demands of your work?	☐	☐	☐	☐	☐	☐

17. In general, how do you find your current job?

(interviewer: please list all)

Not at all stressful ☐
Mildly stressful ☐
Moderately stressful ☐
Very stressful ☐
Extremely stressful ☐

18. In the last 4 weeks, did you work for pay, profit or income for at least 3 hours between midnight and 5 am?

Yes ☐
No ☐ → ***to next part***

19. In the last 4 weeks, what is the total number of nights that you worked for at least 3 hours between midnight and 5am?

_______ Nights in 4 weeks

Part 3: You and your household

1. Have you ever smoked tobacco?

Yes ☐
No ☐ → ***to 7***

2. What do/did you smoke? *(interviewer: please list all)*

Cigars ☐☐☐ Cigarettes ☐☐☐ Pipe ☐ ☐☐Other ☐

3. In what year did you start smoking?: _________

4. Do you still smoke? **Yes** ☐☐☐ → ***to 6***

No ☐☐☐

5. What year did you stop smoking? _____

6. How many do/did you smoke per day?: ________

7. How tall are you (in cm)? _______________ cm

8. How much to you weigh (in kg)? __________ kg

9. How many people in your household are in each of the following age-groups *(excluding yourself)*?

0-5 years ____
6-12 years ____
13-18 years ____
19-24 years ____
25-60 years ____
60+ years ____

10. How many of these people need looking after by you *(excluding yourself)*? ________ *people*

Part 4: Respiratory symptoms

1. Have you had wheezing or whistling in your chest at any time in the past 12 months?

Yes ☐
No ☐ → *to 5*

2. Have you been at all breathless when the wheeze noise was present?

Yes ☐
No ☐

3. Have you had this wheezing or whistling in the chest when you did not have a cold?

Yes ☐
No ☐

4. How many attacks of wheezing or whistling have you had in the past 12 months?

none ☐
1-3 times ☐
4-12 times ☐
more than 12 times ☐

5. Have you been woken by an attack of shortness of breath at any time in the past 12 months?

Yes ☐
No ☐

6. Have you been woken by an attack of coughing at any time in the past 12 months?

Yes ☐
No ☐

7. Have you ever had asthma?

Yes ☐
No ☐ → *to 13*

8. Was the diagnosis confirmed by a doctor?

Yes ☐
No ☐

9. How old were you when you had your first attack of asthma?

_____ years

10. How old were you when you had your last attack of asthma?

_____ years

11. Have you had an attack of asthma in the past 12 months?

Yes ☐
No ☐

12. Are you currently taking any medicine (including inhalers, aerosols or tablets) for asthma?

Yes ☐
No ☐

13. Do you have any nasal allergies including hay fever?

Yes ☐
No ☐ → *to 16*

14. How old were you when you first had hay fever or nasal allergy?

_____ years

15. How old were you when you had hay fever or nasal allergy for the last time?

_____ years

16. Do you cough almost daily for at least part of the year?

Yes ☐
No ☐ → *to 20*

17. Do you usually have this cough in winter?

Yes ☐
No ☐

18. Do you cough up phlegm almost daily for at least part of the year?

Yes ☐
No ☐ → *to 20*

19. Do you usually have this cough (with phlegm) in winter?

Yes ☐
No ☐

20. In the past 12 months, how often have you been unable to work because of respiratory symptoms, i.e. cough, phlegm, wheezing/whistling or shortness of breath?

Never ☐ At least 31 days ☐
1-7 days ☐ Don't know ☐
8-30 days ☐

21. Have you ever had eczema (or atopic dermatitis)?

Yes ☐
No ☐ → *to next part*

22. Was the diagnosis confirmed by a doctor?

Yes ☐
No ☐

Part 5: Sleep Patterns

1. How many hours sleep do you usually get **on a day off** (counting naps as well)? …………… hours

2. How often do you get enough sleep?

0 ☐ Never 1 ☐ Rarely 2 ☐ Often 3 ☐ Always

3. How often do you wake up feeling refreshed?

0 ☐ Never 1 ☐ Rarely 2 ☐ Often 3 ☐ Always

4. How often do you snore?

0 ☐ Never 1 ☐ Rarely 2 ☐ Often 3 ☐ Always

5. Has anyone ever told you that you stop breathing sometimes during sleep?

1 ☐ Yes 0 ☐ No

6. How likely are you to doze off or fall asleep in the following situations?
Please choose one answer for each of the following:

	would never doze	*slight chance*	*moderate chance*	*high chance*
Sitting and reading	0 ☐	1 ☐	2 ☐	3 ☐
watching TV	0 ☐	1 ☐	2 ☐	3 ☐
Sitting inactive in a public place (eg. theatre, meeting)	0 ☐	1 ☐	2 ☐	3 ☐
Lying down in the afternoon when circumstances permit	0 ☐	1 ☐	2 ☐	3 ☐
Sitting and talking to someone	0 ☐	1 ☐	2 ☐	3 ☐
Sitting quietly after a lunch without alcohol	0 ☐	1 ☐	2 ☐	3 ☐
In a car, while stopped for a few minutes in traffic	0 ☐	1 ☐	2 ☐	3 ☐

7. Do you consider that you have a sleep problem?

1 ☐ Yes 0 ☐ No → ***to next part***

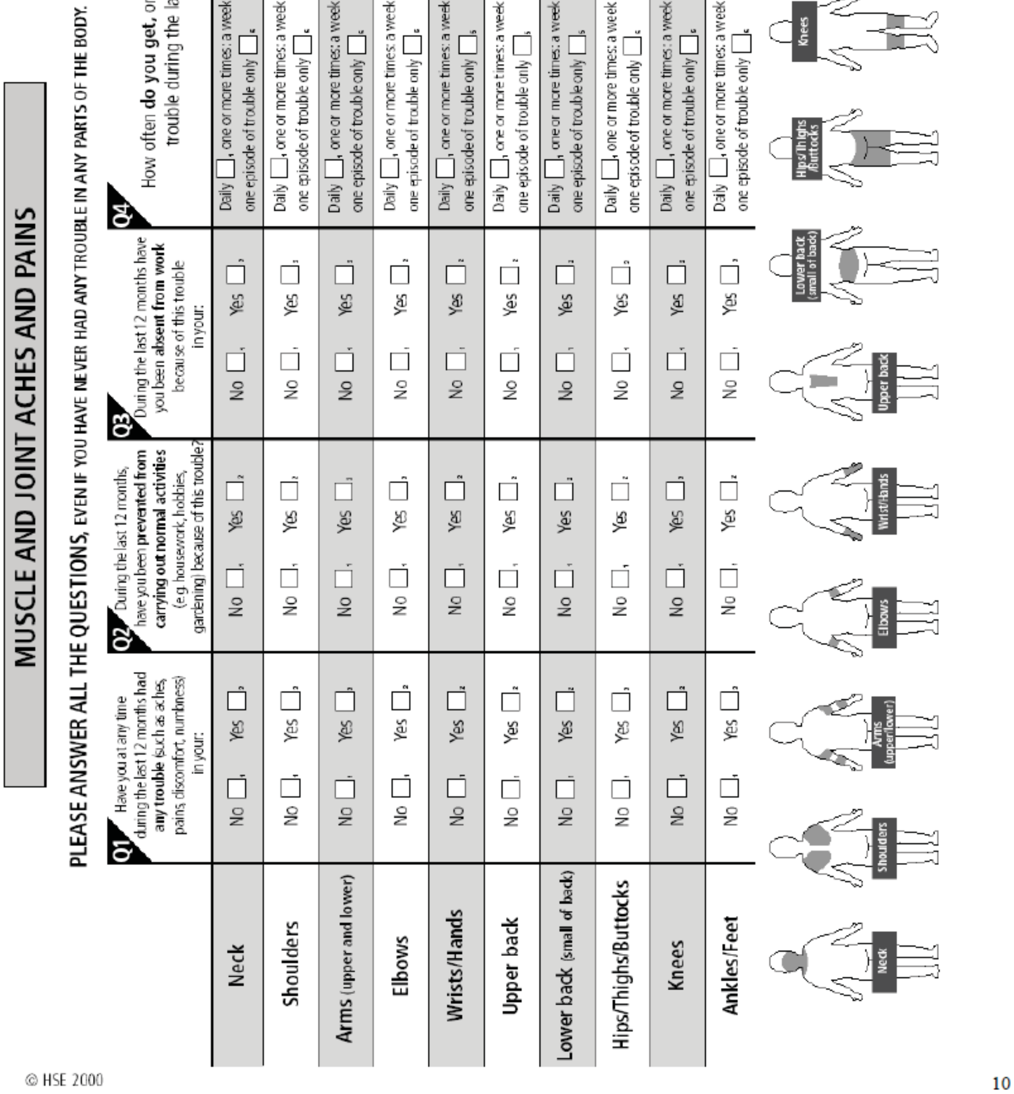
8. How long have you had a sleep problem?

1 ☐ less than 4 weeks 2 ☐ 1-6 months 3 ☐ More than 6 months

Comments welcome →……………………………………………………………………………………

Part 6: Muscle and joint aches

1. *Interviewer: please complete this question by starting with the list of body parts (Q1). If any is 'yes', complete all other questions (Q2-Q4) for this body part, then continue with the list of body parts (Q1).*



MUSCLE AND JOINT ACHES AND PAINS

PLEASE ANSWER ALL THE QUESTIONS, EVEN IF YOU HAVE NEVER HAD ANY TROUBLE IN ANY PARTS OF THE BODY.

	Q1 Have you at any time during the last 12 months had **any trouble** (such as aches, pains, discomfort, numbness) in your:	**Q2** During the last 12 months, have you been **prevented from carrying out normal activities** (e.g. housework, hobbies, gardening) because of this trouble?	**Q3** During the last 12 months have you been **absent from work** because of this trouble in your:	**Q4** How often **do you get,** or **have you had** this trouble during the last 12 months?
Neck	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Shoulders	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Arms (upper and lower)	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Elbows	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Wrists/Hands	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Upper back	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Lower back (small of back)	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Hips/Thighs/Buttocks	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Knees	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6
Ankles/Feet	No ☐1 Yes ☐2	No ☐1 Yes ☐2	No ☐1 Yes ☐2	Daily ☐1, one or more times: a week ☐2, a month ☐3, a year ☐4, one episode of trouble only ☐5 Never ☐6

Appendix A3 Published paper for Chapter 2

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Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group

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ABSTRACT

Although musculoskeletal symptoms (MSS) are common worldwide, little is known about its prevalence amongst the working population in relation to gender, age, and occupational/industrial group. This paper describes the prevalence of MSS in a sample of 3003 men and women aged 20–64 randomly selected from the New Zealand Electoral Roll. MSS experienced during the previous 12 months in 10 body regions was assessed in telephone interviews using a modified version of the Nordic Musculoskeletal Questionnaire (NMQ). MSS prevalence was 92% (for any body region). The highest prevalence was for low back (54%), neck (43%), and shoulders (42%). Females reported a statistically significantly higher prevalence of MSS in the neck, shoulders, wrist/hands, upper back and hips/thighs/buttocks regions compared to males while males reported more symptoms of the elbows, low back and knees. There were no statistically significant differences in prevalence among age groups. In general, participants with heavy physical workloads had significantly higher prevalence of symptoms in most body regions than those with light physical workloads although women with light physical workloads reported more neck symptoms. The study indicates that the New Zealand working population has a high prevalence of MSS and that exposure in the workplace plays a role.

Relevance to industry: The findings of this study imply that efforts to reduce MSS in the workplace should focus on females and employees with high physical workloads.

1. Introduction

In many countries, musculoskeletal problems are common amongst the general and working population and can result in serious social and economic impacts on individuals and communities (Buckle and Devereux, 2002; Hanson et al., 2006; National Research Council and Institute of Medicine National Research CouncilInstitute of Medicine, 2001). For example, the United Kingdom Health and Safety Executive estimated, on the basis of a Labour Force Survey, in 2009–2010 musculoskeletal disorders were the most commonly reported illness types and 37% of working days lost were due to musculoskeletal disorders (Health and Safety Executive and National Statistics, 2010). In the state of Washington between 1997 and 2005, 27% of all state fund-accepted claims were due to work-related musculoskeletal disorders (WMSDs) of the neck, back and upper extremities (Silverstein and Adams, 2007). In South Australia, sprains and strains were the most common claims (35%), and the claims for musculoskeletal and connective diseases were 13.2% during 2008–2009 (WorkCoverSA, 2010). In New Zealand, a report for the National Occupational Health and Safety Advisory Committee (NOHSAC) indicated that 36% of the total compensation cost in 2004–2005 was due to sprains and strains and 14% due to diseases of the musculoskeletal system and connective tissue (Access Economics, 2006).

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Appendix A4 Published paper for Chapter 3

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Gender differences in work-related risk factors associated with low back symptoms

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The prevalence of low back symptoms (LBS) in many working populations is high and differences in prevalence between genders are inconsistent. However, gender-specific risk factors for LBS have seldom been examined. Hence, the aim of the present study was to indicate gender-specific LBS risk factors. A sample of 3003 people was interviewed by telephone to get information about current workplace exposure and LBS. The risk of LBS for the whole population increased with work in awkward/tiring positions (OR 1.37, 95% CI 1.12–1.68) and very/extremely stressful jobs (OR 1.46, 95% CI 1.05–2.03). None of the explanatory variables were significantly associated with LBS for males but working in awkward/tiring positions (OR 1.51, 95% CI 1.04–2.20), dissatisfaction with contact and cooperation with management (OR 1.68, 95% CI 1.02–2.78) and finding their job to be very/extremely stressful (OR 2.27, 95% CI 1.46–3.52) were significantly associated with LBS for females. Interventions to reduce LBS in workplaces should focus on reducing working in awkward/tiring positions, improving contact and cooperation with management, and reducing stressful jobs, especially amongst females.

Practitioner Summary: Strategies to prevent or reduce LBS should focus on reducing exposure to awkward or tiring positions at work, improving contact and cooperation with management, and reducing stressful jobs, especially for females.

Keywords: back pain; gender; Nordic questionnaire; organisational culture; psychosocial factor

Introduction

Low back symptoms (LBS) are a significant health problem in Western countries. The one-year prevalence has been estimated at 22–65% for developed countries (Walker 2000). Among New Zealand workers the prevalence is 54% (Widanarko *et al.* 2011a). Previous studies have identified four categories of risk factors for LBS as: physical, psychosocial, and organisational (Bernard 1997, Beeck and Hermans 2000, Lotters *et al.* 2003). Systematic reviews of epidemiological studies have identified many risk factors for LBS. For combined-gender populations, they have identified physical risk factors as frequent trunk bending and rotation (Bernard 1997, Burdorf and Sorock 1997, Hoogendoorn *et al.* 1999, Beeck and Hermans 2000, Lotters *et al.* 2003), high levels of manual handling (Bernard 1997, Burdorf and Sorock 1997, Hoogendoorn *et al.* 1999, Lotters *et al.* 2003), vibration (Burdorf and Sorock 1997, Hoogendoorn *et al.* 1999, Lotters *et al.* 2003, Burdorf and Hulshof 2006) and heavy physical load (Bernard 1997, Hoogendoorn *et al.* 1999). For psychosocial risk factors, only monotonous work (Bongers *et al.* 1993, Bernard 1997, Linton 2001) and low social support (Bongers *et al.* 1993, Bernard 1997, Beeck and Hermans 2000, Hoogendoorn *et al.* 2000) are reported to have a consistent association with LBS. Inconsistent psychosocial associations have been reported for some other risk factors. Beeck and Hermans (2000), Hoogendoorn *et al.* (2000), Linton (2001) and Lotters *et al.* (2003) reported a positive association between job dissatisfaction at work and LBS but Bongers *et al.*(1993) and Burdorf and Sorock (1997) found inconsistent evidence for this association. Bongers *et al.*(1993) and Bernard (1997) found a positive association between low job decision latitude and LBS, whereas Burdorf and Sorock (1997) reported inconsistent evidence for this association. Linton (2000, 2001) proposed a positive association between high work stress and LBS but Hartvigsen *et al.* (2004) found insufficient evidence to support this association. The inconsistencies between findings in these review papers might be due to the different operational definition of psychosocial factors as well as inclusion criteria used to select the studies used in each of

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Appendix A5 Published paper for Chapter 4

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Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms

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ABSTRACT

Although quite a lot is known about the risk factors for low back symptoms (LBS), less is known about the risk factors for the consequences of LBS. A sample of 3003 men and women randomly selected from the New Zealand Electoral Roll, were interviewed by telephone about self reported physical, psychosocial, organizational, environmental factors and the consequences of LBS (i.e. self-reported reduced activities and absenteeism). The 12-month period prevalence of reduced activities and absenteeism were 18% and 9%, respectively. Lifting (OR 1.79 95% CI 1.16–2.77) increased the risk of reduced activities. Working in awkward/tiring positions (OR 2.11 95% CI 1.20–3.70) and in a cold/damp environment (OR 2.18 95% CI 1.11–4.28) increased the risk of absenteeism. Among those with LBS, reduced activities increased with working in a hot/warm environment (OR 2.14 95% CI 1.22–3.76) and absenteeism was increased with work in awkward/tiring positions (OR 2.06 95% CI 1.13–3.77), tight deadlines (OR 1.89 95% CI 1.02–3.50), and a hot/warm environment (OR 3.35 95% CI 1.68–6.68). Interventions to reduce the consequences of LBS should aim to reduce awkward/tiring positions, lifting and work in a cold/damp environment. For individuals with LBS, additional focus should be to reduce tight deadlines, and work in hot/warm environments.

1. Introduction

Low back symptoms (LBS) are very prevalent amongst general and working populations and are a significant health problem due to their serious economic and social impact (Hanson et al., 2006; National Research Council and Institute of Medicine, 2001). Between 1997 and 2005 27% of all Washington State fund-accepted health insurance claims were for work-related musculoskeletal disorders (WMSDs) involving the back (51%), upper extremity (37%), neck (12%) with an average direct cost of USD 12,377 per claim (Silverstein and Adams, 2007). In Finland, the direct and indirect cost of managing patients with LBS was 624 EUR per visit to general practitioners (Mantyselka et al., 2002). A study in Sweden estimated the annual cost for sick listed more than one month due to back and neck problems was about 1.3% of Gross National Product (Hansson and Hansson, 2005).

The social consequences of LBS, including its severity, may be assessed in terms of the extent to which people are prevented from carrying out their normal activities (i.e. reduced activities) and absenteeism. Although many studies have reported on this, the findings of those that have used identical or very similar methods to that of the present study are summarised below. The social consequences of LBS arise from disability (i.e. diminished capacity for everyday activities and gainful employment, etc) (Wadell, 1991) and absenteeism. Although 10% of Chinese offshore workers (Chen et al., 2005), 17% of New Zealand dentists (Palliser et al., 2005), 21% of Swedish ambulance personnel (Aasa et al., 2005), and 42% of New Zealand veterinarians (Scuffham et al., 2010) are reported to have had reduced activities due to LBS, there are few other similar studies. The prevalence of absenteeism due to LBS was 9% for Irish health service workers (Cunningham et al., 2006), 9% of New

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E-mail addresses: baiduri@ui.ac.id, b.widanarko@massey.ac.nz (B. Widanarko).

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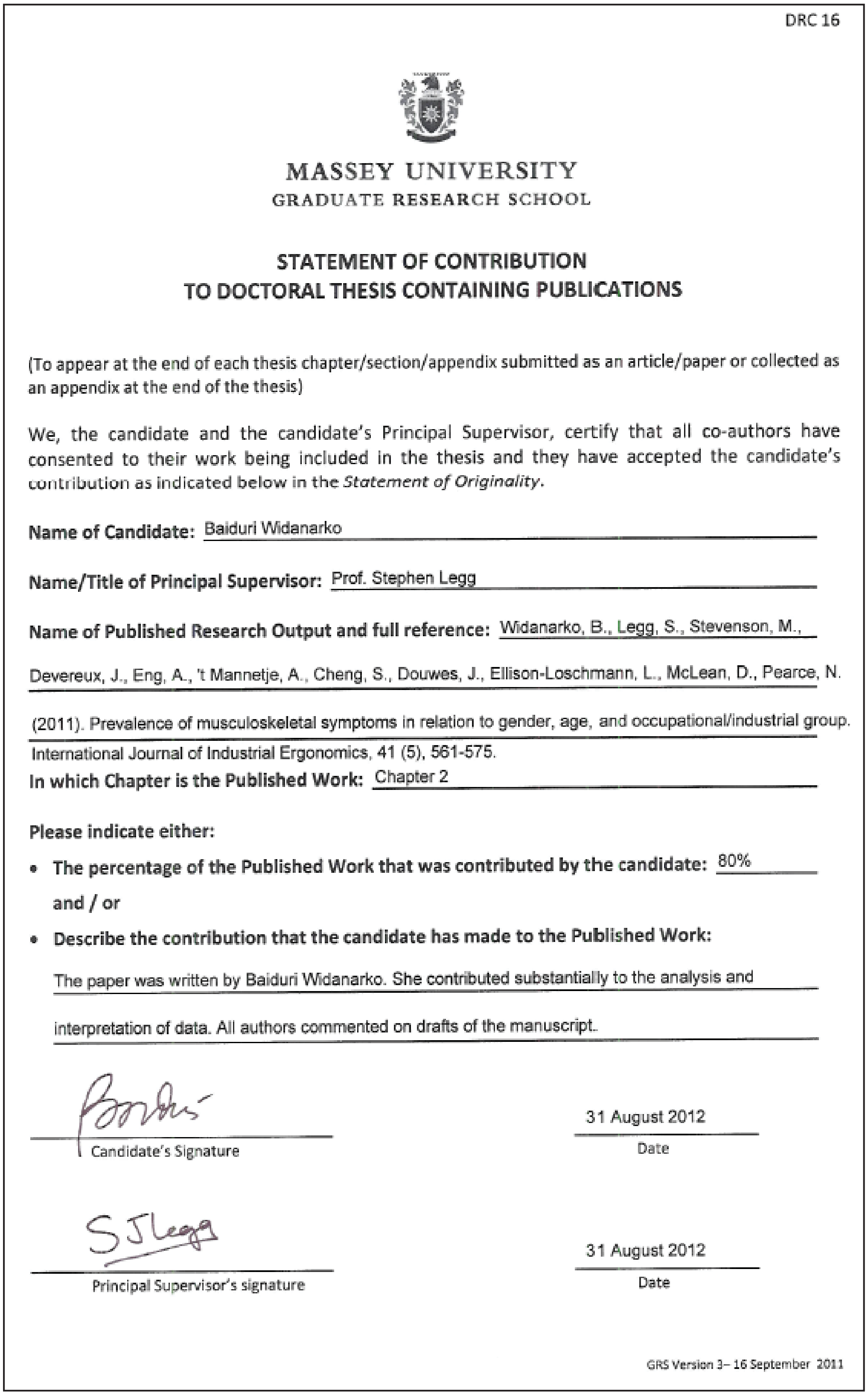
Appendix A6 Statement of contribution for Chapter 2



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We, the candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of Candidate: Baiduri Widanarko

Name/Title of Principal Supervisor: Prof. Stephen Legg

Name of Published Research Output and full reference: Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., 't Mannetje, A., Cheng, S., Douwes, J., Ellison-Loschmann, L., McLean, D., Pearce, N. (2011). Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. International Journal of Industrial Ergonomics, 41 (5), 561-575.

In which Chapter is the Published Work: Chapter 2

Please indicate either:

- **The percentage of the Published Work that was contributed by the candidate:** 80%

  and / or

- **Describe the contribution that the candidate has made to the Published Work:**

  The paper was written by Baiduri Widanarko. She contributed substantially to the analysis and interpretation of data. All authors commented on drafts of the manuscript.

Candidate's Signature

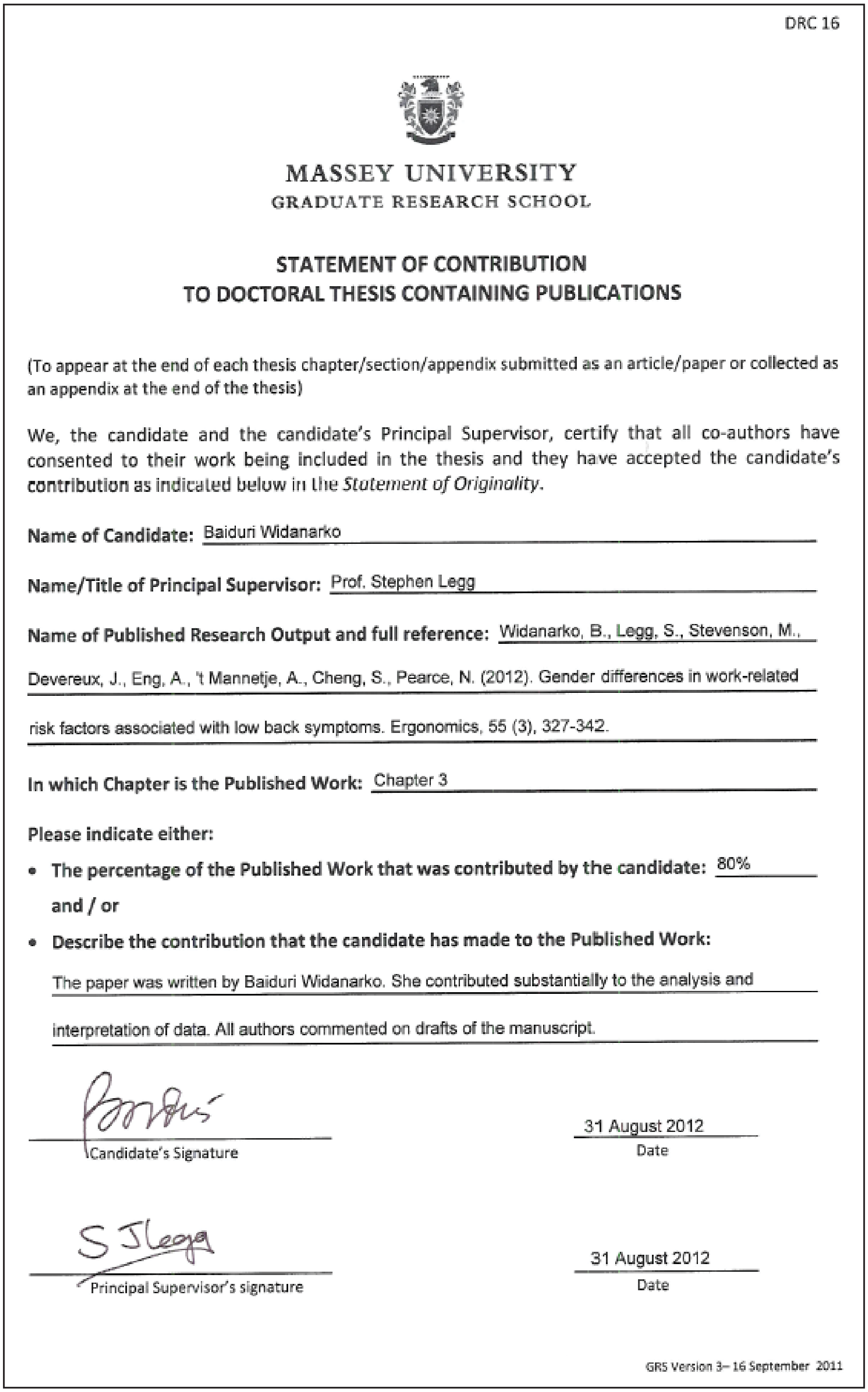
31 August 2012
Date

S J Legg
Principal Supervisor's signature

31 August 2012
Date

GRS Version 3– 16 September 2011

Appendix A7 Statement of contribution for Chapter 3



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Name of Candidate: Baiduri Widanarko

Name/Title of Principal Supervisor: Prof. Stephen Legg

Name of Published Research Output and full reference: Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., 't Mannetje, A., Cheng, S., Pearce, N. (2012). Gender differences in work-related risk factors associated with low back symptoms. Ergonomics, 55 (3), 327-342.

In which Chapter is the Published Work: Chapter 3

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- **Describe the contribution that the candidate has made to the Published Work:**

  The paper was written by Baiduri Widanarko. She contributed substantially to the analysis and interpretation of data. All authors commented on drafts of the manuscript.

Candidate's Signature

31 August 2012
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Principal Supervisor's signature

31 August 2012
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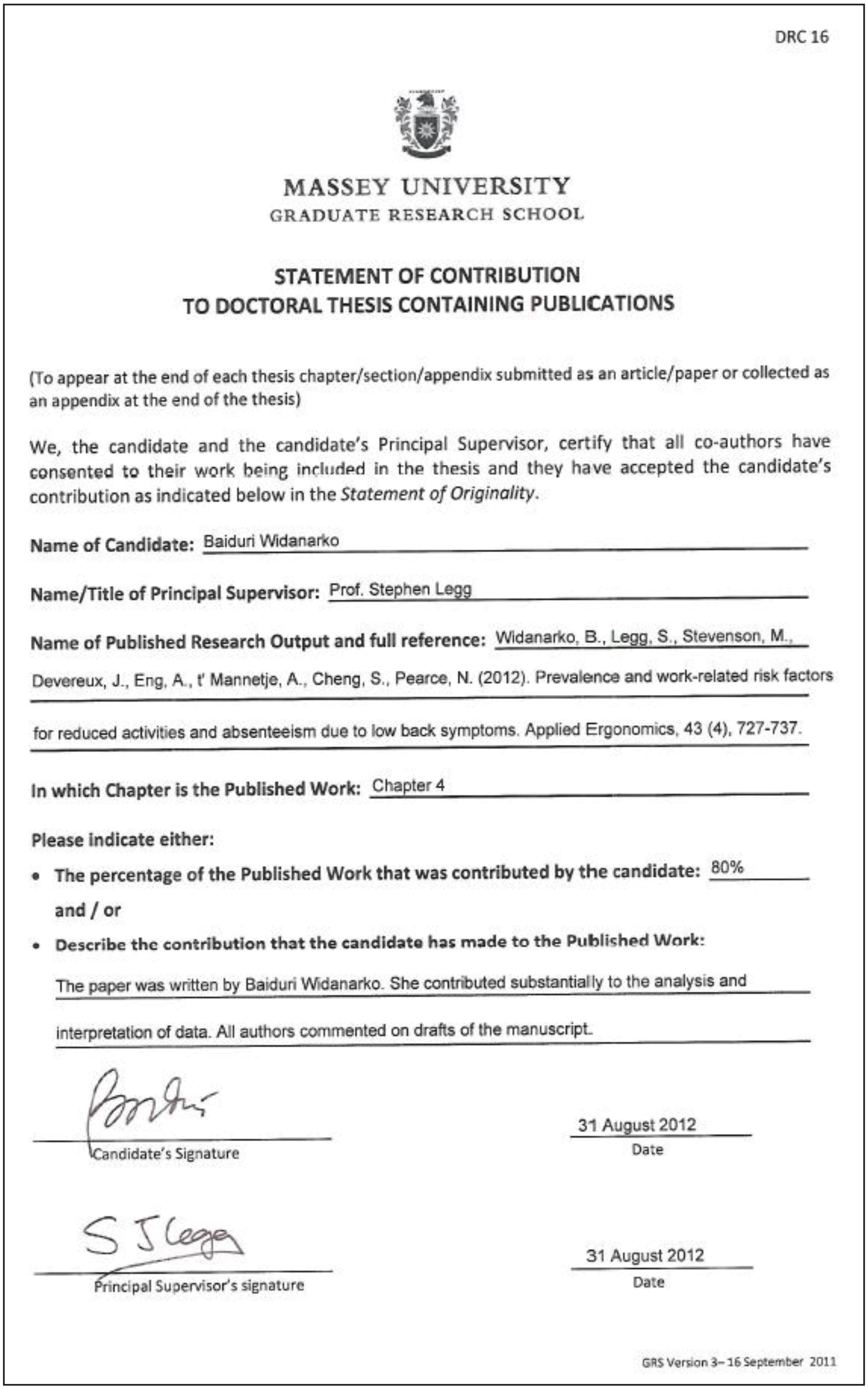
Appendix A8 Statement of contribution for Chapter 4



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We, the candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of Candidate: Baiduri Widanarko

Name/Title of Principal Supervisor: Prof. Stephen Legg

Name of Published Research Output and full reference: Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., t' Mannetje, A., Cheng, S., Pearce, N. (2012). Prevalence and work-related risk factors for reduced activities and absenteeism due to low back symptoms. Applied Ergonomics, 43 (4), 727-737.

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- **Describe the contribution that the candidate has made to the Published Work:**

  The paper was written by Baiduri Widanarko. She contributed substantially to the analysis and interpretation of data. All authors commented on drafts of the manuscript.

Candidate's Signature

31 August 2012
Date

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Principal Supervisor's signature

31 August 2012
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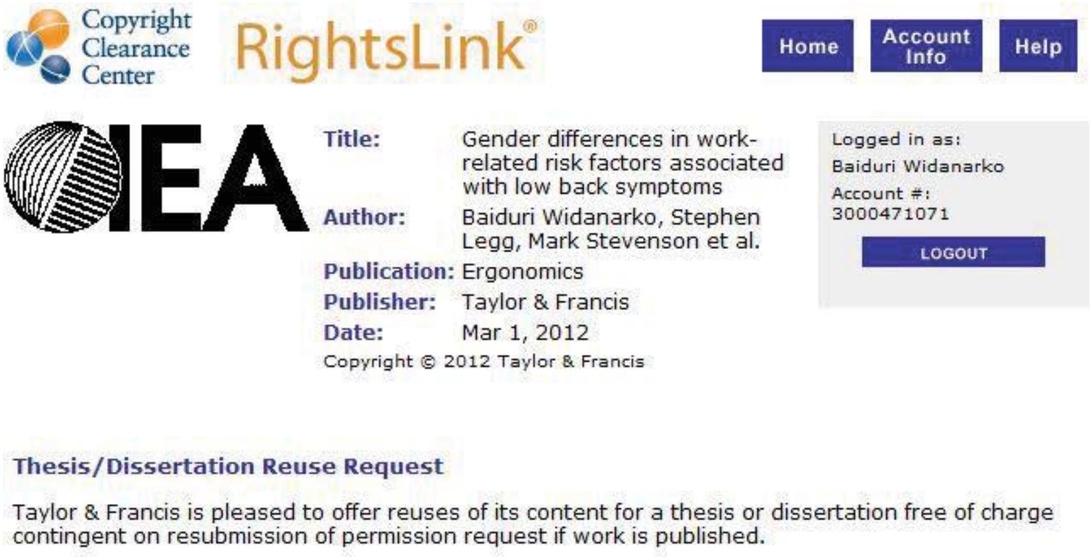

Title: Gender differences in work-related risk factors associated with low back symptoms

Author: Baiduri Widanarko, Stephen Legg, Mark Stevenson et al.

Publication: Ergonomics

Publisher: Taylor & Francis

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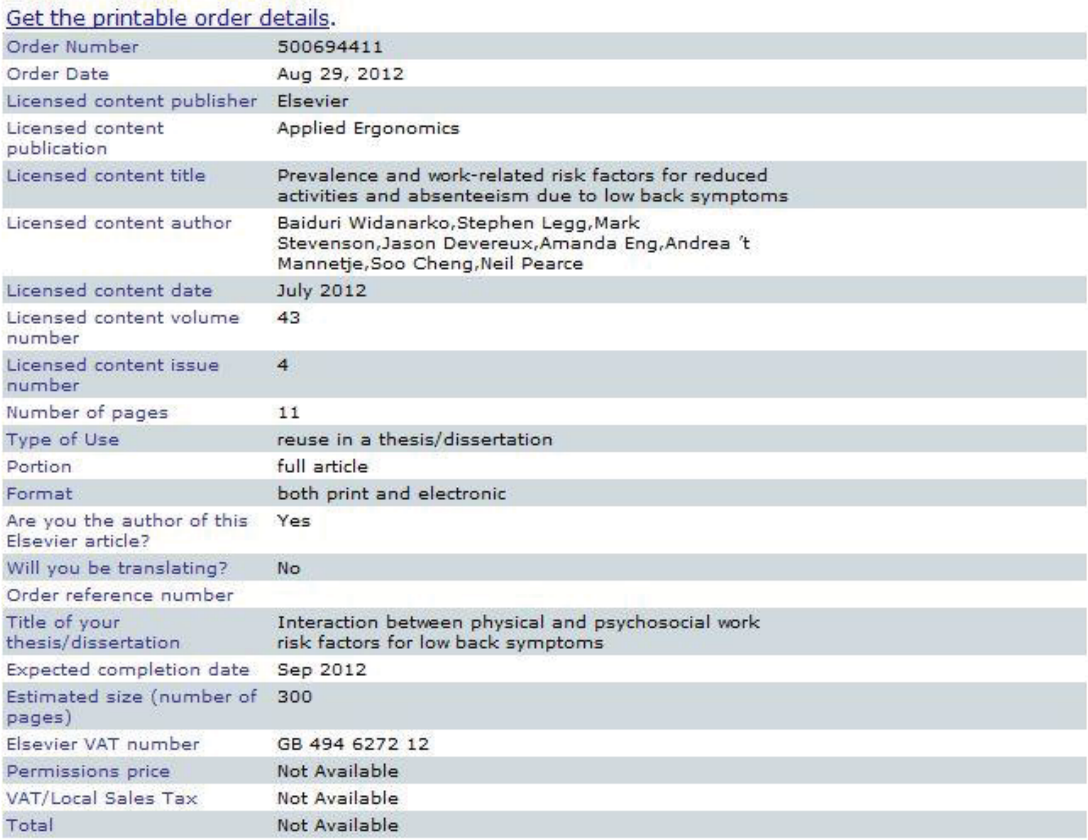

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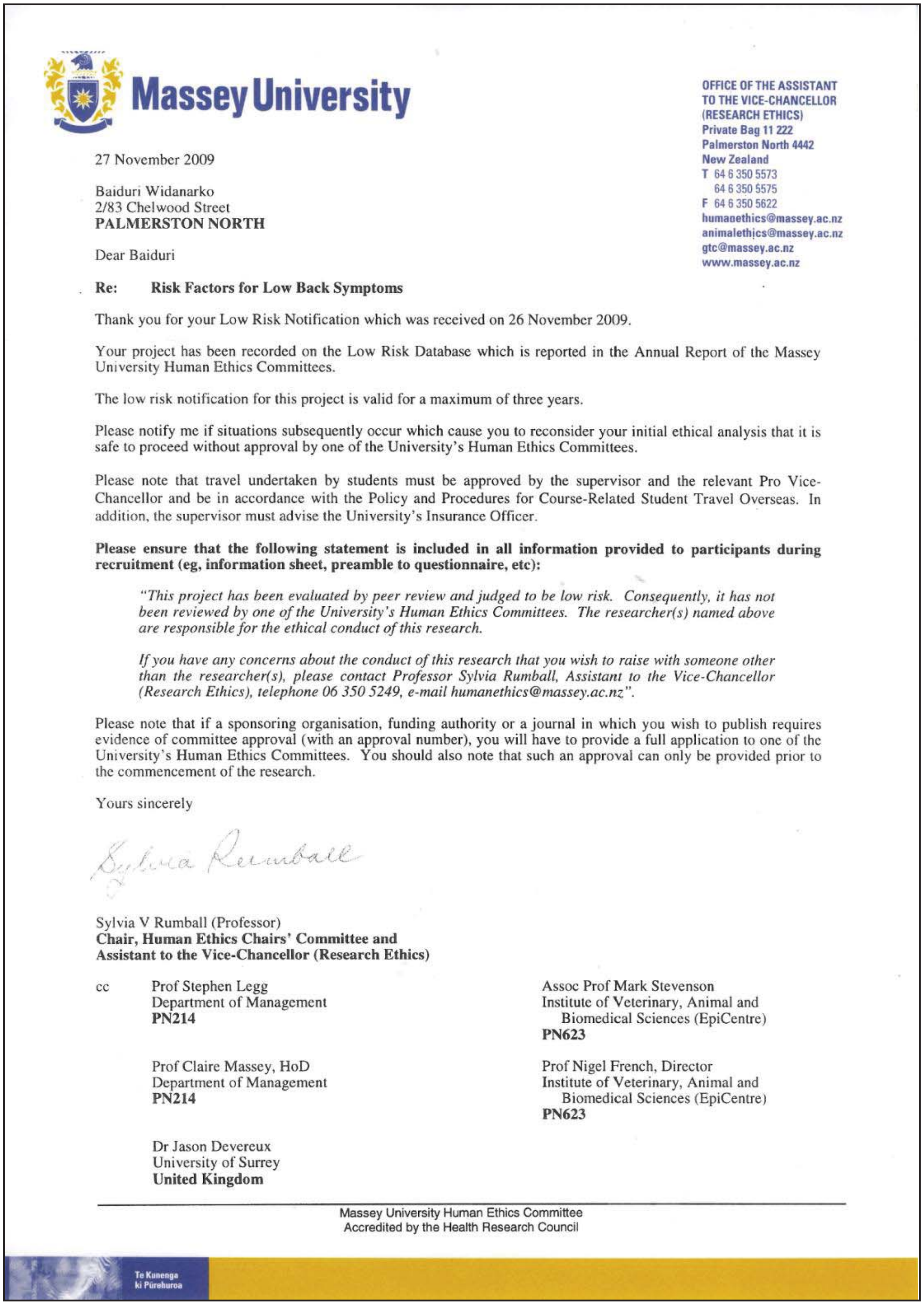
Appendix B Indonesian Coal Mining Study

Appendix B1 Ethical approval documentation for Indonesian coal mining study



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27 November 2009

Baiduri Widanarko
2/83 Chelwood Street
PALMERSTON NORTH

Dear Baiduri

Re: Risk Factors for Low Back Symptoms

Thank you for your Low Risk Notification which was received on 26 November 2009.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

Please ensure that the following statement is included in all information provided to participants during recruitment (eg, information sheet, preamble to questionnaire, etc):

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Sylvia Rumball

Sylvia V Rumball (Professor)
Chair, Human Ethics Chairs' Committee and
Assistant to the Vice-Chancellor (Research Ethics)

cc

Prof Stephen Legg
Department of Management
PN214

Assoc Prof Mark Stevenson
Institute of Veterinary, Animal and
Biomedical Sciences (EpiCentre)
PN623

Prof Claire Massey, HoD
Department of Management
PN214

Prof Nigel French, Director
Institute of Veterinary, Animal and
Biomedical Sciences (EpiCentre)
PN623

Dr Jason Devereux
University of Surrey
United Kingdom

Massey University Human Ethics Committee
Accredited by the Health Research Council

Te Kunenga ki Pūrehuroa

Appendix B2 Validity and reliability of the original physical exposure questionnaire

Questions	Reply Alternatives	Validity					Reliability				References
		Sen	Spe	κ	r_s[a]	%[b]	κ	ICC[c]	r_s[a]	%[b]	
1. How much of your work time do you perform work in sitting position?	☐ A little, 10% of the time or less ☐ About 25% of the time ☐ About 50% of the time ☐ About 75% of the time ☐ Almost all of the time	.71	.91	.81	.83	47	.92		.92	74	(Leijon, et al., 2002)
2. Does your work involve that you kneel or squat?	☐ A little, 10% of the time or less ☐ About 25% of the time ☐ About 50% of the time ☐ About 75% of the time ☐ Almost all of the time						.45	.59			(Wiktorin, et al., 1996)
3. How much of your work time do you perform work with trunk bent?	☐ Almost never/not at all ☐ Little, maybe 10% of the time ☐ About 25% of the time ☐ 50% or more of the time	.47	.87	.76 .48	.41	88 69	.74		.69	84	(Wiktorin, et al., 1993) (Leijon, et al., 2002)
4. How much of your work time do you perform work with hands above shoulder level?	☐ Almost not at all/never ☐ Little, about 10% of the time ☐ About 25% of the time ☐ 50% or more of the time	.79	.76	.48	.53	69	.79		.80	80	(Leijon, et al., 2002)
5. In your work – do you have to	☐ Almost all of the time	.81	.55	.38	.39	45	.83		.78	76	(Leijon, et al., 2002)

Questions	Reply Alternatives	Validity					Reliability				References
		Sen	Spe	κ	r_s [a]	% [b]	κ	ICC [c]	r_s [a]	% [b]	
bend and twist our trunk in the same way several times an hour?	☐ About 75% of the time ☐ Half of the time ☐ About 25% of the time ☐ Seldom, maybe 10% of the time or less										
6. Does your work involve that you work below knee level (trunk flexion) >30 minutes/day?	☐ Almost never/not at all ☐ 1 – 3 days per month ☐ One day per week ☐ 2 – 4 days per week ☐ Every workday	.38	.94		.66						(Wiktorin et al., 1999)
								.58 to .77			(Torgen, et al., 1997)
7. Do you have to lift or carry at least 10 kg several times a day at your work?	☐ Almost never/not at all ☐ 1 – 10 times per day ☐ 11 – 50 times per day ☐ More than 50 times per day	.67	.88	.54	.54	60	.81		.83	76	(Leijon, et al., 2002)
8. Does your work involve that you lift or carry burdens weighing between 6 and 15kg?	☐ Almost never/ not at all ☐ 1 – 3 days per month ☐ 1 day per week ☐ 2 – 4 days per week ☐ Every workday, how frequent:							.79 to .89			(Torgen, et al., 1997) *Note.* This study used the burden weighing between 5 and 15 kg as the standard.
	☐ < 1 time/hour ☐ 1 – 10 times/hour ☐ 11 – 30 times/hour			.66		86					(Wiktorin, et al., 1993)

Questions	Reply Alternatives	Validity					Reliability				References
		Sen	Spe	κ	r_s [a]	% [b]	κ	ICC [c]	r_s [a]	% [b]	
	☐ >30 times/hour										
9. Does your work involve that you lift or carry burdens weighing between16 and 25kg?	☐ Almost never/ not at all ☐ 1 – 3 days per month ☐ 1 day per week ☐ 2 – 4 days per week ☐ Every workday, how frequent: ☐ < 1 time/hour ☐ 1 – 10 times/hour ☐ 11 – 30 times/hour ☐ >30 times/hour			.65		93		.66 .50 to .83			(Wiktorin, et al., 1996) (Torgen, et al., 1997) *Note*. This study used the burden weighing more than 15 kg as the standard. (Wiktorin, et al., 1993) *Note*. This study used the burden weighing between 16 and 45 kg as the standard.
10. Do you work on jolting surfaces e.g. vibrating floor, ship floor, vehicle seat	☐ Not at all ☐ A little, 10% of the time or less ☐ About 25% of the time ☐ 50% of the time ☐ About 75% of the time ☐ Almost all of the time							.70			(Wiktorin *et al*. 1996)
11. Do you work with hand-held tools which vibrate or give impact?	☐ Not at all ☐ A little, 10% of the time or less ☐ About 25% of the time ☐ 50% of the time ☐ About 75% of the time ☐ Almost all of the time							.84			(Wiktorin *et al*. 1996)

Questions	Reply Alternatives	Validity					Reliability				References
		Sen	Spe	κ	r_s [a]	%[b]	κ	ICC[c]	r_s [a]	%[b]	
12. How much have you moved and exerted your-self in your work during the last year?	☐ Sedentary, light work ☐ Light, but somewhat mobile work ☐ Mobile, fairly heavy work ☐ Heavy work	.88	.80	.66	.71	50	.85		.86	77	(Leijon, et al., 2002)
13. How much have you moved and exerted your-self during your leisure (spare) time during the last year?	☐ Sedentary leisure time ☐ Moderate physical exercise during leisure time ☐ Moderate, regular physical exercise during leisure time ☐ Regular physical exercise and sports	.92	.84	.74			.86		.86	83	(Leijon, et al., 2002)

Note. Sen = sensitivity; Spe = specificity; κ = Cohen's kappa coefficient; ICC = interclass correlation coefficient.
[a] Spearman rank correlation coefficient. [b] Agreement

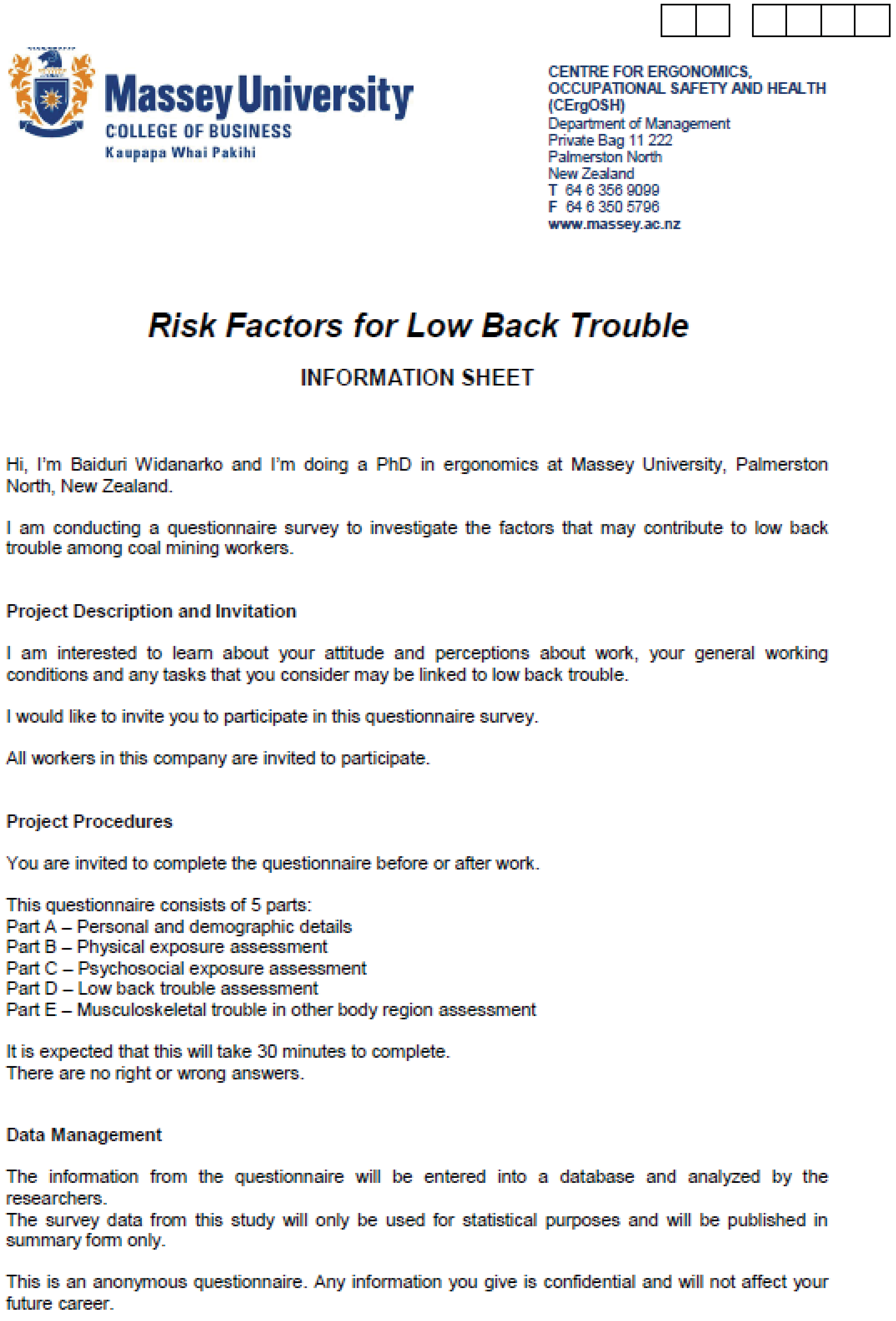
Appendix B3 Reliability of the original psychosocial exposure questionnaire

Questionnaire	Item(s)	Cronbach's alpha	References
Short Version of Effort Reward Imbalance Questionnaire	Effort	.74	(Siegrist, et al., 2008)
	Reward	.79	
	Overcommitment	.79	
The Copenhagen Psychosocial Questionnaire II (COPSOQ II)	Job satisfaction	.82	(Pejtersen, et al., 2010)
Job Content Questionnaire (JCQ)	Skill discretion	.72 to .73	(Karasek, et al., 1998)
	Decision authority	.63 to .66	
	Psychological job demand	.59 to .61	
	Supervisor social support	.85 to .86	
	Coworker social support	.79 to .80	

Appendix B4 Cross cultural adaptation

Since the original questions were all in English and the study was conducted in Indonesia(n), a cross-cultural adaptation of the questionnaire was undertaken in order to assure equivalence between the English and Indonesian versions (Beaton, et al., 2000). The process of cross-cultural adaptation of the questionnaire included both translation into Indonesian and cultural adaptation (Beaton, et al., 2000) and was performed in accordance with guidelines for adaptation of health related subjective data collection tools (Beaton, et al., 2000; Bullinger et al., 1998). It involved six steps. Firstly, translation of the questionnaire from English to Indonesian was conducted by two translators who work independently. One translator (T1) was an informed translator (i.e. principle investigator) who was familiar with musculoskeletal problems and the concepts underlying the study. The second translator (T2) was an industrial engineer who was not familiar with the concept of the study. Second, the written versions (T12) made by T1 and T2 were discussed, synthesised and any discrepancies resolving leading to original document. Third, the back translation (Indonesian to English) of the synthesised Indonesian version (T12) was conducted by two back translators (BT1 and BT2). They were not informed about concept of the study and worked independently and were totally blind to the original version. Fourth, an expert committee review was undertaken. The committee consisted of all four translators (T1, T2, BT1 and BT2) one methodologist, one health professional and one language professional, whose aim it was to reach consensus on any ambiguity, and to establish a pre-final version (Indonesian). Fifth, the pre-final version was pre-tested in Indonesian to the target language version to examine the meaning, layout, wording, ease of understanding and completion of the questionnaire. Sixth and lastly, the documentation of steps 1 – 5 were submitted to the original developer of the questionnaire (i.e. Ola Leijon for physical factors, Robert Karasek for Job Content Questionnaire, and Johannes Siegrist/Morten Wahrendorf for Effor-Reward Imbalance Quenstionnaire) so that they could ensure that the process had been carried out correctly and an accurate translation had been obtained.

Appendix B5 English version of the questionnaire for Indonesian coal mining study



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Risk Factors for Low Back Trouble

INFORMATION SHEET

Hi, I'm Baiduri Widanarko and I'm doing a PhD in ergonomics at Massey University, Palmerston North, New Zealand.

I am conducting a questionnaire survey to investigate the factors that may contribute to low back trouble among coal mining workers.

Project Description and Invitation

I am interested to learn about your attitude and perceptions about work, your general working conditions and any tasks that you consider may be linked to low back trouble.

I would like to invite you to participate in this questionnaire survey.

All workers in this company are invited to participate.

Project Procedures

You are invited to complete the questionnaire before or after work.

This questionnaire consists of 5 parts:
Part A – Personal and demographic details
Part B – Physical exposure assessment
Part C – Psychosocial exposure assessment
Part D – Low back trouble assessment
Part E – Musculoskeletal trouble in other body region assessment

It is expected that this will take 30 minutes to complete.
There are no right or wrong answers.

Data Management

The information from the questionnaire will be entered into a database and analyzed by the researchers.
The survey data from this study will only be used for statistical purposes and will be published in summary form only.

This is an anonymous questionnaire. Any information you give is confidential and will not affect your future career.

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New Zealand
T 64 6 356 9099
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Your Rights

Completion and return of the questionnaire implies that you agree to participate in this study. You can choose not to answer any particular questions and can withdraw from the study at any time.

Ethical assurance

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Research Ethics), telephone +64 6 350 5249, email humanethics@massey.ac.nz.

Project contacts

If you have any questions regarding the project, please contact me or my chief supervisor.

Baiduri Widanarko
Phone : +62 816 1968 414
Email : B.Widanarko@massey.ac.nz

Professor Stephen Legg (Chief Supervisor)
Phone : +64 6 356 9099 extn 2784
Email : S.J.Legg@massey.ac.nz

Thank you for considering this invitation.

Kind regards,

Baiduri Widanarko

PART A – Personal and Demographic Details

Please fill in the blank for each of the following questions.
Please answer <u>all</u> questions!

1. What is your date of birth?

   Date........ Month.......... Year...........

2. How tall are you? .... cm

3. How much do you weigh? .... kg

4. What is your job title? ....

5. How many years have you worked in your current job?
   .... years .... months

6. How long have you worked for this company?
   .... years .... months

Please tick (√) one box for each of the following questions.
Please answer <u>all</u> questions!

7. What is your sex?

   ☐ Female
   ☐ Male

8. What is your marital status?

   ☐ Single
   ☐ Married
   ☐ Divorced/Separated
   ☐ Widowed

9. What is you highest education?

   ☐ Primary school
   ☐ High school
   ☐ College/University

10. What is your smoking status?

    ☐ Non-smoker (never smoked at all or never smoked 100 cigarettes)
    ☐ Former smoker (have smoked more than or equal to 100 cigarettes but quit smoking during the year prior to the survey or longer ago)
    ☐ Current smoker (have smoked more than or equal to 100 cigarettes and currently smoke)
    On average, how many cigarette(s) do you smoke a day?
    ☐ 1 – 14 cigarettes per day
    ☐ 15 – 24 cigarettes per day
    ☐ more than 25 cigarettes per day

11. What is your current employment situation?

    ☐ Permanent employee
    ☐ Non permanent employee

12. Do you perform shift work?

    ☐ No
    ☐ Yes, but without nightshift
    ☐ Yes, with nightshift

PART B – Physical Exposure Assessment

This part refers to your physical activities in your current job.

For each of the following questions, please circle one of the alternative responses to indicate how much of time your job involves any of these situations.

The response alternatives are: Not at all (0%), 1 – 10 % of the time (1 – 10%), 11 – 25% of the time *(11 – 25%),* 26 – 50% of the time *(26 – 50%),* 51 – 75% of the time *(51 – 75%), atau* 76 – 100% of the time *(76 – 100%)*

Please answer <u>all</u> questions!

For example:

How much of your work time do you perform work in a standing position?	*0%*	*1 – 10%*	*11 – 25%*	*26 – 50%*	*[✓ 51 – 75%]*	*76 – 100%*

Questions	Not at all (0%)	1 – 10% of the time	11 – 25% of the time	26 – 50% of the time	51 – 75% of the time	76 – 100% of the time
13. How much of your work is performed in a sitting position?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
14. How much of your work involves kneeling or squatting?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
15. How much of your work is performed with your trunk bent?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
16. How much of your work is performed with your hands above shoulder level?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
17. How much of your work involves bending and twisting your trunk in the same way several times an hour?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
18. How much of your work is performed on unstable surfaces (e.g. vibrating floor, ship floor, vehicle seat)?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
19. How much of your work involves using hand-held tools which vibrate or give impact?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%

Please tick (√) one box for each of the following questions.
Please answer <u>all</u> questions!

20. How often does your work involve lifting or carrying **at least 10 kg**?

- ☐ Almost never/not at all
- ☐ 1 – 10 times **per day**
- ☐ 11 – 50 times **per day**
- ☐ More than 50 times **per day**

21. How often does your work involve working below knee level (trunk flexion) for more than 30 minutes per day?

☐ Almost never/not at all
☐ 1 – 3 days **per month**
☐ One day **per week**
☐ 2 – 4 days **per week**
☐ Every workday

22. How often does your work involve lifting or carrying objects weighing **between 6 and 15 kg**?

☐ Almost never/ not at all
☐ 1 – 3 days **per month**
☐ 1 day **per week**
☐ 2 – 4 days **per week**
☐ Every workday
If you have ticked *'Every workday'*, please indicate how frequently:
☐ Less than 1 time **per hour**
☐ 1 – 10 times **per hour**
☐ 11 – 30 times **per hour**
☐ More than 30 times **per hour**

23. How often does your work involve lifting or carrying objects weighing **between 16 and 25 kg**?

☐ Almost never/ not at all
☐ 1 – 3 days **per month**
☐ 1 day **per week**
☐ 2 – 4 days **per week**
☐ Every workday
If you have ticked *'Every workday'*, please indicate how frequently:
☐ Less than 1 time **per hour**
☐ 1 – 10 times **per hour**
☐ 11 – 30 times **per hour**
☐ More than 30 times **per hour**

24. How often does your work involve lifting or carrying objects weighing **more than 25 kg**?

☐ Almost never/ not at all
☐ 1 – 3 days **per month**
☐ 1 day **per week**
☐ 2 – 4 days **per week**
☐ Every workday
If you have ticked *'Every workday'*, please indicate how frequently:
☐ Less than 1 time **per hour**
☐ 1 – 10 times **per hour**
☐ 11 – 30 times **per hour**
☐ More than 30 times **per hour**

25. How would you describe your activity **in your current work** during the last year?

☐ Sedentary work
Your work is mainly sedentary and you do not walk much during your work time.
☐ Light, but somewhat mobile work
Your work involves walking quite a lot, but no manual handling of loads.
☐ Fairly hard work
You walk a lot in your work and also have quite a lot of manual handling of loads or you walk on stairs or on slopes.
☐ Hard work
Your work is hard. It includes heavy manual handling of loads and is physically strenuous .

26. How would you describe your activity **in your leisure (spare or non work)** time during the last year?

☐ Sedentary leisure time
    You mostly do reading, looking at the TV, cinema or other sedentary activities during your leisure time. You walk, (bi-)cycle or move yourself in other ways less than 2 hours per week.

☐ Moderate physical exercise during leisure time
    You walk, bicycle or move yourself in other ways for at least 2 hours per week, often without perspiration. This includes for example walking or (bi-)cycling to and from work, week-end promenades, ordinary gardening work, fishing, playing table-tennis, bowling.

☐ Moderate, regular physical exercise during leisure time
    You exercise regularly 1-2 times per week for at least 30 minutes per occasion with jogging, swimming, tennis, badminton or other activities that make you perspire.

☐ Regular physical exercise and sports
    You use your leisure time for example for jogging, swimming, tennis, badminton, aerobics or other physical activities on average at least 3 times per week for at least 30 minutes on every occasion.

PART C – Psychosocial Exposure Assessment

This part refers to your psychosocial exposures in your current job.

The following statements refer to your present occupation.

Please circle to indicate whether you Strongly Agree (SA), Agree (A), Disagree (D) or Strongly Disagree (SD) with each of the statements that best fits your job situation.

Sometimes none of the answers fit exactly. Please choose the answer that comes closest.

Please answer <u>all</u> statements!

For example:

I enjoy my work	[✓ *SA*]	*A*	*D*	*SD*

Statements	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly disagree (SD)
27. I have constant time pressure due to a heavy work load.	SA	A	D	SD
28. I have many interruptions and disturbance while performing my job.	SA	A	D	SD
29. Over the past few years, my job has become more and more demanding.	SA	A	D	SD
30. I receive the respect I deserve from my superior or a respected relevent person.	SA	A	D	SD
31. My job promotion prospects are poor.	SA	A	D	SD
32. I have experienced or I expect to experience an undesirable change in my work situation.	SA	A	D	SD
33. My job security is poor.	SA	A	D	SD
34. Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.	SA	A	D	SD

Statements	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly disagree (SD)
35. Considering all my efforts and achievements, my job promotion prospects are adequate.	SA	A	D	SD
36. Considering all my efforts and achievements, my salary/income is adequate.	SA	A	D	SD
37. I get easily overwhelmed by time pressures at work.	SA	A	D	SD
38. As soon as I get up in the morning I start thinking about work problems.	SA	A	D	SD
39. When I get home, I can easily relax and 'switch off' work.	SA	A	D	SD
40. People close to me say I sacrifice too much for my job.	SA	A	D	SD
41. Work rarely lets me go, it is still on my mind when I go to bed.	SA	A	D	SD
42. If I postpone something that I was supposed to do today I'll have trouble sleeping at night.	SA	A	D	SD
43. My job requires that I learn new things.	SA	A	D	SD
44. My job involves a lot of repetitive work.	SA	A	D	SD
45. My job requires me to be creative.	SA	A	D	SD
46. My job requires a high level of skill.	SA	A	D	SD
47. I get to do a variety of different things on my job.	SA	A	D	SD
48. I have an opportunity to develop my own special abilities.	SA	A	D	SD
49. My job allows me to make a lot of decisions on my own.	SA	A	D	SD
50. On my job, I have very little freedom to decide how I do my work.	SA	A	D	SD
51. I have a lot of say about what happens on my job.	SA	A	D	SD
52. My job requires working very fast.	SA	A	D	SD
53. My job requires working very hard.	SA	A	D	SD
54. I am not asked to do an excessive amount of work.	SA	A	D	SD
55. I have enough time to get the job done.	SA	A	D	SD
56. I am free from conflicting demands that others make.	SA	A	D	SD
57. My supervisor is concerned about the welfare of those under him.	SA	A	D	SD
58. My supervisor pays attention to what I am saying.	SA	A	D	SD
59. My supervisor is helpful in getting the job done.	SA	A	D	SD
60. My supervisor is successful in getting people to work together.	SA	A	D	SD

Statements	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly disagree (SD)
61. People I work with are competent in doing their jobs.	SA	A	D	SD
62. People I work with take a personal interest in me.	SA	A	D	SD
63. People I work with are friendly.	SA	A	D	SD
64. People I work with are helpful in getting the job done.	SA	A	D	SD

The following questions are about your work in general.

Please circle one choice to indicate whether you are Very Satisfied (VS), Satisfied (S), Unsatisfied (US), Very Unsatisfied (VUS) or the question is Not Relevant (NR) in response to each of the questions below.

Some of the questions may fit better to your work than others, but please answer <u>all</u> questions.

For example:

How satisfied are you with your salary?	*VS*	[✓ *S*]	*US*	*VUS*	*NR*

Questions	Very Satisfied (VS)	Satisfied (S)	Unsatisfied (US)	Very Unsatisfied (VUS)	Not Relevant (NR)
65. How satisfied are you with your work prospects?	VS	S	US	VUS	NR
66. How satisfied are you with the physical working conditions?	VS	S	US	VUS	NR
67. How satisfied are you with the way your abilities are used?	VS	S	US	VUS	NR
68. How satisfied are you with your job as a whole, taking everything into consideration?	VS	S	US	VUS	NR

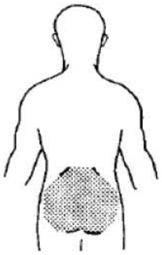
The following question is about your perceived job stress in general.

Please tick (√) one box for the following question.

69. In general, how do you find your job?

☐ Not at all stressful
☐ Mildly stressful
☐ Moderately stressful
☐ Very stressful
☐ Extremly stressful

PART D – Low Back Trouble Assessment



In this section please tell us about any trouble (such as aches, pains, discomfort, numbness or fatigue) that you have had in your lower back region (as shown by the shaded area in this diagram).

Please tick (√) one box for each of the following questions.

70. Have you ever had low back trouble?

☐ No
☐ Yes,
In what year did you **first have** low back trouble? Year............ Month.............

71. Have you ever hurt your low back in an accident?

☐ No
☐ Yes,
What was the approximate year of the accident? ....

DURING THE LAST 7 DAYS

72. During the **last 7 days,** have you at any time had **any trouble** (such as aches, pains, discomfort, numbness or fatigue) in your low back region?

☐ No never
☐ Yes, once or twice
☐ Yes, sometimes
☐ Yes, often
☐ Yes, all the time

73. During the **last 7 days**, have you been prevented from carrying out **normal activities** because of your low back trouble?

☐ No
☐ Yes,
Please specify which activity(s) have been prevented...
....

74. During the **last 7 days,** have you been **absent from work** because of your low back trouble?

☐ No
☐ Yes,
How many days have you been absent from work with low back trouble in the **last 7 days**? .... day(s)

DURING THE LAST 12 MONTHS

75. During the **last 12 months,** have you at any time had **any trouble** (such as aches, pains, discomfort, numbness or fatigue) in your low back region?

☐ No never
☐ Yes, once or twice
☐ Yes, sometimes
☐ Yes, often
☐ Yes, all the time

76. During the **last 12 months,** how often do you get or have you had low back trouble?

☐ No never
☐ One episode of trouble only
☐ One or more times every few years
☐ One or more times a year
☐ One or more times a month
☐ One or more times a week
☐ Daily

77. During the **last 12 months,** what is the total length of time that you have had low back trouble?

☐ 0 days
☐ 1 – 7 days
☐ 8 – 30 days
☐ More than 30 days, but not every day
☐ Every day

78. During the **last 12 months**, have you been prevented from carrying out **normal activities** because of your low back trouble?

☐ No
☐ Yes,
Please specify which activity(s) have been prevented..
....

79. During the **last 12 months,** have you been **absent from work** because of your low back trouble?

☐ No
☐ Yes,
How many days have you been absent from work with low back trouble in the **last 12 months**? .... day(s)

LOW BACK PAIN INTENSITY

In this section we are interested in the intensity of any low back pain.

For each of the following questions, please circle one number on the 0 – 10 scale which represent your pain intensity, where 0 is 'No pain' and 10 is 'Pain as bad as could be'

	Questions	☺ No pain										☹ Pain as bad as could be
80.	How intense is your low back pain at **the present time**, that is right now?	0	1	2	3	4	5	6	7	8	9	10
81.	In the past 6 months, how intense was **your worst** low back pain?	0	1	2	3	4	5	6	7	8	9	10
82.	In the past 6 months, **on the average**, how intense was your low back pain? (That is, your usual pain at times you were experiencing low back pain)	0	1	2	3	4	5	6	7	8	9	10

DISABILITY QUESTIONS

In this section we are interested in any disability due to low back pain.

For each of the following questions, please circle one number on the 0 – 10 scale which represents any disability you may have as a result of your low back pain.

	Questions	☺ No interference										☹ Unable to carry on any activities
83.	In the past 6 months, how much has low back pain **interfered with your daily activities** (where 0 is 'no interference' and 10 is 'unable to carry on any activities')?	0	1	2	3	4	5	6	7	8	9	10
		☺ No change										☹ Extreme change
84.	In the past 6 months, how much has low back pain **changed your ablility to take part in recreational, social, and family activities** (where 0 is 'no change' and 10 is 'extreme change')?	0	1	2	3	4	5	6	7	8	9	10
85.	In the past 6 months, how much has low back pain **changed your ability to work (including housework)** (where 0 is 'no change' and 10 is 'extreme change')?	0	1	2	3	4	5	6	7	8	9	10

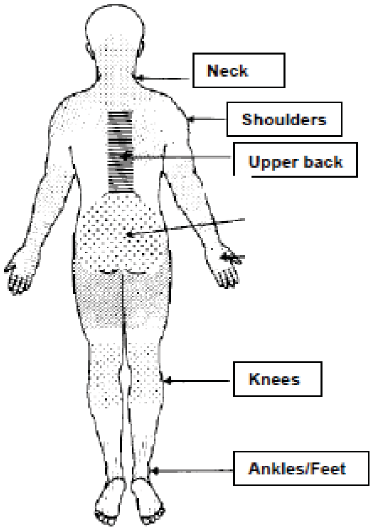
Please fill in the blank for the question below:

86. In the last 6 months, about how many days have you been kept from your usual activities (work or housework) because of the low back pain? .... days

PART E – Musculoskeletal Trouble in Other Body Region Assessment

In this section please tell us about any trouble (such as aches, pains, discomfort, numbness or fatigue) that you have had in any of your other body region: neck, shoulders, upper back, knees or ankles/feet (as shown by the shaded area in this diagram).

Please tick (√) one box for each of the following questions.



Body Region	Have you at any time during the **last 7 days** had **any trouble** (such as aches, pains, discomfort, numbness or fatigue) in this body region?	Have you at any time during the **last 12 months** had **any trouble** (such as aches, pains, discomfort, numbness or fatigue) in this body region?	During the **last 12 months**, have you been prevented from carrying out **normal activities** because of this trouble in this body region?	During the **last 12 months,** have you been **absent from work** because of this trouble in this body region?
NECK	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No ☐ Yes, Please specify which activity(s) have been prevented..................	☐ No ☐ Yes, For how many day(s)? .... day(s)
SHOULDERS	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No ☐ Yes, Please specify which activity(s) have been prevented..................	☐ No ☐ Yes, For how many day(s)? .... day(s)
UPPER BACK	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No ☐ Yes, Please specify which activity(s) have been prevented..................	☐ No ☐ Yes, For how many day(s)? .... day(s)
KNEES	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No ☐ Yes, Please specify which activity(s) have been prevented..................	☐ No ☐ Yes, For how many day(s)? .... day(s)
ANKLES/FEET	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No never ☐ Yes, once or twice ☐ Yes, sometimes ☐ Yes, often ☐ Yes, all the time	☐ No ☐ Yes, Please specify which activity(s) have been prevented..................	☐ No ☐ Yes, For how many day(s)? .... day(s)

You are finished. Thank you for your help

Appendix B6 Indonesian version of the questionnaire for Indonesian coal mining study

☐☐ ☐☐☐☐

Massey University
COLLEGE OF BUSINESS
Kaupapa Whai Pakihi

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Palmerston North
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Faktor Risiko untuk Gejala pada Punggung Bawah

LEMBAR INFORMASI

Halo, saya Baiduri Widanarko mahasiswa PhD (S3) di bidang ergonomic, Massey University, New Zealand.

Saat ini saya sedang melaksanakan survei untuk mempelajari faktor risiko yang mungkin berkaitan dengan gejala pada punggung bawah pada pekerja tambang batu bara.

Garis Besar Survei dan Undangan

Saya tertarik pada sikap dan persepsi anda tentang kerja, kondisi lingkungan kerja secara umum dan aktivitas-aktivitas yang diperkirakan memiliki kaitan dengan gejala pada punggung bawah.

Saya mengundang semua karyawan di perusahaan ini untuk berpartisipasi pada survei ini.

Prosedur Survei

Anda diminta untuk mengisi kuesioner sebelum atau sesudah kerja.

Kuesioner ini terdiri dari 5 bagian:
Bagian A – Data pribadi dan sosiodemografi
Bagian B – Kajian pajanan fisik
Bagian C – Kajian pajanan psikososial
Bagian D – Kajian gejala pada punggung bawah
Bagian E – Kajian gejala pada otot rangka

Diperkirakan dibutuhkan waktu sekitar 30 menit untuk mengisi kuesioner ini.
Tidak ada jawaban yang benar atau salah.

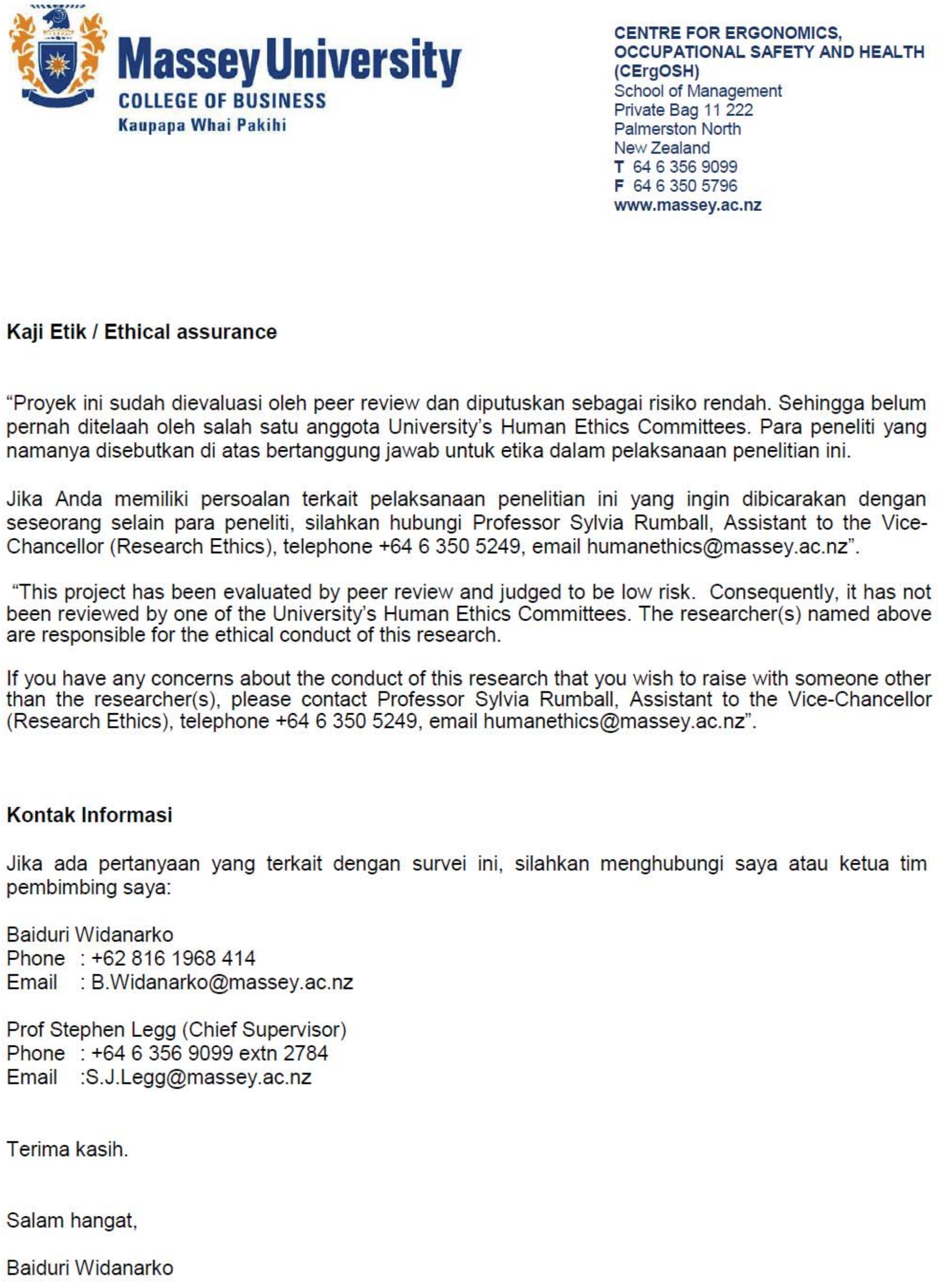
Manajemen Data

Data yang telah terkumpul akan dimasukkan ke dalam basis data dan dianalisa oleh peneliti.
Data hasil survei ini hanya digunakan untuk tujuan statistik dan akan dipublikasikan hanya dalam bentuk rangkuman.

Anda tidak perlu mencantumkan nama. Semua informasi bersifat rahasia serta tidak memiliki dampak terhadap masa depan karir Anda.

Hak Anda

Dengan mengisi dan mengembalikan kuesioner ini berarti Anda memutuskan untuk berpartisipasi. Anda boleh tidak menjawab pertanyaan – pertanyaan tertentu, ataupun memutuskan untuk mundur dari survei ini kapanpun.



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Kaji Etik / Ethical assurance

“Proyek ini sudah dievaluasi oleh peer review dan diputuskan sebagai risiko rendah. Sehingga belum pernah ditelaah oleh salah satu anggota University’s Human Ethics Committees. Para peneliti yang namanya disebutkan di atas bertanggung jawab untuk etika dalam pelaksanaan penelitian ini.

Jika Anda memiliki persoalan terkait pelaksanaan penelitian ini yang ingin dibicarakan dengan seseorang selain para peneliti, silahkan hubungi Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Research Ethics), telephone +64 6 350 5249, email humanethics@massey.ac.nz”.

“This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University’s Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Research Ethics), telephone +64 6 350 5249, email humanethics@massey.ac.nz”.

Kontak Informasi

Jika ada pertanyaan yang terkait dengan survei ini, silahkan menghubungi saya atau ketua tim pembimbing saya:

Baiduri Widanarko
Phone : +62 816 1968 414
Email : B.Widanarko@massey.ac.nz

Prof Stephen Legg (Chief Supervisor)
Phone : +64 6 356 9099 extn 2784
Email :S.J.Legg@massey.ac.nz

Terima kasih.

Salam hangat,

Baiduri Widanarko

BAGIAN A – Data Pribadi dan Demografi

Silahkan isi titik-titik di bawah ini untuk setiap pertanyaan berikut.
Mohon jawab semua pertanyaan.

1. Kapan Anda lahir?

   Tanggal........ Bulan.......... Tahun...........

2. Berapa tinggi badan Anda? .... cm

3. Berapa berat badan Anda? .... kg

4. Apa nama jabatan Anda? ....

5. Sejak kapan Anda menduduki jabatan Anda sekarang?

   Tahun .... Bulan ....

6. Sejak kapan Anda bekerja di perusahaan ini?

   Tahun .... Bulan ....

Silahkan beri tanda centang (√) pada salah satu kotak untuk setiap pertanyaan berikut.
Mohon jawab semua pertanyaan.

7. Apa jenis kelamin Anda?

   ☐ Wanita
   ☐ Pria

8. Bagaimana status pernikahan Anda?

   ☐ Belum menikah
   ☐ Menikah
   ☐ Pisah/Cerai
   ☐ Janda/duda

9. Apa pendidikan terakhir Anda?

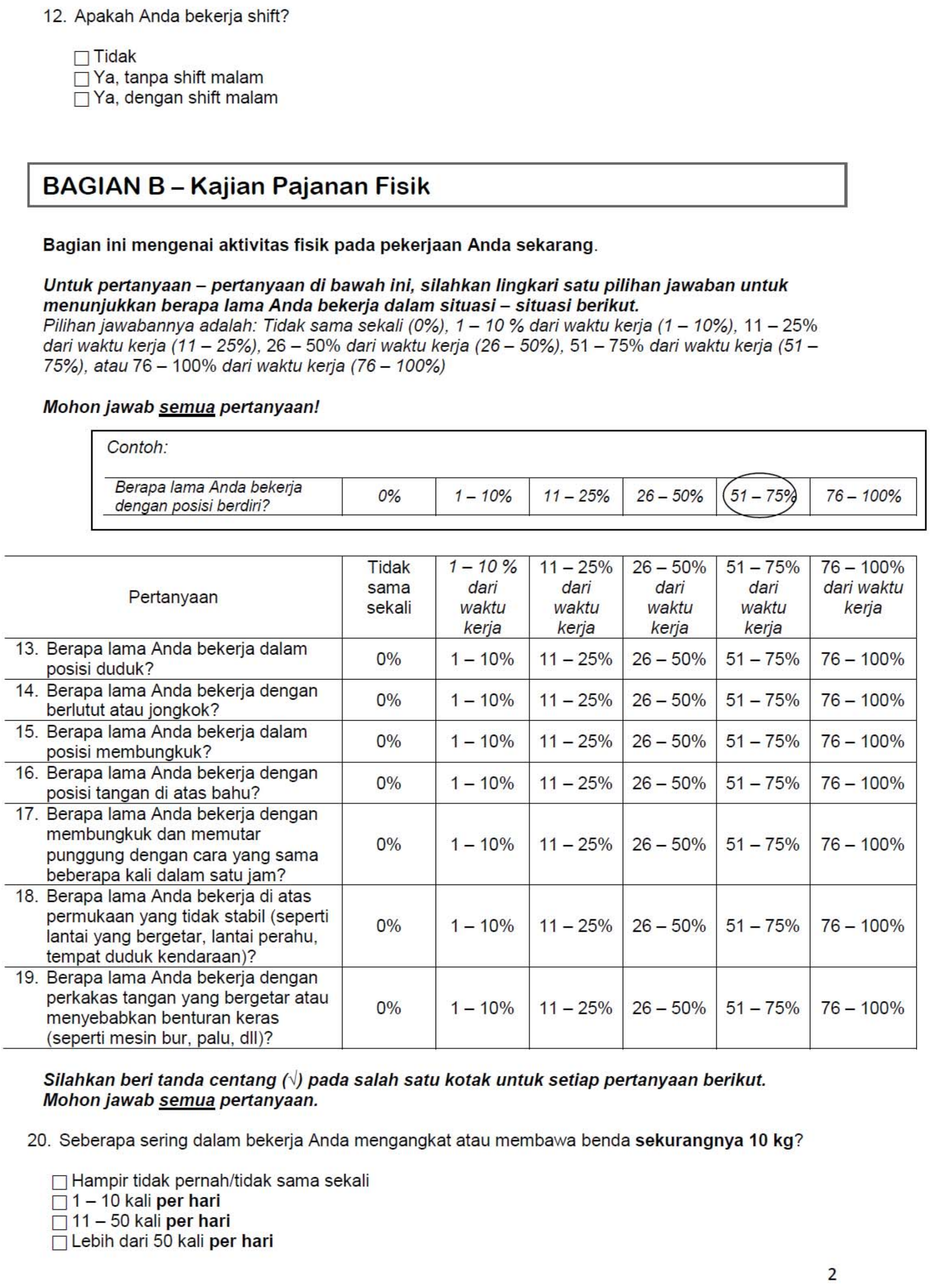
   ☐ Sekolah Dasar
   ☐ Sekolah Menengah Atas
   ☐ Diploma/Sarjana

10. Bagaimana status merokok Anda?

    ☐ Tidak pernah merokok
    Tidak pernah merokok sama sekali atau pernah merokok kurang dari 100 batang rokok.
    ☐ Mantan perokok
    Sudah merokok sebanyak 100 batang rokok atau lebih tapi sudah berhenti merokok selama setahun atau lebih.
    ☐ Perokok (
    Sudah merokok sebanyak 100 batang rokok atau lebih dan saat ini masih merokok.
    Rata-rata, berapa batang rokok Anda hisap dalam sehari?
    ☐ 1 – 14 rokok per hari
    ☐ 15 – 24 rokok per hari
    ☐ Lebih dari 25 rokok per hari

11. Bagaimana status kepegawaian Anda sekarang?

    ☐ Pegawai Tetap / Permanent employee
    ☐ Pegawai Tidak Tetap / Non – permanent employee



12. Apakah Anda bekerja shift?

☐ Tidak
☐ Ya, tanpa shift malam
☐ Ya, dengan shift malam

BAGIAN B – Kajian Pajanan Fisik

Bagian ini mengenai aktivitas fisik pada pekerjaan Anda sekarang.

Untuk pertanyaan – pertanyaan di bawah ini, silahkan lingkari satu pilihan jawaban untuk menunjukkan berapa lama Anda bekerja dalam situasi – situasi berikut.
Pilihan jawabannya adalah: Tidak sama sekali (0%), 1 – 10 % dari waktu kerja (1 – 10%), 11 – 25% dari waktu kerja (11 – 25%), 26 – 50% dari waktu kerja (26 – 50%), 51 – 75% dari waktu kerja (51 – 75%), atau 76 – 100% dari waktu kerja (76 – 100%)

Mohon jawab <u>semua</u> pertanyaan!

Contoh:

Berapa lama Anda bekerja dengan posisi berdiri?	*0%*	*1 – 10%*	*11 – 25%*	*26 – 50%*	[✓ *51 – 75%*]	*76 – 100%*

Pertanyaan	Tidak sama sekali	*1 – 10 % dari waktu kerja*	11 – 25% *dari waktu kerja*	26 – 50% *dari waktu kerja*	51 – 75% *dari waktu kerja*	76 – 100% *dari waktu kerja*
13. Berapa lama Anda bekerja dalam posisi duduk?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
14. Berapa lama Anda bekerja dengan berlutut atau jongkok?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
15. Berapa lama Anda bekerja dalam posisi membungkuk?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
16. Berapa lama Anda bekerja dengan posisi tangan di atas bahu?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
17. Berapa lama Anda bekerja dengan membungkuk dan memutar punggung dengan cara yang sama beberapa kali dalam satu jam?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
18. Berapa lama Anda bekerja di atas permukaan yang tidak stabil (seperti lantai yang bergetar, lantai perahu, tempat duduk kendaraan)?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%
19. Berapa lama Anda bekerja dengan perkakas tangan yang bergetar atau menyebabkan benturan keras (seperti mesin bur, palu, dll)?	0%	1 – 10%	11 – 25%	26 – 50%	51 – 75%	76 – 100%

Silahkan beri tanda centang (√) pada salah satu kotak untuk setiap pertanyaan berikut.
Mohon jawab <u>semua</u> pertanyaan.

20. Seberapa sering dalam bekerja Anda mengangkat atau membawa benda **sekurangnya 10 kg**?

☐ Hampir tidak pernah/tidak sama sekali
☐ 1 – 10 kali **per hari**
☐ 11 – 50 kali **per hari**
☐ Lebih dari 50 kali **per hari**

21. Seberapa sering Anda bekerja dengan posisi tangan di bawah lutut (membungkuk) lebih dari 30 menit per hari?

☐ Hampir tidak pernah/tidak sama sekali
☐ 1 – 3 hari **per bulan**
☐ Satu hari **per minggu**
☐ 2 – 4 hari **per minggu**
☐ Setiap hari kerja

22. Seberapa sering dalam bekerja Anda mengangkat atau membawa benda seberat antara **6 dan 15 kg**?

☐ Hampir tidak pernah/tidak sama sekali
☐ 1 – 3 hari **per bulan**
☐ Satu hari **per minggu**
☐ 2 – 4 hari **per minggu**
☐ Setiap hari kerja
Jika Anda memilih *'Setiap hari kerja'*, mohon sebutkan seberapa sering:
  ☐ < 1 kali **per jam**
  ☐ 1 – 10 kali **per jam**
  ☐ 11 – 30 kali **per jam**
  ☐ >30 kali **per jam**

23. Seberapa sering dalam bekerja Anda mengangkat atau membawa benda seberat antara **16 dan 25 kg**?

☐ Hampir tidak pernah/tidak sama sekali
☐ 1 – 3 hari **per bulan**
☐ Satu hari **per minggu**
☐ 2 – 4 hari **per minggu**
☐ Setiap hari kerja
Jika Anda memilih *'Setiap hari kerja'*, mohon sebutkan seberapa sering:
  ☐ < 1 kali **per jam**
  ☐ 1 – 10 kali **per jam**
  ☐ 11 – 30 kali **per jam**
  ☐ >30 kali **per jam**

24. Seberapa sering dalam bekerja Anda mengangkat atau membawa benda lebih dari **25 kg**?

☐ Hampir tidak pernah/tidak sama sekali
☐ 1 – 3 hari **per bulan**
☐ Satu hari **per minggu**
☐ 2 – 4 hari **per minggu**
☐ Setiap hari kerja
Jika Anda memilih *'Setiap hari kerja'*, mohon sebutkan seberapa sering:
  ☐ < 1 kali **per jam**
  ☐ 1 – 10 kali **per jam**
  ☐ 11 – 30 kali **per jam**
  ☐ >30 kali **per jam**

25. Bagaimana aktivitas Anda **saat bekerja** selama satu tahun terakhir?

☐ Pekerjaan duduk
Pekerjaan Anda secara umum dilakukan dengan duduk dan Anda tidak terlalu banyak berjalan selama waktu kerja.
☐ Pekerjaan ringan, namun kadang-kadang aktif bergerak
Anda relatif banyak berjalan saat bekerja, namun tidak mengangkat beban secara manual (tidak melakukan manual handling).
☐ Pekerjaan agak berat
Anda banyak berjalan saat bekerja dan juga sering melakukan manual handling atau berjalan di tangga/tanjakan.
☐ Pekerjaan berat
Anda memiliki pekerjaan berat. Termasuk banyak melakukan manual handling, dan memiliki

pekerjaan fisik yang berat.

26. Bagaimana aktivitas Anda **saat waktu senggang (tidak bekerja)** selama satu tahun terakhir?

☐ Bersantai dengan duduk

Anda paling sering membaca, menonton TV, bioskop, atau pekerjaan duduk lainnya selama waktu senggang. Anda berjalan kaki, bersepeda atau menggerakkan badan dengan cara lain kurang dari 2 jam per minggu.

☐ Latihan fisik secukupnya selama waktu senggang

Anda berjalan kaki, bersepeda, atau menggerakkan badan dengan cara lain sekurangnya 2 jam per minggu, sering tanpa berkeringat. Termasuk jalan kaki atau bersepeda dari/ke tempat kerja, berjalan kaki akhir pekan, pekerjaan berkebun biasa, memancing, bermain tenis meja, bowling.

☐ Latihan fisik secukupnya dan teratur selama waktu senggang

Anda berolah raga teratur 1 – 2 kali seminggu sekurangnya selama 30 menit per aktivitas dengan jogging, renang, tenis, bulu tangkis atau aktivitas lain yang membuat Anda berkeringat.

☐ Latihan fisik secara teratur and berolah raga

Anda menggunakan waktu senggang Anda untuk jogging, renang, tenis, bulu tangkis, aerobik atau aktivitas fisik lainnya rata – rata 3 kali per minggu. Sekurangnya 30 menit setiap latihan.

BAGIAN C – Kajian Pajanan Psikososial

Bagian ini mengacu pada pajanan psikososial di tempat kerja Anda sekarang.

Pernyataan berikut ini merujuk pada situasi jabatan atau pekerjaan Anda sekarang.

Silahkan lingkari salah satu pilihan untuk menunjukkan apakah Anda: Sangat Setuju (SS), Setuju (S), Tidak Setuju (TS) atau Sangat Tidak Setuju (STS) dengan setiap pernyataan berikut yang paling sesuai dengan kondisi pekerjaan Anda.

Kadang – kadang tidak ada jawaban yang pas, namun silahkan pilih jawaban yang paling mendekati.

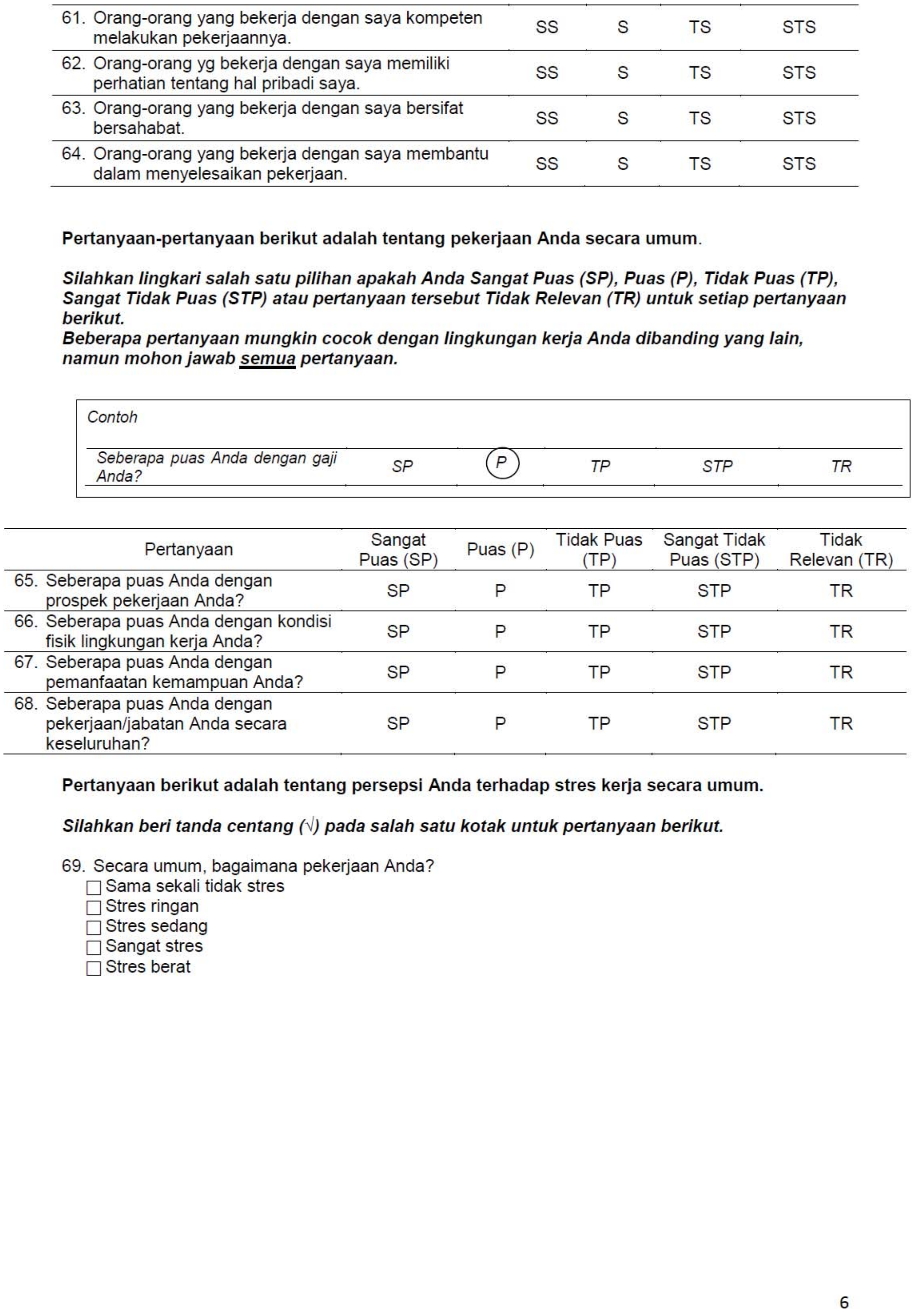
Mohon jawab <u>semua</u> pernyataan!

Contoh:

Saya menikmati pekerjaan saya	[✓ SS]	S	TS	STS

Pernyataan	Sangat Setuju (SS)	Setuju (S)	Tidak Setuju (TS)	Sangat Tidak Setuju (STS)
27. Saya menghadapi tekanan waktu terus menerus karena beban kerja yang tinggi.	SS	S	TS	STS
28. Saya sering mendapatkan interupsi dan gangguan ketika bekerja.	SS	S	TS	STS
29. Selama beberapa tahun terakhir, pekerjaan saya semakin lama semakin banyak (menuntut).	SS	S	TS	STS
30. Saya dihargai dengan layak oleh atasan atau orang-orang yang berwenang.	SS	S	TS	STS
31. Harapan kenaikan pangkat saya buruk.	SS	S	TS	STS
32. Saya telah mengalami atau saya kira akan mengalami perubahan yang tidak menyenangkan di tempat kerja saya.	SS	S	TS	STS
33. Jaminan kelangsungan kerja saya buruk.	SS	S	TS	STS

34. Berdasarkan semua usaha dan prestasi saya, saya dihargai dengan yg layak di tempat kerja.	SS	S	TS	STS
35. Berdasarkan semua usaha dan prestasi saya, harapan promosi pekerjaan saya telah sesuai.	SS	S	TS	STS
36. Berdasarkan semua usaha dan prestasi saya, gaji/pendapatan saya telah sesuai.	SS	S	TS	STS
37. Saya mudah kewalahan akibat keterbatasan waktu di tempat kerja.	SS	S	TS	STS
38. Saya mulai memikirkan masalah pekerjaan segera sejak bangun tidur.	SS	S	TS	STS
39. Ketika sampai rumah, saya dengan mudah beristirahat dan melupakan pekerjaan.	SS	S	TS	STS
40. Orang-orang yang dekat dengan saya mengatakan saya berkorban terlalu banyak untuk jabatan/perkerjaan saya.	SS	S	TS	STS
41. Masalah pekerjaan jarang lepas dari saya, dan masih ada di pikiran saya ketika mau tidur.	SS	S	TS	STS
42. Jika saya menunda sesuatu yang seharusnya dilakukan hari ini, tidur malam saya akan terganggu.	SS	S	TS	STS
43. Pekerjaan saya mengharuskan saya belajar hal-hal baru.	SS	S	TS	STS
44. Pekerjaan saya banyak melibatkan pekerjaan yang berulang-ulang (repetitif).	SS	S	TS	STS
45. Pekerjaan saya mengharuskan saya untuk kreatif.	SS	S	TS	STS
46. Pekerjaan saya membutuhkan tingkat keterampilan/keahlian yang tinggi.	SS	S	TS	STS
47. Saya harus melakukan berbagai hal yang berbeda dalam bekerja.	SS	S	TS	STS
48. Saya memiliki kesempatan untuk mengembangkan kemampuan istimewa saya.	SS	S	TS	STS
49. Pekerjaan saya memungkinkan saya untuk dapat mengambil keputusan sendiri dalam banyak hal.	SS	S	TS	STS
50. Dalam bekerja, saya memiliki sangat sedikit kebebasan untuk menentukan bagaimana saya menyelesaikan tugas.	SS	S	TS	STS
51. Saya berpengaruh besar pada pekerjaan saya.	SS	S	TS	STS
52. Pekerjaan saya mengharuskan untuk bekerja dengan sangat cepat.	SS	S	TS	STS
53. Pekerjaan saya mengharuskan untuk bekerja sangat keras.	SS	S	TS	STS
54. Saya tidak diminta untuk melakukan banyak pekerjaan.	SS	S	TS	STS
55. Saya memiliki cukup waktu untuk menyelesaikan pekerjaan saya.	SS	S	TS	STS
56. Saya bebas dari tuntutan-tuntutan yang saling bertentangan yang dibuat oleh orang lain	SS	S	TS	STS
57. Atasan saya memperhatikan kesejahteraan bawahannya.	SS	S	TS	STS
58. Atasan saya memperhatikan apa yang saya katakan.	SS	S	TS	STS
59. Atasan saya membantu dalam menyelesaikan pekerjaan.	SS	S	TS	STS
60. Atasan saya berhasil membangun kerja tim.	SS	S	TS	STS



61. Orang-orang yang bekerja dengan saya kompeten melakukan pekerjaannya.	SS	S	TS	STS
62. Orang-orang yg bekerja dengan saya memiliki perhatian tentang hal pribadi saya.	SS	S	TS	STS
63. Orang-orang yang bekerja dengan saya bersifat bersahabat.	SS	S	TS	STS
64. Orang-orang yang bekerja dengan saya membantu dalam menyelesaikan pekerjaan.	SS	S	TS	STS

Pertanyaan-pertanyaan berikut adalah tentang pekerjaan Anda secara umum.

Silahkan lingkari salah satu pilihan apakah Anda Sangat Puas (SP), Puas (P), Tidak Puas (TP), Sangat Tidak Puas (STP) atau pertanyaan tersebut Tidak Relevan (TR) untuk setiap pertanyaan berikut.
Beberapa pertanyaan mungkin cocok dengan lingkungan kerja Anda dibanding yang lain, namun mohon jawab semua pertanyaan.

Contoh

Seberapa puas Anda dengan gaji Anda?	*SP*	[✓ *P*]	*TP*	*STP*	*TR*

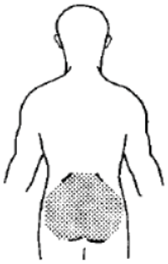
Pertanyaan	Sangat Puas (SP)	Puas (P)	Tidak Puas (TP)	Sangat Tidak Puas (STP)	Tidak Relevan (TR)
65. Seberapa puas Anda dengan prospek pekerjaan Anda?	SP	P	TP	STP	TR
66. Seberapa puas Anda dengan kondisi fisik lingkungan kerja Anda?	SP	P	TP	STP	TR
67. Seberapa puas Anda dengan pemanfaatan kemampuan Anda?	SP	P	TP	STP	TR
68. Seberapa puas Anda dengan pekerjaan/jabatan Anda secara keseluruhan?	SP	P	TP	STP	TR

Pertanyaan berikut adalah tentang persepsi Anda terhadap stres kerja secara umum.

Silahkan beri tanda centang (√) pada salah satu kotak untuk pertanyaan berikut.

69. Secara umum, bagaimana pekerjaan Anda?
☐ Sama sekali tidak stres
☐ Stres ringan
☐ Stres sedang
☐ Sangat stres
☐ Stres berat

BAGIAN D – Kajian Gangguan pada Punggung Bawah



Pada bagian ini mohon berikan informasi tentang masalah apapun (seperti sakit, nyeri, tidak nyaman, mati rasa atau lelah) yang Anda rasakan pada bagian punggung bawah Anda (seperti ditunjukkan pada area yang diarsir pada diagram di samping).

Silahkan beri tanda centang (√) pada salah satu kotak untuk setiap pertanyaan berikut.

70. Apakah Anda pernah memiliki masalah pada punggung bawah?

☐ Tidak
☐ Ya
Kapan Anda **pertama kali** merasakan masalah pada punggung bawah ini?
Tahun .... Bulan ....

71. Apakah punggung bawah Anda pernah cidera akibat kecelakaan?

☐ Tidak
☐ Pernah
Kapan kira-kira kecelakaan itu terjadi? Tahun ....

SELAMA 7 HARI TERAKHIR

72. Selama **7 hari terakhir,** pernahkan Anda memiliki **masalah** (sakit, nyeri, tidak nyaman, mati rasa atau lelah) pada bagian punggung bawah Anda?

☐ Tidak pernah
☐ Ya, satu atau dua kali
☐ Ya, kadang - kadang
☐ Ya, sering
☐ Ya, selalu

73. Selama **7 hari terakhir**, pernahkah Anda terhalang dalam menjalankan **aktivitas normal** karena masalah pada punggung bawah Anda?

☐ Tidak
☐ Ya,
Tolong sebutkan aktivitas apa saja yang terhalang ....
....

74. Selama **7 hari terakhir**, pernahkah Anda **absen** dari kerja karena masalah pada punggung bawah Anda?

☐ Tidak
☐ Ya,
Berapa hari Anda absen dari kerja karena masalah pada punggung bawah ini dalam **7 hari terakhir**? .... hari

SELAMA 12 BULAN TERAKHIR

75. Selama **12 bulan terakhir,** pernahkan Anda memiliki **masalah** (sakit, nyeri, tidak nyaman, mati rasa atau lelah) pada bagian punggung bawah Anda?

☐ Tidak pernah
☐ Ya, satu atau dua kali
☐ Ya, kadang - kadang
☐ Ya, sering
☐ Ya, selalu

76. Selama **12 bulan terakhir,** seberapa sering Anda mendapatkan masalah pada punggung bawah ini?

☐ Tidak pernah
☐ Hanya pernah satu kali
☐ Satu atau beberapa kali setiap beberapa tahun
☐ Satu atau beberapa kali dalam setahun
☐ Satu atau beberapa kali dalam sebulan
☐ Satu atau beberapa kali dalam seminggu
☐ Setiap hari

77. Selama **12 bulan terakhir,** berapa lama secara total Anda mengalami masalah punggung bawah ini?

☐ 0 hari
☐ 1 – 7 hari
☐ 8 – 30 hari
☐ Lebih dari 30 hari, tapi tidak setiap hari
☐ Setiap hari

78. Selama **12 bulan terakhir**, pernahkah Anda terhalang dalam menjalankan **aktivitas normal** karena masalah pada punggung bahwa Anda?

☐ Tidak
☐ Ya,
Tolong sebutkan aktivitas apa saja yang terhalang..

79. Selama **12 bulan terakhir**, pernahkah Anda **absen** dari kerja karena masalah pada punggung bawah Anda?

☐ Tidak
☐ Ya,
Berapa hari Anda absen dari kerja karena masalah pada punggung bawah ini dalam **12 bulan terakhir**? ....hari

INTENSITAS RASA SAKIT PADA PUNGGUNG BAWAH

Pada bagian ini kami ingin mengetahui intensitas rasa sakit pada punggung bawah jika ada.

Untuk pertanyaan – pertanyaan berikut, silahkan lingkari salah satu angka antara 0 – 10 untuk menggambarkan rasa sakit Anda, dimana 0 menggambarkan 'tidak sakit' dan 10 menggambarkan 'rasa sakit terburuk yang mungkin dialami'

	Pertanyaan	☺ Tidak sakit										☹ Rasa sakit terburuk yang mungkin dialami
80.	Bagaimana Anda menilai intensitas rasa sakit pada punggung bawah Anda **sekarang**, yaitu pada saat ini?	0	1	2	3	4	5	6	7	8	9	10
81.	Pada 6 bulan terakhir, bagaimana intensitas rasa sakit **yang terburuk** pada punggung bawah yang pernah Anda rasakan?	0	1	2	3	4	5	6	7	8	9	10
82.	Pada 6 bulan terakhir, bagaimana **rata-rata** intensitas rasa sakit pada punggung bawah Anda? (Yaitu rasa sakit yang biasa Anda rasakan jika rasa sakit pada punggung bawah menyerang).	0	1	2	3	4	5	6	7	8	9	10

KETIDAKMAMPUAN DALAM MELAKUKAN AKTIVITAS AKIBAT SAKIT PUNGGUNG BAWAH

Pada bagian ini kami ingin mengetahui ketidamampuan Anda dalam melakukan aktivitas akibat sakit pada punggung bawah Anda.

Untuk pertanyaan – pertanyaan berikut, silahkan lingkari salah satu nomor pada skala 0 – 10 untuk menggambarkan ketidakmampuan Anda dalam melakukan aktivitas akibat sakit pada punggung bawah.

	Pertanyaan	☺ Tidak ada gangguan										☹ Tidak mampu melakukan aktivitas apapun
83.	Selama 6 bulan terakhir, seberapa jauh masalah pada punggung bawah Anda **membatasi aktivitas sehari-hari** jika digambarkan dalam skala 0 – 10, dimana 0 menggambarkan ‘tidak ada gangguan’ dan 10 menggambarkan ‘tidak mampu melakukan aktivitas apapun’.	0	1	2	3	4	5	6	7	8	9	10
		☺ Tidak ada perubahan										☹ Perubahan sangat besar
84.	Selama 6 bulan terakhir, seberapa jauh masalah pada punggung bawah Anda **mengubah kemampuan Anda dalam mengikuti kegiatan rekreasi, sosial, dan aktivitas keluarga**, dimana 0 menggambarkan ‘tidak ada perubahan’ dan 10 mengambarkan ‘perubahan besar’.	0	1	2	3	4	5	6	7	8	9	10
85.	Selama 6 bulan terakhir, seberapa jauh masalah pada punggung bawah Anda **mengubah kemampuan Anda dalam bekerja (termasuk pekerjaan rumah),** dimana 0 menggambarkan ‘tidak ada perubahan’ dan 10 mengambarkan ‘perubahan sangat besar’	0	1	2	3	4	5	6	7	8	9	10

Silahkan isi titik – titik untuk pertanyaan di bawah ini:

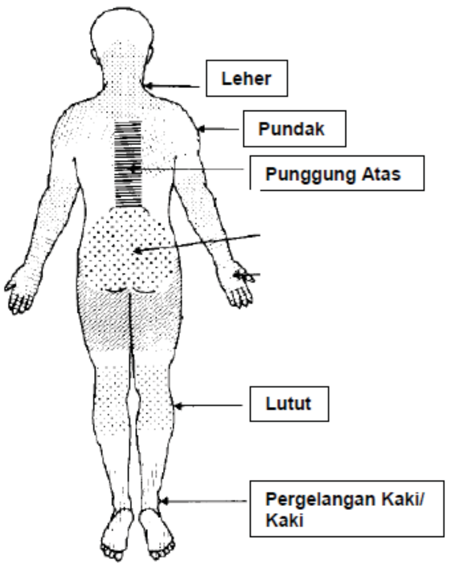
86. Selama 6 bulan terakhir, kira-kira berapa hari Anda terhalang untuk melakukan aktivitas sehari-hari (baik pekerjaan di tempat kerja maupun rumah) karena masalah pada punggung bawah?

..........................hari

BAGIAN E – Kajian Gangguan Otot Rangka pada Bagian Tubuh Lain

Pada bagian ini mohon berikan informasi tentang masalah apapun (seperti sakit, nyeri, tidak nyaman, mati rasa atau lelah) yang Anda rasakan pada bagian tubuh Anda: leher, bahu, punggung atas, lutut atau pergelangan kaki/kaki (seperti ditunjukkan pada area yang diarsir pada diagram berikut).

Silahkan beri tanda centang (√) pada salah satu kotak untuk setiap pertanyaan berikut.

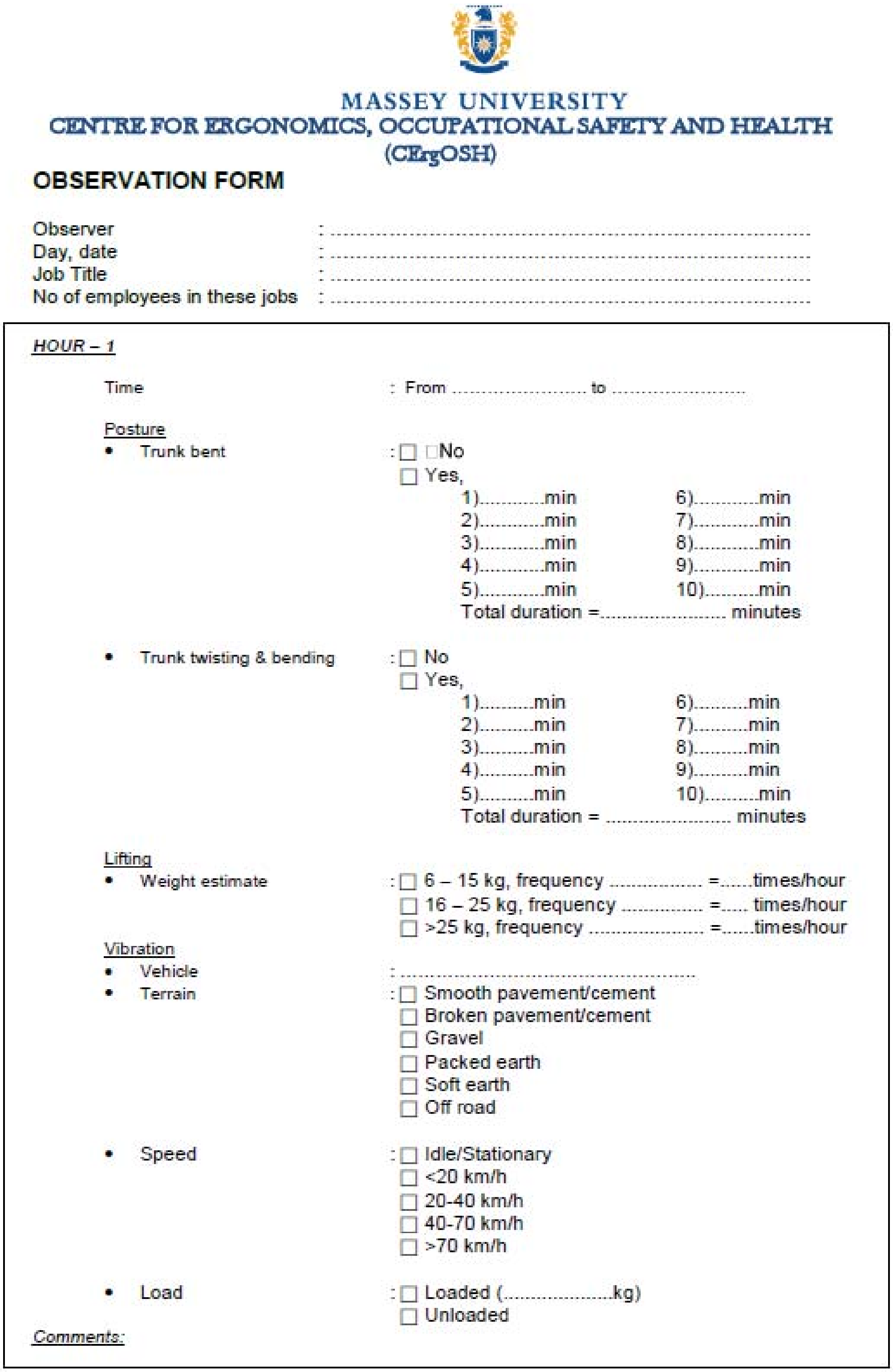


Bagian Tubuh	Apakah dalam **7 hari terakhir** Anda pernah memiliki **masalah** (sakit, nyeri, tidak nyaman, mati rasa atau lelah) pada bagian tubuh ini?	Apakah dalam **12 bulan terakhir** Anda pernah memiliki **masalah** (sakit, nyeri, tidak nyaman, mati rasa atau lelah) pada bagian tubuh ini?	Selama **12 bulan terakhir**, apakah anda terhalang dalam menjalankan **aktivitas normal** karena masalah tersebut pada bagian tubuh ini?	Selama **12 bulan terakhir**, apakah anda **absen** dari kerja karena masalah tersebut pada bagian tubuh ini?
LEHER	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak ☐ Ya, Tolong sebutkan aktivitas apa saja yang terhalang	☐ Tidak ☐ Ya, Berapa hari? .... hari
BAHU	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak ☐ Ya, Tolong sebutkan aktivitas apa saja yang terhalang	☐ Tidak ☐ Ya, Berapa hari? .... hari
PUNGGUNG ATAS	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak ☐ Ya, Tolong sebutkan aktivitas apa saja yang terhalang	☐ Tidak ☐ Ya, Berapa hari? .... hari
LUTUT	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak ☐ Ya, Tolong sebutkan aktivitas apa saja yang terhalang	☐ Tidak ☐ Ya, Berapa hari? .... hari
PERGELANGAN KAKI/ KAKI	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak pernah ☐ Ya, satu atau dua kali ☐ Ya, kadang - kadang ☐ Ya, sering ☐ Ya, selalu	☐ Tidak ☐ Ya, Tolong sebutkan aktivitas apa saja yang terhalang	☐ Tidak ☐ Ya, Berapa hari? .... hari

Selesai. Terima kasih atas bantuan Anda

Appendix B7 Observation form

☐☐ ☐☐☐☐



MASSEY UNIVERSITY
CENTRE FOR ERGONOMICS, OCCUPATIONAL SAFETY AND HEALTH
(CErgOSH)

OBSERVATION FORM

Observer : ....
Day, date : ....
Job Title : ....
No of employees in these jobs : ....

HOUR – 1

Time : From .... to ....

Posture

- Trunk bent : ☐ ☐No
  ☐ Yes,
  1)............min 6)............min
  2)............min 7)............min
  3)............min 8)............min
  4)............min 9)............min
  5)............min 10)..........min
  Total duration =........................ minutes
- Trunk twisting & bending : ☐ No
  ☐ Yes,
  1)..........min 6)..........min
  2)..........min 7)..........min
  3)..........min 8)..........min
  4)..........min 9)..........min
  5)..........min 10)..........min
  Total duration = ... minutes

Lifting

- Weight estimate : ☐ 6 – 15 kg, frequency .... =......times/hour
  ☐ 16 – 25 kg, frequency .... =..... times/hour
  ☐ >25 kg, frequency .... =......times/hour

Vibration

- Vehicle : ....
- Terrain : ☐ Smooth pavement/cement
  ☐ Broken pavement/cement
  ☐ Gravel
  ☐ Packed earth
  ☐ Soft earth
  ☐ Off road
- Speed : ☐ Idle/Stationary
  ☐ <20 km/h
  ☐ 20-40 km/h
  ☐ 40-70 km/h
  ☐ >70 km/h
- Load : ☐ Loaded (.....................kg)
  ☐ Unloaded

Comments:

HOUR – 2

Time : From .... to ....

Posture

- Trunk bent : ☐ ☐No
  ☐ Yes,
  1)............min 6)............min
  2)............min 7)............min
  3)............min 8)............min
  4)............min 9)............min
  5)............min 10)..........min
  Total duration =...................... minutes

- Trunk twisting & bending : ☐ No
  ☐ Yes,
  1)..........min 6)..........min
  2)..........min 7)..........min
  3)..........min 8)..........min
  4)..........min 9)..........min
  5)..........min 10)..........min
  Total duration = ... minutes

Lifting

- Weight estimate : ☐ 6 – 15 kg, frequency .... =......times/hour
  ☐ 16 – 25 kg, frequency .... =..... times/hour
  ☐ >25 kg, frequency .... =......times/hour

Vibration

- Vehicle : ....
- Terrain : ☐ Smooth pavement/cement
  ☐ Broken pavement/cement
  ☐ Gravel
  ☐ Packed earth
  ☐ Soft earth
  ☐ Off road

- Speed : ☐ Idle/Stationary
  ☐ <20 km/h
  ☐ 20-40 km/h
  ☐ 40-70 km/h
  ☐ >70 km/h

- Load : ☐ Loaded (....................kg)
  ☐ Unloaded

Comments:

HOUR – 3

Time : From …………………. to …………………..

Posture

- Trunk bent : ☐ □No
  ☐ Yes,
  1)………..min 6)………..min
  2)………..min 7)………..min
  3)………..min 8)………..min
  4)………..min 9)………..min
  5)………..min 10)………min
  Total duration =…………………… minutes

- Trunk twisting & bending : ☐ No
  ☐ Yes,
  1)……….min 6)……….min
  2)……….min 7)……….min
  3)……….min 8)……….min
  4)……….min 9)……….min
  5)……….min 10)……….min
  Total duration = …………………… minutes

Lifting

- Weight estimate : ☐ 6 – 15 kg, frequency …………….. =……times/hour
  ☐ 16 – 25 kg, frequency …………… =….. times/hour
  ☐ >25 kg, frequency ………………… =……times/hour

Vibration

- Vehicle : …………………………………………….
- Terrain : ☐ Smooth pavement/cement
  ☐ Broken pavement/cement
  ☐ Gravel
  ☐ Packed earth
  ☐ Soft earth
  ☐ Off road

- Speed : ☐ Idle/Stationary
  ☐ <20 km/h
  ☐ 20-40 km/h
  ☐ 40-70 km/h
  ☐ >70 km/h

- Load : ☐ Loaded (………………..kg)
  ☐ Unloaded

Comments:

HOUR – 4

Time : From …………………… to ……………………

Posture

- Trunk bent : ☐ ☐No

☐ Yes,

1)…………min 6)…………min

2)…………min 7)…………min

3)…………min 8)…………min

4)…………min 9)…………min

5)…………min 10)……….min

Total duration =…………………. minutes

- Trunk twisting & bending : ☐ No

☐ Yes,

1)……….min 6)……….min

2)……….min 7)……….min

3)……….min 8)……….min

4)……….min 9)……….min

5)……….min 10)……….min

Total duration = ………………….. minutes

Lifting

- Weight estimate : ☐ 6 – 15 kg, frequency …………….. =……times/hour

☐ 16 – 25 kg, frequency ………….. =….. times/hour

☐ >25 kg, frequency ………………. =……times/hour

Vibration

- Vehicle : ……………………………………………
- Terrain : ☐ Smooth pavement/cement

☐ Broken pavement/cement

☐ Gravel

☐ Packed earth

☐ Soft earth

☐ Off road

- Speed : ☐ Idle/Stationary

☐ <20 km/h

☐ 20-40 km/h

☐ 40-70 km/h

☐ >70 km/h

- Load : ☐ Loaded (…………………kg)

☐ Unloaded

Comments:

Appendix B8 Interview form

☐☐ ☐☐☐☐

MASSEY UNIVERSITY
CENTRE FOR ERGONOMICS, OCCUPATIONAL SAFETY AND HEALTH (CErgOSH)

INTERVIEW FORM FOR PSYCHOSOCIAL EXPOSURE ASSESSMENT

The aim of this interview is to obtain information about the respondent’s psychosocial exposures in her/his current job.

The following statements refer to the respondent’s present occupation.

Ask the respondent to explain about the situations below, then the interviewer indicates whether she/he Strongly Agree (SA), Agree (A), Disagree (D) or Strongly Disagree (SD) with each of the statements that best fits her/his job situation.

Sometimes none of the answers fit exactly. Please choose the answer that comes closest.

For example:

I enjoy my work [✓ *SA*] *A* *D* *SD*

Statements	Interview	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly disagree (SD)
1. I have constant time pressure due to a heavy work load.		SA	A	D	SD
2. I have many interruptions and disturbance while performing my job.		SA	A	D	SD
3. Over the past few years, my job has become more and more demanding.		SA	A	D	SD
4. I receive the respect I deserve from my superior or a respected relevent person.		SA	A	D	SD

5. My job promotion prospects are poor.		SA	A	D	SD
6. I have experienced or I expect to experience an undesirable change in my work situation.		SA	A	D	SD
7. My job security is poor.		SA	A	D	SD
8. Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.		SA	A	D	SD

9. Considering all my efforts and achievements, my job promotion prospects are adequate.		SA	A	D	SD
10. Considering all my efforts and achievements, my salary/income is adequate.		SA	A	D	SD
11. I get easily overwhelmed by time pressures at work.		SA	A	D	SD
12. As soon as I get up in the morning I start thinking about work problems.		SA	A	D	SD

13. When I get home, I can easily relax and ‘switch off’ work.		SA	A	D	SD
14. People close to me say I sacrifice too much for my job.		SA	A	D	SD
15. Work rarely lets me go, it is still on my mind when I go to bed.		SA	A	D	SD
16. If I postpone something that I was supposed to do today I’ll have trouble sleeping at night.		SA	A	D	SD

17. My job requires that I learn new things.		SA	A	D	SD
18. My job involves a lot of repetitive work.		SA	A	D	SD
19. My job requires me to be creative.		SA	A	D	SD
20. My job requires a high level of skill.		SA	A	D	SD

21. I get to do a variety of different things on my job.		SA	A	D	SD
22. I have an opportunity to develop my own special abilities.		SA	A	D	SD
23. My job allows me to make a lot of decisions on my own.		SA	A	D	SD
24. On my job, I have very little freedom to decide how I do my work.		SA	A	D	SD

25. I have a lot of say about what happens on my job.		SA	A	D	SD
26. My job requires working very fast.		SA	A	D	SD
27. My job requires working very hard.		SA	A	D	SD
28. I am not asked to do an excessive amount of work.		SA	A	D	SD

29. I have enough time to get the job done.		SA	A	D	SD
30. I am free from conflicting demands that others make.		SA	A	D	SD
31. My supervisor is concerned about the welfare of those under him.		SA	A	D	SD
32. My supervisor pays attention to what I am saying.		SA	A	D	SD

33. My supervisor is helpful in getting the job done.		SA	A	D	SD
34. My supervisor is successful in getting people to work together.		SA	A	D	SD
35. People I work with are competent in doing their jobs.		SA	A	D	SD
36. People I work with take a personal interest in me.		SA	A	D	SD

37. People I work with are friendly.		SA	A	D	SD
38. People I work with are helpful in getting the job done.		SA	A	D	SD

The following questions are about her/his work in general.

Ask the respondent to explain about the following questions. Then the interviewer indicate whether she/he are Very Satisfied (VS), Satisfied (S), Unsatisfied (US), Very Unsatisfied (VUS) or the question is Not Relevant (NR) in response to each of the questions below.

For example:

How satisfied are you with your salary?	*VS*	[✓ *S*]	*US*	*VUS*	*NR*

Questions	Interview	Very Satisfied (VS)	Satisfied (S)	Unsatisfied (US)	Very Unsatisfied (VUS)	Not Relevant (NR)
39. How satisfied are you with your work prospects?		VS	S	US	VUS	NR
40. How satisfied are you with the physical working conditions?		VS	S	US	VUS	NR
41. How satisfied are you with the way your abilities are used?		VS	S	US	VUS	NR
42. How satisfied are you with your job as a whole, taking everything into consideration?		VS	S	US	VUS	NR

The following question is about her/his perceived job stress in general.

43. In general, how do you find your job?
Interview:

Conclusion:
☐ Not at all stressful
☐ Mildly stressful
☐ Moderately stressful
☐ Very stressful
☐ Extremly stressful

Appendix B9 Validity and reliability of the questionnaire in Indonesian coal mining workers population

Risk factors	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	% full agreement	Kappa [95% CI]	Cronbach's alpha
Physical factors							
Working in sitting positions	88	100	100	85	73.33	.63 [.37, .88]	--
Working with a bent trunk	100	100	100	100	60.00	.54 [.24, .85]	--
Working with a bent and twisted trunk	50	92	50	92	60.00	.49 [.19, .79]	--
Whole body vibration	100	100	100	100	73.33	.86 [.66, 1.00]	--
Lifting 6-15 kg	85	100	100	88	73.33	.57 [.14, .99]	--
Lifting 16-25 kg	100	100	100	100	93.33	.63 [.28, .98]	--
Lifting >25 kg	100	90	60	88	86.67	.53 [.11, .95]	--
Psychosocial factors							
Effort	80	100	100	90	76.19	.59 [.38, .80]	.70
Reward	71	85	83	75	54.31	.56 [.41, .71]	.79
Over commitment	85	85	85	85	69.05	.59 [.44, .75]	.69
Decision latitude	90	66	90	66	65.62	.67 [.56, .78]	.56
Psychological demands	75	83	85	71	70.00	.68 [.52, .84]	.54
Social support	100	100	100	100	78.57	.67 [.53, .81]	.78
Job satisfaction	85	85	85	85	76.79	.67 [.49, .85]	.70
Work stress	100	100	100	100	76.19	.53 [.16, .91]	--

Note. PPV = positive predictive value; NPV = negative predictive value; CI = confidence interval

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE

Prevalence of Low Back Symptoms and Its Consequences in Relation to Occupational Group

Baiduri Widanarko, MOHS,[1,2*,†] Stephen Legg, PhD,[1] Mark Stevenson, PhD,[3] Jason Devereux, PhD,[4] and Geoff Jones, PhD[5]

Background *The purpose of this study was to examine: (1) the prevalence of low back symptoms (LBS) and its consequences (reduced activities and absenteeism); (2) the association between occupational group and LBS; and (3) the association between LBS and its consequences.*

Methods *A self-administered questionnaire was used to determine the prevalence of LBS in 1,294 Indonesian coal mining workers. A Cox proportional hazards model was developed to quantify the 12-monthly hazard of LBS. Logistic regression models were developed to identify risk factors for reduced activity and absenteeism from the workplace.*

Results *The 12-month period prevalence for LBS, reduced activities, and absenteeism were 75%, 16%, and 13%, respectively. The 12-monthly hazard of LBS for blue-collar workers was 1.85 (95% CI: 1.06–3.25) times that of white-collar workers. LBS and smoking increased the risk of reduced activity and absenteeism.*

Conclusions *Indonesian coal mining workers have a high prevalence of LBS. The findings imply that efforts to reduce LBS and in the workplace should focus on blue-collar workers. For smokers who report reduced activities and/or absenteeism, there should be a focus on rehabilitation and/or return-to-work programs.* Am. J. Ind. Med. *© 2012 Wiley Periodicals, Inc.*

KEY WORDS: back pain; developing country; blue-collar worker; sick leave; healthy worker effect

INTRODUCTION

The prevalence of low back symptoms (LBS) and its associated risk factors has been widely reported. The 12-month period prevalence of LBS has been reported to range between 21% and 73% among various occupational groups [Ghaffari et al., 2006; Scuffham et al., 2010; Matsudaira et al., 2011; Widanarko et al., 2011]. Since the amount of physical work activity undertaken in different occupations represents a substantial component of a person's overall physical activity [Proper and Hildebrandt, 2006] and around one third of the risk of back pain has been attributed to occupation [Punnett et al., 2005], various studies have assessed the prevalence of LBS in relation to occupational groupings [Johansson, 1994; Holmström and Engholm, 2003; Alexopoulos et al., 2006; Ghaffari et al., 2006; Widanarko et al., 2011]. The accumulation of exposure in the workplace is suspected of being related to cumulative load in the tissues of the lower

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Disclosure Statement: The authors report no conflicts of interests.

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Appendix B11 Published papers for preliminary study of Chapter 6

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IOS Press

Interaction between physical, psychosocial, and organisational work factors for low back symptoms and its consequences amongst Indonesian coal mining workers

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Abstract. Although there is strong evidence that single physical, psychosocial and organisational risk factors are each independent predictors of low back symptoms (LBS) and its consequences, little is known about their combination/interaction. A preliminary study was conducted among 673 workers as part of a larger study (*n*=1294) in a coal mining company in Indonesia. A self-reported questionnaire was used to obtain physical and psychosocial exposures, and organisational factors. Each participant was grouped into one of four combination exposure groups: 1) high physical (working with bent trunk, whole body vibration exposure, lifting) and high psychosocial (high effort, low reward, work stress), 2) high physical and low psychosocial, 3) low physical and high psychosocial, 4) low physical and low psychosocial (as the reference group). Individuals in the high physical and high psychosocial group were the most likely to report LBS (OR 3.47 95% CI 1.81-6.64), reduced activities (OR 6.94 95% CI 1.58-30.49) and absenteeism (OR 7.01 95% CI 2.04-24.10). Permanent workers were more likely to report LBS and its consequences whereas night shift work increased the risk of LBS consequences. Interventions to reduce LBS and its consequences should address both physical and psychosocial factors, with a focus on permanent and night shift workers.

Keywords: musculoskeletal disorders; back pain; developing country; blue-collar worker; disability; sick leave

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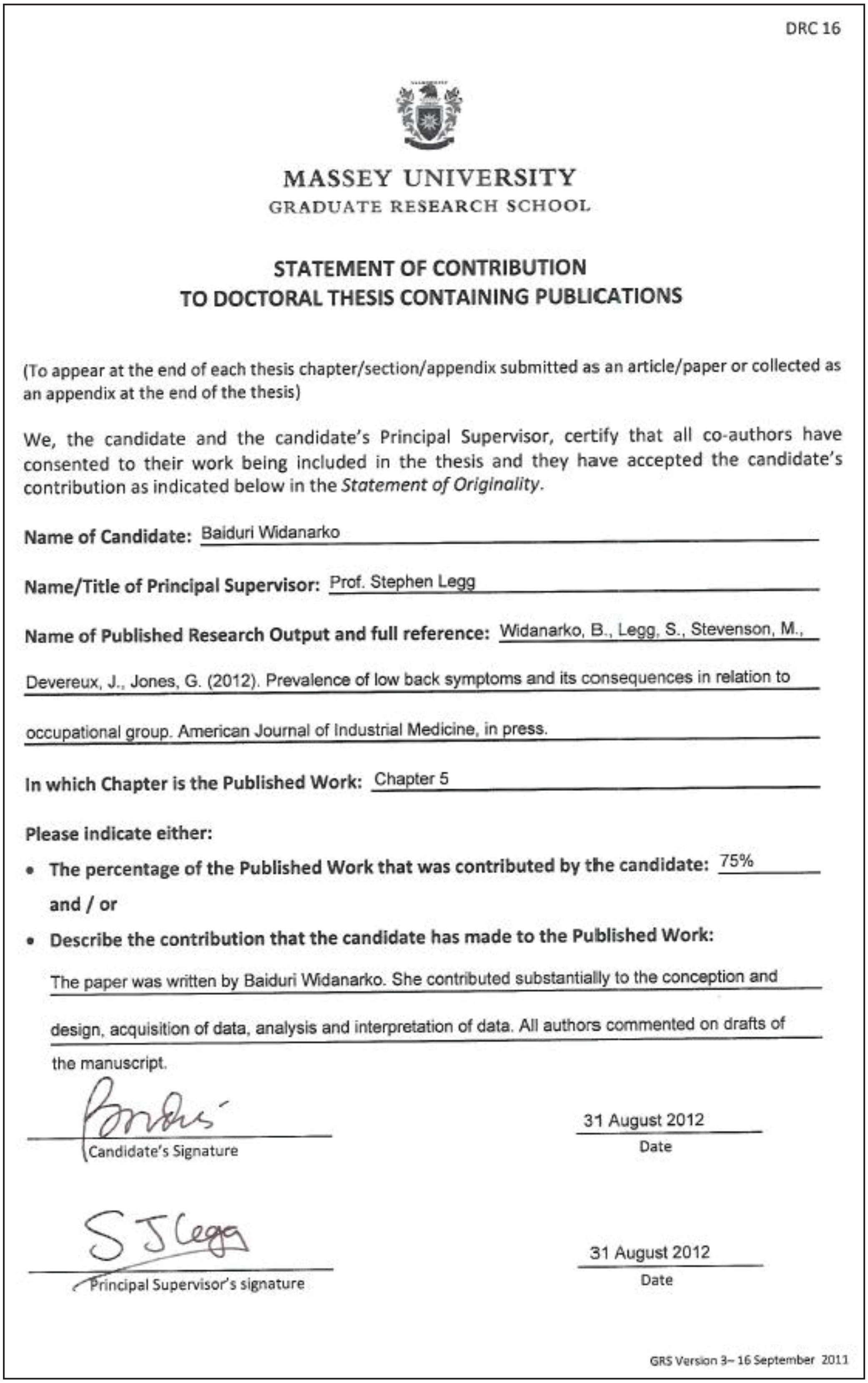
Appendix B12 Statement of contribution for Chapter 5



DRC 16

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STATEMENT OF CONTRIBUTION
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Name of Candidate: Baiduri Widanarko

Name/Title of Principal Supervisor: Prof. Stephen Legg

Name of Published Research Output and full reference: Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Jones, G. (2012). Prevalence of low back symptoms and its consequences in relation to occupational group. American Journal of Industrial Medicine, in press.

In which Chapter is the Published Work: Chapter 5

Please indicate either:

- **The percentage of the Published Work that was contributed by the candidate:** 75%

  and / or

- **Describe the contribution that the candidate has made to the Published Work:**

  The paper was written by Baiduri Widanarko. She contributed substantially to the conception and design, acquisition of data, analysis and interpretation of data. All authors commented on drafts of the manuscript.

Candidate's Signature

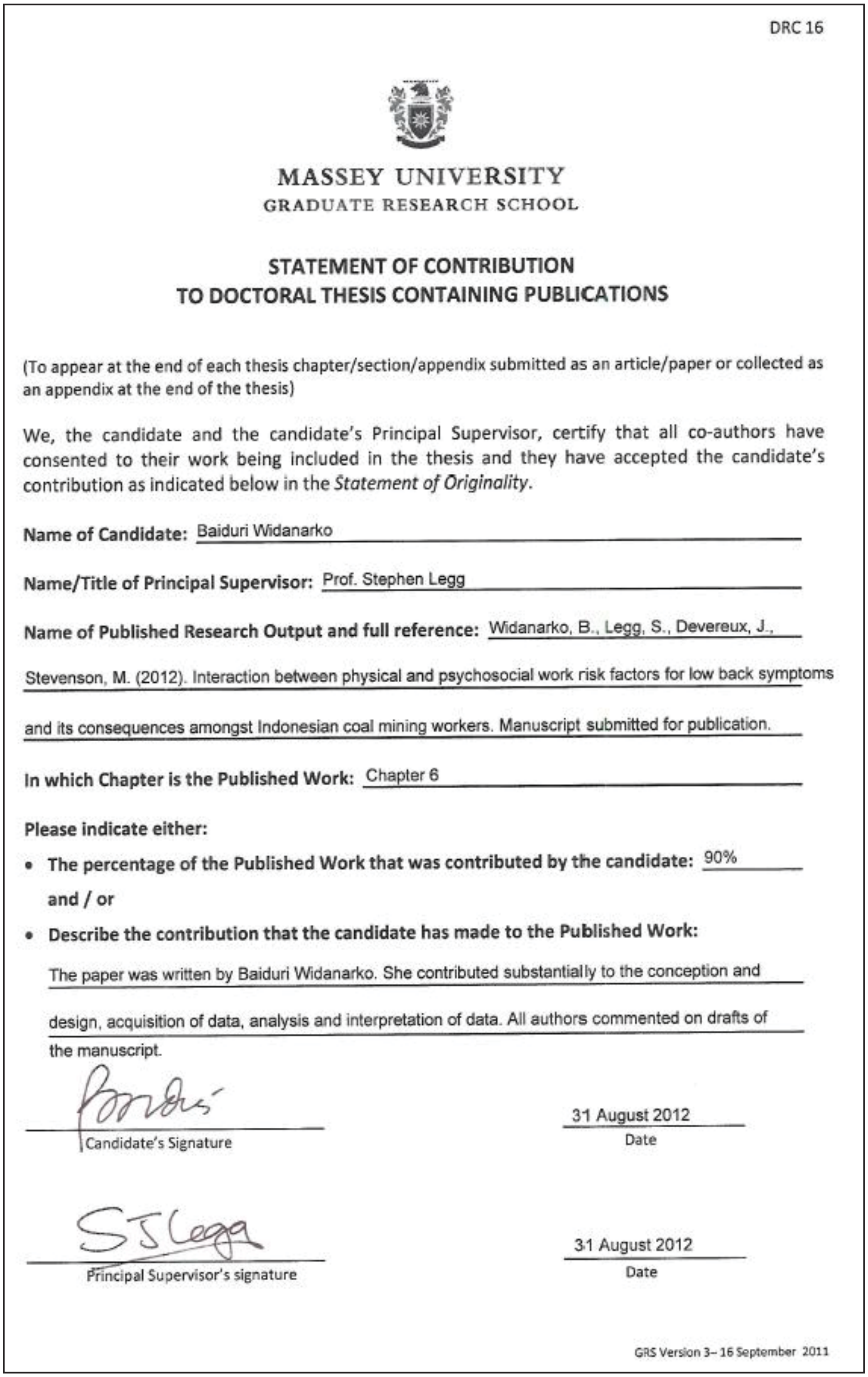
31 August 2012
Date

S J Legg
Principal Supervisor's signature

31 August 2012
Date

GRS Version 3– 16 September 2011

Appendix B13 Statement of contribution for Chapter 6



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Name of Candidate: Baiduri Widanarko

Name/Title of Principal Supervisor: Prof. Stephen Legg

Name of Published Research Output and full reference: Widanarko, B., Legg, S., Devereux, J., Stevenson, M. (2012). Interaction between physical and psychosocial work risk factors for low back symptoms and its consequences amongst Indonesian coal mining workers. Manuscript submitted for publication.

In which Chapter is the Published Work: Chapter 6

Please indicate either:

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  and / or

- **Describe the contribution that the candidate has made to the Published Work:**

  The paper was written by Baiduri Widanarko. She contributed substantially to the conception and design, acquisition of data, analysis and interpretation of data. All authors commented on drafts of the manuscript.

Candidate's Signature

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SJ Legg
Principal Supervisor's signature

31 August 2012
Date

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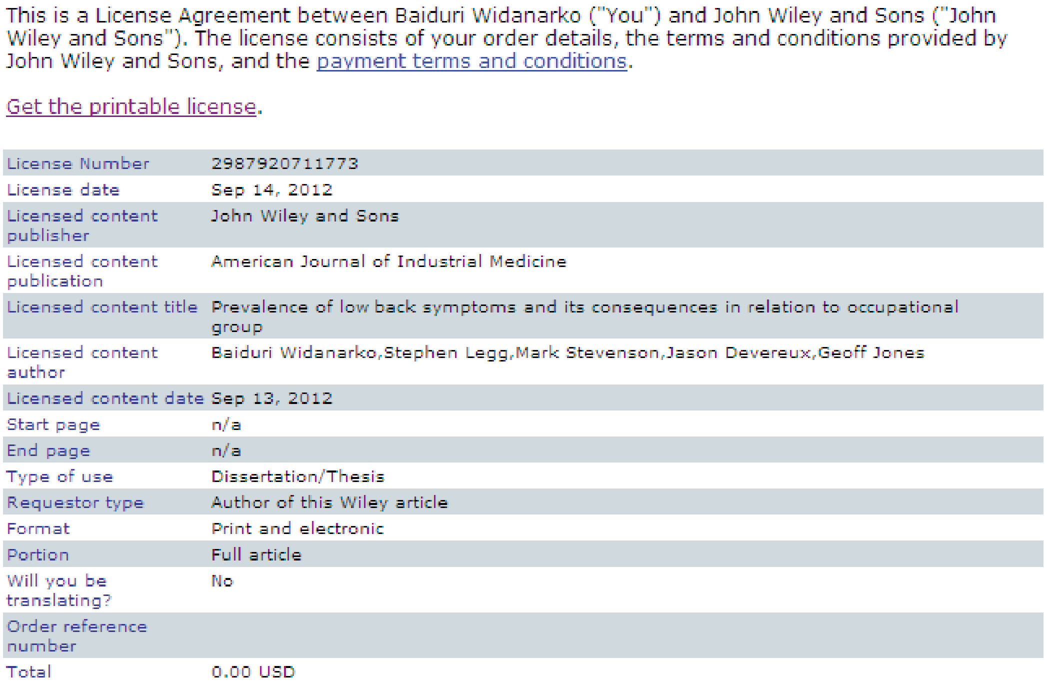

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